CAN FISH OWN WATER?: ENVISIONING NONHUMAN PROPERTY IN ECOSYSTEMS

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INTRODUCTION

Ownership of property figures prominently in the design of legal institutions to manage natural resources, including living resources in the human environment. When should one person be able to exclude another from valuable resources? How much authority should the government have in regulating the uses that people make of the things that they own? What are the boundaries between government ownership or trusteeship, and the powers of private property holders? From forests to fisheries, the targets of human economic endeavors set the stage for these familiar topics of debate.[1]

These central ownership issues are about human power, human autonomy, and human organization. In the standard economic version of property, only people own property, or in the extended formulation, property law addresses the relationships of people to each other with respect to things, not the relationship of people to things.[2] Other organisms are potential objects of ownership or trusteeship, but they are not themselves owners,[3] even if they are

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1. *See generally* DALE D. GOBLE & ERIC T. FREYFOGLE, WILDLIFE LAW (2002) (providing a wide-ranging exploration of laws defining and affecting private and public authority over wildlife) [hereinafter GOBLE & FREYFOGLE].

2. "[N]early everyone agrees that the institution of property is not concerned with scarce resources themselves ("things"), but rather with the rights of persons with respect to such resources." Thomas W. Merrill, *Property and the Right to Exclude*, 77 NEB. L. REV. 730, 731-32 (1998) (footnote omitted). "We often think of property as some version of entitlement to things . . . . In a more sophisticated version of property, of course, we see property as a way of defining our relationships with other people . . . . On this classical view, the institution of property mediates peoples' conflicting desires about resources, and it does so by allocating exclusive rights." Carol M. Rose, *Property as Storytelling: Perspectives from Game Theory, Narrative Theory, Feminist Theory*, 2 YALE J.L. & HUMAN. 37, 40 (1990).

3. *See, e.g.*, Citizens to End Animal Suffering & Exploitation v. New England Aquarium, 836 F. Supp. 45, 49-50 (1993) (explaining that animals under the relevant state laws "are treated as the property of their owners, rather than entities with their own legal rights.").

wild and "unowned." The range and structure of human interactions with nonhuman organisms have only subsidiary importance because the focus is defining the authority of human beings, managing human conflict over desired resources, and coordinating human transactions.[4]

Can fish own water? Can squirrels own acorns? From a standard understanding of ownership, such questions sound strange or even foolish.[5] Nevertheless, the problems of adequately understanding and representing nonhuman organisms and other environmental "things" in legal frameworks and proceedings have been noted for some time in debates over the shaping of environmental and natural resources laws. As Professor Holly Doremus has observed, the most difficult question in environmental policy continues to be: how much room should we leave for nature?[6] From Christopher Stone's classic 1972 essay advocating legal rights for natural objects,[7] to recent writings addressing the influence of environmental ethics in law,[8] legal literature continues to raise fundamental questions about why nonhuman organisms and ecosystems are important, and how their importance should be recognized and decided through legal requirements and procedures. The configuration of property regimes is part of those broader discussions.

A growing appreciation of just how complex and unpredictable ecosystems are has made the task of elaborating wise systems for ecological decision-making seem ever more challenging. Scientists have gained increasingly sophisticated insights into the dynamic and evolutionary qualities of ecosystems, and they have developed deeper understandings of the complex interactions and nonlinear effects of diverse species and human activities in ecosystem

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4. *See* Craig Anthony (Tony) Arnold, *The Reconstitution of Property: Property as a Web of Interests*, 26 HARV. ENVTL. L. REV. 281, 284-291 (2002) (tracing the emergence of an emphasis on relationships among persons in contemporary understandings of property).

5. "The fact is, that each time there is a movement to confer rights onto some new entity, the proposal is bound to sound odd or frightening or laughable." CHRISTOPHER D. STONE, SHOULD TREES HAVE STANDING?: TOWARD LEGAL RIGHTS FOR NATURAL OBJECTS 8 (1974) (footnote omitted). This book republished the article that appeared in 1972, Christopher D. Stone, *Should Trees Have Standing?— Toward Legal Rights for Natural Objects*, 45 S. CAL. L. REV. 450 (1972).

6. Holly Doremus, *Environmental Ethics and Law: Harmony, Dissonance, Cacophony, or Irrelevance?*, 37 U.C. DAVIS L. REV. 1 (2003) (introducing symposium).

7. STONE, *supra* note 5.

8. Susan Emmenegger & Axel Tschentscher, *Taking Nature's Rights Seriously: The Long Way to Biocentrism in Environmental Law*, 6 GEO. INT'L ENVTL. L. REV. 545 (1994) (tracing emergence of biocentrism in international law). *See also* Doremus, *supra* note 6; Alyson C. Flournoy, *In Search of an Environmental Ethic*, 28 COLUM. J. ENVTL. L. 63 (2003).

processes.[9] They have come to see that "self-organizing" processes[10] at multiple scales affect the "resilience" of ecosystems.[11] These advances in research have not led to assurances that ecosystem management practices can be easily targeted to accomplish desired outcomes, however. The complexities and nonlinear phenomena in ecosystems mean that firm predictions cannot be made and that ecosystems cannot be successfully "managed" or closely controlled in an engineering sense.[12]

A key policy conclusion growing from these findings is that the very concept of "managing" ecosystems must be reinvented to involve an ongoing process of learning and adapting in an iterative fashion to ecological phenomena. The goal must not be to establish a static model of operations or to maximize harvests of particular species, since these tasks will be fruitless at best, or worse, produce rigid and inflexible decisions that erode ecosystem functions. Minor impacts may build imperceptibly into sudden changes, and to ecological degradation that is detrimental to human welfare.[13]

Modern ecological understandings thus pose challenges to the adequacy of existing legal systems.[14] Adaptive management approaches require creation of decision-making organizations that can perceive patterns of activity and change in ecosystems and respond in a flexible way. Commentators warn that better legal means must be found for coordinating human activities with ecological processes. This coordination requires new institutional means of "seeing," learning, and adapting to ecological signals, and better approaches protecting capacities for reorganization and renewal in ecosystems.[15]

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9. Fred Bosselman, *What Lawmakers Can Learn from Large-Scale Ecology*, 17 J. LAND USE & ENVTL. LAW 207 (2002) (providing an extended discussion of recent scientific developments).

10. "These processes produce patterns and are in turn reinforced by those patterns; that is, they are self-organized." C.S. Holling et al., *Sustainability and Panarchies*, *in* PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS 63, 69 (Lance H. Gunderson & C.S. Holling eds., 2002) (citation omitted) [hereinafter PANARCHY].

11. Holling & Gunderson, *Resilience and Adaptive Cycles*, *in* PANARCHY, *supra* note 10, at 25.

12. *See id.* at 26-27.

13. C. S. Holling & Steven Sanderson, *Dynamics of (Dis)harmony in Ecological and Social Systems*, *in* RIGHTS TO NATURE: ECOLOGICAL, ECONOMIC, CULTURAL, AND POLITICAL PRINCIPLES OF INSTITUTIONS FOR THE ENVIRONMENT 57, 65-66 (Susan S. Hanna et al. eds., 1996). *See also* Holling & Gunderson, *supra* note 11, at 60-61.

14. *See* A. Dan Tarlock, *Slouching Toward Eden: The Eco-pragmatic Challenges of Ecosystem Revival*, 87 MINN. L. REV. 1173, 1181-86 (2003) (reviewing problems that the dynamic and uncertain characteristics of ecological processes pose for ecosystem revival efforts); Jonathan Baert Wiener, *Law and the New Ecology: Evolution, Categories, and Consequences*, 22 ECOLOGY L.Q. 325, 327 (1991) (reviewing JONATHAN WEINER, THE BEAK OF THE FINCH: A STORY OF EVOLUTION IN OUR TIME (1994)).

15. James Wilson, *Scientific Uncertainty, Complex Systems, and the Design of Common-*

This essay offers suggestions for understanding and shaping property regimes to cope with modern scientific understandings.[16] The discussion ventures beyond established definitions in suggesting extensions of property concepts to encompass nonhuman organisms, as a matter of institutional design and legal analysis. The argument links scientific understandings of ecosystem resilience, including understandings of the self-organizing capabilities and autonomy of ecological entities, with two rather different approaches in recent literature addressing the structure of property regimes. The first of these suggests that property rights must be pared back and reconfigured to fit their ecological context, while the second suggests, from another perspective, that property concepts should be expanded to recognize previously unnoticed forms of "commons management."

The goal here is to elaborate potential means for addressing the inability of human socioeconomic systems to respond to ecological signals in a far-sighted and adaptive manner. It dovetails with recent "socio-ecological" literature that seeks bridging mechanisms for coordinating human institutions with dynamic ecosystem processes.[17] The suggestion is that a more far-sighted understanding of property will help illuminate the interactions and relationships of people with biological "things," clarify differences among forms of legal arrangements that already exist, open decision-making processes to new information, and offer helpful directions in institutional design.

Part I summarizes some key scientific understandings of ecosystems. It focuses specifically on the insights of complex

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Pool Institutions, *in* THE DRAMA OF THE COMMONS 327, 335-47 (Elinor Ostrom et al. eds., 2002). *See also* Alyson C. Flournoy, *Preserving Dynamic Systems: Wetlands, Ecology and Law*, 7 DUKE ENVTL. L. & POL'Y F. 105, 127 (1996) (discussing institutional means for focusing on ecological processes rather than endpoints).

16. The focus here is on how best to design legal frameworks to serve ecological purposes, rather than on ethical reasons for pursuing ecological goals. Legislation to protect nonhuman organisms or their habitats might be motivated by multiple considerations that vary widely among individual people, ranging from human self-interest to concern for future generations or a sense of appreciation and respect for intrinsic values unrelated to any assessment of benefits. For some differing perspectives on motivations for seeking changes in legal approaches to ecosystem management, see, for example, A. Dan Tarlock, *Environmental Law: Ethics or Science?*, 7 DUKE ENVTL. & POL'Y LAW F. 193 (1996) (urging a science-oriented approach and a departure from the pluralistic bases of environmentalism); Holly Doremus, *Biodiversity and the Challenge of Saving the Ordinary*, 38 IDAHO L. REV. 325, 351-53 (2002) (appealing to affections for local nature to build political support); Douglas A. Kysar, *Law, Environment, and Vision*, 97 NW. U. L. REV. 675 (2003) (noting a shift from moral, cultural, and aesthetic justifications to instrumentalist reasoning) [hereinafter Kysar, *Vision*].

17. Carl Folke et al., *Synthesis: Building Resilience and Adaptive Capacity in Social-Ecological Systems*, *in* NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS: BUILDING RESILIENCE FOR COMPLEXITY AND CHANGE 352 (Fikret Berkes et al. eds., 2003) [hereinafter NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS].

systems research that have provided analytical tools for discerning patterns and understanding dynamic processes in ecosystems as well as in human socioeconomic systems. It considers how these approaches locate human activities within the context of broader ecological phenomena and how they characterize the interactions between people and other organisms.

These modern scientific understandings of ecosystems have posed challenges for established concepts of property. Part II reviews arguments that have been made for revising or reinterpreting existing laws and for construing property rights in light of ecological context. On the one hand, many of these arguments involve modifying existing property rights, and imposing new responsibilities on property owners that reduce the ability to exclude, transfer, and dispose unilaterally of resources. On the other hand, some researchers have pointed out that wise ecosystem management may also, conversely, involve perceiving and creating property rights where none have been recognized previously.

Part III links and builds on these two ideas. It suggests that the ecological design of property regimes may involve "seeing" property in new places where human and nonhuman dependencies on resources conflict. Justifications for recognizing nonhuman entities as property holders resemble reasons for delineating property rights in other areas of law. Even though there are obvious differences between human and nonhuman modes of action and coordination, important insights may be gained by seeing various forms of resource allocation to human and nonhuman organisms in an analogous and connected manner. Broadly speaking, if people and their organizations have property rights in water, so should the fish. Using water management proceedings as an example, the discussion identifies ways that standard approaches in the legal analysis of property rights illuminate the structure and implications of resource management regimes.

I. ECOSYSTEM MANAGEMENT AND THE SCIENCE OF COMPLEX ECOLOGICAL SYSTEMS

Modern understandings of ecosystems reveal dynamic biophysical systems in which organisms interact with each other and with the abiotic components of their environment in complex ways.[18] Feedback mechanisms produce nonlinear results, magnifying some phenomena while minimizing others. Equilibrium conditions exist, but these are dynamic phenomena produced through self-reinforcing patterns of ongoing activity rather than permanent conditions or steady states.[19] A system may shift suddenly from one equilibrium and into another.[20] Much remains uncertain and unpredictable about ecological systems and the organisms within them, precisely because the interactions are so complex and because small events can trigger large changes through nonlinear processes.

The fluid, dynamic, and uncertain characteristics of ecosystems do not mean that meaningful patterns and processes are indecipherable in the midst of the transformation and change. [21] Ecosystems have become the focus of intensive research in complex systems analysis. A key goal is to discern patterns and processes of ecological organization within "chaotic" phenomena.

Complexity researchers see organisms and ecosystems as "self-organizing" at multiple scales.[22] The abilities of an ecosystem to recover in the wake of disturbance, to evolve, and to adapt flexibly to new conditions, reflect self-organizing capacities.[23] Nonlinear interactions of biotic and abiotic

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18. For a thorough overview of key concepts in contemporary "macroecology," see Bosselman, *supra* note 9. *See also,* Fred P. Bosselman & A. Dan Tarlock, *The Influence of Ecological Science on American Law: An Introduction*, 69 CHI.-KENT L. REV. 847 (1994) (providing a historical perspective on changing ecological ideas and the implications for environmental law).

19. "Nonlinear features of processes of predation, reproduction, competition, and nutrient dynamics create the multiple equilibria. Stochastic forces and interactions between fast variables and slow ones mediate the movements of variables among those equilibria." Holling & Gunderson, *supra* note 11, at 26 (citation omitted).

20. Change is neither continuous and gradual nor consistently chaotic. Rather it is episodic, with periods of slow accumulation of natural capital such as biomass, physical structures, and nutrients, punctuated by sudden releases and reorganization of those biotic legacies . . . *Critical processes function at radically different rates that span several orders of magnitude, but these rates cluster around a few dominant frequencies. Episodic behavior is caused by interactions between fast and slow variables.*
Id.

21. *See* Audrey L. Mayer & Max Rietkerk, *The Dynamic Regime Concept for Ecosystem Management and Restoration, in* 54 BIOSCI. 1013 (2004).

22. *E.g.*, SIMON LEVIN, FRAGILE DOMINION: COMPLEXITY AND THE COMMONS 43-51 (1999).

23. *See* Bosselman, *supra* note 9, at 230-31 (providing an overview of recent research on

elements dynamically maintain resilience, or the ability to recover after disruption. The capacity for adaptive change depends both upon sensitivity to external conditions and upon persistence in the face of disturbance. Periods that foster novelty and experimentation are important for maintaining the diversity and variability that in turn provide the means for adapting to new conditions. Meanwhile, conservative processes promoting stability are central to the ability to withstand disruption and to recreate preexisting patterns in the wake of impacts from the environment. These dynamics have been characterized as occurring in an adaptive cycle of four major phases involving processes of exploitation, conservation, release and reorganization.[24]

Self-organizing phenomena may be studied at multiple scales, from microscopic events and individual organisms to interacting populations, and from small geographical pockets to large-scale regional systems. Researchers discern a hierarchy of self-organized levels "nested" within each other. Despite the reliance on hierarchical terminology, the reference is not to a top-down pattern of dominance and subordination. The various levels are seen as semi-autonomous, and "loosely coupled" across scales.[25] The levels may be treated separately for purposes of structured scientific analysis, but interactions between levels are also important in understanding the introduction of the novelty and variability that enable experimentation and adaptation.[26]

For purposes of the current discussion, an important point is that such scientific investigations seek to recognize and define both the separateness of conceptual entities (such as organisms and ecosystems) from their environment and their vulnerability to external variations. These endeavors are complicated by the realization that the boundaries and connections must be seen as changing rather than fixed.[27] The delineation of patterns "inside" and "outside" various levels

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self-organization).

24. Holling & Gunderson, *supra* note 11, at 32-49 (reiterating concepts set forth in C.S. Holling, *Resilience of Ecosystems: Local Surprise and Global Change*, *in* SUSTAINABLE DEVELOPMENT OF THE BIOSPHERE 292 (William C. Clark & R.E. Munn eds., 1986)).

25. Holling & Sanderson, *supra* note 13, at 77.

26. *Id*. at 78.

27. "[S]implistic assumptions are now being recast as more complex, open-ended criteria that emphasize that stability is a function of the time scale of observation and the balance between '(a) rates of change in environmental condition, and (b) rates of change in the biota.'" Tarlock, *supra* note 14, at 1185 (citing Robert V. O'Neill, *Is it Time to Bury the Ecosystem Concept? (With Full Military Honors, of Course!)*, 82 ECOLOGY 3275, 3277-79 (2001)).

and types of organization are steps to understanding and measuring ecological control and influence, on the one hand, and ecological vulnerabilities, dependencies, and linkages on the other. Conceiving and defining evolving semiautonomous entities for purposes of analysis is a key aspect of the effort to gain insight into the dynamics and patterns of biophysical interactions.[28]

Understanding how human and nonhuman activities interact with each other is an important subset of these ecological investigations.[29] People are organisms, and like other organisms they depend on their environment for resources to grow, thrive, and reproduce. They depend on access to soil, air, water, light,heat, and other organisms. Nonhuman organisms, in turn, organize, change, and consume materials in their environments, resulting in complex networks of dependency and influence.

As a result, human and nonhuman organisms are both interdependent and in conflict and competition. The ecological perspective places people *inside* ecosystems. From this point of view, it is misleading to consider the operations of human socioeconomic systems without reference to the ecological systems to which they are bound. The study of *socio-ecological systems* seeks to capture the intertwined dynamics of human and nonhuman activities, using the tools and language of systems analysis in a cross-cutting manner to bridge subjects that are often studied quite separately.[30]

The "ecological economics" literature studies the dependencies of the human economy on the dynamics of ecosystems.[31] Pursuing the science-based image of human

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28. Bosselman, *supra* note 9, at 226-27 (discussing the separation of complex systems into layers and phases for purposes of analysis). While research concerning processes of self-organization and adaptation focuses on discerning internal mechanisms and identifying the effects of external factors, no teleological principles are involved. "One of the most interesting aspects of the large scale ecologist's perspective on nature is the appreciation of how ecological systems change over time by adapting to new environmental conditions in an evolutionary fashion without any overall objective except the pursuit of continuing fitness by the various animals and plants that comprise the system." *Id.* at 228 (citing Simon A. Levin, *Ecosystems and the Biosphere as Complex Adaptive Systems*, 1 ECOSYSTEMS 431 (1998) and SCOTT CAMAZINE ET AL., SELF-ORGANIZATION IN BIOLOGICAL SYSTEMS (2001)).

29. Lance H. Gunderson, *Adaptive Dancing: Interactions Between Social Resilience and Ecological Crises*, *in* NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS, *supra* note 17, at 33.

30. C.S. Holling, *Foreword: The Backloop to Sustainability*, *in* NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS, *supra* note 17, at xv-xvi.

31. Introductions to the field of environmental economics may be found in AN INTRODUCTION TO ECOLOGICAL ECONOMICS (Robert Costanza et al. eds., 1997); ECOLOGICAL ECONOMICS: THE SCIENCE AND MANAGEMENT OF SUSTAINABILITY (Robert Costanza ed., 1991) [hereinafter ECOLOGICAL ECONOMICS].

economic activities embedded within the larger processes of ecosystems, writers in this field highlight human-ecosystem interactions that affect economic production.[32] Ecosystems provide "natural capital" that serves as the underpinnings for human welfare, although their value goes unrecognized in national capital accounts.[33] From the human standpoint, organisms and their aggregations provide beneficial "ecosystem services," for example, by pollinating crops, purifying water, or providing flood control.[34] A key conclusion is that the scale of the human economy, or the human "ecological footprint,"[35] needs to be limited based on scientific awareness about the sustainability of the ecological underpinnings of the economic system.[36]

Ecological economics looks primarily at how people benefit, directly and indirectly, from the activities of other organisms, rather than how other organisms derive benefits from their environments. Nevertheless, despite its one-sided focus, this literature tracks the complex systems perspective by locating human activities (including the complex dynamics of the economic system) within larger-scale ecological phenomena and by highlighting the interconnectedness of socioeconomic and ecological processes.[37]

Despite the embeddedness of the human socioeconomic system within the functioning of ecological systems, people and their organizations are not necessarily good at fostering or contributing to the resilience of the ecosystems to which

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32. *See* Douglas A. Kysar, *Sustainability, Distribution, and the Macroeconomic Analysis of Law*, 43 B.C. L. REV. 1, 8-44 (2001) (tracing the emergence and elaboration of concepts in ecological economics) [hereinafter Kysar, *Sustainability*].

33. Salah El Serafy, *The Environment as Capital*, *in* ECOLOGICAL ECONOMICS, *supra* note 31, at 168. *See also* Kysar, *Vision*, *supra* note 16, at 678-93 (providing an overview of issues in ecological economics).

34. GRETCHEN C. DAILY, NATURE'S SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS (1997); James Salzman et al., *Valuing Ecosystem Services*, 24 ECOLOGY L.Q. 887 (1997); James Salzman, Barton H. Thompson, Jr. & Gretchen C. Daily, *Protecting Ecosystem Services: Science, Economics, and Law*, 20 STAN. ENVTL. L.J. 309 (2001) (introducing symposium issue on ecosystem services); Barton H. Thompson, Jr., *Markets for Nature*, 25 WM. & MARY ENVTL. L. & POL'Y REV. 261 (2000). *See also* J.B. Ruhl, *Valuing Nature's Services: The Future of Environmental Law*, 13 NAT. RESOURCES & ENV'T 359 (1998).

35. *See generally* MATHIS WACKERNAGEL & WILLIAM E. REES, OUR ECOLOGICAL FOOTPRINT: REDUCING HUMAN IMPACT ON THE EARTH (1996).

36. HERMAN E. DALY, BEYOND GROWTH (1996). A corollary to the conclusion that the macroeconomy must be limited is the suggestion that microeconomic transactions provide insufficient means for valuing the ecological underpinnings of the macroeconomy. Kysar, *Sustainability*, *supra* note 32, at 63-70.

37. Fikret Berkes et al., *Introduction*, *in* NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS, *supra* note 18, at 1, 9-13 (discussing ecological economics as one among several integrative approaches to social-ecological systems).

they belong. On the one hand, in modern industrialized locations, human systems are themselves remarkably insulated from local environmental variability.[38] They can maintain stable supplies of goods to serve human needs despite severe disruptions in local environmental conditions. The workings of the global market economy provide means for avoiding impacts of local change by exploiting resources in other locations and transporting goods from afar. Natural resource management techniques offer ways of efficiently exploiting the environment, suppressing disturbances, and maximizing yields to support economic growth. Methods ranging from storage technologies to insurance systems provide ways of buffering or eliminating the effects of local and seasonal variations on human welfare. Over the short term, at least, people do well for themselves in the "exploitation" and "conservation" phases of the adaptive renewal cycle.[39]

On the other hand, the very processes that allow people to efficiently exploit resources and isolate themselves from environmental change have produced rigidities and close dependencies that undermine ecological renewal.[40] Tightly controlled social and economic stability comes at the expense of the more creative but far-ranging fluctuations and evolutionary patterns of ecological resilience.[41] Monocultural agriculture, as a classic example, eliminates biological diversity while maximizing predictable yields of food for people over the short term. Such agricultural systems are closely managed by people to eliminate uncertainty and inefficiency. But they are also vulnerable to dramatic "surprises" from pests or depleted soils, resulting in sudden shifts to sharply degraded conditions — an entirely different ecological equilibrium. The "engineering resilience" that characterizes much of the socio-ecological interactions of the modern human economy does not produce long-term "ecosystem resilience."[42] The loss of biological diversity and the consequential lack of capacity for invention, evolutionary

38. *See* Holling & Gunderson, *supra* note 11, at 27-30.

39. Berkes, *supra* note 37, at 19-20.

40. *See* C.S. Holling, *What Barriers? What Bridges?*, *in* BARRIERS AND BRIDGES TO THE RENEWAL OF ECOSYSTEMS AND INSTITUTIONS 3, 6-9 (Lance H. Gunderson et al. eds., 1995) [hereinafter BARRIERS AND BRIDGES].

41. *See* Lynda L. Butler, *The Pathology of Property Norms: Living Within Nature's Boundaries*, 73 S. CAL. L. REV. 927, 968-69 (2000) (noting effects of closely managing ecosystems to reduce variability and produce particular species for human benefit).

42. Holling & Gunderson, *supra* note 11, at 27–28.

exploration and creative reorganization mean that the very ecosystems on which people depend become less adaptive, flexible, and resilient over the long-term.[43]

The growing scientific understandings of complex dynamics of resilience and adaptation in ecosystems have led to disconcerting questions about the adequacy of human institutions.[44] Human economic, political, and cultural processes effectively buffer society from local changes, but human practices lead to brittle ecosystems and crises. People and their organizations remain insensitive rather than responsive to ecosystem dynamics until confronted with sudden dramatic shifts and losses. The relationships between people and other organisms, and the ecological conditions that human beings strive to maintain are not "sustainable."[45] The question arises: how can human institutions be designed to be less oblivious and more in tune with ecological processes in order to foster long-term ecosystem resilience rather than merely short-term socioeconomic stability?

The broad policy conclusion that has emerged in response to such questions is that human institutions must become newly flexible, adaptive, and open to environmental signals.[46] Instead of seeking to repress disturbance and maximize production of goods, the main goal must be to foster resilience in ecosystems and avoid human-induced alterations beyond the range of perturbations that ecosystems have evolved to absorb.[47] In addition, since ecosystems cannot be perfectly

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43. *See* EDWARD O. WILSON, THE DIVERSITY OF LIFE 14-15 (1992) (describing outcomes when biodiversity is so altered by disturbance that the ecosystem is unable to recover resiliently).

44. A. Dan Tarlock, *The Nonequilibrium Paradigm in Ecology and the Partial Unraveling of Environmental Law*, 27 LOY. L.A. L. REV. 1121 (1994) (examining implications of scientific understandings for environmental protection programs). *See also* Jonathan Baert Wiener, *Beyond the Balance of Nature*, 7 DUKE ENVTL. L. & POL'Y F. 1 (1996).

45. *See* Folke, *supra* note 17, at 353.

46. *See* ADVISORY COMMITTEE FOR ENVIRONMENTAL RESEARCH AND EDUCATION, NATIONAL SCIENCE FOUNDATION, COMPLEX ENVIRONMENTAL SYSTEMS: SYNTHESIS FOR EARTH, LIFE, AND SOCIETY IN THE 21ST CENTURY: A 10-YEAR OUTLOOK FOR THE NATIONAL SCIENCE FOUNDATION 34-37 (2003), *available at* http://www.nsf.gov/geo/ere/ereweb/acere/acere_synthesis_rpt_full.pdf (endorsing efforts to identify and adopt decision-making approaches and institutional arrangements that promote ecosystem resilience). *See also* DANIEL B. BOTKIN, DISCORDANT HARMONIES: A NEW ECOLOGY FOR THE TWENTY-FIRST CENTURY 190 (1990) (noting that in the context of changing environmental conditions, risks, and uncertainties, "our judgments of our own actions must be made against this moving image").

47. *See* Holly Doremus, *Adaptive Management, the Endangered Species Act, and the Institutional Challenges of "New Age" Environmental Protection*, 41 WASHBURN L.J. 50 (2001); Bradley C. Karkkainen, *Adaptive Ecosystem Management and Regulatory Penalty Defaults: Toward a Bounded Pragmatism*, 87 MINN. L. REV. 943, 945-65 (2003) (providing overviews of adaptive management approaches and commentary on barriers to implementation). *See also*

controlled, and "normal" disturbances and changes should not be avoided, human society itself must also develop better means for responding flexibly to disruptions of human activities.[48]

Contemporary "adaptive" approaches to ecosystem management tend to retain a hopeful view of human capacity to find means for beneficially coordinating human activities with emerging understandings of ecosystem dynamics.[49] The approach relies significantly on processes of learning and building on experience.[50] Because knowledge at any given moment is uncertain and incomplete, decision-making rests on observing, testing, and assessing probabilities.[51] The experimental aspects of adaptive management, and the evolving conditions in the environment, mean that decisions should not be treated as final, but must be reassessed and adjusted over time.[52] The more far-reaching interpretations

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Flournoy, *supra* note 15 (discussing reform of wetlands laws to deal with ecological functions and processes).

48. "Until modern human institutions are built on ecological dynamism, and designed to flex with natural variability, their principal impact will be to impede nature, not to sustain it." Holling & Sanderson, *supra* note 11, at 79.

49. *See* BARRIERS AND BRIDGES, *supra* note 40, at 15 (distinguishing views of "Nature Resilient" and "Nature Evolving" from the hyperbolic view of "Nature Anarchic" that asserts "humans are *incapable* of learning how to deal with the technology they unleash"). *See also* Holling & Gunderson, *supra* note 11, at 27 (suggesting that management policies must be compatible with "some version of both Nature Resilient and Nature Evolving"); Butler, *supra* note 42, at 952 (suggesting that management can still affect ecological systems in a positive way, despite their chaotic aspects, if property norms are changed to eliminate "pathological effects"). *But see* Doremus, *supra* note 47, at 52-56 (discussing political and other barriers to effective implementation of adaptive management approaches).

50. "Generally lacking are theories of social dynamics that can complement the emerging theories of ecosystem dynamics to produce real understanding of the long-term, large-scale interactions of environment and development. Among those social theories that are dynamic, the most striking common feature is reference to learning." Edward A. Parson & William C. Clark, *Sustainable Development as Social Learning: Theoretical Perspectives and Practical Challenges for the Design of a Research Program*, *in* BARRIERS & BRIDGES, *supra* note 40, at 428-29 (providing an overview of theories of learning that are relevant to ecosystem management). A frequently-cited discussion of adaptive management that focuses on stakeholder participation and social learning is KAI N. LEE, COMPASS AND GYROSCOPE: INTEGRATING SCIENCE AND POLITICS FOR THE ENVIRONMENT 51-86 (1993); *see also* John M. Volkman, *How Do You Learn from a River? Managing Uncertainty in Species Conservation Policy*, 74 WASH. L. REV. 719, 738-62 (1999) (describing tools for learning to deal with scientific uncertainty, and urging efforts at systematic experimentation).

51. CARL WALTERS, ADAPTIVE MANAGEMENT OF RENEWABLE RESOURCES 2-3 (Wayne M. Getz ed., 1986) (calling for an "adaptive learning process, where management activities themselves are viewed as the primary tools for experimentation").

52. Important analytical commentary has tied adaptive management, with its experimental and incremental approaches and emphasis on "learning by doing," to the pragmatism of John Dewey. *See* Symposium, *The Pragmatic Ecologist: Environmental Protection as a Jurisdynamic Experience*, 87 MINN. L. REV. 847 (2003). *See also* J.B. Ruhl, *Working Both (Positivist) Ends Toward a New (Pragmatist) Middle in Environmental Law*,

of adaptive management suggest that developing societal capabilities may require broad adjustments in how people and their organizations gather and use knowledge and deal with unexpected events.[53]

The next section examines connections between these developments in science and ecosystem management policy and recent scholarship on property regimes.

II. FROM COMPLEX ECOSYSTEMS TO PROPERTY REGIMES

As ecological understandings have expanded, legal and economic literature has addressed the challenges of modifying natural resource management laws and institutional frameworks to respond more effectively to ecological concerns. One widespread assertion is that property regimes are at the center of existing problems, and that solutions will involve changes and reinterpretations in property law.[54] Property definitions and arrangements are seen as critical institutional mechanisms for coordinating human legal and economic systems with ecosystems.[55]

Two major lines of argument for adapting property regimes to meet ecological needs bear particular mention here as a backdrop to the subsequent discussion. The first line of argument urges paring back or reconfiguring property rights and imposing far-reaching responsibilities on owners to address ecological concerns. The second position counsels

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68 GEO. WASH. L. REV. 522 (2000) (reviewing DANIEL A. FARBER, ECO-PRAGMATISM: MAKING SENSIBLE ENVIRONMENTAL DECISIONS IN AN UNCERTAIN WORLD (1999)).

53. Folke, *supra* note 17, at 354-55 (outlining societal capabilities that must be fostered in order to deal with ecosystem dynamics).

54. *E.g.*, Susan Hanna et al., *Property Rights and the Natural Environment*, *in* RIGHTS TO NATURE: ECOLOGICAL, ECONOMIC, CULTURAL, AND POLITICAL PRINCIPLES OF INSTITUTIONS FOR THE ENVIRONMENT 1, 9 (Susan S. Hanna et al. eds., 1996) [hereinafter RIGHTS TO NATURE] ("[T]here is an urgent need to design institutions that safeguard this dynamic capacity of the natural environment. Property rights regimes are critical institutions in this regard. They link society to nature and have the potential to coordinate human and natural systems in a complementary way for both ecological and human long-term objectives."); Alison Rieser, *Prescriptions for the Commons: Environmental Scholarship and the Fishing Quotas Debate*, 23 HARV. ENVTL. L. REV. 393, 420 (1999) (concluding that reforms should consider "complex and dynamic features of ecosystems").

55. *See* Robert Costanza & Carl Folke, *The Structure and Function of Ecological Systems in Relation to Property-Rights Regimes*, *in* RIGHTS TO NATURE, *supra* note 54, at 13, 26-28; Alison Rieser, *Property Rights and Ecosystem Management in U.S. Fisheries: Contracting for the Commons?*, 24 ECOLOGY L.Q. 813, 817-18 (1997) (discussing the importance of designing property regimes to deal with the complexity of ecosystems, and analyzing alternatives). S*ee also*, Berkes, *supra* note 37, at 11-12 (identifying property rights systems as institutions of key importance and including them in a broader category of "cultural capital" that provides human societies with means for organizing their interactions with the natural environment).

recognizing previously-unnoticed communal governance arrangements as important kinds of property regimes.

A. Redefining Property Rights According to Ecological Context

As understandings of ecosystems have grown, legal scholars have urged redefining or limiting property rights to include an array of community responsibilities, placing concepts of private ownership within a broader context of ecological considerations.[56] While there are some significant differences among these writers, they share a willingness to question classic economic understandings of property.[57] Their views of property depart from images of individual autonomy and unilateral control within clear, fixed boundary lines.[58] Professor Joseph Sax, in a well-known commentary on the Supreme Court's decision in *Lucas v. South Carolina Coastal Council*,[59] has explored the challenges that ecologically-oriented legislation poses for standard ideas of land ownership.[60] He sketches two opposing perspectives on property grounded in two differing concepts of the "economy":

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56. This failure to give serious consideration to the connections between land development, water use, and ecosystem health reflects a fundamental problem within American property law and current ecosystem and resource management practices....The obstacles raised by property norms are especially evident in the core justifications, fundamental principles, and key policies of American property law, and in the legal principles governing allocation and management of natural resources. Butler, *supra* note 41, at 928. *See also* Lee P. Breckenridge, *Reweaving the Landscape: The Institutional Challenges of Ecosystem Management for Lands in Private Ownership*, 19 VT. L. REV. 363, 382-86 (1995).

57. Arnold, *supra* note 4, at 318-21 (providing an overview of environmental concepts of property). *See also* John G. Sprankling, *The Antiwilderness Bias in American Property Law*, 63 U. CHI. L. REV. 519, 520 (1996) (questioning whether modern property law influences wilderness destruction).

58. *See, e.g.*, Butler, *supra* note 41, at 943-47; J. Peter Byrne, *Green Property*, 7 CONST. COMMENT. 239 (1990); Terry W. Frazier, *The Green Alternative to Classical Liberal Property Theory*, 20 VT. L. REV. 299 (1995); Eric T. Freyfogle, *Ownership and Ecology*, 43 CASE W. RES. L. REV. 1269 (1993); David B. Hunter, *An Ecological Perspective on Property: A Call for Judicial Protection of the Public's Interest in Environmentally Critical Resources*, 12 HARV. ENVTL. L. REV. 311 (1988). *See also* Donald W. Large, *This Land is Whose Land? Changing Concepts of Land as Property*, 1973 WIS. L. REV. 1039 (providing an early contribution to this line of analysis).

59. Lucas v. S.C. Coastal Council, 505 U.S. 1003 (1992).

60. Joseph L. Sax, *Property Rights and the Economy of Nature: Understanding* Lucas v. South Carolina Coastal Council, 45 STAN. L. REV. 1433, 1439 (1993) ("In general, Lucas addresses legislation imposed to maintain ecological services performed by land in its natural state. The Court correctly perceives that an ecological worldview presents a fundamental challenge to established property rights, but the Court incorrectly rejects that challenge.").

> There are two fundamentally different views of property rights to which I shall refer as land in the "transformative economy" and land in the "economy of nature." The conventional perspective of private property, the transformative economy, builds on the image of property as a discrete entity that can be made one's own by working it and transforming it into a human artifact. . . . Traditional property law treats undeveloped land as essentially inert. . . . An ecological view of property, the economy of nature, is fundamentally different. Land is not a passive entity waiting to be transformed by its landowner. Nor is the world comprised of distinct tracts of land, separate pieces independent of each other. Rather, an ecological perspective views land as consisting of systems defined by their function, not by man-made boundaries. Land is already at work, performing important services in its unaltered state.[61]

The ecological perspective thus perceives active ecosystems rather than passive "things," and it places human endeavors within the context of ecosystem dynamics. This contextualization has several key implications. First, the attention to ecosystem functions requires paring back powers to use, destroy, and alienate resources that have been defined without reference to ecological boundaries and connections.[62] Webs of local ecological dependencies mean that property must be tied down in space and time.[63] A quantity of water, for example, may have great ecological importance in a particular location and season, given the array of organisms and ecological processes that depend upon it. Transferred to another spot, it may serve no comparable role.[64] The ecological perspective redefines private property by limiting rights to

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61. *Id.* at 1442 (footnote omitted).

62. *See id.* at 1448. *See also* Lynda L. Butler, *Private Land Use, Changing Public Values, and Notions of Relativity*, 1992 BYU. L. Rev. 629, 631 (1992) (noting that traditional expectation of exploitative use is no longer "reasonable" in light of ecological knowledge).

63. Eric T. Freyfogle, *Context and Accommodation in Property Law*, 41 STAN. L. REV. 1529, 1541 (1989). *See also* Carol M. Rose, *Given-ness and Gift: Property and the Quest for Environmental Ethics*, 24 ENVTL. L. 1, 5-6 (1994) (addressing problems caused by compartmentalizing environmental resources that should be managed as wholes).

64. *See* Carol M. Rose, *Energy and Efficiency in the Realignment of Common-Law Water Rights*, 19 J. LEGAL STUD. 261, 291-92 (1990).

specific uses and locations, tailored to recognize ecological dependencies and avoid impacts.[65] It foregoes the simplicity of clear, broad definitions of unilateral control in favor of more complex, relational, place-specific delineations.

Second, property rights are not fixed, but change over time.[66] This conclusion resonates with suggestions from conservation biologists that ecosystem "management" in general must involve an adaptive, experimental learning process that revises controls in light of new information. As circumstances change, and as scientific information elucidates previously unknown ecological relationships, the delineations of ownership rights to exploit resources must shift to accommodate the new situation.[67] Property rights are less secure, in part because of continuing uncertainties in knowledge about how ecosystems function.[68]

Third, an ecological perspective on property can involve significant expansions in government regulatory and administrative activities. [69] Regulations and permits issued by expert agencies are prominent mechanisms for introducing and redefining the ecological responsibilities associated with ownership. Many writers also advocate expanded concepts of public property and the public trust doctrine, seeing government ownership and trusteeship as means for limiting private property rights, placing ownership in the context of

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65. Sax, *supra* note 60, at 1452-53 (discussing the shift to a usufructuary model of property).

66. *Id*. at 1446-49. "Property law has always been functional, encouraging behavior compatible with contemporary goals of the economy." *Id*. at 1447. *See also* Butler, *supra* note 41, at 995 (emphasizing "the inherent adaptability and the civic nature of property"); Freyfogle, *supra* note 58, at 1293 ("In the years ahead the Court's task shall be to find a way to think of property as an evolving social institution, as an institution that responds to social needs.").

67. The view that a society can change its definitions of property to serve evolving needs is prevalent in the recent literature. Not all advocates of an ecological perspective on property have adopted this view, however. *See* Eric T. Freyfogle, *Owning the Land: Four Contemporary Narratives*, 13 FLA. ST. U. J. LAND USE & ENVTL. L. 279, 297-303 (1998) (contrasting a "narrative of social evolution" with a "narrative of natural use" that looks to nature itself as a source of rules).

68. "Because ecosystems are ever changing and unpredictable, protection of ecosystems will require policies that conflict with the certainty goal underlying many property law principles." Butler, *supra* note 41, at 936 (*citing* Robert B. Keiter, *Ecosystems and the Law: Toward an Integrated Approach*, 8 ECOLOGICAL APPLICATIONS 332, 332 (May 1998)).

69. The process of contextualizing property to meet ecological goals runs the obvious risk of encountering constitutional objections. Much of the legal literature on reconfiguring property to match ecological realities has been at least partially concerned with the threshold question of whether the proposed changes unfairly disrupt owner expectations or run afoul of constitutional restrictions on uncompensated regulatory takings. *See, e.g.*, Sax, *supra* note 60, at 1449-51, 1454-55; Tarlock, *supra* note 44, at 1141-43.

community responsibilities, and managing resources to serve the public at large.[70]

The ecological perspective on property includes biocentric themes.[71] It discerns the need for imposing new responsibilities on property holders specifically directed at avoiding impacts on organisms and disruptions of ecosystems. Whether because of ethical concerns or because of precautionary attitudes about the indirect implications for people, organisms and ecosystems become the focus of individual and institutional attention.[72] In essence, people are repositioned as participants in a larger ecological enterprise.[73] People are not the only organisms that "work."[74] Resources of concern include those that benefit nonhuman organisms and entities as well as people.[75]

How should property regimes allocate resources to, and among, the participants in this ecologically-reconceived

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70. *See* Lynda L. Butler, *Environmental Water Rights: An Evolving Concept of Public Property*, VA. ENVTL. L.J. 323 (1990); John D. Echeverria, *The Politics of Property Rights*, *50* OKLA. L. REV. 351, 370-72 (1997); Gary Meyers, *Variation on a Theme: Expanding the Public Trust Doctrine to Include Protection of Wildlife*, 19 ENVTL. L. 723, 724-25 (1989); Alison Rieser, *Ecological Preservation as a Public Property Right: An Emerging Doctrine in Search of a Theory*, 15 HARV. ENVTL. L. REV. 393 (1991). *See also* Carol M. Rose, *Joseph Sax and the Idea of the Public Trust*, 25 ECOL. L. Q. 351 (1998). *But see* Richard J. Lazarus, *Changing Conceptions of Property and Sovereignty in Natural Resources: Questioning the Public Trust Doctrine*, 71 IOWA L. REV. 631 (1986) (questioning the wisdom of relying on the public trust doctrine as the means for expanding public oversight).

71. Freyfogle, *supra* note 58, at 1289 ("When property law focuses on the owner against other people we lose all sense of the peculiar thing at issue. Let us regain a sense that we are talking about vital components of the natural fabric of things, not just people.").

72. See Ruhl, *supra* note 52, at 542 (observing that environmental protection is "inherently a biocentric matter" when biodiversity becomes the measure of policy success).

73. The implicit biocentric attention occurs even in analyses that purport to focus on long-range human welfare. A. Dan Tarlock, *Slouching Toward Eden: The Eco-Pragmatic Challenges of Ecosystem Revival*, 87 MINN. L. REV. 1173, 1178 (2003) (noting that "[w]hile philosophers continue to debate whether non-anthropocentric ethics are possible, economists and ecologists have progressed operationally by framing the question as a wholly anthropocentric one . . . .").

74. In portraying people as participants in a larger ecological enterprise with other organisms, the contemporary legal literature finds parallels in Aldo Leopold's writings portraying people as members of a "land-community": "In short, a land ethic changes the role of Homo sapiens from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also respect for the community as such." Aldo Leopold, *The Land Ethic*, *in* A SAND COUNTY ALMANAC AND SKETCHES HERE AND THERE 203-04 (1949). Even though Aldo Leopold's concepts of ecology, which assumed the possibility of maintaining stable equilibria in nature, have been superseded by more recent concepts of ecological change, the image of people participating in a larger ecological "community" remains influential in the adaptive management literature. *See* Holly Doremus, *The Rhetoric and Reality of Nature Protection: Toward a New Discourse*, 57 WASH. & LEE L. REV. 12, 34, 65-69 (2000); Rieser, *supra* note 54, at 420.

75. *See* Sax, *supra* note 60, at 1445 (characterizing a wetland as "an adjunct of a river, in service to the river . . .").

common enterprise? We revisit this question later, but turn next to the ideas of another group of scholars who suggest a broadened attention to self-organized resource management systems that may emerge outside the forums of formal law-making.

B. Recognizing Self-Organized Resource Management Regimes

A second and rather different literature urges expanding concepts of property regimes to encompass the sometimes highly adaptive practices of informally-organized local groups. This line of research investigates the structure and efficacy of self-organized resource management institutions.[76] It challenges the adequacy of established approaches to property, but it does so by advocating recognition of previously unnoticed forms of governance.

In the classic understanding of the "tragedy of the commons,"[77] short-sighted and self-interested behavior by people exploiting an open access resources leads to ecological disaster. What institutional arrangements might avoid this tragedy? The standard answer has been that private property systems and state ownership or management are the two means for capping total resource use at an ecologically tolerable level while gaining economic returns.[78] In a private property regime, society relies upon the definition of individual property rights to provide the boundaries and authority for excluding excessive resource use and reaping the benefits of careful management. In a "coercive" regime, governments limit total use and allocate access to resources through administrative mechanisms.

Recent commentators have urged broader understandings of the available means for limiting and

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76. Various terms have been used in describing such resource management systems, including "common property regimes" (CPRs) and "community-based management regimes" (CBMRs). *See* Carol M. Rose, *Common Property, Regulatory Property, and Environmental Protection: Comparing Community-Based Management to Tradable Environmental Allowances*, *in* THE DRAMA OF THE COMMONS, *supra* note 15, at 233, 234.

77. Garrett Hardin, *The Tragedy of the Commons*, 162 SCI. 1243, 1244 (1968). *See also* WILLIAM OPHULS & A. STEPHEN BOYAN, JR., ECOLOGY AND THE POLITICS OF SCARCITY REVISITED: THE UNRAVELING OF THE AMERICAN DREAM 148 (1992) (addressing the use of government coercion). While Hardin has provided the most cited formulation of the "tragedy of the commons," researchers have long discussed the issue, particularly in the area of fisheries management. *E.g.*, H. Scott Gordon, *The Economic Theory of a Common-Property Resource: The Fishery*, 62 J. POL. ECON. 124 (1954).

78. *See* Hardin, *supra* note 77, at 1247.

coordinating human activities to avoid the "tragedy of the commons."[79] "Common property" institutions provide resource management systems that differ from systems based on private property or state control.[80] In particular, Elinor Ostrom and others working from a *new institutional economics* perspective have shown that traditional communal practices, cultural norms, religious taboos, and other forms of self-governance found in local groups may also serve to limit uses, prevent conflict, and allocate economic returns while sustaining the underlying renewable resource base.[81] Over the past twenty years, extensive research efforts have focused on identifying the factors that affect the formation and success of these community-based resource management systems.[82]

In successful common property regimes, the resources are held "in common" but they are not "open-access commons." On the contrary, the community's ability to exclude excessive resource uses is important, just as it is to the success of other forms of governance. Placing an effective cap on resource use entails, first, the ability to establish and police boundaries and to exclude outsiders who are not participants in the group.[83] Within those boundaries common property regimes also need the capacity to regulate activities by members of the group, but these internal governance arrangements may take many

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79. *See* Rieser, *supra* note 54, at 396-403 (tracing the development of scholarship on the management of common pool resources); Carol M. Rose, *Expanding the Choices for the Global Commons: Comparing Newfangled Tradable Allowance Schemes to Old-Fashioned Common Property Regimes*, 10 DUKE ENVTL. L. & POL'Y F. 47-50 (2000) (discussing scholarship on common property regimes). *See also* Robert C. Ellickson, *Property in Land*, 102 YALE L.J. 1315, 1320-21 (1993) (considering development of property norms in "close-knit" groups).

80. Arun Agrawal, *Common Resources and Institutional Sustainability*, *in* THE DRAMA OF THE COMMONS, *supra* note 15, at 41.

81. Much of this scholarship builds on ideas developed in ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION (1990). More recent work by Ostrom and others appears in THE DRAMA OF THE COMMONS, *supra* note 16. *See also* COMMON PROPERTY RESOURCES: ECOLOGY AND COMMUNITY-BASED SUSTAINABLE DEVELOPMENT (Fikret Berkes ed., 1989); THE QUESTION OF THE COMMONS: THE CULTURE AND ECOLOGY OF COMMUNAL RESOURCES (Bonnie J. McCay & James M. Acheson eds., 1987) [hereinafter THE QUESTION OF THE COMMONS].

82. See Paul C. Stern et al., *Knowledge and Questions After 15 Years of Research*, *in* THE DRAMA OF THE COMMONS, *supra* note 15, at 445, 456-57 (summarizing key findings).

83. *See* Fred P. Bosselman, *Replaying the Tragedy of the Commons*, 13 YALE J. ON REG. 391 (1996) (reviewing ELINOR OSTROM ET AL., RULES, GAMES, AND COMMON-POOL RESOURCES (1994)) (discussing the importance of "boundary rules" and limitations on the number of users). *See also* James M. Acheson, *The Lobster Fiefs Revisited: Economic and Ecological Effects of Territoriality in the Maine Lobster Industry*, *in* THE QUESTION OF THE COMMONS, *supra* note 81, at 37-41 (discussing "perimeter defense" practices).

different forms for limiting and allocating access to resources.[84]

Some studies of group property have focused on specific renewable resources, emphasizing the group's ability (for example) to manage the supply of water in irrigation systems.[85] In these circumstances, the implicit measures of "success" are narrower than in the literature on ecosystem resilience.[86] Nevertheless, common property regimes have begun to receive increasing attention from a broad ecological standpoint.[87] Some studies suggest that in certain circumstances, community-based management systems show remarkable capacities for fostering ecological resilience and responding adaptively to environmental change.[88]

As noted earlier, the adaptive management literature criticizes standard market and regulatory schemes for failing to foster the "release" and "reorganization" phases in the ecological adaptive cycle, as they promote economic efficiency in the short-term. Some common property regimes, by contrast, take a highly adaptive, experimental, and precautionary approach to resource management, pursuing practices that amount to a kind of ecological "insurance" against future surprises and losses.[89] These practices foster redundancies and variabilities in the landscape and maintain reservoirs of biological diversity that support renewal of the ecosystem in the wake of a destructive event.[90] The ecological knowledge that supports these practices originates in "trial-and-error experience" that may be remembered and transferred across generations, particularly in groups of

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84. *See, e.g.*, Johan Colding & Carl Folke, *The Taboo System: Lessons About Informal Institutions for Nature Management*, 12 GEO. INT'L ENVTL. L. REV. 413 (2000).

85. *See generally* ELINOR OSTROM, CRAFTING INSTITUTIONS FOR SELF-GOVERNING IRRIGATION SYSTEMS (1992).

86. Rose, *supra* note 76, at 239 (noting that the example of irrigation systems "presents at best an ambiguous case of environmental conservation"); Stern, *supra* note 82, at 457 (noting differing concepts of "success" in the literature).

87. *See* Colding & Folke, *supra* note 84, at 415 (noting that hotspots of high biodiversity correlate with regions of high cultural diversity, suggesting linkages). *See also* Lee P. Breckenridge, *Protection of Biological and Cultural Diversity: Emerging Recognition of Local Community Rights in Ecosystems Under International Environmental Law*, 59 TENN. L. REV. 735 (1992) (discussing recognition of ecological roles for local groups under international law).

88. *See* Fikret Berkes & Carl Folke, *Back to the Future: Ecosystem Dynamics and Local Knowledge*, *in* PANARCHY, *supra* note 10, at 121.

89. *See* Johan Colding et al., *Living with Disturbance: Building Resilience in Social-Ecological Systems*, *in* NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS, *supra* note 17, at 163, 179-81.

90. Berkes & Folke, *supra* note 88, at 129-37.

resource users that are closely dependent on resources in the local landscape.[91]

The literature on community-based resource management regimes makes several important observations regarding the structure of property. Of particular relevance to the current discussion is the conclusion that property regimes, broadly defined, include practices and arrangements within the community that may not appear in the state's formal framework of laws. Such regimes amount to "order without law"[92] — systems that guide uses of the environment by members of the group, although the internal mechanisms are not expressed in legal requirements. The common property literature treats the resource management rules (or norms) of self-organizing groups as important aspects of the property regime, despite the absence of formal promulgation.

Another key observation, however, is that the authority and boundaries of common property regimes may be formally recognized in law, and indeed that community systems often need to have such recognition if they are to survive and function effectively in the face of various outside pressures.[93] When a larger-scale regional or national governmental entity recognizes, defines, and protects the authority and boundaries of the local group, the resulting institutional arrangement is "limited common property — the often-ignored regimes that we might consider 'property on the outside, commons on the inside.'"[94] When external legal mechanisms reinforce and uphold the group's authority and boundaries vis-à-vis outsiders in this fashion, the common property regime can be seen as "nested" within a larger institutional structure.[95]

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91. *Id*. at 122.

92. *See generally* Robert C. Ellickson, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES (1991).

93. *See* Colding & Folke, *supra* note 84, at 414 (observing that local resource management systems are increasingly embedded in formal rules adopted at various governmental levels and suggesting that such protection is necessary).

94. Carol M. Rose, *The Several Futures of Property: Of Cyberspace and Folk Tales, Emission Trades and Ecosystems*, 83 MINN. L. REV. 129, 144 (1998).

95. Early research on "nested enterprises" focused on multi-tier irrigation systems organized from the "bottom up." *See* OSTROM, *supra* note 81, at 101-02. But the general image of nested enterprises may be applied to a variety of embedded governance relationships, many established and supervised in a more hierarchical fashion. *See* Colding & Folke, *supra* note 84, at 441-45 (describing "nested enterprises" enabled and protected by governments); Rieser, *supra* note 55, at 817, 825-29 (discussing co-management arrangements in the fisheries context). *See also* Olivia S. Choe, Note, *Appurtenancy Reconceptualized: Managing Water in an Era of Scarcity*, 113 YALE L.J. 1909 (2004) (recommending that eastern states consider

In this regard, a "nested" community resource management system bears some resemblance to other semiautonomous entities such as corporations, condominium associations, and nonprofit organizations.[96] There, too, resources are managed and distributed within self-governing organizations, but under the general supervision of larger institutions.[97]

C. Linking the Two Approaches

The arguments for limiting existing property rights and for recognizing common property regimes present rather different perspectives on ecosystem management, but they share some similar goals: Both view people as participants in ecosystems, and both recognize the dynamic complexities and uncertainties of ecological processes; both suggest revising concepts of property to illuminate the relationships of people to organisms and ecosystems and to manage the human use of ecosystems in a more ecologically sound way; both approaches emphasize the importance of flexibility and change, but this does not mean a lack of boundaries or an absence of strong, clear rules limiting resource uses. To the contrary, exclusionary aspects are central to both perspectives. Even as these approaches promote crossing and removing old boundary lines, they propose establishing or recognizing new limits on resource use that imply new boundary lines and means of exclusion, tailored to ecosystem patterns and processes.

Each approach, when taken together, lay the groundwork for elaborating ideas about legal arrangements for allocating resources to nonhuman uses. The first approach imposes responsibilities on property owners to support the self-organizing capacities of other organisms or ecosystems.

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models of "nested enterprises" in regulating water withdrawals, combining local group controls with broad governmental oversight).

96. Rose, *supra* note 76, at 252-53 (discussing models of common "liberal property" regimes that "entail a mix of self-government with the supervision of larger legal institutions").

97. "Hybrid" regulatory systems that establish tradable permits within the umbrella of a government regulatory scheme also share this feature of local decision making and government oversight. In those regimes, the government regulatory authority sets the limit on total resource use and assigns initial entitlements, while a system of private property and market transactions operates within the framework of that cap. *See generally* Rose, *supra* note 76, at 239.

The second approach suggests structured means for envisioning semiautonomous entities, other than the persons and organizations that are already well-recognized in law, as relevant actors protected by exclusionary boundaries within a larger property regime. The linkages between these two themes are pursued in the following section.

III. SEEING NONHUMAN PROPERTY

A. Translating Territory into Property

We can find an astonishing array of ways that organisms gather, transport, transform, protect, and reap benefits from resources in their environments. These endeavors can include novel methods for managing, harvesting, sequestering, and defending resources from intrusion,[98] as well as complex means of interacting with other organisms.[99] Biologists in fact sometimes use the language of human property and human economic activity to describe biological phenomena,[100] just as legal commentators sometimes analogize human claim-staking activities to nonhuman actions.[101]

As the terms are used here, though, the territoriality or "turf" of organisms is not the same as "property," unless it is recognized and protected by people and their institutions.[102]

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98. Many animals gather and place food stores in caches for later consumption. STEPHEN B. VANDER WALL, FOOD HOARDING IN ANIMALS (1990). The hoarders take various measures to protect their items in the caching process ("preparation, transportation, placement, and concealment"), *id.* at 2, and to defend their stores from "robbers." *Id.* at 104. Some organisms store extra amounts of prey as a form of insurance against loss. *Id.* at 109.

99. For instance, nonhuman organisms engage in agricultural activities, manipulating and controlling other organisms to produce beneficial products. The agricultural activities of fungus-farming ants provide an example: Fifty million years before the emergence of human agriculture, certain species of ants began cultivating fungi. In their "gardens" they grow diverse varieties, protecting their crops from weed molds with antibiotic "herbicides" and engaging in elaborate manuring regimes to maximize fungal harvests. Recent research shows that exchanges of cultivars between ant species have occurred. Researchers recommend further investigation of likely "ecological zoning" and "artificial selection" practices. Ulrich G. Mueller, Stephen A. Rehner & Ted R. Schultz, *The Evolution of Agriculture in Ants*, 281 SCI. 2034, 2037 (1998); *see also* Jared Diamond, *Ants, Crops, and History*, 281 SCI. 1974 (1998). (I am grateful to Robert V. Tauxe for pointing out these examples to me).

100. *See supra* notes 98-99.

101. *E.g.*, Rose, *supra* note 95, at 134 (comparing territorial behavior by humans and crows).

102. Despite the sociobiological temptation to describe animal territoriality as a kind of proto-property, territoriality is not the same thing as property. We see territoriality in the way that animals constantly guard some area against challenge, but the distinctive hallmark

Organisms may be in possession of resources to the extent that they exercise control and ward off intruders. But the term "property" is used here, as it usually is, to include norms, made in human forums, and backed by some mode of enforcement, whether through the state or through more informal means adopted in social groups.[103]

The issue raised, then, is how the territoriality of nonhuman organisms and their reliance on resources should figure in the development of human rules governing resource allocation. This portion of the essay argues that modern ecological understandings of the relationships and conflicts between human economic activity and ecosystem resilience point toward an elaboration of property regimes that recognizes nonhuman organisms as distinct participants or "owners" of resources rather than simply as owned "things." As discussed below, resource management regimes that encompass specific attention to nonhuman resource uses can have distinctly property-like characteristics and purposes. These lend themselves to analysis and comparisons in terms that are conventionally used in discussing the formulation and distribution of property rights among people.

B. Instream Flow Protection as an Example of Resource Allocation to Nonhuman Organisms Through Human Institutions

Legal systems for allocating water resources in aquatic ecosystems provide useful examples for studying the emergence of property-like norms governing the relationship between human and nonhuman uses. This section considers briefly the legal changes that occur in a riparian jurisdiction as it moves from reliance on common law "reasonable use" requirements to a "regulated riparian" statutory system administered through a government agency. Such water rights systems adopt increasingly formalized provisions for taking

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of property, as opposed to territoriality, is the *absence* of challenge from others.

Carol M. Rose, *Property and Expropriation: Themes and Variations in American Law*, 2000 UTAH L. REV. 1, 3 (2000) (citation omitted).

103. Merrill, *supra* note 2, at 732-33.

ecosystem concerns into account and for dedicating resources to support particular organisms and ecosystem processes.

In the paradigmatic common law riparian regime, nonhuman organisms have no legal protection for access to resources separate from the property rights of human claimants.[104] A court in an action among riparians might prohibit the diversion or impoundment of water by an upstream user in order to foster downstream human uses, but in this conflict over water, fish and other organisms does not receive attention separate from the consideration of the downstream riparian's interests in fishing, navigating, or otherwise enjoying a particular level of water flow.[105] The allocation of resources is among people, and the protection of instream resources (including nonhuman organisms) derives indirectly from the effort to deal with human conflict. Although human riparian rights remain uncertain and subject to change in light of considerations of "reasonableness," the duties of accommodation are among people.

Where growing human populations and sprawling urban development have led to increasing controversies over scarce water resources, common law riparian systems have proven to be inadequate in ensuring reliable water supplies and resolving conflicts in times of drought. As eastern states have faced water shortages akin to those of drier western states, common law systems have given way to "regulated riparian" statutory schemes that establish administrative frameworks for expert planning and agency oversight of water resources allocations to serve the public interest.[106] Even as these systems offer more secure, defined, and quantified water rights to human users, they also tend to provide more explicit attention to the instream resource needs of nonhuman

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104. *See* RESTATEMENT (SECOND) OF TORTS § 850 cmt. b (1979) (discussing interests protected in litigation among riparian proprietors). *See also* Joseph W. Dellapenna, *The Law of Water Allocation in the Southeastern States at the Opening of the Twenty-First Century*, 25 U. ARK. LITTLE ROCK L. REV. 9, 11-18 (2002) (discussing problems of reliance on common law riparian systems).

105. *See, e.g.*, Harris v. Brooks, 283 S.W.2d 129 (1955) (enjoining water diversions that interfere unreasonably with a downstream fishing and boating enterprise).

106. *See* Joseph W. Dellapenna, *The Origin of the Regulation of Riparian Rights*, *in* 1 WATERS AND WATER RIGHTS § 9.01 (Robert E. Beck ed., 1991) (Supp. 2003) (tracing the emergence of regulated riparian systems in the eastern United States).

organisms in the context of administrative proceedings.[107] Massachusetts' water management statute, to provide one example, requires numerous competing factors be "considered" by the state environmental agency before large new water withdrawals are authorized, including "[r]easonable protection of public drinking water supplies, water quality, wastewater treatment capacity, waste assimilation capacity, groundwater recharge areas, navigation, hydropower resources, water-based recreation, wetland habitat, fish and wildlife, agriculture, and flood plains"[108] as well as "[r]easonable economic development and the creation of jobs in the commonwealth."[109]

Such public interest "considerations" in administrative permit systems potentially provide some regulatory protection of instream water flows to support fish populations and other wildlife. The resource allocation regime offers an undefined level of protection for resource needs of nonhuman organisms as a limitation on competing human demands for water. Nevertheless, standing alone, such statutory provisions do not include nonhuman organisms as explicit recipients of resource allocations, since only people receive permits for specified quantities of water.

In this sense, human and nonhuman resource needs are treated quite differently: human water rights are quantified and secured, although they may be limited by a permit term and other conditions. These rights amount to entitlements that are more formal and definite than under the common law. The protections of resources for nonhuman organisms, meanwhile, are not comparable to those of human users. In the absence of additional regulations, water levels needed by fish and wildlife are reconsidered over and over on an ad hoc basis, as new permit applications are filed. The way in which competing needs are to be weighed remains unspecified. Thus, such resource allocation systems merely provide wide agency discretion to "consider" nonhuman resource needs along with

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107. *See, e.g.*, Robert H. Abrams, *Replacing Riparianism in the Twenty-First Century*, 36 WAYNE L. REV. 93, 101-03 (1989) (discussing both the importance and difficulties of implementing instream flow protections).

108. Massachusetts Water Management Act, MASS. GEN. LAWS ch. 21G, § 7(9) (2002).

109. *Id*. § 7(10).

multiple human-oriented factors in defining the limits of private human entitlements.[110] While the resource allocation regime recognizes the existence of nonhuman resource needs, the amounts of water dedicated to supporting those needs are not securely delineated or protected from human intrusion.

In a more fully elaborated statutory system, however, laws and regulations may establish defined allocations of water dedicated to instream flow.[111] These defined allocations are sometimes, though not necessarily, formulated as resource allocations specifically for nonhuman organisms or larger-scale ecosystem dynamics.

If narrowly configured to support boating and other human recreational uses, instream flow regulations will have only indirect beneficial effects for those organisms that thrive in the same minimum flow levels. The regulatory systems of particular interest here are those that, in contrast, design streamflow standards with a modern ecological perspective, for the specific purpose of supporting the long-term resilience of ecosystems, including the dynamic and evolving roles and relationships of the nonhuman organisms within them.

The Regulated Riparian Model Water Code,[112] for example, calls for promulgation of water laws and regulations delineating and reserving the water necessary for protecting the ecological integrity of aquatic ecosystems.[113] To the extent

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110. In general, ecosystem management legislation that simply requires "consideration" of wildlife values along with other factors tends to allow human economic concerns to overshadow ecological concerns in ad hoc proceedings. "If the road to hell is paved with good intentions, the road to extinction [of species] is often paved with statutes requiring 'equal consideration.'" GOBLE & FREYFOGLE, *supra* note 1, at 1217-18 (discussing federal statutes that require administrative "consideration" of impacts on species).

111. Robert E. Beck, *The Regulated Riparian Model Water Code: Blueprint for Twenty First Century Water Management*, 25 WM. & MARY ENVTL. L. & POL'Y REV. 113, 125-44 (2000) (reviewing proposals for legislative reform, and highlighting provisions that seek to establish a baseline of ecological needs to limit the volumes of water available for withdrawal); Lynda L. Butler, *Environmental Water Rights: An Evolving Concept of Public Property*, 9 VA. ENVTL. L.J. 323, 344-51 (1990) (discussing legislative instream flow protections as expressing emerging concepts of public property in water resources). *See also* Joseph W. Dellapenna, *Protecting Minimum Flows*, *in* 1 WATERS AND WATER RIGHTS § 9.05(b) (Robert E. Beck ed., 1991) (Supp. 2003).

112. WATER RES. PLANNING & MGMT. DIV., AM. SOC'Y OF CIVIL ENG'RS, THE REGULATED RIPARIAN MODEL WATER CODE: FINAL REPORT OF THE WATER LAWS COMMITTEE OF THE WATER RESOURCES PLANNING AND MANAGEMENT DIVISION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS (Joseph W. Dellapenna ed., 1997) [hereinafter MODEL CODE]. A thorough discussion of important provisions in the model code is provided by Beck, *supra* note 112.

113. MODEL CODE, *supra* note 112, § 1R-1-11, at 18. S*ee also id.* § 3R-2-01, at 39 (Protected

that the definitions of water reserved for instream flow give careful attention to natural diversity and variability, with the goal of fostering resilience in ecosystems, an important shift occurs in the process of resource allocation. Such regimes in essence put the allocations of resources to nonhuman organisms on an "equal footing" with authorizations for human uses of water.[114] The definitions of the amounts of water to be kept instream or otherwise withheld for nonhuman uses become as well-defined and secure as the delineations of water that may be withdrawn for human endeavors. The substantive commitment to reserving water for nonhuman uses occurs prior to administrative proceedings to consider new water withdrawals, so that the delineations are not revisited case-by-case as new human demands arise. The resulting water "budget" thus involves monitoring and accounting for human and nonhuman uses of water resources in equivalent ways.

Ecologically-oriented instream flow requirements provide a good illustration of a type of resource management system, developed within the umbrella of a statutory scheme that ties well-defined resource allocations directly to the needs of nonhuman organisms and the support of ecosystem processes. Instream flow provisions are not the only available example. Other federal and state environmental and natural resource management laws likewise provide legal bases (if not always successful implementing actions) for allocating resources to foster a diverse and resilient community of organisms. Critical habitat designations for species under the Endangered Species Act,[115] wildlife sanctuaries and refuges,[116]

Minimum Flows or Levels Not to Be Allocated or Withdrawn); *id*. § 3R-2-02, at 40 (Standards for Protected Minimum Flows or Levels); *id*. § 3R-2-02 cmt., at 40 ("The trend today is to manage withdrawals (including releases from reservoirs) so as to mimic natural seasonal variations in flow in order to preserve the biological integrity of the water source." (citation omitted)).

114. *See* INSTREAM FLOW COUNCIL, INSTREAM FLOWS FOR RIVERINE RESOURCE STEWARDSHIP 142 (2002) (recommending "equal footing" for different sorts of water reservations and licenses, given the concern that otherwise "off-stream demands will be given priority over instream needs as competition for water increases." *See also* A. Dan Tarlock, *Appropriation for Instream Flow Maintenance: A Progress Report on "New" Public Western Water Rights*, 1978 UTAH L. REV. 211, 217 (discussing the emergence of "equal footing" for instream uses in western states' water rights systems).

115. Endangered Species Act, 16 U.S.C. §§ 1532(5), 1533(a)(3) (2000).

116. *See generally* GOBLE & FREYFOGLE, *supra* note 1, at 981-1099 (providing an overview

government land management systems that include habitat protection measures,[117] and conservation restrictions or easements,[118] for example, can all involve identifying and setting aside resources, with the implicit or explicit purpose of promoting survival and protecting the welfare of nonhuman organisms. There are significant differences in the structure, focus, security, and current effectiveness of existing arrangements.[119] The important point for the current discussion is that such legal settings potentially provide means for translating modern scientific understandings into legislative and administrative frameworks that delineate and set aside resources for nonhuman uses and ecological processes in the face of competing human demands.

The discussion in the next section uses the example of formalized instream flow requirements to explore questions that are relevant to other environmental and natural resource management regimes as well: To what extent does a shift toward more secure and well-defined resource allocations for nonhuman organisms, such as those accomplished through instream flow requirements, resemble the evolution of property regimes among people? Do institutional mechanisms that allocate, set aside, or protect resources for nonhuman organisms have features and justifications that resemble those of human property? By extension, are the analytical approaches conventionally used in addressing different definitions and allocations of property rights among people relevant in allocating natural resources between people and nonhuman organisms?

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of federal statutes that establish various means for protecting wildlife habitat). *See also* Robert L. Fischman, *The National Wildlife Refuge System and the Hallmarks of Modern Organic Legislation*, 29 ECOLOGY L.Q. 457 (2002).

117. *See, e.g.*, Oliver A. Houck, *On the Law of Biodiversity and Ecosystem Management*, 81 MINN. L. REV. 869 (1997) (surveying and evaluating the effectiveness of ecosystem and biodiversity planning programs in federal and non-federal lands and waters).

118. *E.g.*, Environmental Easement Program, 16 U.S.C. §§ 3839-38339d (2000).

119. *See* John Harte, *Land Use, Biodiversity, and Ecosystem Integrity: The Challenge of Preserving Earth's Life Support System*, 27 ECOLOGY L.Q. 929 (2001) (evaluating effectiveness of existing legal mechanisms for protecting habitat, and noting the importance of reaching beyond traditional parks and refuges).

C. Examining Parallels between Human Property Regimes and Ecologically-Motivated Allocations of Resources to Other Organisms

1. A Standard Account of the Emergence of a Property Regime

A standard account of property from an economic perspective focuses on the problems of human conflict over resources that arise when resources are scarce, and on the benefits of adopting a system for eliminating that conflict.[120] When resources are plentiful, the story goes, a property system is unnecessary, as there is no competition over resources.[121] The desires of all in the community can be met. But when resources are scarce relative to demands, conflicts arise. The landscape becomes "congested" as more people vie with each other for access to resources.[122] Effort goes into grabbing and defending resources and confronting competitors. The very resources that members of the community wish to have may be ruined in the rush to exploit, creating a "tragedy of the commons."[123]

A property system that establishes boundaries, allocates resources among participants, and excludes unauthorized intrusions on decision-making within those boundaries, has beneficial effects.[124] When participants are able to act autonomously and derive benefits from resources without interference, they are encouraged to invest in the resources, and to use, transform, and care for them, instead of engaging in efforts simply to find, hold and defend them.

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120. *See Introduction*, *in* PROPERTY RIGHTS: COOPERATION, CONFLICT, AND LAW 13 (Terry L. Anderson & Fred S. McChesney eds., 2003) (outlining key features of an economic perspective on property rights). *See also* Edwin G. West, *Property Rights in the History of Economic Thought*, *in* PROPERTY RIGHTS: COOPERATION, CONFLICT, AND LAW 20 (Terry L. Anderson & Fred S. McChesney eds., 2003) (tracing the emergence of utilitarian justifications for property).

121. *See* Rose, *supra* note 94, at 134-35.

122. Carol M. Rose, *Rethinking Environmental Controls: Management Strategies for Common Resources*, 1991 DUKE L.J. 1, 5 (discussing problems of conflict in "congestible" resources).

123. Hardin, *supra* note 77. *See also* discussion *supra*, part II.B. (addressing informal property norms as potentially effective mechanisms for avoiding a "tragedy of the commons").

124. STEVEN SHAVELL, FOUNDATIONS OF ECONOMIC ANALYSIS OF LAW §§ 2.1- 2.8, at 11-23 (2004). *See also* Rose, *supra* note 2, at 40 (summarizing the classic account of the benefits of property).

When control is secure, the property holder has incentives to work, to create new or more effective products and uses, and to store resources as protection against risk. A property system may also lay a framework for orderly exchanges among private owners: The ability to exclude others from resources within defined boundaries, coupled with a system for exchanging resources in trades, provides a means for shifting resources among participants to more valuable uses without violent conflict.[125]

A property system can be costly, because it requires methods for establishing, monitoring and enforcing boundaries. In addition, if there is a system of exchange, there must be ways of determining and tracking owners. Nevertheless, in "congested" circumstances, it is said, the costs of the property system may become worthwhile.[126] More value is derived from the resources through investments and trade, and the costs of wasteful disputes are eliminated.[127]

This story line depicts overall social welfare enhanced by the introduction of a system for allocating resources to autonomous decision-makers and excluding conflicting claims to control.[128] To what extent does this narrative translate to allocations of resources for nonhuman use in "nature's economy?" As discussed next, many of the themes in the conventional account of property are relevant to the development of systems for allocating resources between people and other organisms.

2. The Problems of Conflict and "Congestion"

From an ecological perspective, human resource uses are in direct conflict with the resource uses of other organisms. Water withdrawals from a river for human use may provide many short-term benefits to people, but they may simultaneously deplete a stream so that aquatic organisms cannot reach suitable places to feed, shelter, or spawn. Losses to biological diversity, multiple small scale actions causing

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125. SHAVELL, *supra* note 124, § 2.4, at 18-20.
126. Rose, *supra* note 122, at 21-24.
127. SHAVELL, *supra* note 124, § 2.5, at 20.
128. *But cf.* Rose, *supra* note 2 (exploring and questioning assumptions in the classic story line about how people form preferences and reach decisions).

large cumulative harms and incremental erosion of ecosystem resilience may lead to sudden shifts in equilibrium.[129] Organisms may die when the stream disappears or when it shifts to pond-like conditions.

If aquatic organisms and people are seen to be in competition for water, the scenario just described provides a classic image of a "congested" landscape where conflict among competing users results in wasteful resource depletion. Although the "violence" and destructiveness of the conflict may go unexpressed in economic terms, the ecological losses may be extensive, as aquatic organisms struggle to find alternative locations and to survive in stressed conditions.

The ecological perspective thus tracks the narrative of the "congested" landscape found in standard property literature, although it deviates from the standard economic perspective by demanding attention to nonhuman organisms as separate participants in resource management and members of the relevant ecological community.

Certainly, the scenario of ecological decimation just described may also involve purely human conflict, as fishermen or fish-lovers and city-dwellers or municipal water companies engage in wasteful disputes over claims to water. An ecological perspective does not deny the importance of the conflict among people over potential uses of a river, but it views the human confrontations over losses to aquatic organisms as occurring because of underlying physical conflicts between human and nonhuman uses of water. Thus, an ecological perspective adopts a somewhat different idea of where the most important conflict occurs. Like the standard economic approach to property, the ecological perspective acknowledges the importance of reducing conflict and allocating resources among competing actors, but it defines the relevant participants in broad ecological terms.[130]

Despite some differences in the characterization of the conflict and reliance on an expanded list of community participants, an ecological perspective on human-nonhuman

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129. *See* discussion *supra* part I (addressing equilibrium shifts and loss of resilience in degraded ecosystems).

130. *See supra* note 74 and accompanying text (regarding the broadened concept of participants in an ecologically-defined community).

conflicts over resources arrives at a conclusion that parallels a more traditional economic perspective: Unregulated conflict among ecosystem participants produces a "tragedy of the commons" when water resources are grabbed for human uses without accounting for the effects on the other organisms in the ecosystem. The recognition of ecological destruction leads to a search for a system to reduce that conflict by allocating resources among competing users.

3. Exclusionary Mechanisms and the Making of Boundaries

So far, we have seen that an ecological perspective highlights problems of human-nonhuman conflict and coordination that are analogous to the problems of human interactions addressed in standard property concepts. Conflicts over resources cause undesirable destruction and losses, leading to a search for systematic means of reducing and managing conflict. Do the standard structures of human property regimes therefore offer solutions in the ecological context?

It is often said that the key constituent of a property regime is the ability to exclude.[131] Some argue that the right of exclusion is in fact the one fundamental feature of a property regime: "[T]he right to exclude others is a necessary and sufficient condition of identifying the existence of property."[132]

This "in rem" concept of property finds close parallels in formalized resource allocations targeted to the needs of nonhuman organisms.[133] The delineation of instream flow requirements provides an example. When instream flows are defined and quantified under a statutory water management system so as to support aquatic organisms and ecosystem functions, the process serves to define a boundary between

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131. Merrill, *supra* note 2.

132. *Id*. at 731.

133. The ecological economics literature has generated perhaps the largest-scale proposal for an exclusionary system; a boundary line drawn around the perimeter of an acceptable human "ecological footprint," leaving other resources to control by nonhuman phenomena. *See supra* text accompanying notes 35-36. *See also The Wildlands Project Mission, Vision, and Purpose*, *in* WILD EARTH: WILD IDEAS FOR A WORLD OUT OF BALANCE 10 (Tom Butler ed., 2002) (summarizing key elements of large-scale "wildlands" restoration and protection efforts).

resources available for human endeavors and those reserved for nonhuman uses.

Other resource allocation systems provide similar examples. The Endangered Species Act, for instance, offers especially clear, if narrow, illustrations of formalized resource allocations dedicated to fostering the welfare of particular nonhuman organisms. For the select number of species designated as endangered or threatened, the statute establishes mechanisms for determining the resources that the species need, mapping "critical habitat," and excluding human uses.[134]

To recognize the straightforward correlation between human and nonhuman resource allocation mechanisms in terms of their exclusionary aspects does not imply that determining and enforcing boundaries to serve ecological purposes is necessarily a simple matter. Delineation of ecologically-based exclusionary limits depends upon obtaining extensive scientific information and developing methods and technologies for designating and policing boundaries. Establishing meaningful but easily identifiable and enforceable boundaries can be a difficult and controversial issue in the ecological context.[135] These difficulties no doubt hinder the adoption of property-like systems in many

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134. Endangered Species Act, §§ 4, 7, 9, 16 U.S.C §§ 1533, 1536, 1538 (2004). "What the ESA does, in effect, is draw a small (but growing) number of circles of enforceable restraint around the nests, breeding grounds, and habitats of a few creatures on the brink of extinction." Houck, *supra* note 117, at 978. *See also, e.g.*, Doremus, *supra* note 16, at 329-31 (discussing the limitations in the scope of the statute); Harte, *supra* note 119, at 943-45 (evaluating effectiveness of Endangered Species Act in protecting habitat); J.B. Ruhl, *Biodiversity Conservation and the Ever-Expanding Web of Federal Laws: Regulating Nonfederal Lands: Time for Something Completely Different?*, 66 U. COLO. L. REV. 555, 579-89 (1995) (discussing effectiveness of the Endangered Species Act as an approach to biodiversity conservation).

135. For instance, the selection of indicator, keystone, and umbrella species to provide simplified measures or signposts for a wider set of resource needs in ecosystems is both promising and controversial. *See, e.g.*, Houck, *supra* note 117 (noting successes and failures in federal programs in delineating resources for indicator species); Karkkainen, *supra* note 47, at 30-32 (discussing use of management indicator species by the U.S. Forest Service); Doremus, *supra* note 17, at 329-31. *See also* James Salzman & J.B. Ruhl, *Currencies and the Commodification of Environmental Law*, 53 STAN. L. REV. 607, 648-68 (2000) (addressing the difficulties of correlating ecologically-significant factors in wetlands functions with proxy measures that are clear and simple enough to allow exchanges in markets under wetlands mitigation programs).

circumstances where the scope of the ecological degradation would otherwise seem to invite such a solution.[136]

Where ecologically-based boundary lines are developed, however, the analogies to the exclusionary structure of a conventional property rights system are obvious. And, as discussed next, the parallels often extend beyond the mere existence of an exclusionary mechanism. The motivations for establishing the resource boundary lines may also parallel those that are typically said to underlie conventional property systems.

4. The Concern with Fostering Autonomy and Self-Organization

In a traditional property system, exclusionary boundary lines serve to foster human autonomy within the scope of defined territorial limits. This encouragement and support for independent action with respect to resources, protected from outside interference, extends to individuals as well as to self-organized groups operating within delineated boundaries.[137]

Analogous concerns with fostering autonomy and self-organization appear conspicuously in the ecological literature. As we have seen, an ecological perspective focuses on dynamic processes and the self-organizing capacities of ecosystems.[138] This is a perspective that sees semi-autonomous phenomena at multiple scales. The control of resources achieved through human decision-making is just one type of "resource management" that occurs from an ecological point of view: Other organisms are also engaged in their own endeavors affecting resources in the environment.[139]

The diversity of self-organizing phenomena at all levels is central to the resilience of ecosystems. Thus, the proponents

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136. For instance, states that have established statutory authority for the development of instream flow standards nevertheless find that administrative agencies fail to adopt the necessary implementing regulations. Choe, *supra* note 95, at 1938-39 (discussing regulated riparian states' failures to set streamflow standards).

137. *See* discussion *supra* Part II.B (addressing property ownership by groups).

138. *See* discussion *supra* Part I.

139. *See* Holly Doremus, *Restoring Endangered Species: The Importance of Being Wild*, 23 HARV. ENVTL. L. REV. 1, 15-18 (1999) (discussing the concept of wildness, including preservation of evolutionary processes and autonomous choices, as a goal in species restoration).

of an ecological perspective assert that human activities must be curtailed and adapted to avoid domination and elimination of these self-organizing phenomena. What must be preserved is not simply a static condition or a set of passive objects; it is a range of ecological processes in which nonhuman organisms are transformative agents.[140]

Allocating resources to support ecosystem resilience thus means something quite different from allocating resources to single purposes or monocultures that are fully within human understanding and control. It means fostering the diversity, redundancy, and variability in ecosystems that are critical to persistence in the wake of disturbance. And in essence, this means that resources are diverted or reserved for processes where people do not expect to know the outcomes in advance, and where the management of resources occurs beyond human specifications and engineering judgments.

In summary, an ecological perspective advocates treating ecological transformations as authoritative choices even when they do not stem directly from human planning and lie outside of human predictive capabilities. Just as traditional property systems are developed to provide a protection and scope for autonomous human activities, the boundary-drawing and exclusionary protection provided to resource allocations such as instream flows include fostering autonomous actions by nonhuman organisms.

5. Encouraging Work and Investment

A standard economic justification for a property system is that it fosters social welfare by encouraging people to work, to create and produce goods, and to maintain and improve things.[141] Significant parallels may be discerned in the justifications for ecologically-based allocations of resources to nonhuman organisms. While the relevant processes and actors include those that lie beyond the human economy, an ecological perspective emphasizes the importance of allocating

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140. *See* Harte, *supra* note 119, at 934-35 (discussing roles of species in maintaining and transforming habitats).

141. SHAVELL, *supra* note 124, §§ 2.2 - 2.3, at 11-18.

resources to encourage biologically-based investment and productivity.

From an ecological perspective, all organisms in ecosystems are "at work" acquiring, storing, transforming and transferring energy and materials. In the terms used to describe the adaptive cycles of ecosystem dynamics, organisms colonize disturbed areas through "exploitation" of resources, they accumulate and store materials through slower processes of "conservation," they disperse materials in phases of "release," and they accomplish innovation and restructuring of materials in periods of "reorganization."[142]

Some of these activities produce direct services to human society, as, for example, when wetlands plants act as filters, removing contaminants from water that will be used by people for drinking. This sort of productivity is well recognized by now in ecological economics.[143] Other ecosystem activities and "investments" are much less directly connected to immediate effects on people but they are important to ecosystem resilience. A wide array of ecological processes in essence store up the materials and ecological information necessary for reorganization and renewal.[144] The ecological literature thus points to the importance of allocating resources to promote resilience and adaptability in a broad sense, and the productivity and investments of nonhuman organisms in particular, even when the precise contributions to long-term human welfare are not yet understood.

6. Protection against Risk

The justifications for property rights systems include the advantages they offer in protecting against risk.[145] The theme of risk reduction also appears prominently in the ecological literature. Diversity, variability, and redundancies in ecosystems, and the activities of organisms in sequestering resources or investing them in multiple ways are important facets of ecosystem resilience because they serve to buffer the

142. *See supra* Part I.
143. *See supra* note 34 and accompanying text.
144. Folke, *supra* note 17, at 361-66.
145. SHAVELL, *supra* note 124, § 2.6, at 20-21.

effects of destructive events.[146] Thus, allocating resources to promote risk-buffering factors and functions in ecosystems may be seen as providing insurance-like advantages parallel to those of conventional property systems.

7. Interaction and Exchange

Although the right of exclusion is often emphasized as the most important feature of property, the economics literature often treats boundary-drawing as simply the first step toward a primary goal of fostering a market economy.[147] From this perspective, the power to transfer is central to most types of property, and possibilities of gains from trade figure prominently among the reasons for having a property regime in the first place. Bargaining, buying and selling in this view are closely linked to the very concept of property.

Other commentators question the simplistic assumptions about self-interested behavior and purely arms-length exchange that appear in this emphasis on property as a vehicle for trade, seeing property as embedded in a much more complex array of human interactions.[148] This perspective emphasizes ways in which property reflects and creates relationships among people, and involves communication, conversation, persuasion, deliberation, and mutual understanding.

There is much in both accounts that presupposes human consciousness, cognitive abilities, and expectations, as well as two-way communication and consensus-building, not merely in the initial development of property regimes, but subsequently in the observance of boundaries, the signaling of intentions, the development of agreement, and the exchange of goods.

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146. *See* LEVIN, *supra* note 22, at 198-206; *see* Bobbi Low et al., *Redundancy and Diversity: Do They Influence Optimal Management?*, *in* NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS, *supra* note 17, at 83; VANDER WALL, *supra* note 98, at 109. *See also supra* notes 89-90 and accompanying text (discussing the "insurance" aspects of property regimes that rely on informal norms).

147. *Introduction*, *supra* note 120, at 6. *See also* SHAVELL, *supra* note 124, § 2.4, at 18-20 (discussing the incentives to transfer things as a justification for a property rights system).

148. *See generally*, CAROL M. ROSE, *Seeing Property*, *in* PROPERTY AND PERSUASION: ESSAYS ON THE HISTORY, THEORY AND RHETORIC OF OWNERSHIP 267 (1994). *See also* Rose, *supra* note 2, at 43-57 (highlighting the cooperative and community-oriented actions that go into creating a property regime.

What are the implications of these views in the effort to see nonhuman organisms as property holders, when they do not share human modes of thinking, language, and consensus-building? There are several plausible responses. First, we may return to the argument that the central feature of property is the right of exclusion, and that property therefore exists even in the absence of an ability to engage in contractual exchange, as long as exclusionary boundaries are established and maintained.[149] A "keep-out" structure protects a group or individual from encroachment while limiting transactions involving the allocated resources to the "inside" of the boundary line. Even if the designated resources are purely in the form of a reservation — not subject to alienation in markets (and to the signaling and communication that accompanies market transactions) — they may nevertheless be said to fall within the spectrum of arrangements that we should recognize as property regimes.

A second and more nuanced response, however, is that allocations of resources that appear to be purely exclusionary may nonetheless set the stage for subsequent meaningful interactions across boundaries. People and nonhuman organisms may in fact develop modes of interaction that are different from human language-based communication, but that nevertheless involve forms of signaling, coordination, and co-evolution.[150] Indeed, inventing new ways for people to notice and interact with nonhuman organisms may be the most important purpose in setting boundaries and elaborating frameworks akin to property regimes to govern human-nonhuman relationships.

In most circumstances, it may not be possible to use traditional markets as coordinating mechanisms to accomplish decentralized adjustments in allocations of specific resources between human and nonhuman uses.[151] But human-style markets do not exhaust the possibilities for reciprocity. The very process of setting and monitoring an ecological boundary

149. *See supra* note 132 and accompanying text.

150. *See* STONE, *supra* note 5, at 24 (discussing the communication of nonhuman wants or needs to people).

151. Salzman & Ruhl, *supra* note 135, at 648-68 (discussing the obstacles to developing trading frameworks in the context of habitat protection programs).

line can draw human attention and resources, leading to deepened human understandings of nonhuman organisms and ecosystem processes, and ultimately, to boundary adjustments, reallocations of resources, and development of more interactive governance arrangements. As more sophisticated means of monitoring, signaling, and triggering responsive actions develop, more flexible interactions may be possible.[152]

In any event, as the writings of Oliver Houck suggest, setting firm, measurable boundary lines between human and nonhuman resource allocations would appear to be a prerequisite rather than a hindrance to fostering ecologically-minded human-nonhuman interactions.[153] Although some small societies that are closely affiliated with the nonhuman organisms and ecological processes in their immediate environments seem to develop a sense of reciprocity within a unified human-nonhuman community, leading to effective informal means of resource allocation and exchange,[154] more formal and clear-cut entitlements seem to be needed in the many settings that involve coping with the self-isolation and resulting ecological "obliviousness" of modern industrialized societies As commentators on human property relationships have observed, a stark and simple exclusionary line may be especially appropriate when those on either side of the line are, in essence, heterogeneous strangers who lack detailed mutual understanding and means of complex communication.[155]

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152. *Cf.* Carol M. Rose, *Crystals and Mud in Property Law*, 40 STAN. L. REV. 577 (1988) (discussing shifts between hard-edged entitlements and more uncertain and contextual decision-making in property doctrine).

153. Houck, *supra* note 117, at 977. *See also* Oliver A. Houck, *Are Humans Part of Ecosystems?*, 28 ENVTL. L. 1, 6-11 (1998) (emphasizing the importance of a two-step process separating the analysis of human desires from the setting of biological goals).

154. *See supra* notes 89-91 and accompanying text.

155. *Cf.* Henry E. Smith, *Property and Property Rules*, 79 N.Y.U. L. REV. 1719, 1794 (2004) (suggesting that simple exclusionary property rules are preferable when information is uncertain and the audience lacks specialized background knowledge, while more finely tailored governance arrangements may be appropriate among members of a close-knit community). Paradoxically, though, it also seems that a sense of affiliation and community understanding would nevertheless be needed in order to develop such a property regime in the first place. *See* Doremus, *supra* note 16, at 352 (noting the importance of "[g]enuine affection for and personal commitments to nature" in developing new systems for ecological protection); Rose, *supra* note 2, at 51 (noting importance of cooperation in establishing property regimes).

D. Some Thoughts on the Structure of Nonhuman Property

The preceding discussion has highlighted a variety of ways in which justifications for secure and well-defined resource allocations aimed at fostering resilience in ecosystems have parallels in the justifications for conventional property rights systems. The analogy suggests that the relationship of people and nonhuman organisms with respect to resources may be described in terms of a property regime. But since property regimes, broadly defined, can take various forms, questions arise as to specifically how the boundaries will be drawn and the relationships structured.

A workable delineation of nonhuman property in the ecological context will frequently take the intermediate form of a "nested" ecological enterprise, similar to limited common property or corporate ownership.[156] This conclusion rests on an acknowledgement of limits to scientific understandings and human control, and on the substantive purpose of fostering self-governing processes in ecosystems that include interactions among nonhuman organisms.

The ecological literature suggests that the most workable forms of ecosystem management should focus on maintaining key "structuring variables" in ecosystem processes at multiple scales:

> Focus should be on the structuring variables that control the lumpy geometry and lumpy time dynamics [of landscapes]. They set the stage upon which other variables play out their own dramas. That is, it is the physical and temporal infrastructure of biomes *at all scales* that sustains the theater; given that, the actors will look after themselves![157]

The implication is that resource allocations to promote ecosystem resilience will often resemble property regimes that allocate resources to intermediate forms of organization, setting boundaries based on understandings of the key

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156. *See supra* Part II.B.
157. Holling, *supra* note 40, at 28.

structuring variables in ecosystems, while leaving resource management activities to internal processes. For example, a water management regime may allocate water quantities in seasonally fluctuating volumes and rates, based on understandings of the structuring variables and the hydrological variations that the organisms in the ecosystem have evolved to accommodate. Such arrangements will likely rely on identifying specific organisms and events that can serve as meaningful indicators and triggering signals, given human scientific understandings, technologies, and cognitive capabilities. The ecological boundary line might consequently be expressed (for example) as an allocation of water resources "to the fish," but the allocation would in essence be to a broader ecological enterprise that is internally self-organizing.

CONCLUSION

This essay has suggested that concepts of property should be expanded to encompass allocations of resources to nonhuman organisms and ecosystems. The suggestion corresponds to advances in scientific understandings about the complex and self-organizing dynamics of ecosystems, and observations about the inadequacies of existing legal institutions in coordinating human activities with those of nonhuman organisms. Better coordination of human activities with ecological dynamics will require new institutional means of perceiving and adapting to ecological signals, and better approaches to protecting ecosystem capacities for reorganization and renewal.

The arguments presented are fundamentally instrumental: Once the importance of fostering semi-autonomous ecological processes at multiple scales is acknowledged, the conclusion follows that new ways must be found for dealing with conflicts between human and nonhuman uses of resources, and for bridging the divide between social and ecological forms of organization. One means for accomplishing these purposes involves recognizing ecological processes of self-organization as forms of resource management or governance that are protected by property regimes. The suggestions for elaboration and change in property regimes draw on scholarship reinterpreting existing

property rights in light of ecological context, as well as on scholarship recommending recognition in property law of intermediate forms of governance characterized as "limited common property" or "nested enterprises."

Establishing boundaries and finding means of exclusion are central features in proposals for coordinating human activities with ecosystem dynamics. Such mechanisms are found in existing resource management systems that may be characterized as creating property-like regimes. For example, instream flow requirements in water management systems serve to resolve wasteful conflicts between human and nonhuman demands. They establish exclusionary mechanisms recognizing and protecting autonomous ecological processes within designated boundaries. As in a traditional property regime, the system of quantifying, monitoring, and enforcing formal allocations may be costly, but the costs are justified by reference to the benefits of ecosystem resilience that are enhanced through the management and transformation of the allocated resources.

The analogy between ecological resource allocations and conventional property regimes invites consideration of the role of boundary-drawing and exclusionary protections in managing conflict between human and nonhuman uses of natural resources, and it suggests ways in which human-nonhuman relationships both shape and are affected by the boundaries that are drawn. The property analogy alone does not provide conclusive answers to a variety of potential questions about the best ways to designate nonhuman "owners," formulate boundaries, or encourage signaling, coordination, and adjustments across boundaries. These are areas where recognition of the relevance of property law and scholarship provides fruitful areas for analysis and further research into meaningful parallels, rather than simple conclusions.