DYNAMIC ENVIRONMENTALISM AND ADAPTIVE MANAGEMENT:
Legal Obstacles and Opportunities

JONATHAN H. ADLER

"Stationarity is dead." So declared the authors of a widely cited *Science* article on water management.[1] In the 21st Century, resource managers can no longer operate under the assumption that "natural systems fluctuate within an unchanging envelope of variability."[2] Long-standing assumptions about the operation of natural systems would have to be revised due to climate change and other anthropogenic influences on environmental systems. Resource decisions could no longer be guided by models that rely upon the past to predict the future. The inevitable and-yet-uncertain ecological changes wrought by climate change would demand the development of more adaptive and resilient approaches to environmental management.

Climate change brought the need for more adaptive approaches to environmental management to the forefront of environmental policy discussions. Yet the emerging reality of climate change is not the only reason more dynamic and resilient approaches to environmental protection are necessary. Stationarity was never a sound premise for ecological management. Ecologists have long recognized the dynamic nature of environmental systems, but their counsel had not been heeded. If the need for more adaptive and resilient approaches to environmental management has become urgent, it is perhaps because the need was ignored for so long. If stationarity is dead, perhaps it never existed.

Most of today's environmental laws and programs are based upon outmoded assumptions about the relative stability of natural systems when free of human interference. Scientists have understood for decades that ecosystems are anything but stable. To the contrary, ecosystems are incredibly dynamic and change over time due to both internal and external forces. An ecosystem is the "paradigmatic complex system," exhibiting dynamic and discontinuous behavior.[3] To be effective, therefore, environmental management systems must themselves be sufficiently adaptive.

Noted ecologist Daniel Botkin argues that "solving our environmental problems requires a new perspective" of environmental concerns that incorporates contemporary scientific understandings and embraces humanity's role in environmental management.[4] Recognizing a new perspective is but the first step, however. There is also a need to identify how this perspective can inform environmental policy, not just on the ground but in the very institutional architecture of environmental law and management. Then comes the really hard part, for even if it is possible to conceive of how environmental management should proceed, it may be devilishly difficult to put such ideas into practice. Old habits die hard. Legal and institutional norms die even harder.

Accounting for dynamic nature may require revisiting conventional notions of environmental protection and the underpinnings of environmental law and management. This presents an enormous challenge. Conventional approaches to environmental management may be unable to heed dynamic environmentalism's call so long as they are confined by contemporary notions of fair administrative process, whether such constraints are the product of norms, statutes or even the Constitution. The challenge of recognizing dynamic nature as such implicates the very foundations of contemporary environmental law and policy.

Part I of this chapter provides a brief overview of how contemporary ecological science has upset traditional notions of ecology, emphasizing the dynamic nature of natural systems. Part II explains how the dominant approach to environmental protection, as constrained as it is to begin with, is a particularly poor fit for the management and protection of dynamic ecological systems. Part III provides a brief overview of "adaptive management," the dominant management approach suggested to accommodate the dynamic nature of natural systems. Part IV then identifies some of the obstacles to (and opportunities for) adaptive management in environmental law. The aim here is to identify potential avenues for further study and analysis more than to define or delimit the prospects for adaptive management in environmental law.

DYNAMIC ENVIRONMENTALISM

Contemporary environmental law embodies archaic assumptions about the natural world. Through the middle of the 20th century, "the predominant theories in ecology either presumed or had as a necessary consequence a very strict concept of a highly structured, ordered, and regulated, steady-state ecosystem."[5] Under this view, nature naturally tended toward an equilibrium state—a "balance"—absent human interference.[6] Maintaining and protecting this balance was, in this view, ecologically superior and ultimately better for humanity as well.

Contemporary ecological science has "dismissed" these theories and the accompanying notion of a "balance of nature."[7] Notions such as Aldo Leopold's famous "land ethic" are based upon an "equilibrium paradigm" that has unraveled under examination.[8] In Wallace Kaufman's eloquent formulation, the equilibrium paradigm of ecology made for "good poetry but bad science."[9] Leopold's land ethic provided the foundation for an environmental philosophy that ultimately had little to do with ecology. However normatively or aesthetically attractive such conceptions of nature may be, and however much such conceptions facilitate the development of legal rules governing human interactions with nature, they lack a meaningful grounding in contemporary ecological science.

The architecture of contemporary environmental law was erected when the equilibrium paradigm still held sway. As a consequence, the edifice of environmental law sits on an unstable foundation. The equilibrium paradigm justified "a wide range of prohibitions on human activities that alter 'natural' land and water systems" and other environmental restrictions on productive activity.[10] Yet this paradigm has not "been rejected in ecology and replaced with a complex, stochastic nonequilibrium one."[11] As Botkin explains,

> we had approached environmental problems from the wrong set of assumptions, assumptions deeply rooted in our civilization and culture. These assumptions, considered at the time to be scientific, were in fact heavily based on ancient, pre-scientific myths about nature.[12]

Myth or not, these conceptions heavily influenced the contours of environmental law and regulation.

Contemporary ecological science embraces a more dynamic understanding of the natural world and rejects the idea of a "balance of nature" that would exist but for human interference. Two insights about natural systems are essential to the

contemporary view. First is the recognition that ecological systems are always in flux. There is no true "natural" state for ecosystems.[13] No "climax" or endpoint toward which ecosystems move or evolve if left undisturbed. Second, in this day and age, there is no part of the globe in which ecosystems exist wholly apart from human influence. As noted environmental historian William Cronon observed, "the natural world is far more dynamic, far more changeable, and far more entangled with human history than popular beliefs about 'the balance of nature' have typically acknowledged."[14]

The idea of a balance of nature still infects much environmental discourse, and remains embedded into much environmental law and policy, but scientists recognize that ecosystems are not static systems and do not trend toward equilibria. They are complex, dynamic systems that are always changing and evolving and that even exhibit a degree of chaotic flux; "ecosystems fluctuate without equilibrium and beyond the capabilities of humans to assess and control them without error."[15] Like social and market-based economic systems, ecological systems are "complex, dynamic, and subject to abrupt and unpredictable change."[16]

Even those who once embraced the static view of ecosystems now recognize that "an ecosystem is a thermodynamically open, far from equilibrium system."[17] Botkin states it well: "Nature changes over essentially all time scales, and in at least some cases these changes are necessary for the persistence of life, because life is adapted to them and depends on them."[18] Further, "nature is not a constant, it is not like a single tone held indefinitely, but is composed of patterns that themselves change, like a melody played against random background noises."[19]

Equally important to the idea that ecosystems are inherently dynamic, complex, and adaptive systems is the recognition that nature does not exist apart from humanity, and humanity inevitably influences the course and operation of natural systems. Human beings have been altering the landscape and altering the operation of ecosystems for centuries. Whether such a degree of influence is desirable, it is unavoidable, for "there is no longer any part of the Earth that is untouched by our actions in some way."[20] "Nature," as an ideal, is over.

Consider the concept of wilderness. The federal Wilderness Act "recognize[s]" wilderness as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain."[21] It further defines wilderness as, *inter alia*,

> an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which

> generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable.

Yet whether the "imprint" of human activity is "noticeable," it is there. However wild and untouched by human hands a given landscape may appear, it is not truly primeval or "natural." The idea of a wilderness as a natural area completely free from human influence is as fantastical as a unicorn.

The idea of wilderness is really something in our minds, not something that exists out in nature. Wilderness, writes Cronon, "is not quite what it seems. Far from being the one place on earth that stands apart from humanity, it is quite profoundly a human creation."[22] The idea of "wilderness" as it has manifested itself in the United States in particular, has been quite unnatural, and has denied the very humanity of this continent's first human inhabitants. That is, the "natural" state of many ecosystems is one that was heavily influenced by Native Americans. Yet "wilderness serves as the unexamined foundation on which many of the quasi-religious values of modern environmentalism rest."[23] It is an idea that, left unexamined, "poses a serious threat" to responsible environmental management.

In practice, wilderness today consists of those areas that people have decided to cordon off, separate from the rest of nature, and "protect" from additional human intrusion. Yet the very act of defining and demarcating such lands, and treating them differently from other lands nearby, alters them. True "wilderness", in the sense of places free from human influence of any kind, does not exist.[24] "Wilderness is managed land, protected by three-hundred page manuals specifying what can and cannot be done on it."[25] If natural parks and designated wilderness areas represent what is natural, "then nature is synonymous with human intervention," for it is only human intervention that keeps such places as they are.[26] Designated wilderness areas are, in this respect, merely the most conspicuous example of a wider phenomenon.

Contemporary ecology has embraced the dynamic view of nature and recognizes the pervasiveness of human influence on natural systems. Even steadfast proponents of the equilibrium model have recanted.[27] Yet there is relatively little evidence of contemporary understanding in contemporary environmental policy. The environmental laws and regulations on the books are "out of date."[28] As Botkin observes, "whether or not environmental scientists know about geological time and evolutionary biology, their policies ignore them."[29] Too often environmental policy and protection measures are based upon "nonrational, ideological beliefs instead of rationally derived facts in harmony with modern understanding of the environment."[30] Yet, many of the most pressing environmental problems today "exhibit the hallmark characteristics of

complex adaptive systems."[31] As Professor Ruhl explains, "[t]heir behavior emanates from a multitude of diverse, dispersed sources responding to coevolving interactions, feedback loops, and nonlinear cause and effect properties."[32]

The dynamic nature of natural systems is no longer disputed, but it is not embodied in contemporary environmental laws. Federal environmental law, in particular, incorporates and relies upon outdated conceptions of nature and environmental problems, often at the expense of more effective environmental protection. As Botkin counsels,"[t]he idea that change is natural and the failure to accept it have created problems in natural resource management and have led to destructive, undesirable results."[33] Existing environmental management efforts are hampered by their lack of fit with the nature of the environment they seek to manage.

STATIC REGULATION

The dominant approach to environmental protection in the United States has been a top-down, administrative regulatory model.[34] Though often adorned with symbolic flexibility or market-oriented ornamentation, the system retains a relatively rigid and centralized structure at its core. Flexibility is rarely more than interstitial or on the margin. Existing environmental laws also implicitly, and at times explicitly, presume an antiquated, static equilibrium model of natural systems. This is particularly true of those statutes which seek to conserve species or otherwise manage living natural resources.[35] Yet for all of its faults, the conventional administrative regulatory model seems entrenched. Writes Botkin:

> If you ask ecologists whether nature is always constant, they will always say "No, of course not." But if you ask them to write down a policy for biological conservation or any kind of environmental management, they will almost always write down a steady-state solution.[36]

The conventional administrative regulatory model of environmental protection is capable of achieving some environmental gains, and it has.[37] Yet this approach experiences severely diminishing marginal returns once the "low-hanging fruit" are picked.[38] It is relatively rigid and mal-adaptive, and is increasingly unable to generate environmental gains at an acceptable cost. As Richard Stewart observes, centralized environmental regulation is inherently limited by "the inability of central planners to gather and process the information needed to write directives appropriately responsive to the diverse and changing conditions of different economic actors, and the failure of central planning commands to provide the necessary incentives and flexibility

for environmentally and economically beneficial innovation."[39] Adopting market-based reforms helps on the margin, but only on the margin so long as environmental protection is dominated and constrained by a top-down administrative regulatory model.[40]

The dynamic, complex environmental problems that remain are particularly difficult to address through traditional regulatory approaches because "there are no readily available targets for the prescriptions and, even worse, we have no idea what response the system would exhibit to any particular command."[41] Many existing environmental laws impose binary decisions on agencies—either a species is endangered or it is not, a level of pollution may be anticipated to endanger health or it is not, etc. Once such determinations are made, specific regulatory consequences follow automatically. If a species is endangered, it triggers the regulatory requirements of the Endangered Species Act (ESA).[42] If a pollutant may be reasonably anticipated to threaten health and welfare, certain types of emission controls must be imposed.[43] And so on. Meaningful agency discretion only comes after the initial determination is made.

This regulatory approach was adopted, in part, because Congress was wary of leaving agencies more discretion about how to handle certain types of environmental problems for fear that agencies would shirk their duties or devote resources elsewhere. Yet a consequence of this approach is that agencies do not have as much flexibility or discretion as might be desirable to match specific policy measures with specific problems, and abandon the largely "one-size-fits-all" approach embodied in much federal environmental law. Many environmental laws leave little room for marginal analysis or comparative assessment of alternative policy measures.

Markets are also complex, adaptive, and dynamic systems. Just as it is not always possible to predict the ecological consequences of specific environmental management measures, it is often not possible to predict the market effects of such measures, or—perhaps more importantly—how such interventions will affect the interplay of economic decisions and environmental outcomes. Market actors will often respond to regulatory constraints in unanticipated ways, with unforeseen (and perhaps undesirable) effects.

Examples of unintended, and often unanticipated, effects from environmental regulatory interventions are legion.[44]

- Restricting a private landowner's ability to cut pine trees on his land today may preserve those trees as habitat for red-cockaded woodpeckers today, but it may also discourage other landowners from allowing their trees to grow long enough to become woodpecker habitat in the future.[45]

- Banning the use of ethylene dibromide (EDB), a pesticide, due to concerns about its carcinogenicity reduces human exposure to one potential health threat, but may result in the increased production of natural compounds, such as aflatoxin, that pose an equal, if not greater, threat to human health.[46]
- Mandating emission reductions of all ozone precursors seems like an effective means of reducing tropospheric ozone pollution (smog) until one learns that ozone formation is a function of the ratio of such pollutants in the atmosphere, and not merely their absolute level, such that emission reductions can, in some instances, increase ambient ozone levels.[47]
- Requiring oil companies to increase oxygen levels in gasoline may reduce carbon monoxide emissions—at least until automakers are required to install emission-control systems that provide the same benefit—but it may also encourage the use of a fuel additive (methyl tertiary butyl ether, aka MTBE) that causes substantial groundwater pollution throughout the United States.[4]
- Requiring the use of ethanol in gasoline may, by some account, reduce the life-cycle carbon intensity of transportation fuels, but may also increase pressures on fresh water supplies, encourage the displacement of waterfowl habitat, and increase food prices.[49]

If it were not difficult enough to anticipate the ecological effects of human activities, including environmental measures, it is also necessary to anticipate how such measures will influence human activity, and how such activity feeds back into the system and generates additional environmental effects. Fully accounting for all this information so as to predict the likely consequences of regulatory interventions is tremendously difficult.

Environmental policy also often proceeds as if the answers to many questions are purely scientific. Yet the lack of a true environmental nature—of a natural state of the environment that would exist through time were it not for human interference—means that environmental management necessarily involves making choices about what sort of environmental resources and amenities should be protected, preserved, enhanced, or conserved. Further, as Botkin notes, "choosing what to do is not a search for the single 'true' condition of nature. Rather it is a design problem."[50] Environmental management decisions necessarily involve trade-offs, and often these trade-offs are between incommensurable things. Should there be more wolves in Yellowstone National Park, or more elk? More elk or more Aspen trees? As Cronon notes, "we face the dilemma of deciding whether to clean up waste dumps even if doing so might endanger the creatures that now make their homes there."[51]

The existence of such trade-offs does not mean that there are no "right" answers. Normative disagreement remains possible. The implication is only that we cannot resolve such debates by resorting to what is "natural" or dictated by science.[52] While scientific and technical expertise may—indeed, must—inform environmental decision-making, it cannot tell us what to do. Ecological research may help us identify the likely consequences of one course of action or another, and help to document the effects of such decisions after they have been made, but it cannot substitute for the inherently value-based decisions that must be made about how environmental policy should proceed. And if such decisions are to be made through a relatively centralized administrative apparatus—as most environmental policy decisions are made today—then environmental management will be political management.

ADAPTIVE MANAGEMENT

One response to the contemporary ecological understanding is the adoption of "adaptive management." Though much discussed, it is still relatively underutilized in environmental management.[53] Although some federal agencies have sought to implement some forms of adaptive management—or what some might call "adaptive management-lite"[54]—there is not much to show for it; "its implementation has failed more often than not."[55] As Professors Craig and Ruhl report, "Putting adaptive management into practice has proven far more difficult than its early theorists expected."[56]

Different commentators have put forward slightly different formulations of what adaptive management requires, but there are some common threads. According to Professor Ruhl, "The 'essence' of adaptive management [theory is] an iterative, incremental, decision-making process build around a continuous process of monitoring the effects of decisions and adjusting decisions accordingly."[57] The National Research Council fleshed out what adaptive management requires:

> The concept of adaptive management promotes the notion that management policies should be flexible and should incorporate new information as it becomes available. New management actions should build upon the results of previous experiments in an iterative process. It stresses the continuous use of scientific information and monitoring to help organizations and policies change appropriately to achieve specific environmental and social objectives.[58]

Adaptive management requires agencies to emphasize the discovery and acquisition of information through ongoing monitoring and evaluation of existing management decisions against a reliable metric that can be fed back through the

policy-making and management process so that mid-course corrections can be made, and then made again as information and circumstances require. In this sense, adaptive management also favors ongoing environmental assessments over *ex ante*, predictive examinations of expected environmental impacts, such as those required under NEPA.[59] Whereas the NEPA process operates under the tacit assumption that an agency can with enough effort, identify all relevant information about the environmental consequences of a potential course of action *before* that action is undertaken, adaptive management recognizes that much relevant information will not be known until after management decisions have been made and things are underway. Thus adaptive management calls for regular reevaluation and adjustment to account for what has been learned.[60]

Adaptive management approaches cannot be static. Rather, they must evolve in response to new information and experience. As Professor Tarlock notes, "Adaptive management . . . is premised on the assumption that management strategies should change in response to new scientific information. All resource management is an ongoing experiment."[61] Yet adaptive management is more than simple trial and error or contingency planning. It requires a meaningfully structured process than ensures iterative consideration of the problem to be solved, measurements of success at solving the problem, evaluation of existing measures, and modification of ongoing measures in response to new information and discovery.[62]

Although adaptive management seems quite alien to how most government agencies operate most of the time, it is not all that new. As Professor Ruhl comments, "nothing about this is startlingly new or unusual as a general means of decision-making—business implement adaptive management all the time, or they perish."[63] Successful firms in competitive industries routinely adapt to changing market conditions and new information, lest they fall behind their competition. What is new is expecting administrative agencies to behave in this fashion, at least in those contexts in which adaptive management is possible and desirable. Applied in this context, it is somewhat revolutionary, but it is also necessary. As Professors Craig and Ruhl advise:

> adaptive management is not a panacea for the administrative state, yet it is difficult to conceive how regulation can function effectively in the future without making true adaptive management available to agencies in contexts where it is likely to be useful.[64]

Unlike private firms that may adopt adaptive management techniques in order to maintain or enhance their position in a competitive marketplace, government

agencies have little incentive to innovate or adapt in response to a changing environment, as their survival does not depend upon it.

CONSTRAINTS AND OPPORTUNITIES

There are opportunities to improve the adaptive and responsive nature of environmental protection efforts in the United States, but such opportunities are inherently limited so long as environmental protection is dominated by a relatively centralized, top-down administrative structure. Conventional regulatory and administrative systems are not particularly adaptive or responsive to changing environmental conditions, or even to changed understanding of environmental needs. Bureaucratic systems change slowly and are rarely forward looking. This is due, in part, to legal constraints, but also due to the nature of monopolistic bureaucratic systems, and the inherent information limitations that hamper the ability of such systems to acquire and account for relevant information—let alone to encourage the discovery of such information in the first place. Bureaucratic structures are resistant to change, and this is particularly true where such resistance poses few risks. Regulatory agencies do not go out of business when they fail to adapt. To the contrary, a failing agency is more likely to see a budget increase than it is to close its doors. The feedback mechanisms that force private firms to be adaptive and responsive to changing market conditions are largely absent from the administrative state.

If adaptive management is to be successful, there must be careful consideration of how to integrate it into the modern administrative state. While many have advocated greater reliance upon adaptive management, "very few commentators from science or law are asking whether it can succeed in the conventional administrative law system."[65] Those that have considered such questions are often quite skeptical that adaptive management can be grafted onto existing agency processes to any meaningful degree. The obstacles are both practical and political. "Institutional structures and arrangements, in particular, have repeatedly been fingered as key impediments to realizing the promise of adaptive management," observes Professor Doremus.[66] Yet so are the practical political realities that substantial change in agency operations will threaten the balance of interest group power and potentially deprive some groups of their ability to influence environmental policy decisions. In some manifestations, efforts to adopt adaptive management could even chafe against constitutional constraints.

What follows is a partial list and exploration of some of the obstacles to the adoption of adaptive management in federal environmental policy and potential reform opportunities worthy of further exploration.

Resource Constraints

Environmental agencies face substantial resource constraints. Existing environmental laws impose more obligations on environmental agencies than Congress appropriates the funds to carry out. Neither the money nor person-hours exist to do what Congress has called upon these agencies to do.

Adaptive management, with its requirement of iterative evaluation and course correction, is far more resource intensive than conventional, top down regulatory strategies. Where agencies have sought to adopt adaptive management, even what some would consider "adaptive management lite," they have chafed against the additional demands this approach places upon agency resources, in particular the "additional burdens of monitoring and evaluation."[67] Unless the legislative authorization of adaptive management is accompanied by an increase in resources, it is unlikely that many agencies will rush to implement such approaches, at least not in any meaningful respect. Agencies may well use the mantra of adaptive management to justify a greater degree of discretion where desired, but it takes far more than the embrace of agency discretion to make adaptive management work.

Adaptive management not only places greater demands on financial and personnel resources, it also demands more information. The knowledge problem has always constrained environmental regulation.[68] Existing environmental laws do a poor job of encouraging the development and discovery of the environmental information, and knowledge upon which successful environmental management depends.[69] Once one acknowledges the dynamic nature of natural systems, this problem is multiplied many times over. If nature cannot be relied upon to guide itself to some ideal, natural state, environmental managers must know even more about the systems they seek to conserve and protect. And yet, "in most areas, we lack even the most basic information on the condition of nature."[70] Implementing adaptive management, if it is to be effective, will also require an increase in resources devoted to research and information gathering, above and beyond that which is required for the management process itself.

Centralization

A common critique of federal environmental law is that it is unduly centralized, and places too much control in Washington, D.C. While some environmental problems are global in scope, most environmental problems manifest themselves at the local or regional level. Few are "national," and yet most environmental policy-making occurs at the national level.[71] Federal statutes impose uniform environmental priorities and standards without much regard for regional variation in ecological conditions or local priorities.[72] This mismatch hampers effective environmental protection.[73]

Existing environmental statutes provide relatively little meaningful opportunity for state level innovation. While most pollution control statutes speak of cooperative federalism and reaffirm the need to respect state-level policymakers, most priority-setting occurs at the federal level. In practice, state level policymakers have relatively little flexibility in identifying and selecting environmental policy goals and implementing regulations offer states relatively little leeway to experiment. Statutes such as the Clean Air Act and their implementing regulations constraint the ability of states to adopt new approaches, even as they pay lip service to flexibility. State implementation plans, for instance, are evaluated based upon how they fare under the Environmental Protection Agency's (EPA) modeling, not based upon the extent to which they produce results or satisfy the needs and demands of local citizens.[74]

Federal agencies are also not particularly supportive of state or local efforts to innovate, particularly if such innovation involves taking a different approach than that preferred in Washington, D.C. As a 2002 Government Accountability Office report found, states faced substantial "cultural resistance" from EPA officials, largely in the form of time- and resource-consuming reviews when they sought to innovate.[75] Although the Clinton Administration made some efforts to facilitate state level experimentation, these initiatives were never legislatively authorized and were short-lived.[76] The Bush Administration showed even less interest in facilitating state-level experimentation.[77]

Fostering greater regional or local experimentation with environmental management is one way to encourage adaptive management, while also responding to the ecological variation found throughout the nation. A more decentralized and "polycentric" approach to many environmental problems may help facilitate more adaptive approaches to environmental management.[78] True adaptive management, particularly if it is to lead to the discovery of additional information about natural systems and how they respond to different types of interventions and conservation measures, must be decentralized and, to some degree competitive.

The competitive regulatory dynamic embodied in the federalist system can facilitate the sort of learning by doing that is so often absent from centralized regulatory agencies. Among other things, such approaches allow for more experimentation and innovation, greater risk diversification, and facilitate active learning from the implementation of differing management approaches. Providing states with a formal mechanism through which they could opt out of existing federal environmental requirements could provide the opportunity for experimentation with different approaches to environmental management, including forms of adaptive management.[79] A mechanism could even be a form of adaptive management insofar as it encouraged

regular evaluation of the successes and failures of competing management approaches and facilitated iterative learning about how to make environmental measures more successful among competing jurisdictions.

Decentralization to encourage adaptive management could also take the form of decentralizing the management of the federal estate. One possibility, that has been tried to a modest degree, would be to provide greater autonomy for individual parks, refuges, or forest units within the federal system so that those managers with the greatest knowledge and experience with the resources in question could experiment with different conservation measures.[80] The National Park Service's fee demonstration project, while not without controversy, could serve as the basis for this sort of decentralized experimentation with park management.[81] If properly structured, it would help reveal substantial information about how such lands can be managed in economically sound and ecologically desirable ways. There is also reason to suspect that decentralizing land management by placing greater responsibility in the hands of state governments would improve the effectiveness and responsiveness of land managers.[82]

Statutory Requirements

Adaptive management, as such, is rarely authorized by statute.[83] As a consequence, adaptive management "has not been seriously incorporated into environmental regulation."[84] This is a meaningful obstacle to more widespread adoption of adaptive management by environmental agencies. In simple terms, "in order for adaptive management to flourish in administrative agencies, legislatures must empower them to do it."[85]

Where agencies have sought to adopt adaptive management, they have generally endeavored to do so by exploiting ambiguities in their statutory delegations of authority. Although some agencies may have genuinely tried to implement true adaptive management strategies, they generally lack statutory authority for such reforms. So even if agency heads are willing to make the effort, they face a daunting gauntlet of interest group opposition and judicial scrutiny. According to Professor Ruhl, when the Fish and Wildlife Service (FWS) sought to integrate adaptive management into the habitat conservation plan (HCP) permitting process, interest group litigants and courts were quick to challenge the agency's authority to incorporate greater flexibility into the program.[86]

The FWS's desired reforms may have prompted litigation and stoked controversy, but they were hardly an example of aggressive adaptive management. To some, what the FWS considers to be "adaptive management" is little more than "a series of pre-specified contingency measures that will be adopted at pre-specified triggering

thresholds if the initial effort fails to produce the expected results."[87] In other words, it is little more than "contingency planning."[88] While it is no doubt preferable to engage in some degree of contingency planning than to blithely assume the accuracy of every predictive assumption upon which a regulatory or other conservation decision was made, this is a far cry from true adaptive management.[89] Thus, Professor Karkkainen concludes, despite lots of statements to the contrary, "FWS may never have really tried to incorporate genuine adaptive management (as the rest of us know it) into the HCP process."[90]

Legislative grants of authority to implement adaptive management schemes are necessary for more federal agencies to begin utilizing such approaches, but they are not sufficient. For agencies to have a meaningful opportunity to adopt adaptive management approaches, Congress must also scale back some of the legislatively created mechanisms that interest groups use to frustrate agency initiatives and pursue agency capture. The combination of expensive procedural requirements, such as those mandated by the Administrative Procedure Act (APA) or specific authorizing statutes, and substantive statutory constraints create a barrier that is hard for all but the most committed agencies to scale.

It is particularly difficult for agencies to promulgate meaningful reforms when any innovative initiative exposes the agency to litigation. Broad citizen-suit standing makes it possible for a wide range of interests to hold up agencies that seek to shift their management approaches. Under cross-cutting statutes, such as the National Environmental Protection Act (NEPA), agencies are required to conduct extensive *ex ante* studies of the likely effects of proposed reforms. Because meaningful predictions are, in a real sense, incompatible with true adaptive management, it will be difficult for many agencies to move forward in this regard while complying with NEPA's requirements. Indeed, interest groups unhappy with the potential results of adaptive management have made such claims in court.[91] While it would be a mistake to reduce agency obligations to consider the environmental effects of their actions, the existing NEPA process will make it particularly difficult for agencies to adopt adaptive management across many environmental programs.

Administrative Law Norms

Above and beyond the specific constraints imposed by existing environmental statutes and the APA, dominant norms of administrative law may provide further obstacles to the widespread adoption of adaptive management.[92] Rule of law concerns may be in tension with the demands of adaptive management.[93] Some might even suggest that they are "incompatible."[94] The requirements for extensive *ex ante* assessment of options

and consequences, meaningful public participation, and subsequent judicial review of agency decision-making may make it difficult to adopt true adaptive management approaches to environmental management even if statutorily authorized.

Administrative law generally requires agencies to invest substantial time and effort up front to analyze potential courses of conduct and solicit public participation. Agencies are expected to explain the bases for the decisions they make and the likely expected consequences, and courts stand ready to review the explanations agencies give to ensure that the agencies have complied with their statutory mandates and engaged in "reasoned decisionmaking." This general approach leaves little room for "learning by doing" or meaningful experimentation.[95]

Whereas adaptive management requires an ongoing iterative process in which managers are evaluating newly revealed information about the consequences of existing measures and adjusting management policies accordingly, administrative law places a premium on finality.[96] This creates a stark conflict. As Professor Tarlock comments, "The idea that all management is an ongoing experiment poses a profound challenge to our legal system because it undermines a core principle of procedural and substantive fairness: finality."[97] Adaptive management's emphasis on "feedback loops to update regulatory efforts as information increases"—to adjust the dial in an ongoing basis—"is counterintuitive for the American legal system, which puts a premium on firm rules of law."[98]

Finality serves several purposes in administrative law. For one, it helps to provide a degree of certainty to regulated parties and those who depend upon administrative agencies. The regulatory process has a definitive endpoint, after which all affected may rely upon a duly promulgated rule as binding and secure. This generates a degree of legal certainty. Yet if the administrative law process desires certainty, adaptive management avoids it:

> Legal certainty does not mesh well with environmental unpredictability. One of the most significant barriers for managing linked social-ecological systems is that often the aspects of a society that make it free (e.g. certainty of law) are not in concert with ecological realities (e.g. multiple regimes and non-linear systems and responses. The certainty of law and institutional rigidity often limit the experimentation that is necessary for adaptive management."[99]

A system in which agencies were free to recalibrate regulatory obligations would provide little certainty for regulated entities. As Professor Tarlock notes, "the application of adaptive management supported by non-equilibrium ecology undermines

settled expectations and increases the risk to those who undertake activities in areas targeted" for ecological protection.[100] Insofar as agencies maintain discretion to alter their decisions, they risk upsetting the expectations of those that have relied upon the agency's decision. And yet, "continuing discretion to alter a decision is *the essence* of adaptive management."[101] This tension, between providing regulated entities with certainty and the need under adaptive management to revisit decisions and make dial adjustments as necessary can be seen in ESA implementation, where the FWS claimed to be working toward an adaptive management approach while simultaneously trying to promise landowners that there would be "no surprises" and that HCP requirements would not change over time.[102]

Insofar as adaptive management relies upon nimble administrative agencies that are able to respond quickly to new information as it emerges, the existing administrative structure is a poor fit. It takes a substantial amount of time for agencies to develop policies to implement statutes, issue regulations, or develop management plans subject to NEPA or other review requirements.[103] Public participation mandates further increase the time and other resources agencies must devote to substantial initiatives, particularly if agencies are responsive to public comments and make any meaningful effort to adjust their proposal in response to the information and opinions submitted to the agency. The current rulemaking process can be cumbersome and does require a substantial investment of agency time and resources. Agencies that are not careful to ground their policy decisions in the relevant grant of statutory authority and properly respond to adverse public comments can find themselves sent back to square one by reviewing courts.

Yet one should not overstate the extent to which existing procedural requirements prevent agencies from adapting to new information and updating outdated policies. The extent to which administrative law entrenches agency decisions and prevents them from revisiting prior policy decisions in light of new scientific or other evidence is likely overstated.[104] The evidence for regulatory "ossification" is mixed.[105] Agencies may be slow to revise or reconsider prior decisions, but this is not because administrative law prevents them from doing so. The Supreme Court has made clear that insofar as agencies are exercising delegated regulatory authority, they are free to reverse course and adopt new policy agendas, provided they remain within the scope of their delegation.[106]

Professors Craig and Ruhl argue that for adaptive management to be truly successful, and advance beyond the watered-down "adaptive management lite" utilized by some federal agencies, there must be an "alternative administrative procedure model that enables agencies to practice adaptive management in its purer form."[107] They

recognize that this requires a model that departs substantially from the dominant administrative law norms. Among other things, such an administrative procedure model may not provide as much room for public participation, at least not in the form utilized now.[108] In addition, agencies will need to forego some degree of ex ante examination and predictive assessment in return for greater responsibility to evaluate programs on an ongoing basis, while being committed to engaging in course adjustments as the consequences of various management approaches reveal themselves.

Professors Craig and Ruhl also suggest that adaptive management requires the scaling back of judicial review of agency actions. In their view, judicial review as currently constituted is too "intrusive" on agency decision-making[109] and does not focus on the right criteria, at least as far as adaptive management is concerned. Such an alternative administrative procedure framework may have some promise, although it would likely be quite controversial. Interest groups—environmentalists and industry-based groups alike—will be wary of any reforms that limit their ability to second-guess potentially unfavorable agency decisions.[110] It could also bump up against some serious constitutional constraints on the ways that agencies exercise their delegated authority. To many, judicial review is an essential element of due process within the administrative state.

Constitutional Concerns

To some degree, trying to make the existing administrative regulatory structure flexible and adaptive is like teaching a shark to fly, insofar as it ignores the fundamental nature of the beast. But even if one is more optimistic about the ability, and desirability, of altering such norms and legal requirements, some obstacles remain. This is not merely a question of what we have allowed and come to expect in administrative law. The requirements outlined in the APA were created by Congress, but we should not be so quick to assume that all such requirements, such as for notice and an opportunity to be heard, are merely a function of statute. There are constitutional law norms underlying the basic protections and procedures of the APA. It may well be that "[o]ur conception of responsible rulemaking was developed with an image of static ecosystems,"[111] but some of the norms of administrative law are also the result of underlying constitutional guarantees.

No matter how desirable adaptive management may be, it cannot operate in a vacuum. As Professor Tarlock cautions, insofar as adaptive management is adopted by regulatory agencies, "it is public regulation that must satisfy constitutional requirements of substantive and procedural due process."[112] Granting agencies the authority to engage in true adaptive management "raises the specter of an unchecked branch of government with the power to alter laws anytime it desires."[113] And this raises due

process concerns. Demands for fair notice and a meaningful opportunity to be heard constrain the extent to which agencies may engage in the constant modification and dial tuning that adaptive management may envision.

Apart from the procedural guarantees provided in the APA, the Fifth Amendment to the Constitution provides that life, liberty and property may not be taken without due process of law. At the time the Fifth Amendment was adopted it was well established that, among other things, due process meant that "the executive could not deprive anyone of a right except as authorized by law, and that to be legitimate, a deprivation of rights had to be preceded by certain procedural protections, characteristic of judicial process."[114]

Although subjecting private land-use to legislatively authorized permitting requirements is not, in itself, a due process violation or a taking, private landowners are constitutionally entitled to due process in the administration of such a system.[115] Among other things, this means that landowners are entitled to notice of what the system requires and "the opportunity to be heard at a meaningful time and in a meaningful manner" before the government infringes upon a constitutionally protected interest.[116] This further means that if an agency denies a landowner the ability to make productive use of her land, such as by imposing a land-use restriction or denying a permit, the landowner must have some opportunity to make her case. In the context of permitting, this entitles the landowner to some degree of administrative, if not judicial, review at a time that is sufficient to safeguard the landowner's interests.

In *Sackett v. Environmental Protection Agency*, the EPA had claimed that it could issue a compliance order mandating that landowners restore land they had begun to develop without a Clean Water Act permit.[117] Under the EPA's interpretation, the landowners could not obtain pre-enforcement review of the EPA's action. The Court unanimously disagreed. Had the Court accepted the EPA's interpretation of the Act, however, the Sacketts would have had a colorable Due Process claim against the federal government.[118] A system of land-use regulation need not deprive a landowner of all productive use in order for it to constitute a deprivation of property for due process purposes. In *Connecticut v. Doehr*, for example, the Supreme Court explained that "even the temporary or partial impairments to property rights that attachments, liens, and similar encumbrances entail are sufficient to merit due process protection."[119] Thus agency decisions that substantially encumber private lands may implicate the Due Process Clause.

Notice is an essential element of due process. Legal obligations and prohibitions must be sufficiently intelligible and clear so that a diligent landowner could be aware of the legal rules to which she is bound. A statute—or regulation for that matter—

that defines obligations or prohibitions "in terms so vague that men of common intelligence must necessarily guess at its meaning and differ as to its application, violates the first essential of due process of law."[120] As the Supreme Court explained as recently in 2012, it is a "fundamental principle" that "laws which regulate persons or entities must give fair notice of conduct that is forbidden or required."[121] Further, "clarity in regulation is essential to the protections provided by the Due Process Clause of the Fifth Amendment."[122] Although due process challenges to federal regulation are relatively rare, lower courts have reaffirmed the importance of notice in this context. The U.S. Court of Appeals for the D.C. Circuit, for example, concluded that the principles of due process also cautions against "validating the application of a regulation that fails to give fair warning of the conduct it prohibits or requires."[123]

Statutory reforms that authorize agencies to sidestep the APA's procedural requirements would not necessarily insulate agency actions from constitutional challenges. Insofar as agencies are authorized to alter regulatory burdens placed upon private lands or otherwise change regulatory requirements in response to emerging information, they may be required to provide some amount of process to regulated parties.

Due process concerns about adaptive management are greatest where federal agencies are engaged in the regulation of private land or the imposition of restrictions that directly affect private rights, including some rights on federal lands. Adopting adaptive management polices and techniques is far less problematic in the context of managing government lands than where environmental management decisions encroach upon private interests or risk infringing upon private property rights. While there may be political obstacles, including interest group resistance, to reducing the procedural obligations of agencies engaged in resource management decisions, there are less likely to be judicially cognizable property interests of the sort that could implicate due process concerns.[124]

Constitutional constraints on the adoption of adaptive management where the regulation of private land-use or disposition of private resources are concerned are largely, if not wholly, absent in the context of federally owned resources.[125] Under current law, statutes like NEPA grant outside groups extensive opportunities to influence and object to resource management decisions. Such procedural rights are purely a creation of statute, and could be legislatively revised or even repealed. So long as federally owned and managed resources are at issue, whether or not to facilitate this degree of public participation and judicial review of agency decisions is a matter of policy to be determined by the legislature. There is no constitutional requirement that citizen groups have more input to such resource management decisions than is provided for within the political process. As a consequence, it would be easier to

implement a dynamic and adaptive approach to the management of federal lands and federally owned resources than it would be to integrate adaptive management into the regulation of private land use under existing environmental laws.

Market Participation

It is a mistake to think that the emergence of a dynamic view of natural systems is the first time the administrative state has had to confront complexity. Markets, and the private ordering that spontaneously emerges where property rights are defined and voluntary exchange is possible, exhibit all the features of complex, dynamic adaptive systems. Government agencies may have more success at implementing adaptive management strategies, and avoiding some of the aforementioned constraints, insofar as they seek to advance environmental goals as market participants, and through the adoption of collaborative, contractual, or voluntary initiatives.

As commentators regularly note, many private entities adopt adaptive management techniques of one sort or another. More broadly, the private marketplace acts as a form of adaptive management as different firms try to innovate and meet market demands in different ways, learning from the successes and failures of other. There is no reason, in principle, why a government owned entity cannot operate in a like fashion, trying new management approaches, learning from its own mistakes, and replicating the successful innovations of others. The question is whether the relevant administrative rules and laws will allow such flexibility and the necessary freedom from political and judicial oversight than can hamstring such efforts.

One possible response to the belated recognition that natural systems are dynamic, complex, adaptive systems would be to rethink the dominant reliance upon regulation as the means for safeguarding environmental values. Where government acts not as a regulator but as a participant in a complex, dynamic and adaptive system—the marketplace—it is both more nimble and less hemmed in by constitutional constraints.

The federal government has substantial ability to intervene directly in markets through the purchase of resources and contracting with private owners and indirectly by providing incentives for market actors to give greater consideration of particular concerns. Such non-regulatory strategies may not suffer from some of the same legal constraints as regulatory strategies. Much as the management of federally-owned resources does not implicate constitutional concerns to the same extent as the management or regulation of resources continued or dependent upon private land, non-regulatory measures may be more amenable to adaptive management strategies.

Some federal agencies already operate programs that could readily become more adaptive in their operation.[126] The Department of Agriculture, for instance, acquires

temporary easements for the purpose of protecting waterfowl and their habitat. Purchasing such easements through voluntary transactions raises no due process concerns. Even forced sales, through eminent domain, raise fewer due process concerns than regulatory impositions on private lands. The temporary, yet renewable, nature of the easements acquired under some programs also facilitates regular reevaluation and necessary course corrections in response to changing conditions and new information. The use of these sorts of contractual measures to address environmental concerns holds substantial promise and has been under-explored to date, particularly insofar as it could contribute to or facilitate adaptive management of environmental resources.

CONCLUSION

The demand for complex, adaptive approaches to environmental protection was generated by a revolution in our understanding of the natural world, and environmental systems in particular. Perhaps notions of environmental management and, in particular, the role of government in advancing environmental values needs to undergo a revolution as well. Particularly insofar as one concludes that the conventional administrative, regulatory model of environmental protection is incompatible with the demands of dynamic environmentalism, it may be worth reconsidering whether such a model continues to be the best way forward for environmental protection. Whether it was ever the best model to adopt, it may have outlived its usefulness. "Only political will and our basic perspective prevent us from moving constructively" toward sounder environmental policy, commented Botkin in 1990.[127] This remains true today.

ENDNOTES

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26 Hayles, "Simulated Nature."

27 See Odum, "Great Ideas." See Tarlock, A. Dan. 1996. "International Water Law and the Protection of River System Ecosystem Integrity." *Brigham Young University Journal of Public Law.* 10(2):181-211.
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99 Allen, et al., "Adaptive Management," p. 1343.
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107 Craig and Ruhl, "Designing Admin. Law," p. 12.
108 Craig and Ruhl, "Designing Admin. Law," p. 30.
109 Craig and Ruhl, "Designing Admin. Law," p. 33.
110 See Freeman and Farber, "Modular Environmental Regulation," pp. 893-94.
111 Profeta, "Managing Without Balance," p. 95.

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113 Profeta, "Managing Without Balance," p. 94.
114 Chapman, Nathan S. and Michael W. McConnell. 2012. "Due Process as Separation of Powers." *Yale Law Journal.* 121:1672-1807.
115 See Village of Euclid, Ohio v. Ambler Realty Co., 272 U.S. 365 (1926)
116 Mathews v. Eldridge, 424 U.S. 319 U.S. 333 (1976).
117 Sackett v. EPA, 132 S.Ct. 1367 (2012).
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120 Connally v. Gen. Contr. Co. 269 U.S. 385, 391 (1926).
121 FCC v. Fox TV Stations, Inc., 132 S.Ct. 2307, 2317 (2012).
122 FCC v. Fox TV Stations, Inc., 132 S.Ct. 2307, 2317 (2012).
123 Gen. Elec. Co. v. EPA, 53 F.3d 1324, 1328 (D.C. Cir. 1995).
124 Whether private interests in public lands or government-managed resources are entitled to Due Process protections under the Fifth or Fourteenth Amendment would be a context-specific inquiry. In some cases, courts have recognized that permits or other private interests in federally managed resources are property interests for Constitutional purposes. See, e.g., Foss v. Nat'l Marine Fisheries Serv., 161 F.3d 584 (9th Cir. 1998).
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