MANAGING WITHOUT A BALANCE: ENVIRONMENTAL REGULATION IN LIGHT OF ECOLOGICAL ADVANCES

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INTRODUCTION

Several recent developments in the field of ecology have rendered a large part of the environmental law of the United States out of date. These changes boil down to two main concepts: that humans no longer should be considered separate from ecosystems and that ecosystems operate in dynamic, uncertain ways that cannot be mastered. This article asks how environmental law can reformulate itself to address these changes, especially in light of obstacles such as legal traditions, political opposition, and agency inertia.

The concept of the "Balance of Nature," so politically successful in the late 1960's and early 1970's, has been dismissed by ecological science.[1] The "Balance of Nature" hypothesized that ecosystems would progress to a steady state, at which they could exist perpetually in "balance." Ecosystems are now seen as dynamic and stochastic rather than in equilibrium; anthropogenic actions most often are seen as inescapably intermingled with ecological systems, rather than avoidable.[2] Unfortunately, however, many of the laws designed to regulate ecological resources were passed when the "Balance of Nature" paradigm was king and have not been redrafted to comport with advances in ecology.

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1. *See, e.g.*, Judy L. Meyer, *The Dance of Nature: New Concepts in Ecology*, 69 CHI-KENT L. REV. 875, 877 (1994); DANIEL B. BOTKIN, DISCORDANT HARMONIES 13 (1990); Wallace Kaufman, *How Nature Really Works*, AM. FORESTS, Mar.-Apr. 1993, at 17, 18 (stating that "[The Balance of Nature] makes good poetry but bad science").

2. *See* Meyer, *supra* note 1.

These early environmental laws were conceived with the idea that if nature is left alone, it will maintain itself in equilibrium.[3] Moreover, human interaction was seen as an intrusion and unnatural.[4] Nature was best set aside. These beliefs were supported by other disciplines that influenced ecology to continue to search for predictable, balanced systems. Ecologists were even accused of having "physics-envy."[5] Environmental theorists often drew the line between humans and the "natural world,"[6] supporting the conclusion that humans were either trespassers or caretakers for all of nature.[7] Finally, the impetus to incorporate uncritically these teachings into the law was great, as environmental degradation from human causes had reached disturbing proportions.

Environmental statutes such as the Endangered Species Act (ESA)[8] and the Clean Water Act (CWA)[9] contain examples of this approach. The ESA has been interpreted to preclude cross-breeding of endangered species despite evidence that species sometimes cross-breed without human influence.[10] This approach demonstrates an outdated conception of an endangered species as a static entity rather

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3. Fred P. Bosselman and A. Dan Tarlock, *The Influence of Ecological Science on American Law: An Introduction*, 69 CHI-KENT L. REV. 847, 863 (1994), *see also* BOTKIN, *supra* note 1, at 6 (describing the tendency of humans to view nature as "a Kodachrome still-life").

4. Bosselman and Tarlock, *supra* note 3.

5. J.E. Cohen, *Mathematics as a Metaphor*, 172 SCIENCE 674 (1971); *see also* EUGENE ODUM, FUNDAMENTALS OF ECOLOGY 35 (2d ed. 1959) (stating that "[h]omeostasis at the organism level is a well known concept in physiology . . . . We find that equilibrium between organisms and environment may also be maintained by factors which resist change in the system as a whole.")

6. *See, e.g.*, JOHN PASSMORE, MAN'S RESPONSIBILITY FOR NATURE 28-40 (1974); RODERICK NASH, THE RIGHTS OF NATURE (1989).

7. *See* Jonathan B. Wiener, *Law and the New Ecology: Evolution, Categories, and Consequences*, 22 ECOL. L.Q. 325, 337 (1995) (describing the "separatist-dominion" (lord or caretaker) and "separatist-taint" (trespasser) perspectives).

8. 16 U.S.C. §§ 1531-1544 (1994).

9. 33 U.S.C. §§ 1251-1387 (1988).

10. Wiener, *supra* note 7, at 339 n. 74; Stephen J. O'Brien and Ernst Mayr, *Bureaucratic Mischief: Recognizing Endangered Species and Subspecies*, 251 SCIENCE 1187 (1991). Recently, the Department of the Interior proposed a rule to reverse this policy and protect hybrids that possess the morphological characteristics of the protected species. *See* Endangered and Threatened Wildlife and Plants; Proposed Policy and Proposed Rule on the Treatment of Intercrosses and Intercross Progeny (The Issue of "Hybridization"); Request for Public Comment, 61 Fed. Reg. 4,710 (proposed Feb. 7, 1996). This rule has been put on the back-burner, largely as a consequence of potential legal challenge based on the ESA's definition of species that was mentioned in the comments to the proposed rule. Telephone Interview with David Harrelson, U.S. Dept. of the Interior (July 31, 1996).

than evolving through time.[11] Likewise, section 404 of the CWA[12] attempts to conserve wetland ecosystems by setting them apart from human contact on the assumption that they will maintain themselves in equilibrium.

In the end, both the ESA and section 404 have demonstrated flaws. They had envisioned neither the influence of greatly attenuated human actions on valued ecosystems nor the stochastic, non-static mechanisms of those same ecosystems. Subsequent ecological learning has taught that neither of these elements can be ignored.

Human actions are now seen as inextricably intertwined with the operation of ecosystems. As Daniel Botkin wrote in *Discordant Harmonies*,[13] the book that is often credited with bringing these ecological advances to the fore of environmental policy, "[l]ife and the environment are one thing, not two, and people, as all life, are immersed in the one system."[14] Human effects are evident in nearly every natural system. For example, even before the European colonists arrived in America, the forests of southern New England had been shaped by the burning practices of Native Americans.[15] With universal effects such as global warming and the thinning of the ozone layer, no part of the Earth is untouched by human influence. Thus, as we now are properly identified as merely a force among ecosystems, traditional attempts to simply separate ourselves from ecosystems are no longer prudent.

Ecological research has also borne out the hypothesis that ecosystems fluctuate without equilibrium and beyond the capabilities of humans to assess and control them without error.[16] Instead of being a Kodachrome still-life, the environment is "a moving picture show"[17] replete with random events. These random events are often just part of the system. Disturbances such as fires are now considered essential to the maintenance of healthy ecosystems, whereas in

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11. It is becoming increasingly apparent that evolution occurs within the scope of generations, a much shorter time scale than envisioned by Darwin. *See generally* Jonathan WEINER, THE BEAK OF THE FINCH: A STORY OF EVOLUTION IN OUR TIME (1994).

12. 33 U.S.C. § 1344 (1988).

13. BOTKIN, *supra* note 1.

14. *Id.* at 188.

15. WILLIAM CRONON, CHANGES IN THE LAND: INDIANS, COLONISTS, AND THE ECOLOGY OF NEW ENGLAND 49-51 (1983).

16. KAI LEE, COMPASS AND GYROSCOPE 54 (1993).

17. BOTKIN, *supra* note 1, at 6.

previous years they would have been avoided.[18] Random variation in the genetic makeup of a species are the grist for natural selection.

In light of this new understanding, goverment organizations have been attempting to account for this disparity between science and the law.[19] Unfortunately, they have been operating without well-focused statutory authority. The optimal solution would be to recraft environmental law with explicit language allowing administrative agencies to operate under current ecological understanding. However, due to the large political interests involved in environmental law, a quick adaptation of the legal system is unlikely.[20] While efforts to change the underlying authority move forward, administrative agencies operating under the current legal framework also should look to readjust their regulatory approach to further account for recent scientific advances.

Regulators need to address the implications of two important readjustments in ecology in order to craft a better system. Specifically, society's perspective on environmental regulation must change to recognize "a global view of life on the Earth"[21] and "the dynamic rather than the static properties of the Earth and its life-support system . . . ."[22] To effectively regulate the environment for society, administrative agencies must similarly alter their perspective in these two basic ways.

First, if environmental law recognizes "a global view of life," or humans as part of, rather than separate from nature, then several scholars have suggested a reappraisal of the moral basis for environmental laws.[23] If anthropogenic changes in the environment are part

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18. Meyer, *supra* note 1, at 879-81; *see also* BOTKIN, *supra* note 1, at 51-71 (discussing the degradation of an old-growth oak forest in New Jersey because of fire suppression); V.H. Resh et al., *The Role of Disturbance In Stream Ecology*, 7 J. N. AM. BENTHOLOGICAL SOC'Y 433-55 (1988) (concluding that disturbance is essential to maintain aquatic ecosystems).

19. *See* FOREST ECOSYSTEM MANAGEMENT ASSESSMENT TEAM, FOREST ECOSYSTEM MANAGEMENT; AN ECOLOGICAL, ECONOMIC AND SOCIAL ASSESSMENT VIII-17 - VIII-25 (1993) [hereinafter FEMAT Report] (recommending the use of adaptive management in the Forest Plan for the Pacific Northwest); CALIFORNIA RESOURCES AGENCY, RESOURCEFUL CALIFORNIA 5 (1991) (describing the Natural Communities Conservation Planning program in California, which would create plans to protect endangered species through voluntary habitat conservation in critical ecosystems).

20. *See* Wiener, *supra* note 7, at 337; Richard B. Stewart, *Madison's Nightmare*, 57 U. CHI. L. REV. 335 (1990).

21. BOTKIN, *supra* note 1, at 6.

22. *Id.*

23. *See* Wiener, *supra* note 7, at 350; *see also* A. Dan Tarlock, *The Nonequilibrium Paradigm in Ecology and the Partial Unraveling of Environmental Law*, 27 LOY. L.A. L. REV.

of nature, they ask, how do we distinguish between those that are environmentally desirable and those that are undesirable?

Under the previous paradigm, these questions were easy to answer and formed the basis of environmental regulation. The "Balance of Nature" was a self-maintaining entity and humans had only to keep from distorting its equilibrium. Under the new paradigm, a new approach must be taken. This is not to say that all human influence on the environment is *per se* valid. It only means that humans must engage in a much more complex analysis of our impacts, rather than reverting to a simple separatist model.

Second, if ecosystems are dynamic, shifting systems, then management with perfect or nearly-perfect information is impossible. Instead, resources must be regulated under considerable and ever-changing uncertainty. Always a factor in environmental management, this uncertainty must now be accepted as a given with ecological systems. Moreover, factors that influence these systems are more numerous than what can be easily taken into account. Thus, both the type and degree of forces influencing ecosystems often are not evident to the decision-maker.

Even in light of these problems, regulation must be pursued. Anthropogenic effects have the potential to be too fast and too severe for ecosystems to adjust.[24] Without government oversight, there is insufficient economic incentives to protect public resources.[25] Therefore, a new approach to management of the nation's ecological resources must be crafted in order to provide environmental protection while minimizing concerns arising from uncertainty.

Given the challenge posed to environmental law by ecological advances, Part I of this Article will suggest a new approach to regulating with the understanding that humans are unavoidably linked with the earth's ecosystems. Part II will then address the problems of uncertainty and investigate the use of the adaptive management methodology to conquer these problems. Finally, Part III will look at the implications of the 104th and 105th Congresses' actions for these new approaches.

1121 (1994) (advocating use of science as source of environmental law's legitimacy).

24. Meyer, *supra* note 1, at 882.

25. Supporters of Professor Roald Coase's theorem might quarrel with this statement. *See* Warren J. Samuels, *The Coase Theorem and the Study of Law and Economics*, 14 NAT. RESOURCES J. 1 (1974). However, environmental protection rarely, if ever, has low enough transaction costs to allow the market to protect the environment without government involvement.

I. HUMANS WITHIN THE ECOSYSTEM: IMPLICATIONS FOR MANAGEMENT

A. Humans as part of nature?

The line between humans and ecosystems has come crashing down. Some anthropogenic influence is an unavoidable part of ecosystems. As Botkin stated, "there is no longer any part of the Earth that is untouched by our actions in some way. . . ."[26] Native Americans shaped the old-growth forests of North America long before European colonization.[27] Deep in the rain forests of South America, human influences over the landscape can be seen.[28]

These revelations have influenced the moral sense that underlies instinctive justifications inherent in environmental law. As Botkin's writings reflect, many environmental theorists have readjusted their approaches away from a separatist perspective.[29] Instead, humans are seen as part of nature. Under this approach, New Jersey's industry is no less a part of nature than the alpine ecosystems of the Rocky Mountains. If we acknowledge this point, we are faced with a quandary: if New Jersey and the Rockies are both natural occurrences, then how can we say that New Jersey's oil refinery should be regulated while the wolves of the Rocky Mountains should be protected?

The answer is not to answer the question. For the purposes of ecological management, whether humans are part of nature should be an irrelevant semantic argument. "Nature" as a word contains too much baggage for it to contribute to the discussion. It can mean all usual occurrences or it can mean untouched wilderness. It can be used to signify any version of the status quo.[30] The issue is better left to the philosophers; for management purposes, it is a distraction.

To make judgments based on a natural/unnatural distinction would be to ignore one of our species' greatest attributes. Whether or not we as *Homo sapiens* are separate or part of "nature," we are

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26. BOTKIN, *supra* note 1, at 194.

27. CRONON, *supra* note 15, at 50-51.

28. Carol K. Yoon, *Rain Forests Seen As Shaped by Human Hand*, N.Y. TIMES, July 27, 1993, at C1.

29. BOTKIN, *supra* note 1, at 188. *But see* HOLMES ROLSTON III, PHILOSOPHY GONE WILD (1986) (refusing to accept humans as a part of nature in anything but the metaphysical sense).

30. *See* Wiener, *supra* note 7, at 348.

unique in that we are a deliberative society that has the potential to reflect and adjust our behavior in relation to our surroundings.[31] To use an inflexible binary rationale for ecological management would be to deprive us of our deliberative opportunities. It would be incongruous to claim that humans were distinct from "nature" because of our ability to make judgments and then preclude us from making such judgments.

Finally, the use of a natural/unnatural heuristic would not only be flawed, but could lead to dangerous consequences. If the distinction is taken to favor "natural" products over human-produced synthetics, some risks may actually increase. The synthetic pesticide ethylene dibromide (EDB) was banned as a carcinogen in 1983,[32] allowing a great increase in the fungi aflatoxin on peanuts.[33] Although it was "natural," the aflatoxin actually posed a greater cancer risk than the risk from ethylene dibromide.[34] Similarly, the chlorination of water in Peru was banned in 1991, reportedly because of a United States report on the risks involved in this "unnatural" activity.[35] This led to an outbreak of cholera, a "natural" pathogen, that exceeded the potential adverse effects of the chlorine.[36]

Alternatively, if the decision is made to allow all human actions, as they are definitionally "natural," the consequences would be even more severe. Human-caused changes often occur with speed, severity, and size that far exceed ecological change and are often beyond the

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31. *See* William C. Clark, *Managing Planet Earth*, SCIENTIFIC AM., Sept. 1989, at 47:

> [T]he same wellsprings of human inventiveness and energy that are so transforming the earth have also given us an unprecedented understanding of how the planet works, how our present activities threaten its workings and how we can intervene to improve the prospects for its sustainable development . . . . With this knowledge comes a responsibility not borne by the bacteria: the responsibility to manage the human use of planet earth.

32. Ethyl Dibromide; Decision and Emergency Order Suspending Registrations of Pesticide Products Containing Ethyl Dibromide for Use as a Soil Fumigant, 48 Fed. Reg. 46,228 (1983); Food for Human Consumption; Tolerances for Pesticides in Food Administered by the Environmental Protection Agency, 49 Fed. Reg. 44,458 (1984) (codified at 21 C.F.R. § 193.225(a)).

33. S. Kilman, *Spreading Poison: Fungus in Corn Crop, A Potential Carcinogen Invades Food Supplies, Regulators Fail to Stop Sale of Last Fall's Harvest Laden with Aflatoxin*, WALL ST. J., Feb. 23, 1989, at A1.

34. *Id.*

35. Christopher Anderson, *Cholera Epidemic Traced to Risk Miscalculation*, 354 NATURE 255 (1991).

36. *Id.*

physiological capabilities of the organisms within an ecosystem.[37] To give humans carte blanche over the environment would be a recipe for ecological destruction.

B. A Consequentialist Approach

Once the natural/unnatural dichotomy is abandoned, a new decision-making calculus is needed to replace it. In lieu of their former technique, agencies should determine those ecological goods that our deliberative society desires to conserve and use these objectives to guide policy.[38] The decision whether to subject human activities to regulation should be guided by the consequences of the activities relative to the goal that has been set. For example, if it is determined that a wetland provides an essential ecological function or value,[39] then those human activities, both direct and indirect, that significantly reduce the wetland's ability to provide that function or value should be curtailed.[40] Of course, these policy determinations

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37. Meyer, *supra* note 1, at 882.

38. Several recent federal documents have suggested the need to determine criteria to judge the consequences of environmental management. In the report of the Interagency Ecosystem Management Task Force, the Task Force identified the need for "benchmarks" of ecosystem conditions to compare "degraded ecosystems" with "fully functional ecosystems." INTERAGENCY ECOSYSTEM MANAGEMENT TASK FORCE, THE ECOSYSTEM APPROACH: HEALTHY ECOSYSTEMS AND SUSTAINABLE ECONOMIES 59 (1995). The identification of ecological goods is also similar to the "sustainable development indicators" that are being developed pursuant to the recommendations of the President's Council on Sustainable Development. THE PRESIDENT'S COUNCIL ON SUSTAINABLE DEVELOPMENT, SUSTAINABLE AMERICA; A NEW CONSENSUS FOR PROSPERITY, OPPORTUNITY, AND A HEALTHY ENVIRONMENT FOR THE FUTURE 66 (1996) [hereinafter SUSTAINABLE AMERICA].

39. In the parlance used here, there is some distinction between a function and a value. A function is an ecosystem's ability to operate in a way that is necessary for the health of the environment — e.g. a wetland's ability to sequester carbon. A value is a quality of an ecosystem that society finds important — e.g. the beauty of a landscape. Sometimes, the two terms overlap — e.g. the filtration of water by a wetlands in order to preserve valued water quality.

40. This approach would be well served by use of the developing techniques of decision analysis. Decision analysis techniques could analyze a regulatory option in a non-anthropogenic manner in order to optimize the functions desired from the wetlands. Robert T. Clemen, MAKING HARD DECISIONS: AN INTRODUCTION TO DECISION ANALYSIS (1991). Decision analysis tools such as multiple alternative-multiple attribute analysis would allow the consideration of more than two options, facilitate the comparison of the outcomes for different nonquantifiable values, allow for the comparison of the cumulative impact of each option and address the uncertainty and disequilibrium that pervades ecology. *See* Alyson Flournoy, *Coping with Complexity*, 27 LOY. L.A. L. REV. 809, 818-19 (1994). Decision analysis, however, is only a tool to an end. The value judgments that will form the baselines will still come from the decision-makers; decision and risk analysis will only clarify the weighing of these factors.

would need to be adaptable, as the uncertainty about the ecosystems would necessitate monitoring to confirm that the assumptions about both the goods and consequences were correct.[41]

This consequentialist approach opens a Pandora's box of issues. First, who is to determine what goods to protect and what consequences are unacceptable? Should it be the public at large, the agency staff, or somebody else? Furthermore, once the decision-makers are determined, what basis should be used for making the judgment? Should it be purely scientific? Should it be based on feelings of moral obligation?

The former issue once again returns to the long-standing debate of whether the public or the expert is a better decision-maker — a conflict that dates to Plato's *Republic*.[42] More recently, legal scholars have pointed out the variance between the lay and expert perceptions of risk.[43] These scholars argue that the lay person's and expert's perspectives should be treated as equally rational statements of risk perception, neither one being superior to the other.[44] However, the management of ecological resources seems not to be a situation suited for this approach. The lay perspective on health risks usually varies on subjective bases, such as the voluntariness or fear of the specific risk.[45] These variations are inherently linked to the sympathy (or lack thereof) felt by the public representative for those suffering as a result of the risk.[46] Similar empathy for ecosystems is either weak or nonexistent. Moreover, the status of many ecosystems as common resources means that individuals' economic incentives often are adverse to the public good.[47] Finally, the complexity of

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41. *See infra* Part III.

42. PLATO, THE REPUBLIC 219-220 (Allan Bloom trans., Basic Books 2d ed. 1991).

43. Richard Pildes and Cass Sunstein, *Reinventing the Regulatory State*, 62 U. CHI. L. REV. 1, 42 (1995); *see also* U.S. ENVIRONMENTAL PROTECTION AGENCY, UNFINISHED BUSINESS: A COMPARATIVE ASSESSMENT OF ENVIRONMENTAL PROBLEMS (1987) (finding vast differences in the priorities for environmental regulation held by the public and experts); Paul Slovic, *Perception of Risk*, 236 SCIENCE 283 (1987) (finding that public prioritization of risk differs depending on how "dread" or "unknowable" the risk was).

44. Pildes and Sunstein, *supra* note 43.

45. Slovic, *supra* note 43, at 283.

46. For example, Slovic found that the public prioritized risks that were "dread" or "involuntary." *Id.* These are factors that seem to arise because the public sympathizes with the victims of the risk.

47. *See* TOM TIETENBERG, ENVIRONMENTAL AND NATURAL RESOURCE ECONOMICS 54-56 (1992). Public control over the regulation of ecological resources may result in the transfer of ecological risk to other groups such as unrepresented populations beyond the political boundaries and future generations.

dynamic ecosystems makes it very unlikely that the lay public's opinions would be developed under anything approaching perfect information.[48]

On the other hand, the public cannot be completely left out of the regulatory decision-making process. Complete exclusion would be adverse to effective decision-making in several ways. First, governance by elites often satisfies the public's interest in the end results, but ignores its interest in "the process of participation."[49] In other words, involvement in governance has a value separate and apart from the end result. Second, the maintenance of the public's trust in any regulation of risk is essential to preserve the political support for the effort.[50] To maintain such trust, the government must have either close to no communication with the public or an unprecedented openness in decision-making.[51] As the former alternative is not viable in America's political system,[52] the latter is the only possible means to ensure trust.

A proper approach must reconcile these conflicting pressures. Ideally, the authority should lie with a government oversight organization that would determine for society what ecological goods to protect and what consequences are unacceptable. This is not to say that the public's opinion should be irrelevant. General public opinion should be incorporated into the analysis when it pertains to the subjective valuation of ecological values and functions. The majority of public sentiment actually runs in favor of protecting the environment.[53] Still, the inadequacies of the public's perspective should not

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48. Indeed, even the experts are operating under significant uncertainty. See *supra* Part III.

49. PETER BACHRACH, THE THEORY OF DEMOCRATIC ELITISM: A CRITIQUE 95 (1967).

50. Paul Slovic, *Perceived Risk, Trust, and Democracy*, 13 RISK ANALYSIS 675 (1993); Pildes & Sunstein, *supra* note 43, at 40-45.

51. Slovic, *supra* note 50, at 680. Slovic felt that the power in decision-making needed to be shared in order to preserve trust. As was previously stated, decision-making by the public may result in distortions of the risks. Thus, every effort should be directed towards resolving distortions and attaining consensus.

52. *Id.*

53. *See, e.g., Virginians Speak Clearly in Poll; Protect Our Environment*, THE VIRGINIAN PILOT, June 23, 1995, at A14 (finding that 60-70 percent of the voters rejected a lessening of environmental regulation); John H. Cushman, Jr., *Environment Gets a Push from Clinton*, N.Y. TIMES, July 5, 1995 at A11 (describing Clinton's heightened environmental awareness in response to poll results); Bill Lambrecht, *Environmentalists See Poll as Proof of Public Support*, ST. LOUIS POST DISPATCH, Dec. 22, 1994 at A7 (citing support for environmental laws ranging from 56 to 76 percent).

be ignored. The organization could analyze the prevailing public sentiment with an eye to possible distortions. If such distortions exist, the organization should seek to educate the public by giving the public any information it lacks. However, if, in the end, the organization's valuation simply differs from the public's valuation, the organization should prevail because of the aforementioned potential problems with the public's valuation. By overriding the public valuation, the organization should be attempting to protect those ecological functions that are highly valued by society, but have been ignored because of problems of information or externalities.

In other words, it is the role of the organization to represent the public interest.[54] While ecological health is an interest held by all persons, not all people necessarily are aware of it. Thus, the relationship between the experts and the public would be analagous that of the doctor and patient, where a patient may be unaware of his or her health concerns until informed by a doctor.

As a result of this approach, a select group will be created to determine what consequences are and are not desirable. Such a group should be established in a manner that would avoid the pitfalls of similar organizations in the years past. This result should be a highly developed system for communicating between the group and the affected public in order to elicit the public's values and maintain the public's interest and trust. The system must go beyond ordinary public relations efforts. The public's representatives should be sought out and involved in the deliberative process in order to ensure adequate participation and instill trust.

Once the decision-maker is established, a second issue that must be addressed is the basis for decision-making. Some authors have proposed that the rise of non-equilibrium theories of ecology has undermined the "ethical" basis for the regulation of ecosystems.[55] Rather, they suggest that only scientific justifications should form the basis for such regulation.[56]

However, no clear boundary seems to exist between science and ethics. Instead, all justifications seem to be an unavoidable mix of the

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54. Richard E. Klosterman, *A Public Interest Criterion*, 46 J. OF THE AM. PLAN. ASS'N 323, 324 (1980).

55. Tarlock, *supra* note 23, at 1121 n.1.

56. *Id.*

two.[57] Science told us that the bald eagle was not reproducing because of DDT, but it was an ethical decision to protect the eagle. Perhaps the term "science" as used by the above authors is intended to justify the regulation of those dynamics that will have an adverse effect on the ecological well-being of the earth. Even that definition, however, would not include the full set of defensible justifications for environmental protection. In particular, several "nonscientific" grounds for regulation are evident that do not relate to the healthy functioning of ecosystems.[58]

First, environmental economists have long identified values such as "existence value" and "aesthetic value," neither of which necessarily is related to how well an ecosystem is functioning. The former value reflects the public's willingness to pay for the existence of a certain environmental commodity in the world.[59] For example, in one study, persons who do not ever venture into high elevation spruce-fir forests were found to value the existence of these ecosystems at a median value of $10.81 per person.[60] While the willingness to pay may not capture the actual ethical value, it is still indicative of the influence of such a value in society. Similarly, the values corresponding to the aesthetic enjoyment of ecological resources have been determined. For the visitors to Mesa National Park, the aggregate annual benefits from restoring clear visibility in the park

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57. *See* Donald A. Brown, *After the Earth Summit: The Need to Integrate Environmental Ethics Into Environmental Science and Law*, 2 DICK. J. ENVTL. L. & POL'Y 1 (1992).

58. Our values, however, do not lead to the best ecological management in every instance. For example, humans highly value the existence of the dolphin. The controversy over dolphin mortality from tuna fishing resulted in the discouragement of purse seine fishing in favor of techniques such as drag net and line fishing. While the preferred techniques did decrease dolphin mortality, they increase the stress on the ecosystem through bycatch. Jason S. Mubarak, Analysis of Bycatch by Method in the Eastern Tropical Pacific Purse-Seine Tuna Fishery (1996) (unpublished Master's Project on file with the Nicholas School for the Environment).

59. *See* J. Krutilla, *Conservation Reconsidered*, 57 AM. ECON. REV. 777 (1967).

60. Thomas P. Holmes and Randall A. Kramer, *Contigent Valuation of Ecosystem Health*, ECOSYSTEM HEALTH, March 1996, at 1. *See also* Richard G. Walsh et. al., *Valuing Option, Existence, and Bequest Demands for Wilderness*, LAND ECON., Feb. 1984, at 14. However, the mechanism used to attain this value may not sufficiently capture the qualitative value placed on ecosytems. *See* Douglas R. Williams, *Valuing Natural Environments: Compensation, Market Norms, and the Idea of Public Goods*, 27 CONN. L. REV. 365 (1995); MARK SAGOFF, THE ECONOMY OF THE EARTH (1988). *But see* Paul R. Portney, *The Contingent Valuation Debate: Why Economists Should Care*, J. OF ECON. PERSP., Fall 1994, at 3.

were found to be somewhere between $504,000 and $516,000.[61] For the visitors to Great Smoky Mountains, the value ranged between 8.5 million and 10.5 million.[62]

Second, ecosystems also hold a value for the public as a place set apart from the hustle and bustle of modern society. For example, Joseph Sax described the ethereal values of the outdoors when he argued that National Parks should be preserved for human adventurers "precisely because it provides a stimulus to engage the contemplative faculty."[63] Some writers have found Sax's theory to be out-of-date as representative of the separatist view of human apart from nature,[64] and Sax's writings may in fact represent such a bias. However, they are not devoid of meaning. As stated above, whether we as humans are part of or separate from nature should be irrelevant. What is relevant is that a value exists for humans in being able to exist in ecosystems that are more removed from humans' civilization than others. Removing ourselves from civilization can have profound impacts on the processes of human thought, often giving us pleasure and excitement. Most of all, it reduces our hubris in relation to the rest of the world. Just because this concept has been framed in a separatist way does not mean that it should not hold import in the setting of ecological baselines.

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61. Douglas A. Rae, *The Value to Visitors of Improving Visibility at Mesa Verde and Great Smoky Mountain National Parks, in* Managing Air Quality and Scenic Resources at National Parks and Wilderness Areas 217, 232 (Robert D. Rowe and Lauraine G. Chestnut, eds., 1983). *See also* W.D. Schulze et. al., *The Economic Benefits of Preserving Visibility in the National Parklands of the Southwest*, 23 NAT. RESOURCES J. 149 (1983) (finding, among other values, an annual national benefit for visibility in the Grand Canyon of about $3.5 billion).

62. Rae, *supra* note 61.

63. JOSEPH L. SAX, MOUNTAINS WITHOUT HANDRAILS: REFLECTIONS ON THE NATIONAL PARKS 20, 27 (1980).

64. *See* Wiener, *supra* note 7, at 343.

II. REGULATION WITHIN DYNAMIC SYSTEMS

A. Abandoning the Balance

Environmental regulation must also adjust to the dynamic and ever-changing operation of ecosystems. Systems are subject to innumerable influences, and do not tend to remain in any climax state.[65] They operate beyond our ability to manage for certain outcomes.[66] In such a situation, human beings are limited by a "bounded rationality."[67] In other words, instead of being able to consider all of the possible alternatives, regulators will pick from a limited set.[68] In the end, the chosen alternative may not be the optimal one.

Uncertainty derives from several sources. First, ecological systems operate in a chaotic way and vary from system to system.[69] Although trends and tendencies can be delineated for specific types of ecosystems, no firm rule of scientific law can be applied. As such, the next direction an ecosystem will take is unknowable and constitutes a permanent uncertainty that the regulatory system needs to accept.

Second, ecological effects are often so attenuated from the cause that the relationship rarely is foreseen. To pick one of the thousands of available examples, a recent study revealed previously undiscovered repercussions of acid rain for the songbird populations in the Netherlands.[70] The effect occurred at the end of a long causal chain. First, acid deposition had leached the soil of its nutrients, including

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65. *See, e.g.*, Carl J. Walters and C.S. Holling, *Large-Scale Management Experiments and Learning by Doing*, 71 ECOLOGY 2060 (1990); BOTKIN, *supra* note 1, at 12-13.

66. Walters and Holling, *supra* note 65, at 2060 ("[I]n no place can we claim to predict with certainty either the ecological effects of the activities, or the efficacy of most measures aimed at regulating or enhancing them"); Lance H. Gunderson et. al., BARRIERS AND BRIDGES TO THE RENEWAL OF ECOSYSTEMS AND INSTITUTIONS 33 (1995) ("Citizen[s] and politician[s] are now frustrated because they are not hearing simple and consistent answers to the . . . key questions about present environmental and renewable resource issues.")

67. LEE, *supra* note 16, at 52; *See also* HERBERT SIMON, ADMINISTRATIVE BEHAVIOR; A STUDY OF DECISION-MAKING PROCESSES IN ADMINISTRATIVE ORGANIZATION 61-78 (2d. ed. 1957).

68. LEE, *supra* note 16, at 52.

69. BOTKIN, *supra* note 1, at 6.

70. J. Graveland et al., *Poor Reproduction in Forest Passerines from Decline of Snail Abundance on Acidific Soils*, 368 NATURE 446 (1994).

calcium.[71] This led to a reduction in the populations of ground snails who need calcium for the composition of their shells.[72] As the snail shells were the primary source of calcium for the songbirds, the birds' calcium intake declined, resulting in a thinning of the shells of their eggs and increased pre-hatching mortality.[73] To predict this consequence, the regulator would have had to anticipate four or five causal steps.

Third, uncertainty arises because of discontinuities in ecological functions. A classic example of a discontinuity is the freezing of water. Water remains fluid until it reaches a temperature threshold, at which time it goes through significant change.[74] Ecological discontinuities occur when an ecosystem does not show signs of stress until it reaches a threshold. Once it reaches the threshold, the stress becomes evident in critical levels.[75] For example, forest ecosystems undergo "creeping degradation" from acid rain, showing only slight stress until reaching a threshold at which they display severe injury.[76]

Finally, uncertainty is caused by unanticipated synergy between ecological stresses. Synergy occurs when two or more stressors act together to create a cumulative stress that is greater than the sum of their parts.[77] For example, plants that are exposed to unusually high-temperatures and water stress are much more vulnerable to pests and disease than they would be if the two stressors occurred separately.[78]

The management of ecological resources must adjust to confront uncertainty. Faced with a lack of knowledge, humans must use one of the differentiating characteristics of our society — our ability to reflect on the consequences of our actions and readjust our behavior. Instead of attempting to formulate a system that accounts for all contingencies, management efforts should adopt an "adaptive management" technique.

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71. *Id.* at 447-48.

72. *Id.*

73. *Id.*

74. Norman Myers, *Environmental Unknowns*, 269 SCIENCE 358 (1995).

75. *Id.* at 359.

76. F.H. Bormann, *Air Pollution and Forests: An Ecosystem Perspective*, 35 BIOSCIENCE 434 (1985).

77. Myers, *supra* note 74, at 359.

78. *Id.*

"Adaptive management" is an approach with a long history in the academic discussions of ecological management.[79] Proponents of this approach have long counseled that environmental regulation should provide feedback loops to update regulatory efforts as information increases.[80] Such an approach, however, is counterintuitive for the American legal system, which puts a premium on firm rules of law. As a result, it has not been seriously incorporated into environmental regulation. With ecological advances increasingly highlighting the troubles with firm policies, however, adaptive management's day in the sun has arrived.

Adaptive management recognizes that all management of ecological resources is inevitably an ongoing experiment.[81] Accepting this, it seeks to structure the management scheme so that the experiment will yield as much understanding about the ecosystem as possible. An adaptive approach begins with the formulation of a management plan based on the best available scientific understanding.[82] The plan should not only be designed in order to optimize the chosen ecological goods,[83] but should also be designed with an eye to acquiring new knowledge about the influences on the ecosystem.[84]

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79. *See* C.S. HOLLING, ADAPTIVE ENVIRONMENTAL ASSESSMENT AND MANAGEMENT (1978); CARL WALTERS, ADAPTIVE MANAGEMENT OF RENEWABLE RESOURCES (1986); LEE, *supra* note 16.

80. Tarlock, *supra* note 23, at 1139.

81. Kai Lee and Jody Lawrence have proposed five principles of adaptive management for natural resources. Paraphrased, they are: (1) protecting and restoring fish and wildlife is a common objective; (2) projects are inevitably experiments; the choice is to make them good ones or poor ones; (3) action with the expectation of surprise is an important way to produce new knowledge; (4) information has value, not only as a basis for action, but also as a product of action; and (5) enhancement measures may be limited in time, but management is forever. Kai Lee and Jody Lawrence, *Adaptive Management: Learning from the Columbia River Basin Fish and Wildlife Program*, 16 ENVTL. L. 430, 451 (1986).

82. *Id.* at 435; FEMAT Report, *supra* note 19, at VIII-17. Although prediction is difficult with dynamic systems, it is not without merit (much like the weather can be predicted with some success). Moreover, an initial prediction is essential if regulation is going to have any direction. *See* Ann-Marie Stomp, *Genetic Information and Ecosystem Health: Arguments for the Application of Chaos Theory to Identify Boundary Conditions for Ecosystem Management*, ENVTL. HEALTH. PERSP., Dec. 1994, at 71, 72 (stating that "[w]ithout prediction, regulation is meaningless and systematic prevention of deleterious effects is impossible.")

83. *See supra* Part II.

84. Walters and Holling, *supra* note 65, at 2061; LEE, *supra* note 16, at 53-60; John M. Volkman and Willis E. McConnaha, *Through a Glass, Darkly: Columbia River Salmon, The Endangered Species Act, and Adaptive Management*, 23 ENVTL. L. 1249, 1255 (1993). The degree that a regulatory approach should be tailored in order to achieve a greater understanding in lieu of the conservative protection of the ecological resource is a subject of debate. *See infra* notes 85-94.

Once action is taken, the ecosystem's response is monitored with a heightened awareness for occurrences such as attenuated effects, discontinuities and synergisms.[85] Which parameters to monitor is a policy-specific decision. However, the health of populations of a specific species or "functional group" that is sensitive to environmental stressors is one approach that is often recommended.[86] Finally, the monitoring data should be cycled back into the decision-making process, resulting in an updated plan if warranted.[87]

A decision to engage in adaptive management is only the beginning of the inquiry. Adaptive approaches vary in the intensity with which experimental data is pursued. Carl Walters and C.S. Holling have divided the choices into three categories: (1) an evolutionary or "trial and error" approach; (2) a passive adaptive approach; and (3) an active adaptive approach.[88] The first of the three approaches picks an initial managerial plan almost haphazardly and makes later choices given what approaches have yielded the best results.[89] This is easily dismissed; more forethought is nearly always possible before engaging in a plan.[90] Therefore, the choice is often between the passive and active adaptive approaches.

The passive and active adaptive approaches differ in the aggressiveness with which the managerial plan pursues explanatory data. The passive adaptive approach takes the monitoring data available each time a regulatory option is reviewed and manages based on the best estimate or model for response.[91] In contrast, an active approach pursues a plan that achieves a balance between the goals of preserving the ecosystem and gaining further information

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85. FEMAT Report, *supra* note 19, at VIII-17; WALTERS, *supra* note 79, at 163; Walters and Holling, *supra* note 65, at 2060.

86. *See* Meyer, *supra* note 1, at 885 (stating that "populations usually show the first sign of environmental stress"); Stephen R. Carpenter et. al., *Ecosystem Experiments*, 269 SCIENCE 324, 326 (1995) (stating that "population responses are generally more sensitive indicators of stress than ecosystem responses."); Richard Stone, *Taking a New Look at Life Through a Functional Lens*, 269 SCIENCE 316 (1995). *See also* LEE, *supra* note 16, at 67 (finding that focusing on specific sensitive organisms also lowers costs).

87. FEMAT Report, *supra* note 19, at VIII-17; WALTERS, *supra* note 79, at 163; Walters and Holling, *supra* note 65, at 2060.

88. Walters and Holling, *supra* note 65, at 2060.

89. *Id.*

90. *Id.* There are many rare cases where an evolutionary approach is valid. For example, when an ecological stressor is unique, there may be insufficient knowledge about the relationship between the stressor and the ecosystem to tailor a plan.

91. *Id.*

about the ecosystem's current functions.[92] While the passive approach will recognize a misdirected policy and allow it to change, it may not be capable of identifying the reason for a given policy's failure.[93] On the other hand, a passive approach does not subject a managed ecosystem to the same amount of risk as an active approach. An active approach will take more risks with the populations in an effort to discern what influences have significant effects on the ecosystem.[94]

The decision between a passive and active approach also can be very political. Often adaptive management is applied to efforts to protect endangered species, where the consequences of an unsuccessful policy can be severe. The political will to experiment aggressively with already imperiled populations of species is often lacking.[95] Still, over the long-term an active approach may discern a more accurate view of the situation and instigate a more successful program in the end.

Most regulatory schemes should fall between a passive and active approach. First and foremost, they should not risk irreversible changes on a scale that threatens the ecosystem's well-being.[96] On the other hand, an adaptive approach cannot be so passive that it does not succeed in obtaining any data.[97] Thus, in formulating an approach, the manager needs to balance the competing concerns. Generally, the approach should manipulate the ecosystem in a way that is "simple, direct, and sustained long enough to detect changes against background variability,"[98] but no longer.

Given these tradeoffs, the timing of the initiation of an adaptive approach becomes very important. As stated above, if it is a situation

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92. *Id.* at 2061.

93. *Id.* (describing how a passively adaptive plan for changing the hydrology in the Florida Everglades may not provide a clue to its possible failure because the plan will not actively challenge several possible hypotheses).

94. *Id.*

95. Volkman and McConnaha, *supra* note 84, at 1265; LEE, *supra* note 16, at 53.

96. This is a principle that is well-supported by environmental managers. *See* U.S. Environmental Protecton Agency Scientific Advisory Board, *The Report of the Ecology and Welfare Committee*, in REDUCING RISK: SETTING PRIORITIES AND STRATEGIES FOR ENVIRONMENTAL PROTECTION app. A at 69 (1990) (ranking the environmental risks facing the nation on the basis of intensity of the stress, the physical scale of the impact, and the time for recovery from the stress).

97. *See* Walter and Holling, *supra* note 65, at 2061 (objecting to passive approaches because "they are likely to confound management and environmental effects" and they "may fail to detect opportunities for improving system performance"); LEE, *supra* note 16, at 56-57.

98. Carpenter et. al., *supra* note 86, at 324.

involving an endangered species, the political implications of a failed "experiment" could undermine all support for adaptive management.[99] Unfortunately, the management of an endangered species is also a case when knowledge is most needed.[100] Although this Catch-22 seems unavoidable, it does counsel managers to apply the process earlier, before a crisis arises, so that aggressive approaches may be taken to attain information without serious irreversible consequences.

B. Adaptive Management in Practice

Adaptive management has been used in several well-known ecosystems, including the Chesapeake Bay, the Columbia River, and the old growth forests of the Pacific Northwest. These schemes have arisen in several ways. Some have simply evolved an adaptive approach,[101] while others have explicitly adopted the approach.[102] Whatever their source, however, all of these previous attempts have had successes and failures that can shape future attempts.[103]

Efforts to protect the Chesapeake Bay ecosystem evolved to incorporate an adaptive approach.[104] Concern over the Chesapeake ecosystem arose in the early 1970's, when Senator Charles Mathias and EPA Administrator Russell Train voiced concerns over the declining fisheries and rising pollutants in the bay.[105] Congress initially authorized a five-year study of the threats to the bay in 1975.[106] However, it was not until 1983 that a structure was formed

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99. LEE, *supra* note 16, at 53-54 (describing the political risks). Lee also acknowledges that active experimentation when risks to human populations are involved is too risky. Lee and Lawrence, *supra* note 81, at 451. *See also* Volkman and McConnaha, *supra* note 84, at 1257.

100. Passive adaptive management should still be pursued in such a situation as the door should always be open to more information. A passive approach is an improvement from a non-adaptive system. Walters and Holling, *supra* note 65, at 2061 (stating that some things can be learned with a passive approach).

101. *See* Timothy M. Hennessey, *Governance and Adaptive Management for Estuarine Ecosystems: The Case of Chesapeake Bay,* 22 COASTAL MGMT. 119 (1994).

102. *See* FEMAT REPORT, *supra* note 19, at VIII-7.

103. For other adaptive management efforts, *see* Stephen M. Dewhurst et. al., *Developing a Model for Adaptive Ecosystem Management: Goshawk Management on Arizona's Kaibab Plateau,* J. FORESTRY, Dec. 1995, at 35; R.B. Grayson et. al., *Application of AEAM (Adaptive Environmental Assessment and Management) to Water Quality in the Latrobe River Catchment,* 41 J. ENVTL. MGMT. 245 (1994).

104. Hennessey, *supra* note 101.

105. *Id.* at 123.

106. *Id.* at 124.

to govern the ecosystem.[107] This structure, consisting of a decentralized, cooperative system of local, state and federal government, generated a plan and implemented it within two years.[108] Though this action was taken quickly, the organization realized within a few years that it needed to reevaluate and update its regulatory plan.[109] Thus, it began to use an adaptive management strategy.[110]

The adaptive approach highlighted a few informational gaps in the Chesapeake Bay's regulatory program. With the complex interactions of the ecosystem, several key species needed to be identified in order to gauge success.[111] Moreover, the habitat for those key species needed to be better defined.[112] Finally, the impact of different water quality levels had to be correlated with these species and their habitat.[113]

The adaptive approach has resulted in some success. Attention is now given to plankton and benthic communities as key species. They have proven to be good indicators of ecosystem stress since they serve as food sources for species at higher trophic levels.[114] Management efforts have been refined in order to monitor and preserve the habitat for these communities.[115] Still, to date, the program has failed to identify the exact relationships between different levels of water quality and the health of essential habitats.[116]

In his critique of this effort, Thomas Hennessey concentrated on the institutional structure of the Chesapeake organization.[117] Although he complimented the program for opting for a decentralized system over a "single-centered, hierarchical governance system," his review also revealed that the diffuse approach bred its own problems. Specifically, the expansion of the regulatory system into its own complex "ecology of governance" made it more difficult for the

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107. *Id.* at 127.
108. *Id.* at 130.
109. *Id.*
110. *Id.*
111. *Id.* at 136-37.
112. *Id.* at 137.
113. *Id.*
114. *Id.*
115. *Id.*
116. *Id.* (citing a report to Congress recommending further study in these areas).
117. *Id.* at 138-41.

different branches of the program to coordinate their efforts.[118] Hennessey also found a weakness in the program's lack of responsiveness. He pointed out that nearly $120 million and seven years were invested in research before any action was taken.[119] If an adaptive approach had been the initial intent, such learning would have occurred as the management progressed.

Still, the Chesapeake program offers some useful lessons for adaptive management. First, it helped establish that an adaptive approach provided the best alternative to the regulation of complex systems. As Hennessey stated:

> One important lesson derived from the Chesapeake Bay Program experience is that the nature of large-scale estuarine ecosystems and the human uses of them create conditions of complexity, both human and natural, that severely constrain such systems from being managed in a synoptic, integrated, comprehensive manner — at least initially . . . . A significant degree of program comprehensibility and integration can be attained, but only through a process of evolution and discovery. Such a system copes with uncertainty and is not defeated by it.[120]

Second, the Chesapeake program pointed out that the "ecology of governance" is an unavoidable occurrence when addressing a complex system.[121] Any future adaptive management efforts should anticipate the difficulties in coordinating such a system and create institutional structures to facilitate communication between the stakeholders.

A second application of the adaptive management methodology occurred in the management of the Columbia River basin. Intensive management of the basin began with the listing of several Snake River salmon populations as endangered species.[122] The fish had been victim to many human perturbations, the greatest of which was the hydroelectric dams built on the Columbia River.[123] In crafting

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118. *Id.* at 130. Hennessey did feel, however, that such a complex web was inevitable, and that some "ecology of governance" was preferable. *Id.* at 140.

119. *Id.* at 139-40.

120. *Id.* at 140.

121. *Id.*

122. Volkman and McConnaha, *supra* note 84, at 1250.

123. *Id.*

a management plan, an adaptive scheme was proposed and undertaken.[124] In particular, management approaches were designed to further understanding of such ecosystem dynamics as the relationship of river flow to juvenile fish survival and the success of transporting juvenile fish around dams.[125]

In their review of the effort, John Volkman and Willis McConnaha again were supportive of the general approach, but found flaws in the specific implementation. In general, Volkman and McConnaha felt that the system was constrained by the political pressures against experimenting with endangered species and had collected insufficient data as a result.[126] In fact, the uncertainty surrounding the transportation of the juvenile fish even led some environmental groups to conclude that the effort was harming the fish and to sue, albeit unsuccessfully, to enjoin the practice.[127] To Volkman and McConnaha, however, the problem lay in the implementation and not the theory of adaptive management. Their recommendations were to continue the system, but with a more purposeful approach towards finding the answers, even if some risks must be taken with the endangered species.[128]

Finally, adaptive management has been adopted on the largest scale ever in the new forest plan for the Pacific Northwest.[129] The plan governs the federal lands in Oregon, Washington, and northern California and attempts to resolve the conflicts arising from the protection of the spotted owl as an endangered species.[130] It regulates on the basis of ecosystem units, and expressly adopts adaptive management as a core approach.[131] Furthermore, it designates ten areas ranging from 80,000 to 400,000 acres as "Adap-

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124. *Id.* at 1255.

125. *Id.* at 1259-1260.

126. *Id.* at 1260.

127. *Id.* at 1261 (citing Northwest Resource Information Center v. National Marine Fisheries Service, No. 93-469-MA (D. Ore., oral opinion announced Apr. 29, 1993)).

128. *Id.* at 1272.

129. FEMAT REPORT, *supra* note 19, at VIII-1.

130. BERNARD T. BORMANN ET. AL., ADAPTIVE ECOSYSTEM MANAGEMENT IN THE PACIFIC NORTHWEST, 1-3 (1994) (Government document number PNW-GTR-341).

131. FEMAT REPORT, *supra* note 19, at VIII-1.

tive Management Areas" (AMAs).[132] The AMAs are pilot programs for a more active adaptive approach.

At this point, the forest plan has just been initiated and the process will need to go forward before lessons can be drawn. However, several interesting dynamics have evolved in the implementation of the process. According to a report reviewing the Applegate AMA in Oregon, the governance of the AMAs has evolved into a decentralized system in an effort to address the ecosystems' complexities and allow the public a voice.[133] The report stressed the fact that many individuals committed to the prospects were involved with the project and that barriers between the community and the regulatory agency dropped.[134] Moreover, the report stressed that interagency cooperation had heightened in order to address more efficiently the management concerns.[135] Still, institutional barriers seem to have blocked the quick implementation of the adaptive approach in the Applegate AMA. Administrative staff acknowledged that they felt increasingly overburdened with the the additional burdens of monitoring and evaluation from adaptive management.[136] Also, the implementation of adaptive management seems to have provided a perverse incentive. By focusing on learning from ecological responses to management techniques, the scheme has made managers even more risk adverse. Because managers knew that the results would be analyzed, they became even more hesitant and analytical in their actions, attempting to avert any adverse outcomes that could be traced to them.[137]

Aware of these potential institutional barriers, the agencies charged with implementing the Pacific Northwest forest plan have begun to "institutionalize adaptability."[138] Recognizing that "[p]eople tend to limit their thinking to what they already know,"[139]

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132. Margaret Shannon et. al., Organizing for Innovation: A Look at the Agencies and Organizations Responsible for the Adaptive Management Areas: The Case of the Applegate AMA 5 (1996) (report submitted to Interagency Liaison, Forest Service and Bureau of Land Management).

133. *Id.* at 13.

134. *Id.* at 23-25

135. *Id. But see id.* at 13 (stating that "staff in different agencies felt that they were 'smooshed' together and struggling to work collaboratively across agency boundaries shaped by different cultures, professions, policies, and guidelines.")

136. *Id.* at 25-26.

137. *Id.* at 26-27.

138. BORMANN ET. AL., *supra* note 130, at 3.

139. *Id.*

the plan's administrators are seeking to create a "cookbook" approach to adaptive management that will become routine.[140] Such an approach would circumvent some of the problems found at the Applegate AMA, as agency staff should become less reluctant to try and more adept at using the adaptive management methodology.

C. *Instituting Adaptive Management in the Present System*

To adopt adaptive management as the standard would require a major readjustment in the current regulatory system. First, such an approach would need to be pursued through the administrative system. As it definitionally would not have firm rules of law, both the public and the courts might be concerned with the lack of legal finality and political accountability. These concerns would have to be balanced against the benefits derived from the ability to adjust to the uncertainty of ecosystems. Second, it must recognize the numerous scales on which ecological functions occur and the variability from ecosystem to ecosystem. Each ecosystem operates independently and has its own ecological goods, attenuated effects, synergisms, and discontinuities. An ecosystem's boundaries also might differ depending on what function is being analyzed. As a result, the regulation should be defined by the best available ecological boundaries and pursued with an open eye to influences on other scales. Finally, any adaptive management system must be structured so as to overcome practical, non-legal barriers to successful implementation that have been apparent in previous attempts.

Adaptive management cannot be pursued through the legislative branch. Its need to quickly adjust the regulatory system would be thwarted in the political bog that is our democratic process.[141] Accordingly, it must be pursued through an insulated, administrative system that can act without too many procedural burdens.[142]

This alternative, however, raises the specter of an unchecked branch of government with the power to alter laws anytime it desires. Our governing system is premised on political accountability, yet it is

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140. *Id.*

141. *See* R. DOUGLAS ARNOLD, THE LOGIC OF CONGRESSIONAL ACTION (1990) (describing the difficulties of getting policy initiatives for the public good through Congress); STEPHEN BREYER, BREAKING THE VICIOUS CIRCLE 39-42 (1993) (finding Congressional action and reaction to risk often to be misguided and inadequate).

142. *See* LEE, *supra* note 16, at 63 (suggesting that the institutional structure for adaptive management must be responsive and quick to act).

this very thing that an insulated adaptive system would seek to avoid. Furthermore, our economic and legal systems have also put a premium on certainty.[143] These systems intend for regulated bodies to know the rules under which they are operating. Once again, however, an adaptive scheme would be designed to allow quick changes in regulatory schemes, running contrary to our certainty concerns. A viable adaptive system must overcome these contradictions.

These obstacles do not have to be fatal to an adaptive scheme. These predispositions of the law were developed before vast complexity was an issue. Our conception of responsible rulemaking was developed with an image of static ecosystems. If a persuasive case is made to address the reality of ecological disequilibrium, the law, much like organisms and ecosystems, has the ability to evolve in step with real world problems.[144] Furthermore, an adaptive scheme could be structured to maintain the maximum possible political accountability. A scheme should reflect Thomas Hennessey's "ecology of governance,"[145] with state and local officials being equal partners in the experiment. A premium also should be put on public input in order to elicit values and secure public trust.[146] An adaptive approach also would not have to delegate complete discretion to the insulated regulators. Rather, the scheme could consist of a cascade of different rules, providing certainty where possible and allowing discretion where necessary.[147] Finally, the feasibility of an adaptive scheme should increase if the level of trust in agency staff increases among the regulated community. Trust should increase with the success of environmental programs, which will both strengthen and mitigate regulations based on ecological goals. Several current programs sponsored by the Clinton Administration may cultivate this cooperation.[148]

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143. *See* Tarlock, *supra* note 23, at 1140.

144. *See* E. Donald Elliott, *The Evolutionary Tradition in Jurisprudence*, 85 COLUM. L. REV. 38 (1985); Herbert Hovenkamp, *Evolutionary Models in Jurisprudence*, 64 TEX. L. REV. 645 (1985).

145. *See supra* notes 104-121.

146. *See supra* notes 52-55.

147. Such a scheme would be most easily implemented in response to perfomance-based legislation from Congress.

148. Examples include the AMAs of the Pacific Northwest, *see supra* notes 125-136, or Project-XL, a program to provide regulatory flexibility to corporations that achieve lower emissions outside of the regulatory scheme. Gary Lee, *Regulators Urged to Alter Approach to Pollution; Panel Says Government Should Prescribe Targets, Not Means*, WASH. POST, Feb. 14,

The same issues that plague an adaptive approach on the political level could cause legal concerns. Specifically, a management scheme cannot be in a state of constant flux because some certainty is necessary to satisfy substantive and procedural due process.[149] Still, a degree of flexibility sufficient to allow an adaptive approach should be legally permissible. The Supreme Court has expressed sympathy for the need for adaptability in past decisions, although such cases admittedly did not involve an equivalent potential for volatility. For example, in *Motor Vehicle Mfrs. Ass'n v. State Farm Mutual Ins. Co.*, the Court recognized that " '[r]egulatory agencies do not establish rules of conduct to last forever,' . . . and . . . an agency must be given ample latitude to 'adapt their rules and policies to the demands of changing circumstances.'"[150] As long as an adaptive management scheme is approved pursuant to the Administrative Procedure Act, then each individual manipulation in the management plan should not violate due process. After all, an aggrieved party would not be completely at the whim of the regulators; he or she would still be able to bring a claim that the adaptation was "arbitrary and capricious" under the Administrative Procedure Act. In fact, the Pacific Northwest forest plan contained provisions for adaptive management and was approved without any due process concerns.[151] While the due process issue likely was not ripe in the origination of the plan, it is the type of issue that the court could have considered while reviewing under an "arbitrary and capricious" standard.

In addition, legal policy concerns support allowing adaptive techniques to proceed with minimal procedural requirements. To do otherwise would create impediments to wise actions and involve the courts in unnecessary review of administrative actions. For example, in a recent Ninth Circuit case, the court enjoined all projects on national forest land because of the listing of chinook salmon as an endangered species.[152] The court disallowed the Forest Service's attempts to adapt its plans to the new occurrence because the Forest

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1996, at A3.

149. *See* Tarlock, *supra* note 23, at 1141.

150. Motor Vehicle Mfrs. Ass'n v. State Farm Mutual Ins. Co., 463 U.S. 29, 42 (1983) (citing Am. Trucking Ass'ns., Inc. v. Atchison, T. & S.F.R. Co., 387 U.S. 397, 416 (1967) and Permian Basin Area Rate Cases, 390 U.S. 747, 784 (1968)).

151. Seattle Audubon Soc'y v. Lyons, 871 F.Supp. 1291 (W.D. Wash. 1994).

152. Pacific Rivers Council v. Thomas, 30 F.3d 1050 (9th Cir. 1994), *pet. for cert. denied*, 115 S.Ct. 1793 (1995).

Service was not certain of the outcome.[153] Instead, the court ordered the Forest Sevice to redraft the entire forest management plan.[154] Thus, imposing strict requirements on adaptive schemes may bog them down, even when the proper course of action is obvious.[155]

Adaptive management also would be severely hampered if it were not pursued on an ecosystem scale. "Ecosystem" as a concept does not mean any static, defined area.[156] The boundaries of an ecosystem will depend on the type of ecological process that is being analyzed and will be subject to the same rules of disequilibrium that require an adaptive approach. Still, an adaptive approach will need to be able to control the ecosystem on which it is experimenting in order to incorporate the complex ecological interactions into the management scheme. To do so along political boundaries would not allow the regulators to control many of the influences on the area that is to be managed. Thus, adaptive management should be pursued on an ecosystem level that corresponds to the scale of the management problem at hand.

Adaptive management on the ecosystem level will likely involve Hennessey's "ecology of governance," with a complex mix of local, state, and federal government.[157] The latter entity is essential — management on an ecosystem scale should involve federal law. Federalized ecosystem management would avoid the problems that confront environmental regulation on the state and local level. A federal role would avoid externalities by providing oversight to ensure the consideration of environmental impacts that are outside the jurisdictions of the other governments. Moreover, while the ecosystem boundaries would be preferable to political ones, they can not be perfectly drawn in a constantly shifting world that operates on various scales. Impacts from outside the management area are unavoidable and the federal overseer would be better situated to observe them.

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153. *Id.* at 1057.

154. *Id.*

155. Also note that in the *Pacific Rivers* example, the increased regulation stalled efforts that were in favor of the regulated parties, who are thought to be the opponents of too much agency discretion.

156. *See* Francis C. Evans, *Ecosystem as a Basic Unit in Ecology*, 123 SCIENCE 1127 (1956); Peter M. Vitousek and William A. Reiners, *Ecosystem Succession and Nutrient Retention: A Hypothesis*, 25 BIOSCIENCE 376 (1975).

157. This type of intergovernmental cooperation was strongly recommended in the report of the President's Council on Sustainable Development. SUSTAINABLE AMERICA, *supra* note 38, at 53.

Finally, localized regulation of any form would raise a concern about a "race-to-the-bottom," where local governments would try to undercut each other's environmental regulation in order to attract industry.[158] A federal role could operate to disallow any efforts to "race."

By pursuing management on an ecosystem level, the scheme would also avoid some of the pitfalls of federal management. There would be no inflexible national uniform standards. Instead, regulation would be pursued on the scale of the problem and the regulatory impositions could be limited only to the areas necessary. In addition, the scheme could be much more responsive to local needs and assessments of risk than a universally applicable regulation.[159] Responsiveness, after all, is a definitional characteristic of adaptive management.

Problems with the institutional implementation of adaptive management need to be addressed as well. As is being borne out in the Pacific Northwest's Adaptive Management Areas,[160] the agency staff are not predisposed to admitting uncertainty and a need to change.[161] Their authority to regulate comes from their expertise in the field and it is counterintuitive to admit any lack of knowledge. Moreover, the adoption of an adaptive approach would impose new, unwanted, and non-routine duties on agency staff.[162] Finally, agency staff are likely to feel that they have a stake in the outcome of the management experiment, giving them perverse incentives to look for favorable results.[163]

Many of the problems with agency staff are problems of human nature that are best overcome through personal interaction. Still, some measures within the agencies may aid in the smooth adoption

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158. Richard Stewart, *Pyramids of Sacrifice? Problems of Federalism in Mandating State Implementation of National Environmental Policy*, 86 YALE L.J. 1196 (1977). *But see* Richard L. Revesz, *Rehabilitating Interstate Competition: Rethinking the "Race-to-the-Bottom" Rationale for Federal Environmental Regulation*, 67 N.Y.U. L. REV. 1210 (1992).

159. Recall, however, that all local preferences and assessments of risk may not be the proper judgments for regulation, as they may be distorted by prejudices of the locality and the generation. *See supra* notes 42-46.

160. *See supra* notes 125-136.

161. Shannon, *supra* note 132, at 23-25.

162. *Id.*; *See also* LEE, *supra* note 16, at 81.

163. Shannon, *supra* note 132, at 23-25; LEE, *supra* note 16, at 77 ("The first challenge is to do experiments at all . . . . Trapped adminstrators have so committed themselves in advance to the efficacy of the reform that they cannot afford honest evaluation. For them, favorably biased analyses are recommended . . . .")

of adaptive management. In particular, the federal government's effort to "institutionalize adaptability" in the Pacific Northwest may circumvent some problems.[164] If admitting uncertainty is the norm, then agency staff should not feel the need to deny it to further their careers. In addition, once adaptation is made routine, the increased work should not be as severe as the staff become skilled in it.

Second, the lessons of the Chesapeake Bay and the Columbia River efforts need to be heeded.[165] The adaptive process should not be pursued with any of the hesitancy of the Chesapeake Bay situation. In addition, the complexity of the governing system should be anticipated and avenues for easy communication should be preemptively established. Finally, the political problems of experimenting with endangered species such as Columbia River salmon can be avoided if adaptive management is implemented earlier.

A third practical barrier is the lack of standards for deciding when ecosystem effects are sufficient to warrant a change in approach.[166] The discussion so far has assumed that adaptive management will reveal the answers to these questions, but every adaptation will be open to interpretation. This problem once again counsels to insulate the process. To some degree, public participation is essential. The public should be at the table, aware of the science and value judgments that are being made. However, as with the designation of ecological goods,[167] the ultimate judgment should rest with an expert group within the agency. A more open decision-making process may give rise to problems with the public's valuation of public goods and lack of information.

Finally, the adoption of an adaptive management scheme is a long-term investment, as large amounts of money need to be spent on monitoring and analysis before any returns will be evident. Especially in times of budgetary uncertainty, this is a step that agencies will be hesitant to take.[168] This problem will dissolve as adaptive management becomes a proven technique. In contrast, the initial investments will require a great deal of persuasion on the part of the advocates of the technique. In the end, however, nothing is more persuasive than

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164. BORMANN, *supra* note 130, at 3.

165. *See supra* notes 100-117.

166. 1 INTERAGENCY ECOSYSTEM MANAGEMENT TASK FORCE, THE ECOSYSTEM APPROACH: HEALTHY ECOSYSTEMS AND SUSTAINABLE ECONOMIES 46 (1995) [hereinafter IEMTF REPORT].

167. *See supra* Part II.

168. IEMTF REPORT, *supra* note 166, at 46.

success. With the adoption of adaptive management in the Pacific Northwest, the fate of the approach largely is placed on that effort.

III. MANAGING WITHOUT A BALANCE IN THE 104TH AND 105TH CONGRESSES

As with many other areas of regulation, the efforts of the 104th and 105th Congresses may have important impacts on the possibilities for adapting environmental law to ecological advances. Several case-specific pieces of legislation of the 104th Congress have directly undercut or impeded current adaptive management efforts. Moreover, budgetary cuts in general have created financial stress that could preclude movement to more holistic and adaptive techniques. Finally, the regulatory reform legislation that is percolating through Congress would fundamentally alter the regulatory system. For the most part, the passage of the regulatory reform legislation would impose further obstacles to the adoption of an adaptive management system.[169]

One of the 104th Congress' first actions was the Salvage Rider attached to the Budget Recissions Bill, which opened up nearly a billion acres of national forest land in the Pacific Northwest to logging.[170] The rider undermined the Pacific Northwest forest management plan, which had set aside many of the designated parcels for their ecological value.[171] In doing so, Congress has undermined some adaptive management efforts.[172] It directly ordered certain forests to be cut, negating the adaptive managers' need to design the cuts to optimize the knowledge gained from management. Moreover, the pressure to "get out the cut" was greatly intensified, forcing some managers to forego their deliberation over the design of the management plan altogether.[173]

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169. The irony is that this approach should be consistent with the announced policies of the Congressional Republicans. Their efforts have been waged against inflexible rules that do not have adequate means of review. Adaptive management would provide the ultimate scheme of review. Constant review would be the defining characteristic of an adaptive scheme.

170. Salvage Rider, Pub. L. No. 104-16 (1995).

171. *Administration Said Optimistic About Getting Changes to Salvage Rider*, NAT'L ENVT. DAILY (BNA), March 4, 1996, at 1; Margaret Kriz, *Timber!*, NAT. J., February 3, 1996, at 252.

172. Shannon et. al., *supra* note 132, at 27.

173. *Id.*

Congressional actions also affected the effort at adaptive management in the Columbia River basin.[174] Apparently because several Republicans feared that the project would result in more regulations on land, the Interior Appropriations Bill in the House would have severely cut the funding needed to draft an Environmental Impact Statement (EIS).[175] Deliberations managed to reinstate some funding to the project, but the final bill still only allowed enough funds to produce an advisory, rather than a final, EIS.[176]

Budget cuts in environmental programs in general may also hold back the evolution of environmental law. The proposed budgets of recent Congresses cut deeply into the environmental regulatory institutions. For example, in the 104th Congress' proposed 1996 budget, EPA's funding would be reduced 22%[177] and the Fish and Wildlife Service's funding by 40%.[178] The financial stress caused by the cuts may preclude any adaptations, as the agencies would by more risk averse in the spending of their limited funds.[179] In addition, to not adapt would seem frugal, as it would be much cheaper to engage in classic command and control regulations than to attempt to design holistic, adaptive systems.[180]

However, it is the recent Congressional efforts at regulatory reform that could have the most lasting impact on adaptive management. If the current proposals were to be signed into law, their effect largely would be to impose further barriers to adaptive management. In particular, they would increase the procedural burdens upon any action. The proposals require a series of certifications by regulators that various decisional criteria have been satisfied before they are able to move forward with any administrative rule.[181] As Cass Sunstein noted, "many initiatives [toward regulatory reform] attempt to derail the administrative state through paperwork requirements."[182] This

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174. *See supra* notes 118-124.

175. Bob Benenson, *Conferees' Interior Initiatives May Get Clinton's Veto,* CONG. Q. WKLY. REP., Sept. 25, 1995, at 2884.

176. *Id.* However, the bill has never been signed into law.

177. H.R. 2099, 104th Cong. (1995)

178. H.R. 1977, 104th Cong. (1995)

179. IEMTF REPORT, *supra* note 166, at 46.

180. *Id.*

181. H.R. 1022, 104th Cong. (1995); S. 343, 104th Cong. (1995); Draft Amendment of the Regulatory Reform Act of 1996 (March 14, 1996) [Hereinafter Johnston/Robb Amendment].

182. Cass R. Sunstein, *Congress, Constitutional Moments, and the Cost-Benefit State,* 48 STAN. L. REV. 247, 285 (1996).

would serve as an intensification of the very burdens that adaptive management would need to avoid.

In addition, the regulatory reform bills' intensified requirements for risk assessment would exacerbate another practical problem of adaptive management. The requirements would mandate that all risk assessment also go through a long series of paperwork, again ossifying any management efforts.[183] Moreover, the bills would require that all scientific risk assessments be subjected to intense peer review.[184] If this was extended to adaptive management, it could worsen the uncertainty over when to change a management plan.[185] Especially with the complexity of ecosystems, opinions among qualified scientists may vary.

Finally, there is one positive kernel to glean from the regulatory reform legislation. In the most recent drafts of a Senate regulatory reform bill, the language has required an "evaluation of the benefits and costs of a reasonable number of reasonable alternatives, reflecting the range of regulatory options that would achieve the objectives of the statute that are relevant to the rule making, including . . . alternatives that . . . accommodate differences among geographic regions."[186] Passed into law, this language would open the door for increased management using ecosystem boundaries.

CONCLUSION

Ecosystems are inextricably intertwined with human actions. They are also extremely complex and dynamic. But neither of these statements reduces their absolute necessity in sustaining life on earth or their inherent worth to us as humans. Thus, we cannot desert our attempts to protect ecosystems from disturbances that will undermine these functions and values. What we must do is accept these revelations and begin to manage our environment with an approach that reflects our new knowledge of ecological functions.

Some parts of our government have begun to move in that direction. Programs such as the Chesapeake Bay and Columbia River

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183. H.R. 1022, *supra* note 181; S. 343, *supra* note 181; Johnston/Robb Amendment, *supra* note 181.

184. H.R. 1022, *supra* note 181; S. 343, *supra* note 181; Johnston/Robb Amendment, *supra* note 181.

185. *See supra* notes 161-162.

186. Johnston/Robb Amendment, *supra* note 181, §622(c)(2)(B).

projects are essential as initial efforts to adjust our regulatory approach. Hopefully, undertakings like the Pacific Northwest plan will continue to move our society towards a holistic and adaptive approach. On the other hand, other governmental efforts have attempted to bind us to our old ways. Mandates that undercut carefully crafted plans or underfund innovative approaches do not help us pursue better regulation, but rather keep us entrenched in the present system. Increased paperwork only will discourage our managers from attempting to pursue inventive regulatory techniques.

Some time in the future, we must accept the lessons of the environment. Our actions will always affect ecosystems and ecosystems will never become static, balanced entities. In addition, the health of the environment will only increase in importance as humans further populate the world and use its resources. The way the earth functions is not going to change. Instead, we as a species must use one of our defining characteristics and learn from our past mistakes to implement management schemes that can accept human influences and adjust to stochastic events.