The Laws of Nature

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Reflections on the Evolution of Ecosystem Management Law & Policy

Edited by Kalyani Robbins

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Cover photo: Grizzly bear sow and cubs, Yellowstone National Park, by Kim Keating, used with permission.

For Skyler and Maxfield

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I

Understanding and Evaluating Ecosystem Management Thus Far

1 An Ecosystem Management Primer

History, Perceptions, and Modern Definition

Kalyani Robbins, The University of Akron

"When we try to pick out anything by itself, we find it hitched to everything else in the Universe."
—John Muir

Ecosystem management is still a relatively new field of study—then Forest Service Chief F. Dale Robertson coined the term just two decades ago in 1992[1]—so its membership is still fairly small. But the issues are too important, too potentially life-altering, to leave to a handful of experts to worry about. This book is for everyone: law students, college and graduate students, experts, and weekend readers alike. Because it is for everyone, it is essential that it begin at the beginning.

Much like we have shortened biological diversity into the now common term 'biodiversity,' the term 'ecosystem' is the short (and now more common) way of saying ecological system.[2] Systems in general exist on multiple scales, so it is likewise the case that the term 'ecosystem' applies to discrete natural units such as a lake or a valley, as well as vast regions in which the interconnectedness of nature has been observed.[3] Indeed, when multiple systems interact, that is itself a system, and so on, giving rise to a complex and nearly infinite concept. The spatial definition of an ecosystem is any unit of nature, at any scale, in which the biotic organisms and abiotic environment interact in a manner that results in an ongoing and dynamic biotic structure.[4] However, some adhere to a more 'process-based' view,

in which an ecosystem is defined by the processes through which it functions, such as "productivity, energy flow among trophic levels, decomposition, and nutrient cycling."[5] Regardless of the ecosystem understanding one prefers, there is no question that ecosystems provide humans with many essential services, some of which are even subject to economic valuation via a replacement-cost analysis.[6]

The phrase 'ecosystem management' already gives away quite a bit, if we simply look at the combination of terms. The term 'ecosystem' evokes nature. An ecosystem is the most fundamental unit in nature, and the relationships it embodies are essential to understanding our natural world. Arthur Tansley, a pioneer of the science of ecology, coined the term 'ecosystem' in 1935. Tansley stated: "Though the organisms may claim our prime interest, when we are trying to think fundamentally, we cannot separate them from their special environments, with which they form one physical system."[7] 'Management,' on the other hand, suggests human control. It is a very unnatural word, the opposite of letting nature take its course. Indeed, in spite of the fact that the Clinton administration introduced the ecosystem management concept in an effort to incorporate scientific principles into the management of the national forests (recognizing that ecosystems were the focus for scientists),[8] the initial effort involved such excessive top-down government control that it met with great resistance.[9] The concept later evolved into one involving greater shared decision making at multiple levels,[10] though management is still management, a human domination over nature. As such, the term 'ecosystem management,' without more, already gives away the inherent tension between nature and humanity—a tension that spawns both the need for, and the problems with, ecosystem management.

This chapter will first take the reader on a journey through the history of ecosystem management, providing a summary of how it has grown and developed over the past two decades. This will only naturally lead to the next part of the chapter, which focuses on the present understanding of how ecosystem management is to be defined and applied, as well as the variety in perceptions of this modern understanding. Finally, it will serve as an introduction to the remainder of the book, previewing the various contributions collected here, offered by some of the leading scholars in the field of ecosystem management.

I. THE LIFE AND TIMES OF ECOSYSTEM MANAGEMENT

In spite of the development of ecosystem-orientation in the 1930s, the next half-century remained focused on narrowly targeted single-jurisdiction management of land and natural resources. The lack of a more holistic approach capable

of respecting the intricate web of ecosystem relationships accelerated the damage we caused to the natural environment. By the 1970s and 1980s the scientific community had begun to emphasize the need for a broader landscape-based approach to not only understanding, but also regulating, the natural environment. This coincided with the culmination of decades of ecological research that had disproved the previous theory—based on a notion of 'equilibrium'—basically, that ecosystems were stable and self-regulating fully-enclosed entities. What we were discovering instead was that ecosystems were in fact dynamic and interactive with external forces, including humans. And disturbances—such as fires, hurricanes, floods, and drought—previously viewed as potentially harmful, were found to be incredibly valuable players in the evolution of ecosystems and their relationships with one another.[11] We needed to move toward a management approach that could take everything into account—ecological, social, economic, and climate realities—rather than cordoning off a particular tract of land for focused management.

Decades of controlling disturbances and expecting already-fragmented ecosystems to manage on their own, even to benefit from a lack of further human interference, led to fragile ecosystems unable to withstand potentially unavoidable disturbance, much like a coddled child forced to enter the real world. This "command-and-control approach implicitly assumes that the problem is well-bounded, clearly defined, relatively simple, and generally linear with respect to cause and effect."[12] The reality, as we were discovering, is a far more complex, interactive, unpredictable world beyond our complete grasp. Not only was it harmful to attempt to control disturbances, but it was unwise to expect nature preserves to take care of themselves if we simply prevented further human interference with them, given that we had already done the greatest misdeed: turning them into islands forced to devour themselves due to lack of interaction with other ecosystems.[13]

By the 1980s it had become clear to many environmentalists, ecologists, and conservation biologists that our policy decisions for land and resource management needed to take greater care to heed the decades-old advice of Aldo Leopold, that everything is dependent on everything else and no part can be sacrificed without great risk to the whole.[14] Environmental problems cannot be addressed individually in a vacuum; rather, the entire field must be viewed holistically and in a comprehensive manner. Political boundaries and property lines mean nothing to the natural world and as such make for terrible management scales. It finally dawned on administrators, in response to substantial pressure from

environmental and scientific stakeholders, that land and resource management should ideally take place on a landscape scale. People began to understand the complexity of the situation, realizing that in order to "understand realistically complex ecological systems, it is necessary to study how the components affect and are affected by the larger, more complicated systems within which they are located."[15] That said, what is ideal, or even finally understood as ideal, is not always what actually takes place,[16] which is why we are here, over two decades later, still talking about this problem.

It is tough to turn back from a direction already traveled for some time, and we faced the two somewhat-related problems of too many cooks and too many items on the menu. First, as to the excessive menu, we had a very long-standing, firmly entrenched, multiple-use framework for managing natural resources. Agencies at both the state and federal levels had cut their teeth on the primary goal of sustainable commodity extraction and commercial development. To the extent that we restrained ourselves at all, it was only about allowing our economic use to continue into the future. It is not realistic to simply add to such multiple-use goals the new goal of ecological integrity and hope to make everyone happy at once. Throw in the numerous cooks—over a large-scale ecosystem there may be several jurisdictions and numerous private land owners—and it is nearly impossible to manage on a landscape scale. The U.S. Forest Service and Bureau of Land Management (both focused on commodity production and recreation), the Fish and Wildlife Service and National Park Service (arguably a bit more concerned with conservation), the Bureau of Reclamation and Army Corps of Engineers (managing federal irrigation and flood-control projects), state agencies, municipalities, and numerous private land owners would all have to somehow work together to coordinate their various mandates and needs with the needs of the overall ecosystem. Such comprehensive cooperation is the truth of our natural landscape but the impossibility of our political landscape.

In response to this massive-scale problem, concerned environmentalists and scientists began to speak of the concept of 'ecosystem management,' in which land and resource regulation would focus on interactions within and among ecosystems and adapt to changes in either scientific information or ecosystem functioning.[17] The goal of this new methodology was ecological restoration, but the approach included comprehensive consideration of social and economic functioning as well as ecosystem functioning (to the extent that these are even separate considerations; many argue that humans, with all our constructs, are an integral part of the ecosystems we inhabit).

Even before ecosystem management had been formally proposed or adopted, there were already a few examples of the (as-yet-untitled) approach that helped with the concept's development. The earliest examples of such a multi-jurisdiction effort to save a large-scale ecosystem date back to the 1970s—the multistate restorations of the Great Lakes and Chesapeake Bay, both of which involved an ecosystem-based approach.[18] Two of the most famous examples took place in the late 1980s as a result of concern for the habitat of two vulnerable species: the Greater Yellowstone grizzly bear and the northern spotted owl.

The first highly popularized program of ecosystem-focused management was for the Greater Yellowstone Ecosystem (GYE).[19] The GYE spans over eighteen million acres of land, overlapping the states of Montana, Wyoming, and Idaho. In addition to housing critical habitat for the grizzly bear, whooping crane, bald eagle, peregrine falcon, and trumpeter swan, the GYE is home to one of the last free-roaming bison herds and the world's largest herds of elk.[20] The GYE's "complex patchwork of management and ownership"[21] includes two national parks (Yellowstone and Grand Teton); three national wildlife refuges; land held by the Bureau of Land Management, states, and private owners; and overlaps six national forests—twenty-eight distinct political units in all. There are about six million acres of National Park Service and National Forest Service wilderness lands, as well as another six million acres of National Forest Service multiple-use lands. Depending on how the ecological boundaries of the GYE are defined, only about 7 to 30 percent is state or privately owned land, but this is nonetheless land of significant value, encompassing critical wildlife migration zones such as river valleys and other low-elevation areas.[22]

This diffuse set of stakeholders without shared goals had thus far resulted in ecologically harmful circumstances, such as habitat fragmentation, disruption of ecological processes, and an increase in human-wildlife confrontations.[23] The patchwork of habitat and human activity led to these problems, so environmentalists began to push for more integrated land management throughout the area. After their late 1970s discovery that the grizzly bear was foraging throughout the area, and far beyond the borders of Yellowstone National Park, biologists Frank and John Craighead coined the term 'Greater Yellowstone Ecosystem' and began the movement toward a unified bear-management scheme throughout the GYE.[24] Following their lead, the various environmental groups in the area came together to create an umbrella group called the Greater Yellowstone Coalition, in order to advocate for a more comprehensive ecosystem-based management strategy for the GYE.[25]

By the mid-1980s the Park Service and Forest Service still had not adequately coordinated their management of the region, leading to harsh criticism in a congressional hearing, which spurred the agencies to bring back a defunct interagency partnership from the 1960s, called the Greater Yellowstone Coordinating Committee (GYCC). Several years later, in 1990, the GYCC issued a draft vision document recommending ecosystem management and suggesting an interest in keeping the area largely wild. The vision document stated:

> . . . the overall mood of the GY[E] will be one of naturalness, a combination of ecological processes operating with little restraint and humans moderating their activities so that they become a reasonable part of, rather than encumbrances upon, those processes . . . the overarching goal is to conserve the sense of naturalness and maintain ecosystem integrity in the GY[E] through respect for ecological and geological processes and features that cross administrative boundaries.[26]

Naturally, this looked great, if perhaps a bit unrealistically optimistic, to environmentalists, but it inflamed local politicians and economic groups, who saw it as a threat to private property rights and local economies. Negotiations began and the final document cut back dramatically on what had been achieved in the draft. Rather than 19 million acres under diverse ownership, it was now a mere 11.7 million acres of national forest and national park lands. The stated goal of focusing on ecological integrity to preserve a natural state was removed; so much was removed that the length of the document itself was only about a sixth of the draft. In this new form the vision statement fell flat and failed to get any attention.[27]

The tale of the northern spotted owl, while perhaps more infamous than that of the GYE, actually fared quite a bit better in the end. We discovered that spotted owl populations were in decline in the 1970s when Oregon State University graduate student Eric Forsman proposed that the extensive cutting of old-growth forests was threatening the spotted owl with extinction. The state of Oregon listed the spotted owl as 'threatened' in 1975, but the U.S. Fish and Wildlife Service concluded that a listing under the federal Endangered Species Act was not warranted. Still, it was clear that the species was at least vulnerable, so federal land managers did adopt minimal protective measures to avoid the need for listing. Still, because of the power of the region's timber industry, there was little impact from these measures. The owl's condition only worsened, and as the science demonstrated this, the pressure from environmentalists rose to meet the economic pressure. The Pacific Northwest became a battle zone over the now nationally infamous

spotted owl. Bumper stickers carried phrases like "Kill an owl, save a logger." Judges and their families required police protection. The intensity of the old-growth-forest battle grew through the 1980s, finally culminating in 1988 in the federal courts of Portland and Seattle, which essentially shut down the logging of federally owned old-growth forests. The first Bush administration failed to solve the problem before leaving office, so it was passed on to President Clinton.[28]

Shortly after his inauguration, Clinton invited all the major stakeholders in the Pacific Northwest's old-growth forests to a summit, after which he arranged for a team of experts to develop a forest management plan for the region that would pull it out of the mess it had been in for so long. This resulted in the 1994 Northwest Forest Management Plan. Although the plan did not engage stakeholders to the extent generally envisioned for ecosystem management, it is otherwise a nice early example of the methodology. It was large-ecosystem-scaled, bounded according to the spotted owl's range rather than political lines, and included federal, state, and private lands. It considered other species besides the owl, such as salmon, in recognition of the interconnectedness within an ecosystem. It utilized cutting-edge scientific information to create a network of interconnected reserves to facilitate migration of old-growth-dependent species and embraced a return to normal disturbance regimes. It suggested ten different adaptive management areas to give land managers laboratories for new interventions. It even took into account socioeconomic issues, such as job training to help former timber workers move into new fields of work.[29] Such considerations are essential to a successful ecosystem management plan.

II. WHAT IS ECOSYSTEM MANAGEMENT?

A. Defining Ecosystem Management

With the movement from the early application of ecosystem management principles to the formalization of ecosystem management in the 1990s, definitions became more concrete, even if still somewhat ambiguous.

> Ecosystem management is management driven by explicit goals, executed by policies, protocols, and practices, and made adaptable by monitoring and research based on our best understanding of the ecological interactions and processes necessary to sustain ecosystem composition, structure, and function.[30]

As Nagle and Ruhl point out, "this only begs the question: What are the goals, policies, protocols, and practices of ecosystem management?"[31] Of course, much of this cannot be answered by science, as goals and policies are determined

at political levels, a common problem for science-based policy that has been raised by many scholars.[32] As such, this definition is arguably where the scientific community throws the ball into the regulatory community's court, awaiting a response to the policy questions before determining such things as protocols and practices.

As definitions go, it may be easiest to think of ecosystem management in terms of what it does, generally speaking, saving the specifics for further discussion. Much like we have the process-based option for understanding the ecosystem itself, this is the process-based approach to understanding ecosystem management. Arguably the best definition of ecosystem management ever put forward came from R. Edward Grumbine, whose 1994 article fleshed out the concept with brilliant coherence. He began with a relatively simple definition: "Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term."[33]

What made Grumbine's article so important was not so much his own substantive contribution to the question of how to define ecosystem management, albeit quite valuable, but rather the fact that he took it upon himself to synthesize all of the then-existing scholarship on ecosystem management in search of common themes and goals. He found ten common themes, which are useful to this chapter's goal of providing a basic understanding of ecosystem management: 1) "Hierarchical Context," which is another way of describing the systems perspective, where such systems include multiple levels or scales, such as "genes, species, populations, ecosystems, [and] landscapes;" 2) "Ecological Boundaries," which is another way of saying that political boundaries do not apply; 3) "Ecological Integrity," which requires the protection of native diversity and processes, including disturbance regimes; 4) "Data Collection," which is considered a necessary component of ecosystem-wide planning; 5) "Monitoring," with which we maintain a continuous loop of feedback on the successes and failures of management actions to use as a basis for setting policy; 6) "Adaptive Management," which "focuses on management as a learning process or continuous experiment where incorporating the results of previous actions allows managers to remain flexible and adapt to uncertainty," and remains into the twenty-first century the most analyzed aspect of ecosystem management; 7) "Interagency Cooperation," which becomes necessary if we are to manage based on ecological boundaries rather than political ones; 8) "Organizational Change," which is the notion that moving to an ecosystem management approach will necessitate

a restructuring of land management agencies and the manner in which they operate; 9) "Humans Embedded In Nature," or the idea that ecosystems include human beings, who interact with them at a level that must be taken into account in assessing an ecosystem's functioning; and 10) "Values," specifically human values, which unavoidably play a dominant role in determining the goals of ecosystem management, regardless of what we can learn from science.[34]

Grumbine drew his ecosystem management definition from these themes and further noted that most scholars shared the overarching goal of sustaining ecological integrity, most commonly focusing on the following specific goals for ecosystem management:

1. Maintain viable populations of all native species in situ.
2. Represent, within protected areas, all native ecosystem types across their natural range of variation.
3. Maintain evolutionary and ecological processes (i.e., disturbance regimes, hydrological processes, nutrient cycles, etc.).
4. Manage over periods of time long enough to maintain the evolutionary potential of species and ecosystems.
5. Accommodate human use and occupancy within these constraints.[35]

From this list of goals one can see just how difficult a task this is—indeed, potentially internally inconsistent, depending upon the size of human population at issue. Grumbine points out the greatest obstacle of all, which is the need to reconcile "the new goal of protecting ecological integrity and the old standard of providing goods and services for humans."[36] Of course, this leads to the question: Whose goal? Arguably this is simply a framing of the scientific community's goal as 'new' and the goals of our broader society and voting constituents as 'old.' If ecological integrity is indeed to become our new goal, this is only attainable with the very reconciliation Grumbine describes.

This is where ecosystem services may come in, which are detailed in far greater depth in chapters five and twelve. Consumptive value of land and natural resources is arguably a national tradition, but thankfully there is evidence of significant value to humans in the maintenance of healthy-functioning ecosystems. Ecosystem services are the benefits—many of which we depend on for life—derived from natural ecosystems. "Ecosystems, if properly protected and maintained, provide a wide array of valuable services to humans, ranging from the purification of water to the sequestration of carbon to the provision of pollinating insects essential to agricultural crop production."[37] Our work in discov-

ering the range of ecosystem services and evaluating our ability to survive without them has only just begun, and may well pave the road to different attitudes toward conservation in the future.

B. Implementing Ecosystem Management

In implementing ecosystem management, arguably the most core universally expected element is adaptive management, in which land and resource managers treat their management actions themselves as a research study, always prepared to alter them according to the feedback received. Nearly every ecosystem management scholar considers this the essence of ecosystem management, a completely indispensable component.[38] Of course, this creates the question of what sorts of data are of interest,[39] and our response to that data is of course purely a policy question, so it becomes extremely important to consider who is in charge of adaptive management, as it necessarily entails a great deal of power. Thankfully, that power can be somewhat limited via detailed advance directives for responding to a range of potential management outcomes. Perhaps the greater risk is one of lacking the necessary funding to follow up with adaptive management programs once begun, which is a potentially catastrophic situation.[40]

A study by the National Academy of Sciences' National Research Council, asked to advise on agency planning for the Klamath River Basin,

> recommended using adaptive management and outlined its eight essential steps: (1) define the problem; (2) determine management goals and objectives; (3) determine the resource baseline; (4) develop conceptual models; (5) select future restoration actions; (6) implement management actions; (7) monitor ecosystem response; and (8) evaluate restoration efforts and proposals for remedial actions.[41]

Indeed, much of what defines adaptive management overlaps significantly with our understanding of ecosystem management, so the two go hand-in-hand. Ecosystem management, as dependent as it is on adaptive management, is a constantly evolving process.

Implementing ecosystem management also requires the employment of a diverse group of experts, given the variability of concerns to be taken into account. Such interdisciplinary teams must be trained to communicate effectively with one another, in addition to being informed regarding the specific nature of the ecosystem management projects they are to work on together. Further, a system must be in place to receive input from a range of local interests throughout implementation.

Finally, as a practical matter, ecosystem management can require, or at least benefit from, the use of modeling techniques.[42] Management planning requires a significant quantity of data, much of which will be collected after implementation has begun via adaptive management techniques. However, given that we must begin somewhere, the substantial data gaps can be filled via modeling, in which predictions and probabilities are formed into a hypothetical image of the future.[43] Of course, the use of modeling data can also be controversial, and certainly should be applied with care to minimize the risk of error.

C. The Trouble with Ecosystem Management

Given that ecosystem management is so widely considered the ideal approach to land and resource management, why do we continue to flounder in our effort to meaningfully implement it? Robert Lackey suggested that the problems facing ecosystem management have five general characteristics:

1. fundamental public and private values and priorities are in dispute, resulting in partially or wholly mutually exclusive decision alternatives;
2. there is substantial and intense political pressure to make rapid and significant changes in public policy in spite of disputes over values and priorities and the presence of mutually exclusive decision alternatives;
3. public and private stakes are high, with substantial costs and substantial risks of adverse effects (some also irreversible ecologically) to some groups regardless of which option is selected (think of the Endangered Species Act);
4. technical facts, ecological and sociological, are highly uncertain (after all, how certain are we over the long term consequences of farming nearly all of the tall grass prairie?);
5. ecosystem policy problems are meshed in a large framework assuring that policy decisions will have effects outside the scope of the problem (think about the "taking" issue: which "rights" take precedence in public policy?).[44]

The problems Lackey identified fourteen years ago are the same we continue to face today. Moving forward, it is imperative that we find ways of working together, both by clarifying the need for ecosystem management and by addressing some of the concerns of those who stand in its way. It is our hope that this book will take us a step further in the right direction.

III. THE STRUCTURE OF THIS BOOK

Where this book breaks ground is not with the concept of ecosystem management itself—as we have seen in this chapter, the matter has been bounced around for at least two decades. Rather, what I have endeavored to do is to bring together some of the leading scholars (from a range of disciplines) who have put thought into ecosystem management policy and present their input on the state of ecosystem management thus far and going forward. My concern was that ecosystem management had hit a wall. The concept was the result of incredible breakthroughs in our understanding of the natural world, but was not compatible with our existing routine. How, I wondered, will we ever make this happen?

This book is divided into four parts. Part one reviews and evaluates the work we have already done to design and implement an ecosystem management approach. Part two provides us with some valuable theoretical insights, which can support a deeper understanding of ecosystem management concepts. Part three considers how we might work with existing federal statutes to move toward a more systemic, landscape-scale approach to managing land and natural resources. In part four, we take a variety of creative approaches to future policy-making.

A. Understanding and Evaluating Ecosystem Management Thus Far

Once this chapter provides the reader, especially the novice, with some basic background on the history and meaning of ecosystem management, we move through several critical analyses of that background. In chapter two, Judith Layzer draws on her own research and systematic assessments of several landscape-scale ecosystem management projects. Although Layzer finds that ecosystem-based management provides great benefits, both ecologically and educationally, she takes a scalpel to it in an effort to keep only what works best. In so doing, she discovers that one of the common elements of ecosystem management may be doing a disservice to the overall goal of restoring ecosystems.

In chapter three, Dan Rohlf focuses on the integration of law, science, and policy in the management and restoration of ecosystems. Utilizing the more process-based understanding of ecosystem management, Rohlf points out that part of its allure comes from our ability to project our own goals onto the concept, which naturally results in a positive assessment. In reality, however, we live with rather significant constraints—culturally, economically, and politically—that must be taken into account in our efforts to apply the scientific principles of ecosystem management. We must be especially careful in the context of adaptive management, a key component of ecosystem management, so that we use it as a tool for learning as we go, but not as an opportunity to postpone difficult choices.

Finally, in chapter four, Martin Nie offers up the book's strongest criticism of our attempt at ecosystem management, a project he sees as already on the outs. Nie walks us through the dark side of adaptive management, collaboration, and landscape-scale restoration—three of the hallmarks of ecosystem management—noting that the same obstacles we faced two decades ago continue to prevent us from effective use of the methodology. Some examples of such "obstacles include disparate agency missions and planning processes, shifting political priorities, problematic budgets and an assortment of other legal, organizational, and political challenges."[45] Thankfully, Nie offers several suggestions as to how we might move out of the rut in which we find ourselves.

B. Letting Theory Inform Practice

Part two provides valuable theoretical insight to support our effort to grasp our relationship with ecosystem management policy. In chapter five, J.B. Ruhl discusses the relationship between ecosystem services theory and ecosystem management. How do the needs for ecological integrity and human prosperity relate to one another? Ruhl takes a comprehensive approach to the analysis by sifting through Grumbine's ten themes of ecosystem management and considering the relationship each has with our interest in ecosystem services. Ruhl then applies this analysis to a case study to determine whether his conclusions work in a practical context. While Ruhl finds great potential value in ecosystem services theory to support the goals of ecosystem management, he cautions that there are also risks involved with this economic perspective.

In chapter six, Susan Clark and David Cherney explore the tension between two competing ecosystem management paradigms for implementation. They consider the Scientific Management outlook, which views policy-making as an expert-driven technical exercise, and contrast it with the Adaptive Governance standpoint, promoting shared control by diverse stakeholders. Clark and Cherney ground their analysis in case material from one of the most famous early efforts at landscape-scale management, the Greater Yellowstone Ecosystem, in order to demonstrate the advantages and pitfalls of both management theories. They conclude with recommendations based on these observations.

C. Making Better Use of Existing Federal Law

The chapters in part three take a look at the federal statutes that predate the emergence of ecosystem management principles and suggest how they might be applied in light of our current scientific understandings. In chapter seven, Jamison Colburn tackles the National Environmental Policy Act (NEPA) from a

philosophical perspective, providing insight into how we might adjust our NEPA routines to respect systemic ideals, particularly with regard to determining the spatial and temporal scales on which to focus.

In chapter eight, Robert Adler focuses on the restoration goal of ecosystem management, mining through a vast array of federal statutes for provisions that might be useful in achieving it. Adler organizes this material into four categories of applicability to restoration, creating a valuable road map to ecological restoration, and then wraps up with a discussion of the challenges in using this legislative material for this goal.

Finally, in chapter nine, Lynn Scarlett and James Boyd analyze how existing federal statutes can be leveraged to support the two emerging trends (from ecosystem management theory) of landscape-scale conservation and growing interest in ecosystem services.

D. Finding the Right Tools Going Forward

The fourth and final section of this book looks the future squarely in the face, recognizes the gaps in our existing regulatory structure, and begins the brainstorming process for creative approaches that may have some chance of improving our lot. Chapter ten is Robert Keiter's somewhat frightening discussion of the relationship between climate change and wildlife conservation, noting how dramatically our approach must change in the interest of climate adaptation. The good news; ecosystem management methodology, such as landscape-scale planning and adaptive management, are absolutely essential to adapting wildlife to a rapidly changing climate.

We see perhaps our most detailed policy planning in chapter eleven, in which Sara O'Brien and Sara Vickerman argue in favor of a national network of conservation lands, which would help give shape to our thus far limited efforts at an ecosystem management approach to land and natural resources. O'Brien and Vickerman go on to describe the necessary policies (both new policies and new spins on existing ones) to make such a nationally connected system work, allowing for better multilevel collaboration. Their proposed system would be designed in light of conservation principles, emphasizing landscape connectivity and ecosystem resilience to anthropogenic climate change.

Finally, in chapter twelve, Deborah McGrath and Travis Greenwalt explain the processes for economic valuation of ecosystem services, as well as how programs setting up payment mechanisms for such services (PES programs) can create financial incentives to protect and provide them. McGrath and Greenwalt

ultimately propose that such programs may offer a valuable contribution to the improvement of ecosystem management.

In the end we must, as a society, imagine defending our choices to future generations. Often, when we look at the damage our ancestors caused, we give them some moral credit for not knowing what they were doing. What this book makes quite clear is that our generation has no such excuse. We have the benefit of a strong academic understanding of the issues and brilliant efforts to carve out practical plans to implement our scientific knowledge. We ignore this material at our peril.

NOTES

1. *See* James M. Guldin & T. Bently Wigley, *Intensive Management—Can the South Really Live Without It?*, Trans. 63rd No. Am. Wildl. & Natu. Resour. Conf. 362 (1998), *available at* http://www.srs.fs.usda.gov/pubs/ja/ja_guldin003.pdf.

2. John Copeland Nagle & J.B. Ruhl, The Law of Biodiversity and Ecosystem Management 318 (2nd ed. 2006).

3. John M. Blair et al., *Ecosystems as Functional Units in Nature*, 14 Nat. Res. & Env. 150 (2000).

4. Eugene P. Odum, Basic Ecology (1983).

5. Blair, *supra* note 4.

6. *See* James Salzman, *Valuing Ecosystem Services*, 24 Ecology L.Q. 887 (1997); Edward Farnworth et al., *The Value of Natural Ecosystems: An Economic and Ecological Framework*, 8 Envtl. Conserv. 275 (1981).

7. Arthur G. Tansley, *The Use and Abuse of Vegetational Terms and Concepts*, 16 Ecology 284–307 (responding to the contemporary focus on organisms in the field of ecology).

8. The Forest Service chief stated that the new methodology would "blend the needs of people and environmental values in such a way that the National Forests and Grasslands represent diverse, healthy, productive, and sustainable ecosystems." *See* Guldin & Wigley, *supra* note 1.

9. Gary K. Meffe et al., Ecosystem Management, at 4 (2002).

10. *See id*.

11. *See* David A Wardle et al., *Ecosystem Properties and Forest Decline in Contrasting Long-Term Chronosequences*, 305 Science 509 (2004).

12. Crawford S. Holling & Gary K. Meffe, *Command and Control and the Pathology of Natural Resource Management*, 10 Conserv. Biology 328, 329 (1996).

13. *See* Daniel B. Botkin, Discordant Harmonies (1992).

14. Aldo Leopold, A Sand County Almanac and Sketches Here and There 35 (1949).

15. James H Brown et al., *Complex Species Interactions and the Dynamics of Ecological Systems: Long-Term Experiments*, 293 Science 643 (2001).

16. *See* Thomas R. Stanley, Jr., *Ecosystem Management and the Arrogance of Humanism*, 9 Conserv. Biology 255 (1995) (arguing that the "problem is not how to maintain current levels of resource output while also maintaining ecosystem integrity; the problem is how to control population growth and constrain resource consumption.").

17. *See* Christensen et al., *The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management*, 6 Ecological Applications 665–91 (1996); Interagency Ecosystem Management Task Force (IEMTF), *The Ecosystem Approach: Healthy Ecosystems and Sustainable Economies* Vol. 1 (1995); R. Edward Grumbine, *What is Ecosystem Management?*, 8 Conserv. Biology 27 (1994).

18. Howard R. Ernst, Chesapeake Bay Blues (2003); D. Scott Slocombe, Lessons From Experience With Ecosystem-Based Management, 40 Landscape and Urban Planning 31–39 (1998).

19. Judith Layzer, Ecosystem-Based Management and Restoration, The Oxford Handbook of U.S. Environmental Policy (forthcoming 2012).

20. *See* Robert B. Keiter, *An Introduction to the Ecosystem Management Debate*, *in* The Greater Yellowstone Ecosystem: Redefining America's Wilderness Heritage (R.B. Keiter and M.S. Boyce ed., 1991).

21. Bruce Goldstein, *The Struggle Over Ecosystem Management at Yellowstone*, 42 Bioscience 183–87 (1991).

22. *Id*.

23. D.A. Glick & T.W. Clark, *Overcoming Boundaries: The Greater Yellowstone Ecosystem, in* Stewardship Across Boundaries (R.L. Knight & P.B. Landres ed., 1991).

24. *See* Layzer, *supra* note 20.

25. Allan K. Fitzsimmons, Defending Illusions (1999).

26. *See id.* for quotation.

27. Robert B. Keiter, Keeping Faith With Nature (2003).

28. *See* Judith A. Layzer, *Jobs vs. the Environment: Saving the Northern Spotted Owl, in* The Environmental Case (3d ed. 2012); Steven L. Yaffee, Wisdom of the Spotted Owl (1994).

29. *See* Layzer, *supra* note 29.

30. Norman L. Christensen, *The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management*, 6 Ecological Applications 665 (1996).

31. Nagle & Ruhl, *supra* note 2 at 335.

32. *See, e.g.*, Kalyani Robbins, *Strength in Numbers: Setting Quantitative Criteria for Listing Species under the Endangered Species Act*, 27 UCLA J. Envtl L. & Pol. 1, 15 (2009); Katherine Renshaw, *Leaving the Fox to Guard the Henhouse: Bringing Accountability to Consultation Under the Endangered Species Act*, 32 Colum. J. Envtl. L. 161, 174–75 (2007); Carden, *supra* note 77 at 202; Cary Coglianese & Gary E. Marchant, *Shifting Sands: The Limits of Science in Setting Risk Standards*, 152 U. Pa. L. Rev. 1255, 1257–58 (2004); Wendy E. Wagner, *The Science Charade in Toxic Risk Regulation*, 95 Colum. L. Rev. 1613, 1628 (1995).

33. R. Edward Grumbine, *What is Ecosystem Management?*, 8 Conserv. Biology 27 (1994).

34. *Id.*

35. *Id.*

36. *Id.*

37. Barton H. Thompson, Jr., *Ecosystem Services & Natural Capital: Reconceiving Environmental Management*, 17 N.Y.U. Env. L.J. 460 (2008).

38. *See, e.g.*, Ronald D. Brunner & Tim W. Clark, *A Practice-Based Approach to Ecosystem Management*, 11 Conserv. Biology 48 (1997); Paul L. Ringold et al., *Adaptive Management Design for Ecosystem Management*, 6 Ecological Applications 745 (1996); Anne E. Heissenbuttel, *Ecosystem Management—Principles for Practical Application*, 6 Ecological Applications 730 (1996).

39. For somewhat different approaches to this question, *see* Karen V. Root et al., *A Multispecies Approach to Ecological Valuation and Conservation*, 17 Conserv. Biology 196 (2003), and Kenneth F.D. Hughey et al., *Integrating Economics into Priority Setting and Evaluation in Conservation Management*, 17 Conserv. Biology 93 (2003).

40. *See* D. James Baker, *What Do Ecosystem Management and the Current Budget Mean for Federally Supported Environmental Research?*, 6 Ecological Applications 712 (1996).

41. J.B. Ruhl, *The Disconnect Between Environmental Assessment and Adaptive Management*, 36 Trends 1 (July/Aug. 2005).

42. *See* Robert Costanza, *Ecological Economics: Reintegrating the Study of Humans and Nature*, 6 Ecological Economics 978 (1996).

43. For an example of this process, *see* Erik Nelson et al., *Modeling Multiple Ecosystem Services, Biodiversity Conservation, Commodity Production, and Tradeoffs at Landscape Scales*, 7 Frontiers in Ecology and Environment 4, 4–10 (2009).

44. Robert T. Lackey, *Ecosystem Management: Paradigms and Prattle, People and Prizes*, 16 Renewable Resources Journal 1, 8–13 (1998).

45. Nie abstract.