

# Adaptive Management and NEPA: How a Nonequilibrium View of Ecosystems Mandates Flexible Regulation

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*Our understanding of ecosystems has drastically changed since the advent of modern environmental law. Initially, ecosystems were thought of as systems in balance that, without human disturbance, would form stable equilibria. The environmental protection laws of the 1970s were enacted during a time when we believed that the exact state of nature to be preserved or reestablished through environmental protection could be easily defined. In the last few decades, however, a new understanding of ecosystems has evolved. We now understand ecosystems to be in constant flux from the influences of both natural phenomena and human disturbances. Because ecosystems' responses to disturbances are uncertain, fixed baselines indicating a healthy environment are no longer knowable, and disturbances due to human activity or natural fluxes are not always distinguishable. This new awareness of uncertainty regarding the source and extent of environmental harms calls for a more flexible approach to environmental regulation. One such innovative approach to environmental management is the concept of "adaptive management," which recognizes the utility and necessity of experimentation and flexibility in identifying how complex ecosystems respond to disturbances. This Comment looks at how modern ecological theory has undermined the foundational assumptions of the National Environmental Policy Act (NEPA), challenging the notion that we can establish fixed baselines to identify an "undisturbed" ecosystem, and explores whether and how adaptive management can work under the existing NEPA structure.*

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#### INTRODUCTION

The National Environmental Policy Act (NEPA),<sup>1</sup> the first major environmental law enacted in the United States, was developed at a time in which the equilibrium paradigm was the dominant theory for how ecosystems operate. In the late 1960s, nature was seen as a stable balance of elements, and as such, the government's role was to protect the existing equilibrium. Accordingly, NEPA declares a national policy to preserve and enhance the environment where "man and nature can exist in productive harmony."<sup>2</sup> Since then, a new theory for ecosystem function has arisen. Ecosystem studies demonstrate that the environment is neither constant nor predictable as formerly thought. The equilibrium paradigm has been replaced by a dynamic nonequilibrium paradigm that considers the complex interaction between biota and nonliving elements, and recognizes the presence of human influence as an integral part of the environment.

Unfortunately, NEPA has not kept pace with the changing scientific understandings of ecology. Recognition of the constantly changing nature

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1. 42 U.S.C. §§ 4321-4370(f) (2006).

2. *Id.* § 4331.

of ecosystems has undermined the foundational assumptions of NEPA, challenging the notion that we can establish baselines to identify an “undisturbed” ecosystem.<sup>3</sup> Consequently, it has become impossible to determine the exact state of nature to be preserved or reestablished through environmental protection. NEPA requires predictions of environmental impacts based on a static snapshot of an ecosystem. Modern perceptions of ecology tell us that such a snapshot cannot possibly be an accurate depiction of the workings of an ecosystem. Thus, as previously applied, NEPA is limited in its usefulness as an environmental planning tool. Modern understandings of uncertainty regarding the source and extent of environmental harms call for a more flexible approach to environmental regulation.

One such innovative approach to environmental management is the concept of “adaptive management.” Adaptive management, a product of the nonequilibrium paradigm, is a theory of ecological oversight and administration that recognizes the utility and necessity of experimentation and flexibility in identifying how complex ecosystems respond to disturbances. Through its continuing evaluation of the repercussions of a preceding action, adaptive management permits action and reaction in the absence of complete information. This affords the decision maker the opportunity to adapt and change tactics to maximize the environmental benefits of a course of action.

This Comment will consider whether adaptive management can work within the NEPA framework. Part I introduces the evolution of scientific thought regarding ecosystems since the environmental movement of the 1960s and 1970s. Part II briefly introduces NEPA and considers whether this product of old ecosystem theory has been successful in addressing harms to a dynamic environment. Part III considers the possibility of adaptive management under the existing NEPA structure, as well as how our legal system has conceptualized the use of adaptive management in the context of NEPA. Parts IV and V look first at the benefits of applying adaptive management within the NEPA framework, and then consider how adaptive management can be successfully incorporated into the existing structure. Ultimately, this Comment shows that an adaptive management approach based on clear standards for the analysis of environmental impacts both complies with NEPA and offers an invaluable opportunity to enhance environmental decision making and oversight.

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3. RICHARD J. LAZARUS, *THE MAKING OF ENVIRONMENTAL LAW* 8 (2004).

## I. THE NEW ECOLOGY: AN EVOLUTION IN UNDERSTANDING ECOSYSTEMS

A. *The Equilibrium Paradigm*

The first eighty years of twentieth century ecological science were based on the "equilibrium paradigm," the concept that nature is a system in balance.<sup>4</sup> In the early 1920s, Frederic E. Clements hypothesized that ecosystems always followed predictable patterns.<sup>5</sup> An ecosystem evolved through time in relation to its climate until stable associations were formed between members of the ecosystem's vegetative community.<sup>6</sup> While these associations might appear to change, these were merely brief, superficial changes that were part of the stabilizing process.<sup>7</sup> It was thought that a stable ecosystem, without the disturbance of man, could persist through millions of years in a static equilibrium.<sup>8</sup> The well-known ecologist, A.G. Tansley, who in 1935 coined the term "ecosystem," theorized that natural selection favors those biota that could attain the most stable equilibrium.<sup>9</sup> He explained that, "[The] degree of perfection [of an equilibrium] is measured by its stability."<sup>10</sup> Once an ecosystem reached perfection, nature was in a static equilibrium.<sup>11</sup> The healthy existence of the natural world was dependent on the maintenance of that equilibrium.<sup>12</sup>

Mid-century, the famous ecologist and professor of wildlife management, Aldo Leopold, incorporated the equilibrium paradigm in his concept of a "land ethic."<sup>13</sup> The land ethic's core concept embraced the idea of ecosystems as stable communities that had attained a perfect equilibrium. Developed ecosystems were self-regulating entities that existed in a steady state until disturbed by outside forces.<sup>14</sup> Leopold's land

4. *Id.* at 215.

5. Frederic E. Clements, *Nature and Structure of the Climax*, 24 J. ECOLOGY 252, 253-56 (1936).

6. *Id.* at 256. Clements' definition of the biotic community stressed the dominant role of vegetation in controlling the conditions under which all other species existed. *See id.* at 255.

7. *Id.* at 256.

8. *Id.*

9. A.G. Tansley, *The Use and Abuse of Vegetation Concepts and Terms*, 16 ECOLOGY 284, 300 (1935).

10. *Id.* at 301.

11. LAZARUS, *supra* note 3, at 215. A system in static equilibrium is one that will tend to return to equilibrium state after being disturbed. Daniel B. Botkin & Matthew J. Sobel, *Stability in Time-Varying Ecosystems*, 109 AM. NATURALIST 625, 625 (1975).

12. LAZARUS, *supra* note 3, at 8.

13. ALDO LEOPOLD, A SAND COUNTY ALMANAC AND SKETCHES HERE AND THERE 204 (1948).

14. Jianguo Wu & Orie L. Loucks, *From Balance of Nature to Hierarchical Patch Dynamics: A Paradigm Shift in Ecology*, 70 Q. REV. BIOLOGY 439, 440 (1995) (discussing the long-standing Western tradition that ecosystems have been viewed as self-regulating systems that remain in a stable equilibrium if left alone).

ethic enlarged the concept of a plant-dominated ecosystem to include associations between the soil, water, plants, and animals.<sup>15</sup> Although Leopold recognized that humans were no longer separated from nature, he believed that nature without human influence was right.<sup>16</sup> Consequently, destruction of an ecosystem's natural equilibrium by pollution or resource exploitation was wrong. As Leopold explained, "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."<sup>17</sup>

For the ecologist community, including Clements, Tansley, and Leopold, the equilibrium paradigm offered a high degree of predictability and certainty in assessing environmental impact. Change to an ecosystem in response to a disturbance was an orderly, directional, and predictable process.<sup>18</sup> The concept of ecosystem stability was equally attractive to lawmakers and provided a theoretical basis for the environmental laws of the 1970s. The protection of longstanding ecosystems from the deleterious effects of human interference nurtured preservation as an affirmative government goal. The Wilderness Act, for example, sought to preserve designated lands from the harms of "occup[ation] and modif[ication]" by mankind through "the preservation of their wilderness character."<sup>19</sup> Similarly, the Endangered Species Act sought to "conserve" species from being lost;<sup>20</sup> the Wild and Scenic Rivers Act protected and preserved rivers in their "free-flowing condition,"<sup>21</sup> and the National Environmental Policy Act encouraged "harmony between man and his environment."<sup>22</sup> Just as ecology focused on the adverse consequences of human activity, environmental law focused on preserving and protecting the underlying equilibrium of nature from human disturbance in order to prevent ecological transformation. Under this leading ideology, environmental change could only have catastrophic consequences.<sup>23</sup>

### *B. The Nonequilibrium Paradigm*

Over the last forty years, ecological science has undergone a dramatic shift in its basic presumption of how ecosystems work. Studies of actual ecosystems began to discredit the equilibrium paradigm as early

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15. LEOPOLD, *supra* note 13, at 204.

16. *Id.*

17. *Id.* at 225.

18. See Eugene P. Odum, *The Strategy of Ecosystem Development*, 164 *SCIENCE* 262, 262 (1969).

19. 16 U.S.C. § 1131(a) (2006).

20. *Id.* § 1531(b).

21. *Id.* § 1271.

22. 42 U.S.C. § 4321 (2006).

23. LAZARUS, *supra* note 3, at 215 n.14.

as the 1920s, and this unraveling accelerated in the 1960s and 1970s.<sup>24</sup> Ecologists discovered, for example, that the numbers of predators and prey in the wild were neither constant, nor were their oscillations predictable.<sup>25</sup> Studies of fire history in the Boundary Waters Canoe Area revealed that fires were periodic disturbances with varying frequency—data that equilibrium theory could not assimilate.<sup>26</sup> In a 1973 paper, ecologist Daniel B. Botkin suggested that “the concept of stability . . . may be inappropriate for the analysis of ecosystems.”<sup>27</sup> That same year, ecologist C.S. Holling noted that, although the equilibrium paradigm was “analytically more tractable,” it was an unrealistic way to view ecosystem behavior.<sup>28</sup>

In time, sufficient evidence of the inadequacy of the equilibrium paradigm amassed that the scientific community rejected this theory in favor of a dynamic, nonequilibrium model.<sup>29</sup> Two new tenets of ecology have been accepted in modern ecological science: (1) ecosystems are extremely complex and dynamic; and (2) nature is not always, and possibly not ever, a place without humans.<sup>30</sup> The concept of “ecosystem” also changed from one that only considered biota to one that incorporates nonliving elements, such as rocks, soils, climate, and the interlocking chemical cycles that abolish boundaries between the biosphere and geosphere.<sup>31</sup> Ecosystems are now understood never to have been in a homeostatic equilibrium—even before the influence of humankind.<sup>32</sup>

In 1992, Eugene P. Odum, considered by many to be the father of modern ecology, identified the “nonequilibrium paradigm” concept as the first great idea of the 1990s in the field of ecology.<sup>33</sup> This shift in scientific thought created a host of new challenges for the regulatory approach toward environmental management. Recognition of the constantly changing nature of ecosystems destroyed the notion of a fixed natural baseline that could be relied on to define the “undisturbed”

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24. Wu & Loucks, *supra* note 14, at 440.

25. Botkin & Sobel, *supra* note 11, at 629.

26. *Id.* at 628.

27. *Id.* at 626.

28. C.S. Holling, *Resilience and Stability of Ecological Systems*, 4 ANN. REV. ECOLOGY & SYSTEMATICS 1, 15 (1973).

29. A. Dan Tarlock, *The Nonequilibrium Paradigm in Ecology and the Partial Unraveling of Environmental Law*, 27 LOY. L.A.L. REV. 1121, 1123 (1994).

30. *Id.* at 1129.

31. LAZARUS, *supra* note 3, at 6–7.

32. Michael Soulé, *The Social Siege of Nature*, in REINVENTING NATURE 143 (Michael E. Soulé & Gary Lease eds., 1995) (“Living nature is not equilibria . . . [N]ature at the level of local biotic assemblages has never been homeostatic.”).

33. Eugene P. Odum, *Great Ideas in Ecology for the 1990s*, 42 BIOSCIENCE 542, 542 (1992).

ecosystem—the desirable condition to achieve.<sup>34</sup> Consequently, it has become impracticable to attempt to distinguish ecological disturbances that occur naturally from those that are, or might be, human-derived. As a result, difficult questions have arisen in the field of environmental law regarding how to determine which ecological changes should be regulated and which should be left alone. Under this dynamic model of nature, it is impossible for ecologists and lawmakers to determine the exact state of nature that the regulator should seek to achieve, or to preserve, through environmental protection measures.

Several features of the nonequilibrium paradigm create or amplify specific problems in decision making in environmental law. First, the nonequilibrium paradigm does not recognize man-made boundaries to ecosystems.<sup>35</sup> Although the outmoded equilibrium theory itself did not incorporate human boundaries in its definition of an ecosystem, the regulatory structure adopted during that period managed land based on artificial boundaries rather than on the ecosystem of which the land was a part. Examples of this focus on artificial boundaries included differing legal treatment for private versus public land, and for national parks versus national forests. In contrast, the nonequilibrium paradigm recognizes that activities outside of a legal boundary could affect an ecosystem inside the designated line.

Second, in recognizing that ecosystems are complex and that current science lacks the capacity to fully understand them, the nonequilibrium paradigm wiped away the sense of certainty in decisions made about environmental protection.<sup>36</sup> The tremendous complexity of ecosystems has rendered cause and effect relationships among the system's components unpredictable using current scientific techniques. Decision makers, previously able to depend on scientific certainty to rationalize their choices, find themselves confronting environmental problems to which science alone cannot provide guaranteed solutions.<sup>37</sup>

Third, by acknowledging that achieving and maintaining a vigorous ecosystem is an ongoing, lifetime experiment, the nonequilibrium paradigm has extended the time scale over which efforts at environmental protection ideally must extend.<sup>38</sup> Correction of environmental problems is unlikely to be a quick, single-action experience. Instead, trial and error is more likely to be required as the repercussions of remedial actions are identified and assessed.

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34. LAZARUS, *supra* note 3, at 8.

35. Tarlock, *supra* note 29, at 1134 n.57.

36. *Id.*

37. Wendy E. Wagner, *Congress, Science, and Environmental Policy*, 1999 U. ILL. L. REV. 181, 181 (1999).

38. Tarlock, *supra* note 29, at 1134 n.57.

The uncertainty inherent in ecological science, or in any type of science, was not fully recognized in 1970 when an enthusiastic Congress passed the first environmental laws.<sup>39</sup> Those initial laws upon which the modern structure for environmental regulation is founded contemplate a simple ecology with simple solutions—one without the constant specter of complex and uncertain repercussions to regulatory best efforts.

## II. NEPA: A PRODUCT OF EQUILIBRIUM PARADIGM THINKING

### A. *An Introduction to NEPA*

The National Environmental Policy Act (NEPA)<sup>40</sup> was the first major environmental law enacted in the United States. It represented Congress' response to a national consensus demanding a comprehensive national policy to improve and protect the environment.<sup>41</sup> NEPA established a national policy to preserve and enhance the environment where "man and nature can exist in productive harmony"<sup>42</sup> and declared environmental protection to be a public value. The purposes of NEPA are two-fold: (1) to direct informed decision making by requiring federal agencies to consider the environmental impacts of major federal actions;<sup>43</sup> and (2) to increase availability of information and provide opportunities for the public to participate in governmental decisions that affect environmental quality.<sup>44</sup>

NEPA requires that any government agency seeking to implement a "major Federal action" that the environmental assessment reveals may "significantly [affect] the quality of the human environment" must prepare a "detailed statement," known as an Environmental Impact Statement (EIS).<sup>45</sup> The EIS is the heart of NEPA's procedural requirements. The EIS, among other things, must include an analysis of the environmental impact of the proposed action, unavoidable impacts if the proposed action is carried out as planned, and alternatives to the proposed action.<sup>46</sup> NEPA opened governmental decision-making processes to the public by requiring that each environmental assessment

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39. See generally Wagner, *supra* note 37 (discussing why science is limited in its ability to address environmental policy questions and the resulting difficulties of developing environmental legislation).

40. 42 U.S.C. §§ 4321–4370(f) (2006).

41. COUNCIL ON ENVTL. QUALITY, THE NATIONAL ENVIRONMENTAL POLICY ACT: A STUDY OF ITS EFFECTIVENESS AFTER TWENTY-FIVE YEARS 1 (1997), available at <http://ceq.eh.doe.gov/Nepa/nepa25fn.pdf> [hereinafter NEPA EFFECTIVENESS].

42. 42 U.S.C. § 4331.

43. *Id.* § 4332(2)(C).

44. *Id.*

45. *Id.*

46. *Id.*

and EIS be released for public comment. Before the government makes a final decision on how to implement an action, it must consider and respond to these comments.<sup>47</sup>

NEPA also created the Council on Environmental Quality (CEQ) to coordinate federal environmental protection efforts by working closely with agencies and other executive offices to develop environmental policies and initiatives.<sup>48</sup> As the CEQ explains: “In enacting NEPA, Congress recognized that nearly all federal activities affect the environment in some way and mandated that before federal agencies make decisions, they must consider the effects of their actions on the quality of the human environment.”<sup>49</sup> NEPA tasks the CEQ with ensuring that federal agencies meet their obligations under the Act.

### *B. NEPA: Success or Failure Under the New Ecology?*

Although NEPA, like the other environmental legislation passed in the fervor of the early 1970s, is a product of equilibrium paradigm thinking, it differs substantially from the later enactments in its approach to environmental protection. Laws such as the Clean Air Act,<sup>50</sup> the Clean Water Act,<sup>51</sup> and the Endangered Species Act,<sup>52</sup> are regulatory in nature, often exerting command-and-control measures to achieve the goals of the legislation. This form of regulation either requires states to achieve mandated benchmarks for environmental quality, such as through pollution emissions standards, or directly regulates public and private activities, such as through the prohibition against “taking” a designated species or against developing and operating in that species’ critical habitat. NEPA, on the other hand, does not follow the command-and-control model of regulation common to most environmental statutes.

NEPA instead declares environmental protection to be a public value and directs the federal government to consider environmental impact when proposing federal projects.<sup>53</sup> NEPA does not set substantive benchmarks for environmental performance, mandate how an environmental problem is to be addressed, or provide a directive on how to weigh each factor in the required consideration of potential

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47. *Id.*

48. See Council on Env'tl. Quality, <http://www.whitehouse.gov/ceq/aboutceq.html> (last visited May 17, 2006), for a description of the office.

49. *Id.*

50. 42 U.S.C. §§ 7401–7671q (2006).

51. 33 U.S.C. §§ 1251–1387 (2006).

52. 16 U.S.C. §§ 1531–1544 (2006).

53. Although this is generally true, private projects are swept into the NEPA framework if they receive federal funding or assistance, or require regulatory approval. See 40 C.F.R. § 1508.18 (2006). Additionally, many states have enacted “mini NEPAs” that function in a similar way, but on a state and private level. See, e.g., California Environmental Quality Act, CAL. CODE REGS. tit. 14, §§ 15350–15387 (2006).

environmental impacts. Instead, NEPA focuses on ensuring that agencies make an informed choice by requiring collection and consideration of all information regarding the impacts of a proposed agency action and its alternatives. The substance of that choice is left entirely to the discretion of the informed government decision maker. Although agencies are required to consider likely environmental impacts, the courts concluded early in NEPA's history that the statute does not compel the government to take the least environmentally harmful course. An agency's only obligation under NEPA is to comply with the procedural requirements for data gathering and reporting of findings through the environmental assessment or EIS.<sup>54</sup>

NEPA's deviation from the command-and-control approach used by other environmental laws enacted during the same period may be due more to early misperceptions regarding NEPA's purpose and approach than to any intent of the drafters. Professor Lynton K. Caldwell, the principal architect of NEPA, intended the legislation to have a substantive basis. Once implemented, however, NEPA was quickly reduced to a purely procedural statute.<sup>55</sup> Professor Caldwell argues that the most important NEPA provision, section 101,<sup>56</sup> is the least understood.<sup>57</sup>

Section 101 states that economic and environmental qualities are, or should be, compatible. This legislative codification of the idea that man and nature are to exist in "productive harmony"<sup>58</sup> indicates how forward-thinking NEPA was at the time of its enactment. NEPA's call for compatibility of economic growth and environmental protection contemplates concepts such as "sustainable development" that were only beginning to emerge in the 1970s and took nearly two decades to become

54. See *Kleppe v. Sierra Club*, 427 U.S. 390, 417-18 (1976) (holding that 42 U.S.C. § 4332(2)(C) only assures consideration of environmental impacts); see also *Vt. Yankee Nuclear Power Corp. v. Natural Res. Def. Council, Inc.*, 435 U.S. 519, 558 (1978) ("NEPA does set forth significant substantive goals for the Nation, but its mandate to the agencies is essentially procedural.").

55. Lynton K. Caldwell, *Implementing NEPA: A Non-Technical Political Task*, in *ENVIRONMENTAL POLICY AND NEPA: PAST, PRESENT, AND FUTURE* 25, 26 (Ray Clark & Larry Canter eds., 1997) ("If, however, interpretation of NEPA continues to be administered by the courts, statutory amendment to give its substantive provisions juridical status might further realization of the act's intent."). See generally LYNTON K. CALDWELL, *THE NATIONAL ENVIRONMENTAL POLICY ACT: AN AGENDA FOR THE FUTURE* (1998).

56. Section 101 provides

that it is the continuing policy of the Federal government . . . to use all practicable means and measures . . . in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

42 U.S.C. § 4331 (2006).

57. Caldwell, *Implementing NEPA*, *supra* note 55, at 31.

58. 42 U.S.C. § 4331(a).

mainstream in the environmental community. Caldwell asserts that NEPA's chief goal is not balancing economic and environmental "goods" and "bads," but attaining a "productive harmony" that protects both present and future generations.<sup>59</sup> NEPA was intended to commit the government to making environmentally-sound decisions. Instead, Caldwell argues, NEPA has been widely misconstrued by the media and popular opinion to be merely a procedural hurdle, resulting in the widespread misunderstanding that the generation of the EIS is itself the primary purpose and intent of NEPA.<sup>60</sup>

Caldwell places blame for the failure to implement NEPA's substantive principle, to affirmatively act to protect the environment "to the fullest extent possible," on a wide range of actors. Caldwell theorizes that the source of this failure is the lack of political will by Congress and the President to see the substance of the law enforced. The public, because it also does not comprehend and appreciate the true purposes of NEPA, in turn demands little action by the government.<sup>61</sup> The courts, soon after NEPA's enactment, also failed to see any substantive mandate in NEPA and condemned it to encompass merely a process. As Professor Caldwell notes, "The substantive provisions of Section 101 were dismissed, in effect, as harmless rhetoric and as judicially inoperable."<sup>62</sup>

Caldwell, however, does acknowledge that NEPA has "achieved notable results."<sup>63</sup> A seemingly simple three-page statute, NEPA has fundamentally changed the way the federal government operates.<sup>64</sup> In particular, the requirement to consider alternatives and to disclose those findings to the public has often succeeded at minimizing or avoiding major environmental degradation, and has saved taxpayer money as a result. NEPA regulations call the alternatives analysis the "heart of the environmental impact statement."<sup>65</sup>

Furthermore, the public disclosure requirement empowers citizens to actively participate in the protection of environmental quality. NEPA-based public disclosures, such as the release of an EIS or of a finding of no significant impact (FONSI), can provoke public outcry and political or legal pressure strong enough that agencies may respond by either changing their course of action or by completely abandoning ill-conceived

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59. Caldwell, *Implementing NEPA*, *supra* note 55, at 37.

60. *Id.*

61. *Id.* at 26.

62. *Id.* at 37.

63. *Id.* at 25.

64. LAZARUS, *supra* note 3, at 68; *see also Problems and Issues with the National Environmental Policy Act of 1969: Hearing Before the House Comm. on Resources*, 105th Cong. 62-78, 149-215 (1998) (statement of Lynton K. Caldwell, Professor of Pub. & Env'tl. Affairs, Indiana University), *available at* <http://resourcescommittee.house.gov/archives/105cong/fullcomm/98mar18/caldwell.htm>.

65. 40 C.F.R. § 1502.14 (2006).

projects.<sup>66</sup> For example, the Federal Energy Regulatory Commission received strong NEPA-based opposition to the issuance of a license to build a new hydropower dam on the Penobscot River in Maine. The criticism stemmed from the conflict of the proposed dam with efforts to restore the wild Atlantic salmon. As a result, the Commission decided that it was in the public interest to deny the license.<sup>67</sup> In Michigan, the public successfully used NEPA to force the state highway agency to consider alternatives to expanding an existing highway. This action prevented what would have been the largest wetlands loss in Michigan's history, and saved taxpayers \$1.5 billion.<sup>68</sup> These benefits of NEPA implementation must not be underestimated.

As these examples suggest, NEPA provides a very powerful tool by which the public can insist upon environmental protection, or at least insist that environmental impact and reasonable alternatives be considered. Nonetheless, it is difficult to estimate the degree to which NEPA actually affects agency decision making.<sup>69</sup> During the equilibrium paradigm era, when the environmental response to outside disturbances was thought to be predictable, the EIS made perfect sense—determine the purpose of a proposed action, identify alternatives, predict the expected environmental response for each alternative, and choose the

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66. Critics argue, however, that public interest groups often use NEPA-related litigation solely for the purpose of delaying a project. After a devastating hurricane in August 2005 destroyed the levee system, and consequently large portions of New Orleans, many critics of NEPA blamed environmentalists for using NEPA-related litigation to sidetrack the Army Corps of Engineers' original plan to build a twenty-five mile flood barrier and flood gates in New Orleans, which would have allegedly destroyed Lake Pontchartrain's productive fishery. See, e.g., *NEPA Litigation: The Causes, Effects, and Solutions, Hearing Before the House Comm. on Resources*, 109th Cong. 8–61 (2005) (statement of Robert E. Winn, Partner, Sessions, Fishman & Nathan, LLP), available at <http://resourcescommittee.house.gov/nepataskforce/archives/robertwinn.htm>. In *Save Our Wetlands, Inc. v. Rush*, the court enjoined the Corps flood barrier project until a proper NEPA analysis was completed. 424 F. Supp. 354 (E.D. La. 1976).

67. ROBERT G. DREHER, NEPA UNDER SIEGE: THE POLITICAL ASSAULT ON THE NATIONAL ENVIRONMENTAL POLICY ACT 5 (2005), available at <http://www.law.georgetown.edu/gelpi/news/documents/NEPAUnderSiegeFinal.pdf>.

68. *Id.* at 5–6.

69. NEPA has been criticized on the basis that agency decisions have usually been made in advance of the NEPA process, and therefore, NEPA does not influence agency decision making, but is reduced to a “useless paper exercise.” DREHER, *supra* note 67, at 11. A 1997 report by the Council on Environmental Quality states that a study found that some agencies prepare an EIS to fulfill NEPA's requirements, but do not use it as a tool to improve decision making. See CEQ, NEPA EFFECTIVENESS, *supra* note 41, at iii. Rather, agencies attempt to get through the required procedural process by narrowing the content of the EIS to make the document “litigation proof,” rather than truly informative. *Id.* Such actions defeat both the spirit and letter of NEPA by replacing a successful combination of required information gathering and discretionary agency decision making with a useless bureaucratic impediment. These arguments, however, are not criticisms of NEPA itself, but criticisms of how NEPA is implemented.

option with the least environmental impact that comports with the purpose of the action.<sup>70</sup>

However, the recognition of uncertainty in ecological science has made the process of preparing an EIS and choosing between alternatives inherently more difficult. The nonequilibrium paradigm recognizes the necessity of a flexible approach to environmental management, including a willingness to experiment and adapt to the unexpected repercussions of change to an existing ecology. Both the nature and severity of environmental response within an ecosystem are unlikely to be fully predicted. Yet, the EIS process calls for a front-end analysis outlining with relative precision the environmental impact of a proposed project, and requiring certainty in the estimation of how that impact could be mitigated or avoided through alternatives.<sup>71</sup> Thus, while NEPA and the nonequilibrium paradigm do not directly conflict, rigid application of the former are destined to be disappointed by the product of the latter.

Despite the conflict of rigid expectations for certainty with modern understandings of dynamic ecosystem behavior, the public, the legislature, and the courts have routinely deterred federal agencies from adopting project proposals that contemplate flexible management compatible with nonequilibrium paradigm thinking.<sup>72</sup> The agencies have been criticized for abandoning the EIS as a real tool to improve decision making.

However, the future of the EIS as an effective instrument for environmental protection may depend on its ability to incorporate modern ecological concepts of uncertainty and change. One prominent idea for the incorporation of a nonequilibrium view of ecology into the existing regulatory framework that is gaining favor among agencies and ecologists is adaptive management.

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70. I do not intend to make this sound like a simple task. Agencies have increasingly spent large amounts of time and money preparing EISs, and the legal sufficiency of an EIS for a given action has been the source of voluminous litigation since the inception of NEPA. Often it is a question of whether all of the required alternatives have been examined. *See, e.g.,* Vt. Yankee Nuclear Power Corp. v. Natural Res. Def. Council, Inc., 435 U.S. 519 (1978). Only reasonable alternatives need to be considered, but that, of course can be a source of contention. *See, e.g.,* Nat. Res. Defense Council, Inc. v. Morton, 458 F.2d 827 (D.C. Cir. 1972). The courts have held that an EIS must consider a "no action" alternative. *E.g.,* Rankin v. Coleman, 401 F. Supp. 664 (E.D.N.C. 1975).

71. See *infra* Part IV for a more detailed comparison of the differences between a front-end approach to regulatory decision making, in which the regulation establishes government expectations and requirements at the outset of the process, and a back-end approach, in which the regulator assesses the final impact of an action to ensure that protective and preventative requirements have been met.

72. See *infra* Part III for examples of how the courts have responded to an agency's use of adaptive management.

## III. ADAPTIVE MANAGEMENT: A NONEQUILIBRIUM STRATEGY

A. *Introduction and Approaches to Adaptive Management*

Ecologist C.S. Holling coined the term "adaptive management" in the 1970s to describe various ecosystem management approaches that acknowledge that ecosystems are dynamic and complex.<sup>73</sup> A product of the nonequilibrium paradigm, adaptive management is a theory of environmental management that recognizes that experimentation and flexibility are required to address the manner in which complex systems respond to disturbances in the ecosystem. Holling argued that because predictive approaches are based on highly uncertain scientific models, ecosystem management should allow the continual gathering of information and improvement of scientific understanding. This growing body of information could later be used to enhance science's predictive capacity for future projects.<sup>74</sup> Holling's early characterization of adaptive management, however, does not fully grasp the potential of adaptive management to correct environmentally harmful decisions mid-course. It prescribes a monitoring requirement to understand the impact of a current decision, but the information that is gathered and evaluated is not applied to the present decision, only to future decisions. As Holling identified, the initial goal of adaptive management is to improve the science of prediction.

Carl Walters, a fisheries biologist, expanded the concept and application of adaptive management to three types of approaches: evolutionary, passive, and active.<sup>75</sup> The first approach, evolutionary adaptive management, involves undirected learning, or trial by error, where information is gathered from random experiments.<sup>76</sup> Future decisions evolve in response to past performance. The weakness in this approach is the inability to prioritize and focus learning in a certain area.

The second approach, passive adaptive management, implements the best-known practice at the time the agency makes its decision.<sup>77</sup> Preparation of an EIS is a passive adaptive management technique where the agency selects the "best" option based on the best historical data then available, with the assumption that the model on which the predictions of the environmental response are based is correct. The major disadvantage

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73. See generally ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT (C.S. Holling ed., 1978) (discussing limitations and potentials of environmental assessment, planning, and decision making).

74. See *id.* at 133.

75. Carl J. Walters & C.S. Holling, *Large-scale Management Experiments and Learning By Doing*, 71 *ECOLOGY* 2060, 2060 (1990).

76. *Id.*

77. *Id.*

of this method is that it uses historical data. Because each ecosystem is different and is “stressed” by different elements at different times and combinations, the assumption of accuracy in the ecosystem’s predictive model is inherently flawed. The implementation of the best-known practice is based on past experiments that may not be able to be replicated, and proper controls cannot be used to decide what is “best” in the current situation.

The third approach, active adaptive management, focuses on learning about environmental impacts by creating specific scientific experiments designed to test hypotheses.<sup>78</sup> Information gathered from these experiments is used to confirm predictions or detect unpredicted impacts early enough to prevent irreversible damage.<sup>79</sup> Active adaptive management requires the continual monitoring of the state of an ecosystem to learn how human actions and natural occurrences affect the interdependent relationships within the ecosystem. While there is a cost to this monitoring, there are also immediate and general benefits. Most importantly, active adaptive management recognizes the uncertainty in scientific understanding of environmental impacts, but offers a reasonable method for action in the absence of complete information. In order to determine how to proceed in the face of such uncertainty, active adaptive managers evaluate the consequences of each decision and make necessary changes, depending on the observations, to improve the environmental outcome of the specific action.

Despite the progress in developing adaptive management theory, several institutional problems threaten to inhibit the full implementation of this concept. Institutions rely on the finality of an EIS to allow unimpeded execution of a project, particularly short-term projects. Adaptive management does not provide that finality, but insists on a change in direction when new information dictates. Other institutional pressures, such as a commitment to decisions already made, management biases, and political pressures also threaten adaptive management’s success.<sup>80</sup>

As the evolution of adaptive management theory demonstrates, twenty-first century ecology has embraced three primary principles that necessarily must be considered when designing an adaptive management method: (1) ecosystems are complex, but we can still act in the face of uncertainty; (2) what we value in “nature,” or what we consider the “environment,” can only be conserved by addressing each ecosystem as a

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78. *Id.* at 2060–61.

79. W.H. Moir & W.M. Block, *Adaptive Management of Public Lands in the United States: Commitment or Rhetoric?*, 28 ENVTL. MGMT. 141, 141 (2001).

80. Holly Doremus, *Adaptive Management, the Endangered Species Act, and the Institutional Challenges of “New Age” Environmental Protection*, 41 WASHBURN L.J. 50, 55–56 (2001).

whole;<sup>81</sup> and (3) humans are, and will continue to be, a force on ecosystems.<sup>82</sup>

### *B. Structural Rigidity Toward Adaptive Management*

In 1999, Professor Kai N. Lee concluded that “[a]daptive management has been more influential, so far, as an idea than as a practical means of gaining insight into the behavior of ecosystems utilized and inhabited by humans.”<sup>83</sup> Traditional command-and-control regulation is relatively successful in dealing with discrete problems where the causes and effects of an action on the ecosystem can be readily identified, such as curbing pollution from discrete factory pipes. However, such regulation has done little to remedy complex problems, such as controlling urban runoff or invasive species, or restoring and managing whole ecosystems in response to changed human behavior within the ecosystem. Despite the institutional problems with implementing adaptive management mentioned in the prior section, the adaptive management concept has far more potential than command-and-control regulation to solve problems of immense proportions where there is little understanding of what to target, where to start, and how the ecosystem will respond.<sup>84</sup>

In practice, there are currently very few adaptive management projects that have been clearly successful.<sup>85</sup> Since each ecosystem presents its own unique challenges, it is difficult to understand or assess what makes one adaptive management project successful and another a failure. Difficulties in implementing adaptive management (beyond the need for resources) can be attributed to the fact that the fundamental nature of adaptive management is contrary to the “front-end” regulation to which decision makers have become accustomed. The traditional management style responds to identified problems but is not conducive to undertaking the systematic testing necessary to implement active adaptive management.<sup>86</sup> Seeking to identify previously unknown problems without rigid parameters and a well-defined scope of review is contrary to

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81. Kai N. Lee, *Appraising Adaptive Management*, 3 *ECOLOGY & SOC'Y* 3 (1999), available at <http://www.ecologyandsociety.org/vol3/iss2/art3/>.

82. *Id.*

83. *Id.*

84. J.B. Ruhl, *Regulation by Adaptive Management—Is It Possible?*, 7 *MINN. J.L. SCI. & TECH.* 21, 21–22 (2005).

85. See, e.g., John H. Davidson & Thomas Earl Geu, *The Missouri River and Adaptive Management: Protecting Ecological Function and Legal Process*, 80 *NEB. L. REV.* 816 (2001); Courtland L. Smith, Jennifer Gilden & Brent S. Steel, *Sailing the Shoals of Adaptive Management: The Case of Salmon in the Pacific Northwest*, 22 *ENVTL. MGMT.* 671 (1998); Kai N. Lee, *Rebuilding Confidence: Salmon, Science, and Law in the Columbia Basin*, 21 *ENVTL. L.* 745 (1991).

86. See generally Lee, *supra* note 81.

traditional regulatory protocols. The administrative agencies' centralized, top-down decision-making processes conflict with the continuous process of adjusting decisions in response to new information.<sup>87</sup> In addition, the United States' legal system depends on the finality of actions, and is likely to view the flexibility of adaptive management as contrary to the safeguards established to protect the principles of procedural and substantive fairness.<sup>88</sup>

Despite concerns regarding the ability of the existing regulatory structure to implement adaptive management under the NEPA framework, a review of agency activities shows that the agencies are beginning to incorporate adaptive management approaches into their management plans in order to better address situations of changing circumstances.<sup>89</sup> In response, affected parties have filed challenges asking the courts to consider the legality of the adaptive management approach.

### *C. The Legal Authority for Adaptive Management under NEPA: Case Analyses*

A recent case involving the management of the Missouri River System by the U.S. Army Corps of Engineers (Corps)<sup>90</sup> demonstrates that the issue of the legal authority for adaptive management as a part of NEPA compliance has not yet been resolved. In 2004, the Corps adopted a plan to operate the dams and reservoirs on the Missouri River pursuant to a U.S. Fish and Wildlife Service (Service) amended biological opinion that permitted the Corps to forego previously required summer low flow operation<sup>91</sup> The Service's initial biological opinion had recommended summer low flow,<sup>92</sup> provided that the Corps construct 1,200 additional acres of habitat for the endangered pallid sturgeon.<sup>93</sup> In the 2004 plan, the Corps adopted an adaptive management approach, allowing experimental seasonal water releases in order to gather information for a

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87. See generally Ruhl, *Regulation by Adaptive Management*, *supra* note 84.

88. Tarlock, *supra* note 29, at 1140.

89. See, e.g., NEPA TASK FORCE, MODERNIZING NEPA IMPLEMENTATION 44 (2003), available at <http://ceq.eh.doe.gov/ntf/report/finalreport.pdf>; see also CEQ, NEPA EFFECTIVENESS, *supra* note 41, at 26, 32.

90. *In re* Operation of the Mo. River Sys. Litig., 421 F.3d 618 (8th Cir. 2005).

91. *Id.* at 635. The biological opinion for the Missouri River describes the current river operation, the status of the river's species, the environmental baseline, the Service's conclusion of the effects of the current river operation on the continued existence of the river's species, and a list of necessary actions to avoid jeopardizing listed species.

92. Low flow operations decrease the cubic feet per second of water flowing through the river and would create conditions that mimic historic seasonal fluctuations in river flow. Low flows create environmental cues for certain species to begin reproducing and creates shallow zones that are required for feeding shore birds and spawning fish. U.S. FISH & WILDLIFE SERV., MISSOURI RIVER NEWS AND INFORMATION, [http://www.r6.fws.gov/MissouriRiver/archive/qanda\\_92000.htm](http://www.r6.fws.gov/MissouriRiver/archive/qanda_92000.htm) (last visited Sept. 29, 2006).

93. *Id.* at 627.

long-term flow plan.<sup>94</sup> Seasonal variation in water flow is critical for the recovery of several fish and bird species, but also has the potential to disrupt electricity generation, navigation, and affect flood-control measures. The state of Missouri, worried about the potential impacts of flow changes implemented by the Corps in future years, argued that the EIS violated NEPA because the adaptive management plan allowed the Corps to avoid preparing a supplemental environmental impact statement (SEIS), which NEPA requires whenever the agency makes substantial changes to its policy choice, or there are significant changes in circumstances.<sup>95</sup>

The federal district court rejected Missouri's claim, finding that Missouri failed to show any evidence that the Corps intended to avoid NEPA obligations by using an adaptive management approach.<sup>96</sup> The Corps asserted that, in the event of major management changes, it would comply with NEPA by preparing an SEIS.<sup>97</sup> Absent evidence that the Corps actually did violate NEPA by using adaptive management, the district court declared adaptive management a valid approach.<sup>98</sup> While this result does allow an agency to use adaptive management, it makes adaptive management impractical by acknowledging that every management change in response to new information opens the door to litigation over whether NEPA obligations have been violated.

An even more recent case demonstrates how the use of adaptive management might be constrained by both NEPA and other agency legal obligations. In 2006, a district court in Idaho decided a case that arose out of an attempt by the Forest Service to "implement[] a strategy for future management known as 'adaptive management'" to address the impacts of grazing under the Sawtooth National Forest (SNF) management plan.<sup>99</sup> The Forest Service's EIS recognized that existing grazing methods did not comply with the SNF management plan directives in some areas of the forest, including the North Sheep allotment, and that substantial changes in current grazing practices were necessary.<sup>100</sup> However, when it prepared the North Sheep EIS, the only substantial change that the Forest Service listed was the implementation of an adaptive management

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94. Mo. River Basin Ass'n, Judge Magnusen's Ruling, <http://www.mrba-missouri-river.com/magnusen.htm> (last visited July 4, 2006).

95. *In re Operation of the Mo. River Sys. Litig.*, 363 F. Supp. 2d 1145, 1163-64 (D. Minn. 2004), *aff'd in part, vacated in part*, 421 F.3d 618 (8th Cir. 2005) [hereinafter *In re Operation*]; see *infra* note 125 and surrounding text, for further discussion of the relationship of adaptive management to the NEPA requirement for an SEIS.

96. *In re Operation*, 363 F. Supp. 2d at 1164.

97. *Id.*

98. *Id.*

99. *W. Watersheds Project v. United States Forest Serv.*, No. Civ. 05-189, 2006 U.S. Dist. LEXIS 37857, at \*5 (D. Id. Feb. 7, 2006).

100. *Id.* at \*24.

strategy.<sup>101</sup> The Forest Service based its strategy on three principles: “(1) achievement of realistic, clearly defined objectives, (2) ongoing monitoring to assess progress toward those objectives, and (3) the flexibility to alter management when adequate progress is not being achieved.”<sup>102</sup> The Forest Service did not further explain its strategy and protocols for the implementation of adaptive management.<sup>103</sup> The Western Watersheds Project sued the Forest Service for both National Forest Management Act (NFMA) and NEPA violations.<sup>104</sup> The federal district court found that the Forest Service failed to explain how adaptive management would reach those objectives and that this lack of explanation violated NFMA.<sup>105</sup> The court did not discuss whether such a non-descriptive adaptive management approach violated NEPA as well.

Including the use of an adaptive management plan in an EIS is not an outright violation of NEPA, as the Missouri River System case demonstrates. But the Sawtooth National Forest case cautions that courts will likely require more than just the rhetoric of adaptive management. The courts have not yet defined specific parameters for adaptive management application, nor have the CEQ or the agencies attempting to use adaptive management consistently defined the term. Affected interest groups will continue to be skeptical of agencies’ purported use of adaptive management approaches that do not establish standards and guidelines for how each agency expects to accomplish its stated goals.

It is in the agencies’ best interest to develop standards for adaptive management protocols, like those developed for the preparation of an EIS, rather than simply waiting for the courts to establish these requirements through ad hoc determinations.<sup>106</sup> The future application of adaptive management techniques can only benefit from a foundation built on clear legal authority.

#### IV. THE MERITS OF APPLYING ADAPTIVE MANAGEMENT IN THE NEPA FRAMEWORK

In considering the practical application of adaptive management, Professor J.B. Ruhl explained: “It is little wonder that, having to operate in an atmosphere in which each decision involves so much ‘front-end’ preparation designed largely in anticipation of the onslaught of the public’s ‘participation’ and judges’ ‘hard looks,’ that many agencies

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101. *Id.* at \*25.

102. *Id.*

103. *Id.* at \*26–27.

104. *Id.* at \*6.

105. *Id.* at \*27.

106. The courts have played a large role in defining a proper EIS, such as the requirement of a “no action” alternative. Nevertheless, it seems reasonable and foreseeable that agencies themselves can develop standards requiring an adaptive management plan to minimally spell out its objectives, monitoring program, and how it expects to proceed to reach its goals.

display an aversion to adaptation.”<sup>107</sup> Skeptics, possibly for good reason, have expressed concern that adaptive management gives agencies too much discretion to make sweeping decisional changes while limiting public participation in those decisions. However, many agencies have found that the lack of flexibility inherent in traditional management approaches leaves them unable to accomplish their environmental objectives due to unexpected variables outside of the agencies’ control, such as changes in natural conditions, identification of an endangered species on site, or the enactment of new environmental restrictions or legislation.<sup>108</sup> All too frequently, agencies find that they are constrained from making modifications to correct course under an existing plan due to the restrictive “front-end” approach of traditional management theories. This is a particularly salient problem in areas that rely on long-term management plans, such as rangeland and forest management,<sup>109</sup> endangered species protection, and major restoration projects, such as the Columbia River Basin,<sup>110</sup> Glen Canyon Dam,<sup>111</sup> and the Missouri River system.<sup>112</sup>

As discussed, adaptive management is a relatively recent concept in environmental protection and resource management. Most environmental laws do not appear amenable to a flexible management approach due to their foundation in the equilibrium paradigm concepts of certainty and predictability of response to actions within the ecosystem. Recent analyses of agency regulatory behavior question this assumption, however. For example, Ruhl analyzed the possibilities for adaptive management under the requirements of the Endangered Species Act (ESA) and concluded that the enforcement of this legislation has been a

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107. Ruhl, *Regulation by Adaptive Management*, *supra* note 84, at 36.

108. See *Forest Service: Issues Relating to Its Decisionmaking Process, Testimony Before the Subcomm. on Forests and Public Land Management, Senate Comm. on Energy and Natural Resources*, at 4 (1996) (testimony of Barry T. Hill, Associate Dir. Energy, Resources, and Science Issues, Resources, Community, and Economic Development Division, General Accounting Office), available at <http://archive.gao.gov/paprp2pdf/156024.pdf> [hereinafter Hill Testimony].

109. Professor Holly Doremus points out that there already is some flexibility built into the management of public lands. Doremus, *supra* note 80, at 55. For example, the Secretary of Agriculture is required to “develop, maintain, and, as appropriate, revise land and resource management plans for units of the National Forest System.” 16 U.S.C. § 1604(a) (2006). However, monitoring is not required and management plans can take from three to ten years to develop and are intended to cover the following ten to fifteen years. Hill Testimony, *supra* note 108, at 3–4.

110. See generally Lee, *supra* note 81.

111. See generally Vicky J. Meretsky, David L. Wegner & Lawrence E. Stevens, *Balancing Endangered Species and Ecosystems: A Case Study of Adaptive Management in Grand Canyon*, 25 ENVTL. MGMT. 579 (2000).

112. See generally Davidson & Geu, *supra* note 85.

“success story” for natural resources law in terms of adaptation and flexibility.<sup>113</sup>

Ruhl analyzed how the ESA balances both front-end and back-end regulatory tools to identify the provisions of the Act that have the potential to use adaptive management.<sup>114</sup> Front-end approaches to regulation direct agencies to establish long-term policies and decisions based on analyses performed prior to any regulatory action. Back-end approaches allow performance results to be evaluated by the regulator after an activity has begun, and the information obtained is then cycled back into the regulatory process.<sup>115</sup>

The current legal and political framework favor front-end approaches for their certainty and their fixed end-points. For example, an agency knows that its course of action is fixed after it prepares an EIS and makes a final decision. Environmentalist and public interest groups also appreciate that the decision-making process provides certainty, the ability to have public participation before a decision is made, the ability to have that decision reviewed by the courts, and the ability to enforce the final decision.

Ruhl points out, however, that although the ESA takes primarily a front-end approach,<sup>116</sup> its structure is nevertheless conducive to adaptive management. He explains that “[o]ne must extract an adaptive management framework from the statute by implication.”<sup>117</sup> Ruhl finds this framework within section 4 of the ESA, which requires a review of all listed species every five years to determine whether the species’ status should be changed.<sup>118</sup> This provision opens the door to a back-end analysis of the results of the implementation, to determine if the goals of the Act are adequately being achieved. Ruhl argues, however, that although section 4 is a monitoring and adjustment provision that starts the adaptive management loop, the practical implementation quickly falls apart.<sup>119</sup> Agencies routinely fail to monitor species’ status pursuant to the statutorily required five-year cycle.<sup>120</sup> Ruhl argues that even when agencies do monitor a species’ status, the adaptive management loop fails

113. J.B. Ruhl, *Taking Adaptive Management Seriously: A Case Study of the Endangered Species Act*, 52 U. KAN. L. REV. 1249, 1251–52 (2004).

114. *Id.* at 1252; see also *supra* note 71 and surrounding discussion.

115. Ruhl, *supra* note 113, at 1252.

116. Ruhl breaks down the front-end approach of the ESA into four steps: (1) identification of imperiled species; (2) identification of its critical habitat; (3) formulation of a recovery plan; and (4) regulation of land use activities. *Id.* at 1253.

117. *Id.* at 1265.

118. *Id.* at 1266.

119. *Id.* at 1284. Both Professor Ruhl and Professor Doremus have written extensively on adaptive management and the ESA. See generally Ruhl, *Regulation by Adaptive Management*, *supra* note 84; Doremus, *supra* note 80.

120. Ruhl, *supra* note 113, at 1267.

when agencies make superficial assessments of status and meaningless assessments of the species' recovery plan.<sup>121</sup> The ESA has the logical structure to start an adaptive management approach, but fails to compel agencies to use the information gathered to make useful adaptations in light of the new information.<sup>122</sup>

Like the ESA, NEPA seems at first blush to reject the application of an adaptive management approach. Section 102 requires that an environmental analysis be prepared *before* a final decision is made.<sup>123</sup> By contrast, adaptive management contemplates deferring at least some decisions, where the scientific uncertainty is great, until more information is available. NEPA also requires public comment and review before the final decision. Adaptive management is unwieldy and less effective if all decisional changes require public comment. Under NEPA, management plans contain legal obligations, and agencies could find themselves in violation of the Act if they revise existing plans to accommodate new information or changed circumstances without following the statutorily required procedures.<sup>124</sup>

A closer look at NEPA, however, shows that it does provide a mechanism for agencies to make changes to a proposed action or management plan, to take into account new information or changed circumstances, through the use of a supplemental environmental impact statement (SEIS).<sup>125</sup> An SEIS is required when an agency makes substantial changes to the action outlined in the initial EIS, or "when there are significant [sic] new circumstances or information relevant to environmental concerns."<sup>126</sup> In this way, the use of the SEIS contemplates an adaptive management approach, or at least allows flexibility in the event new information warrants changes.

On its face, the SEIS appears to offer only an abbreviated and inadequate version of a true adaptive management approach. First, the SEIS requirement is only triggered when the new conditions exceed the scope of the original NEPA analysis.<sup>127</sup> Preparation of the SEIS, although not as extensive a process as for the initial EIS, may be overly

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121. *Id.* at 1268.

122. *Id.* at 1265.

123. 42 U.S.C. § 4331 (2006).

124. *See, e.g.,* Friends of the Clearwater v. Dombeck, 222 F.3d 552 (9th Cir. 2000) (holding that the Forest Service violated NEPA by refusing to prepare a supplemental EIS for certain timber sales).

125. 40 C.F.R. § 1502.9(c) (2006); *see supra* Part III.C. for an example of how a court has interpreted an adaptive management policy in light of the NEPA requirement for an SEIS.

126. Guidance Regarding NEPA Regulations, 48 Fed. Reg. 34,263 (July 28, 1983), available at <http://ceq.eh.doe.gov/Nepa/regs/1983/1983guid.htm>.

127. An agency must file an SEIS when "the subsequent information raises new concerns of sufficient gravity such that another, formal in-depth look at the environmental consequences of the proposed action is necessary." 40 C.F.R. § 1502.9(c)(1) (2006).

burdensome for minor management corrections. Another concern is the potential for litigation over whether a change in the course of action was significant enough to trigger the SEIS requirement.<sup>128</sup> Without an established standard for distinguishing adaptive management techniques from a substantial change in the agency action plan, it would be difficult to discern when a change in plans falls into the adaptive management umbrella and when the agency must prepare an SEIS.

In addition, neither NEPA nor the SEIS process directly incorporates a monitoring scheme to assess the environmental impact of a current action. It might seem obvious that forest management approaches must be changed from those set out in the original EIS when a catastrophic fire occurs, or an endangered species is found, thus triggering the need for an SEIS. However, without monitoring for less obvious changes in an ecosystem, it could go unnoticed that current grazing allowances on certain rangeland allotments, for example, are impairing a habitat beyond what was contemplated when the decision to allow the activity was made. Without establishing a procedure for monitoring critical environmental impacts over time, the regulator does not gather new information that would trigger the need for an SEIS. Adverse environmental impacts occurring over time might not be recognized by the agency until degradation becomes severe. Without such monitoring, the answers to the scientific uncertainties underlying the agency's decision are not discovered, and therefore are not evaluated, if ever, until it is possibly too late to make meaningful or efficient change.

Despite the lack of an express provision for the application of adaptive management either within the EIS or the SEIS, the permissive structure of NEPA implies the ability to utilize adaptive management techniques. As a legislative enactment, NEPA intentionally leaves agency decision-making discretion untouched. As discussed earlier in this Comment, a primary goal of NEPA is to ensure that agency decision makers have all of the necessary information at the time that they make a decision with significant environmental impact. Thus, it stands to reason that if the original NEPA analysis adequately describes the use of adaptive management, NEPA does not provide any barriers to its use. In fact, adaptive management aligns well with the desire for fully informed decision making. To avoid the prospect of never-ending litigation, agencies will need to carefully define the parameters for the application of adaptive management for each project. As this Comment demonstrates and as courts have recognized, NEPA is compatible with adaptive management.

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128. See, e.g., *So. Trenton Residents Against 29 v. Fed. Highway Admin.*, 176 F.3d 658 (3d Cir. 1999); see also *Colo. Env'tl. Coal. v. Dombeck*, 185 F.3d 1162 (10th Cir. 1999).

## V. A PLAN FOR INTEGRATING ADAPTIVE MANAGEMENT AND NEPA

Despite its front-end focus, NEPA does not obstruct the use of adaptive management. Nor, however, does NEPA give clear guidance on how an adaptive management plan should be applied. Establishing this delineation should be the next important goal of NEPA regulation. Adaptive management should not be thought of as a substitute for a proper *ex ante* environmental impact analysis. Agencies should not, for example, use the guise of adaptive management to evade their NEPA obligations by claiming that scientific uncertainty precludes environmental assessment prior to the agency's decision. Adaptive management should follow sound decision-making practices based on a traditional NEPA environmental assessment. Adaptive management must start from the premise that *some* plan is already in place. The purpose of adaptive management is to evaluate the impact and effectiveness of an action, and then refine the action to minimize adverse environmental consequences in light of the new analytical information. Integration of adaptive management with the front-end requirements of NEPA, rather than replacing the EIS, preserves both the opportunity for public participation in the decision-making process and the benefits to the agency of gathering information regarding likely consequences to the environment of a proposed action in advance of its final decision.

NEPA's environmental analysis provides the information required to develop an adaptive management plan, such as the identification of areas where significant environmental impact is expected, areas of known uncertainty, and possible mitigation measures. Details of each adaptive management plan are likely to vary widely<sup>129</sup> but each plan must start with determination of the baseline environment, definition of environmental goals, and explanation of how those goals will be balanced against other interests. The adaptive management plan requires delineation of the potential scenarios that would indicate boundaries for decisional changes. The plan must give notice to the agency and the public of what corrections would fall under adaptive management and what conditions would trigger the need for an SEIS. For example, the boundaries of adaptive management could be limited to changes described within the alternatives of the original EIS analysis.

Agencies will have to put adaptive management itself through the steps of trial and error learning before agencies can establish the proper parameters for this approach and take full advantage of its potential to effectively target environmental improvement. This will be a strong move into the new era of ecosystem management.

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129. Doremus, *supra* note 80, at 52-53.

## CONCLUSION

As is common in all areas of science and technology, advancements in scientific understandings of ecosystems and the impact of human actions on these systems call into question the adequacy of regulatory presumptions and methodologies. To avoid being out-paced by evolving science, regulatory bodies require either continual revision to statutory authority, or a built-in mechanism for flexible regulation. The likelihood of frequent, responsive legislative change is extremely remote, and for this reason, the legislature relies on agency expertise to maintain regulatory effectiveness. For NEPA, the statutory authority to adopt a flexible, adaptive management approach to the assessment of environmental impacts is implied, at best. Nonetheless, agency experience clearly indicates both the need and the desire to move forward with adaptive management. Periodic updates on the real impact of agency actions after a proposed plan is implemented, compared to the expected results, will enable each agency to better perform its role as a protector of the environment.

