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.

PROTECTING INTERNATIONAL MARINE BIODIVERSITY: INTERNATIONAL TREATIES AND NATIONAL SYSTEMS OF MARINE PROTECTED AREAS

ROBIN KUNDIS CRAIG*

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I. INTRODUCTION

The oceans are one of the truly global resources. All parts of the ocean are connected. Moreover, at least some marine resources that humans deem important have world-wide ranges. Bluefin tuna, for example, are some of the most expensive fish in the world. Buyers in Japan will pay upwards of $80 a pound for high quality bluefin tuna for sushi,[1] and since bluefin tuna can grow up to 1500 pounds,

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1. Eugene H. Buck, *Atlantic Bluefin Tuna: International Management of a Shared*

a single fish can be worth $45,000 or more.[2] Thus, lots of fishers would love to be able to catch more bluefin tuna.

Bluefin tuna have a wide geographic range and are "distributed throughout the Atlantic and Pacific Oceans in subtropical and temperate waters."[3] Nevertheless, increased tuna harvests face two major obstacles. First, bluefin tuna have been overfished to precarious levels.[4] Second, effective sustainable management of bluefin tuna is severely hampered by the fact that bluefin tuna are, from a human perspective, almost completely unpredictable. Such tuna have known near shore feeding and mating grounds, but they also migrate across the oceans for thousands of miles, often halfway around the globe or further.[5] Until recently, once the tuna set off into the open ocean they more or less just disappeared from human observation.[6] Thus, conserving bluefin tuna — and all signs are that they need protection — requires a global effort, in terms of scientific research, fisheries management, and legal protections. Nations of the world have recognized this reality: several countries, including the United States, Canada, Japan, Spain, and France signed the International Convention for the Conservation of Atlantic Tunas in 1966 "to specifically address the conservation issues facing the bluefin and other highly migratory species."[7] Almost three decades later, on the other side of the world, Australia, Japan, and New Zealand formalized the 1994 Convention for the Conservation of Southern Bluefin Tuna "to ensure, through appropriate management, the conservation and optimum utilisation [sic] of the global [Southern Bluefin Tuna] fishery."[8]

Bluefin tuna are only one of several living marine resources whose fate depends on international cooperation and hence on

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Resource (CRS Report to Congress 95-367 ENR) (Mar. 8, 1995), *available at* http://www.ncseonline.org/NLE/CRSReports/Marin e/mar-5.cfm ("In 1991, a Japanese importer paid a record price of $68,503 (or about $96.65 per pound) for a single giant bluefin tuna!").

2. Susie Gardieff, Florida Museum of Natural History, *Ichthyology: Bluefin Tuna*, *at* http://www.flmnh.ufl. edu/fish/Gallery/Descript/BluefinTuna/BluefinTuna.html (last visited Feb. 12, 2005).

3. *Id*.

4. *Id*; Buck, *supra* note 1.

5. Buck, *supra* note 1.

6. *Id*.; *see also Tracking Bluefin Tuna* (National Public Radio Morning Edition radio broadcast, Aug. 17, 2001), *available at* http://www.npr.org/ programs/morning/features/2001/aug/bluefintuna/010817. bluefintuna.html [hereinafter NPR] (describing Stanford University researcher Barbara Block's work in *Science* on bluefin tuna tracking).

7. Gardieff, *supra* note 2.

8. Commission for the Conservation of Southern Bluefin Tuna, *About the Commission*, *at* http://www.ccsbt. org/docs/about.html (last visited Feb. 2, 2005). Korea, Taiwan, and the Philippines also participate in implementing the Convention, and Indonesia and South Africa are considering cooperative non-membership status. *Id*.

international law.[9] Increasingly, preservation of marine biodiversity is recognized as an international law issue, and both general and specific treaties have been extended to protect and restore marine biodiversity. However, there is also increasing recognition that such international legal efforts must be tied to evolving scientific knowledge regarding the causes of marine biodiversity loss. In the case of the bluefin tuna, for example, "[i]n the early 1990s, the western Atlantic bluefin stock appeared to resume its decline while some eastern Atlantic fishing nations continued to ignore ICCAT's [the International Commission for the Conservation of Atlantic Tuna, which implements the Convention] 1974 recommendations" regarding acceptable fishing rates, but there was little understanding of how the western Atlantic and eastern Atlantic populations of bluefin tuna interacted.[10] Recent scientific research reveals that "[t]una in the western Atlantic migrate to feeding grounds in Europe and the Mediterranean. . . . That's important because limits on tuna catches are much tighter in the western Atlantic than in Europe. What fishery managers now realize is that overfishing in Europe may be depleting the Atlantic bluefin population."[11] As a result, ICCAT's recommendations are important to both "stocks" of tuna.

This article reviews the intersection of science and international law in the area of preserving marine biodiversity. It provides an overview of how the science concerning marine biodiversity preservation has changed focus in the last decade or so and then looks at how international law is beginning to react to that change in scientific emphasis in the international preservation of marine biodiversity. It ends with both a recommendation that nations adopt a more comprehensive approach to marine biodiversity preservation and a recognition that such comprehensive protection packages are beginning to become a part of international law.

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9. United Nations Education, Scientific, and Cultural Organization (UNESCO), *Marine Biodiversity*, 21:1 CONNECT INTERNATIONAL SCIENCE, TECHNOLOGY & ENVIRON- MENTAL EDUCATION NEWSLETTER 1, 2 (Mar. 1996) ("Conservation of marine biodiversity is thus an urgent, global issue as physically, oceans cannot be limited by political frontiers. … As in all global problems, there has to be international concertation to deal with problems relating to marine biodiversity if ways are to be found to safeguard it for the future without depriving those that currently depend upon it for their existence.").

10. Buck, *supra* note 1.

11. NPR, *supra* note 6.

II. THE IMPORTANCE OF MAINTAINING MARINE BIODIVERSITY

A. Biodiversity in General

According to the United Nations Convention on Biological Diversity, also known as the Biodiversity Convention, "'[b]iological diversity' means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."[12] As this definition suggests, three levels of biodiversity are important: genetic diversity, species diversity, and ecosystem diversity.[13]

Genetic diversity relates to the variability within a given species, or, more specifically, to "the variation in the amount of genetic information within and among individuals of a population, a species, an assemblage, or a community."[14] For example, in many modern supermarkets, customers often have a choice of five or six commercially grown potatoes. Around the world, however, there are dozens of different kinds of potatoes, each with a slightly different genetic makeup and hence each with a different ability to adapt and respond to different environmental conditions. The value of this genetic variability is reflected in the fact that "[a]t least a dozen countries have established controls over access to their genetic resources, and an equal number of nations are developing such controls."[15]

Species diversity refers to the number of different species in the world,[16] or, more specifically, "the variation in the number and

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12. Convention on Biological Diversity, June 5, 1992, art. 2, 31 I.L.M. 818 (1992), 1993 A.T.S. 32 (entered into force Dec. 29, 1993).

13. Center for Biodiversity and Conservation, American Museum of Natural History, *What Is Biodiversity? Questions and Answers*, *at* http://research.amnh.org/ biodiversity/center/ what.html (last updated 2003); The Natural History Museum, *Measuring Biodiversity Value*, *at* http://www.nhm.ac.uk/science/projects/world map/diversity/index.html (last visited Mar. 2, 2005); *see* Stanford Encyclopedia of Philosophy, *Biodiversity*, *at* http://plato.stanford.edu/ entries/biodiversity (last updated June 11, 2003); *see also* UNESCO, *Marine Biodiversity*, *supra* note 9, at 1 ("Biodiversity is a collective term that encompasses the variety of all living organisms — plants, animals and micro-organisms — on Earth. It includes diversity within species, between species and of ecosystems.").

14. Center for Marine Biodiversity, Canada, *What Is Marine Biodiversity*, *at* http://marinebiodiversity.ca/en/ what.html (last visited Mar. 3, 2005).

15. Convention on Biological Diversity, United Nations Environmental Programme [hereinafter UNEP], "International Level, International Action," *in Sustaining Life on Earth: How the Convention on Biological Diversity Promotes Nature and Human Well-being, at* http://www.biodiv.org/doc/publications/guide.asp?id= action-int (last visited Mar. 1, 2005).

16. UNEP, "Biodiversity – The Web of Life," *in Sustaining Life on Earth: How the Convention on Biological Diversity Promotes Nature and Human Well-being, at* http://www.biodiv.org/doc/publications/ guide.asp?id=web (last visited Mar. 5, 2005).

frequency of species in a biological assemblage or community. Species diversity is the most commonly used synonym for biodiversity, where species richness (number of species in a given habitat) is the main index used for its measurement."[17] According to the United Nations Environmental Programme (UNEP), to date scientists have identified 1.75 million species in the world.[18] The consensus figure among biologists is that probably around 13 million species exist,[19] although individual estimates run as high as 100 million species.[20]

Together, genetic and species diversity contribute to the health and resiliency of individual ecosystems. Within each ecosystem are a number of trophic levels, or levels of hierarchy within the food web, reflecting the fact that different species play different roles in the food web.[21] In a very simplified schematic, for example, plants are photosynthesizers that convert the sunlight into food for other organisms.[22] Herbivores eat the plants, carnivores eat the herbivores (and often each other), omnivores eat both, and decomposers break down the dead plants and animals and their wastes.[23] Higher biodiversity results in greater redundancy at each level, giving ecosystems as a whole, greater resiliency and a greater ability to respond to environmental changes.

Finally, "[e]cosystem diversity is the variation in the collection of assemblages, communities, and habitats within a region."[24] A number of different types of ecosystems exist in the world — tropical rainforest, Arctic tundra, sand desert, pine forests, and so on — each supporting a different set of species exhibiting different genetic variations. "The World Wildlife fund and National Geographic Society recently mapped 867 terrestrial ecoregions of the world."[25] Loss of ecosystems involves loss of habitat, generally considered one of the gravest threats to biodiversity. "While the loss of individual species catches our attention, it is the fragmentation,

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17. Center for Marine Biodiversity, *supra* note 14.

18. UNEP, "Biodiversity — The Web of Life," *supra* note 16.

19. *Id*. *But see* Peter J. Bryant, "Global Patterns of Biodiversity," *in Biodiversity and Conservation: A Hypertext Book*, ch. 6, *at* http://darwin.bio.uci.edu/~sustain/bio65/lec06/b651ec06.htm#MEASURING%20 BIODIVERSITY (2002) (noting "[a] dramatic upward revision in these estimates to 30 million" species as a result of new research).

20. UNEP, "Biodiversity — The Web of Life," *supra* note 16.

21. The Geography Portal, *What are Trophic Levels?*, *at* http://www.kesgrave.suffolk.sch.uk/learningzone/ subjects/geography/trophic.html (last visited Feb. 2, 2005).

22. *Id*.

23. *Id*.

24. Center for Marine Biodiversity, *supra* note 14.

25. Bryant, *supra* note 19; *see also* National Geographic, *Terrestrial Ecoregions of the World*, *at* http://www.nationalgeographic.com/wildworld/terrestrial.html (last visited Feb. 3, 2005) (showing the map of these ecoregions).

degradation, and outright loss of forests, wetlands, coral reefs, and other ecosystems that poses the gravest threat to biological diversity."[26]

According to the UNEP, terrestrial biodiversity is threatened in many parts of the world, especially in crowded industrialized nations.[27]

> The loss of biodiversity often reduces the productivity of ecosystems, thereby shrinking nature's basket of goods and services, from which we constantly draw. It destabilizes ecosystems, and weakens their ability to deal with natural disasters such as floods, droughts, and hurricanes, and with human-caused stresses, such as pollution and climate change.[28]

B. Marine Biodiversity

Despite the growing concerns regarding world biodiversity loss, until recently, little has been done to assess the biodiversity of — and losses of biodiversity within — the world's oceans.[29] There are two basic explanations for this knowledge gap. First, the oceans are difficult for humans to explore.[30] As a result, "marine systems have been relatively neglected because they are 'out of sight, out of mind' to most people, including most scientists."[31] Second, until recently,

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26. UNEP, "We Are Changing Life on Earth," *in Sustaining Life on Earth: How the Convention on Biological Diversity Promotes Nature and Human Well-being*, *at* http://www.biodiv.org/doc/publications/guide.asp?id=changing (last visited Apr. 5, 2005).

27. *Id*.

28. *Id*.

29. *See* Peter M. Vitousek et al., *Human Domination of Earth's Ecosystems*, 277 SCI. 494, 495 (July 25, 1997) ("Human alterations of marine ecosystems are more difficult to quantify than those of terrestrial ecosystems, but several kinds of information suggest that they are substantial."); UNESCO, *Marine Biodiversity*, *supra* note 9, at 1 ("Though biodiversity encompasses all living organisms on earth, perhaps due to semantics, people generally tend to think of biodiversity in terms of terrestrial living organisms."); Elizabeth Culotta, *Is Marine Biodiversity at Risk?*, 263 SCI. 918, 919 (Feb. 18, 1994) ("Only about 7% of the world's oceans has been sampled for biodiversity, and even moderately rare species are easy to miss.").

30. G. Carleton Ray & J. Frederick Grassle, *Marine Biological Diversity: A Scientific Program to Help Conserve Marine Biological Diversity is Urgently Required*, 41:7 BIOSCI. 453, 453 (July-Aug. 1991) ("The inaccessibility of most marine environments to all but divers means that there is little common experience about natural events there, and that observations and experiments there tend to be short-term and narrow in spatial extent.").

31. *Id*.; *see also* Tatiana Brailovskaya, *Obstacles to Protecting Marine Biodiversity through Marine Wilderness Preservation: Examples from the New England Region*, 12:6 CONSERVATION BIOLOGY 1236, 1238 (Dec. 1998) ("Unlike terrestrial wildlife, most commonly known marine species in New England are usually considered food. Most people rarely venture into the underwater marine environment, and they tend to see marine species only in the seafood case at the supermarket. Recognizing this inherent human detachment from

humans tended to view the oceans as too vast for humans to affect much – what has been called the paradigm of inexhaustibility.[32] As scientist Jeremy B.C. Jackson commented in 2001, "[t]he persistent myth of oceans as wilderness blinded ecologists to the massive loss of marine ecological diversity caused by overfishing and human inputs from the land over the past centuries."[33]

As a result, our knowledge about ocean biodiversity is limited, although growing. As author Colin Woodward has noted in his book, *Ocean's End*, "We are better informed about the Moon and Mars than about the bottom of the ocean floor; we know more about the life cycle of stars than those of the sperm whale, giant squid, and many of the creatures sought by the world's fishing fleets."[34] The U.S. Senate, similarly, commented in connection with the Oceans Act of 2000[35] that "many ocean ecosystems, particularly the ocean's deepest regions, remain undiscovered and unexplored."[36]

Nevertheless, any nation or group of nations that cares about preserving biodiversity should view the preservation of marine biodiversity as a high priority — especially given that "ocean health and human health are inextricably linked."[37] Moreover:

> Marine ecosystems are major national capital assets. In addition to providing valuable goods, such as

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marine life as an impediment to support for marine conservation, the National Audubon Society's Living Oceans Program has chosen to address the public's terrestrial wildlife bias as part of its program, adopting the motto that 'fish are wildlife, too.'") (citations omitted).

32. John C. Ogden, *Maintaining Biodiversity in the Oceans*, 43:3 ENV'T 28, 29 (2001) (noting that in 1884, "the population of the world was slightly more than one billion, and the oceans were perceived as mysterious and limitless"); Steve Connor, *Marine Life Being Massacred as the World's Oceans Are Turning Toxic*, THE INDEPENDENT (London), Sept. 3, 1999, at 3 ("Just 30 years ago, scientists believed that the oceans were so vast that they would remain relatively immune from human influence, but recent evidence shows that the seas have become as vulnerable as the terrestrial environment.").

33. Jeremy B.C. Jackson, *What was Natural in the Coastal Oceans?*, 98:10 PROCEEDINGS NAT'L ACAD. OF SCI. (PNAS) 5411, 5411 (May 8, 2001), *available at* http://www.pnas.org/cgi/doi/10.1073/pnas.091092898.

34. COLIN WOODWARD, OCEAN'S END: TRAVELS THROUGH ENDANGERED SEAS 30 (2000). *See also* Ogden, *supra* note 32, at 30 (noting that "it is said that humans know more about the surface of the moon than about the oceans"); C.D. Harvell et al., *Emerging Marine Diseases — Climate Links and Anthropogenic Factors*, 285 SCI. 1505, 1505 (Sept. 3, 1999) ("The paucity of baseline and epidemiological information on normal disease levels in the ocean challenges our ability to assess the novelty of a recent spate of disease outbreaks and to determine the relative importance of increased pathogen transmission versus decreased host resistance in facilitating the outbreaks."); UNESCO, *Marine Biodiversity*, *supra* note 9, at 1 ("[O]ne has to admit perforce that even scientists today have a better idea of the surface of the dark side of the moon than the depths of the oceans!").

35. Oceans Act of 2000, Pub. L. No. 106-256, 114 Stat. 644 (Aug. 7, 2000).

36. S. REP. NO. 106-301, at 3 (2000), *reprinted in* 2000 U.S.C.C.A.N. 534, 537.

37. Nancy Knowlton, *Ocean Health and Human Health*, 112:5 ENV'T HEALTH PERSPS. A262 (Apr. 2004), *available at* http://ehp.niehs.nih.gov/docs/2004/112-5/editorial.html.

> fisheries and minerals, they provide critical life support services, such as diluting, dispersing, and metabolizing the effluents of society, thus purifying waters for recreation. The value of a healthy ocean is difficult to overestimate.[38]

"The oceans cover more than 71 percent of the Earth and, taking depth into account, contain more than 99 percent of the space available for life."[39] The oceans' size thus already suggests their importance as biodiversity reservoirs, and "[m]arine systems are extraordinarily diverse in all aspects, from genetic to taxonomic to ecological."[40] For example, the oceans are important repositories of genetic diversity. Biologists classify all living organisms through a seven-layer hierarchy of groupings of organisms with similar characteristics. From the most general to the most specific, this hierarchy is: kingdom, phylum, class, order, family, genus, and species.[41] The more general the grouping, the more genetic diversity exists among groups at each level. For example, the two most well-known kingdoms are the animal kingdom and the plant kingdom, a distinction that recognizes the significant genetic distinctions between plants and animals.[42] Scientists agree that the oceans contain more phyla — the second most general classification groupings — than exist in terrestrial ecosystems, testifying to the vast genetic diversity that the oceans contain. Canada's Center for Marine Biodiversity, for example, reports that "in the marine environment there are 32 out of the 33 animal phyla present;[43] only 12 occur on land.[44] Moreover, according to the United Nations Education, Scientific, and Cultural Organization (UNESCO), "at least 43 of the more than 70 phyla . . . of *all* life forms are found in the oceans, whereas only 28 are found on land."[45] Most importantly, 45 percent of known phyla exist *only* in the ocean,[46] and "[n]inety

38. Ogden, *supra* note 32, at 31.

39. *Id*.

40. Ray & Grassle, *supra* note 30, at 453; *see also* Harvell et al., *supra* note 34, at 1505 ("The oceans harbor enormous biodiversity in terrestrial terms, much of which is still poorly described taxonomically.").

41. E.D. Hirsch, Joseph F. Kett & James Trefil, "Linnean Classification," *in The New Dictionary of Cultural Literacy* (3d ed. 2002), *available at* http://www.bartelby.com/59/21/linneanclass.html.

42. E.D. Hirsch, Joseph K. Kett & James Trefil, "Kingdom," *in The New Dictionary of Cultural Literacy* (3d ed. 2002), *available at* http://www.bartelby.com/59/21/kingdom.html.

43. Center for Marine Biodiversity, *supra* note 14.

44. Sylvia A. Earle, *Forward to* BOYCE THORNE-MILLER, THE LIVING OCEAN xiii (2d ed. 1999).

45. UNESCO, *Marine Biodiversity*, *supra* note 9, at 1.

46. *See* Ray & Grassle, *supra* note 30, at 453 ("Because phyla represent fundamentally different life forms, marine systems may be the most diverse on our planet.").

percent of all known classes [the next level of classification] are marine."[47] Thus, marine species represent a wide range of genetic diversity, often without parallel representation on land.

Marine species have been less well catalogued than terrestrial species, and in the 1990s "estimates of the number of deep-sea species alone…ranged from fewer than 500,000 to 10 million."[48] According to UNESCO, however:

> [T]aking into account the large amount of information extracted every day from samples gathered from diverse marine environments, it would not be far-fetched to assume that half – or even more – of the earth's living species are to be found in the diverse marine and coastal habitats, ranging from coral reefs, mangroves, sea grasses, rocky or sandy beaches down to the soft sediments of the deepest ocean floors and all the water column in between.[49]

Marine biologists estimate that there may be as many as 10 million undescribed species living in the ocean.[50] While scientists suspect that marine species have gone extinct as a result of human activities, moreover, "documentation of actual extinctions of marine species is just beginning."[51]

Finally, the oceans support a variety of different kinds of ecosystems, such as coral reefs, seagrass meadows, and kelp forests.[52] These ecosystems, like their counterparts on land, vary considerably in the numbers of species they support and in their overall biological productivity. For example, "[c]oral reefs are the most taxonomically diverse marine ecosystems and provide complex habitat for myriad sessile and mobile organisms."[53] In contrast, "[t]ropical American seagrasses are less diverse than corals, but seagrass meadows cover much greater areas than coral reefs."[54]

Human self-interest should provide sufficient reason for protecting this marine biodiversity. For example, marine algae and other marine plants are responsible for 50 to 75 percent of the

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47. Earle, *supra* note 44, at xiii.
48. Culotta, *supra* note 29, at 919.
49. UNESCO, *Marine Biodiversity*, *supra* note 9, at 1.
50. Center for Marine Biodiversity, *supra* note 14.
51. Jackson, *supra* note 33, at 5411.
52. *Id*. at 5412-14.
53. *Id*. at 5412; *see also* Eric Wolanski et al., *Mud, Marine Snow and Coral Reefs*, 91 AM. SCIENTIST 44, 44 (Jan.-Feb. 2003) ("Coral reefs are the most diverse of all marine ecosystems, and they are rivaled in biodiversity by few terrestrial ecosystems.").
54. Jackson, *supra* note 33, at 5412.

oxygen in the atmosphere.[55] According to some estimates, the open ocean provides ecosystem services worth $8.4 *trillion* a year,[56] while the coastal oceans provide $12.6 trillion in ecosystem services every year.[57]

Finally, the oceans' stores of genetic diversity have enormous potential for the development of pharmaceuticals and other commercial products. For example, the ocean is home to the only known non-photosynthesis-based ecosystems.[58] Hydrothermal vents were discovered in the 1970's along the mid-ocean ridge, a ridge which covers 23 percent of the planet's surface.[59] These vents are home to a variety of species that live at temperatures of 80 degrees Celsius/ 176 degrees Fahrenheit — almost hot enough to boil an egg![60] The creatures that live in and near hydrothermal vents are sometimes called extremophiles because they live under such extreme ecological conditions.[61] As a result, they use unique enzymes and other chemicals that allow them to live at such high temperatures — enzymes and other chemicals that other life forms on Earth do not have, and that are potentially valuable in medicine and commercial products. In addition, vent species live through chemosynthesis, not photosynthesis, relying on hydrogen sulfide — a chemical that is toxic to most other forms of life.[62] Again, the enzymes and other chemicals that allow these species to engage in chemosynthesis are potentially commercially valuable and unlikely to be found elsewhere on Earth.

In addition, the discovery of the hydrothermal vent ecosystems underscores the fact that we know very little about what else might be in the ocean. For example, at the other extreme, in 1997 researchers discovered iceworms living in frozen natural gas in cold seeps at the bottom of the ocean.[63] These iceworms are another extremophile species, presumably with a completely different set of

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55. THORNE-MILLER, *supra* note 44, at 11.

56. Robert Costanza et al., *The Value of the World's Ecosystem Services and Natural Capital*, 387 NATURE 253, 257 (May 15, 1997).

57. *Id*.

58. *See* THOMAS E. SVARNEY & PATRICIA BARNES-SVARNEY, THE HANDY OCEAN ANSWER BOOK 371 (2000).

59. Bryant, *supra* note 19.

60. *Id*. (noting that 300 new species were discovered along these vents); University of Delaware, *Voyage to the Deep: Questions and Answers*, *at* http://www.ocean.udel.edu/deepsea/questions/question.html #creature (last visited Feb. 2, 2005).

61. Bryant, *supra* note 19.

62. *See* University of Delaware, *Voyage to the Deep: Tubeworm*, *at* http://www/ocean.udel.edu/deepsea/level-2/creature/tube.html (last visited Mar. 4, 2005); University of Delaware, *Voyage to the Deep: Chemosynthesis*, *at* http://www.ocean.udel.edu/deepsea/level-2/chemistry/chemo.html (last visited Mar. 4, 2005).

63. Penn State University, *Methane Ice Worms Discovered on Gulf of Mexico Sea Floor*, *at* http://www.science.psu.edu/iceworms/iceworms.html (July 29, 1997).

enzymes and other chemicals that allow it to live in extremely cold temperatures.

III. CONCERNS ABOUT MARINE BIODIVERSITY AND SCIENTIFIC EXPLANATIONS FOR ITS LOSS

A. Evidence of Loss of Marine Biodiversity

Concerns about loss of marine biodiversity did not really emerge until the 1990s.

> Th[e] tale of species found, then lost . . . [was] a new story for many marine biologists. Except for large vertebrates like mammals and birds, marine organisms rarely appear on lists of extinct and endangered species. Indeed, although the fossil record is full of such extinctions, marine organisms were believed to be resistant to human-caused extinction, because many sea creatures have larvae that can drift long distances and most are thought to have large geographic ranges.[64]

Nevertheless, several indications have emerged over the last decade and a half that the concerns about loss of marine biodiversity are not misplaced. "[T]he relentless growth of human populations to the present 6 billion is exerting a tremendous influence on the oceans, fundamentally changing their biological diversity and threatening a critical part of the Earth's life support system."[65] "As of 1995, 22% of recognized marine fisheries were overexploited or already depleted, and 44% more were at their limit of exploitation."[66] More recently, according to the Food and Agriculture Organization of the United Nations (FAO), 25 percent of the world's 200 major commercial fishery stocks are overfished or significantly depleted, while another 47 percent are fully fished.[67]

Domestic statistics in the United States underscore the FAO's findings. In 1999, according to the National Marine Fisheries Service (now NOAA Fisheries), only 12 percent of the 844 federally

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64. Culotta, *supra* note 29, at 918; *see also* Ogden, *Maintaining Biodiversity*, *supra* note 32, at 30-31 (noting that during the development of the U.N. Convention on Biological Diversity in 1992, "[b]ecause there was no perceived crisis of extinction in the oceans, they were not featured in the convention").

65. Ogden, *supra* note 32, at 30.

66. Vitousek et al., *supra* note 29, at 495.

67. FOOD & AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO), THE STATE OF WORLD FISHERIES AND AQUACULTURE 23 (2002), *at* http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/005/y7300e/ y7300e00.htm.

managed fish stocks in the United States were overfished or approaching overfished; however, the status of another 64 percent of those stocks was "unknown."[68] Similarly, of the 163 stocks of marine mammals subject to federal management, only five percent are known to be declined — but the status of 66 percent of those stocks is unknown,[69] and 29 species of marine mammals are listed for protection under the federal Endangered Species Act.[70] Moreover, it should be remembered that whales have been protected under federal law since 1949[71] and that all marine mammals have been protected under federal law since 1972.[72] The picture is even bleaker for the stocks of sea turtles found in United States waters: all seven species of sea turtle are listed for protection under the Endangered Species Act,[73] two of the 12 stocks in the United States are known to be decreasing,[74] and the status of another two stocks is unknown.[75]

Historical examinations of marine ecosystems also provide cause for concern. Such studies reveal centuries-long depletions of these ecosystems that, perversely have gone largely unnoticed until recently "because our concept of what is natural today is based on personal experience at the expense of historical perspective. Thus, 'natural' means the way things were when we first saw them or exploited them, and 'unnatural' means all subsequent change."[76] In contrast, historical perspectives in particular ecosystems reveal, for example, that "[s]pecies composition of Caribbean coral communities was stable for at least 125 thousand years, until the collapse in the 1980s."[77]

B. The Traditional Explanation: Marine Pollution

A number of human activities threaten marine biodiversity, including coastal development, destruction of marine habitats, introduction of invasive species, and overfishing.[78] Traditionally,

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68. NATIONAL MARINE FISHERIES SERVICE, NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE, OUR LIVING OCEANS: REPORT ON THE STATUS OF U.S. LIVING MARINE RESOURCES 63 (1999).

69. *Id*. at 231 table 22-1, 235-39 table 23-1, 248-49 table 24-1.

70. *Id*. The Endangered Species Act is codified at 16 U.S.C. §§ 1531-1544 (2004).

71. Whaling Convention Act of 1949, 16 U.S.C. §§ 916-916(*l*) (2005).

72. Marine Mammal Protection Act of 1972, 16 U.S.C. §§ 1361-1421a (2004).

73. NATIONAL MARINE FISHERIES SERVICE, *supra* note 68, at 262.

74. *Id*.

75. *Id*.

76. Jackson, *supra* note 33, at 5411.

77. *Id*. at 5412.

78. *See generally* Robin Kundis Craig, *Oceans and Estuaries*, *in* STUMBLING TOWARD SUSTAINABILITY 227-55 (John C. Dernbach ed. 2002) (discussing threats to the sustainability of marine ecosystems and living marine resources).

however, both scientists and policymakers have focused on marine pollution as the most important problem affecting marine biodiversity. Most prominently, moreover, they have focused on oil pollution and headline-grabbing incidents such as the *Torrey Canyon* oil spill off of England[79] and the *Exxon Valdez* oil spill in Alaska.[80] Such oil spills can kill the birds and other wildlife that become coated with the oil, interfere with respiration and feeding, and destroy marine habitat, often for decades. The *Exxon Valdez* spill, for example, occurred in 1989, and the area affected, Prince William Sound, is still recovering.[81]

Despite the obviousness of oil spills, however, they are a relatively small ocean pollution problem. While the world's oceans receive about 3.25 million tons of oil each year, the majority of that oil comes from street runoff instead of tanker spills.[82] Accidental spills and shipping are responsible for only about 12 percent of all marine pollution, while offshore oil and gas drilling and mining are responsible for another 1 percent.[83] Instead, 77 percent of all marine pollution comes from land-based sources — 44 percent from land-based water pollutant and 33 percent from land-based air pollution.[84] As Nancy Knowlton at the Center for Marine Biodiversity at the Scripps Institution of Oceanography has summarized:

> The most obvious problems stem from our propensity to view dilution as the solution to pollution. Human numbers continue to grow, as do per capita amounts of waste, and much of this waste ultimately finds its way into the ocean. Some waste is toxic, some carries human pathogens, and some alters marine food chains in ways detrimental to human well-being.[85]

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79. IMO, *International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78), at* http://www.imo.imo.org/Conventions/contents.asp?doc_id=678&topic_id=258 (last visited Feb. 2, 2005).

80. Craig, *supra* note 78, at 237.

81. *See Exxon Valdez* Oil Spill Trustee Council, *Restoration Projects*, *at* http://www.evostc.state.ak.us/restoration (last visited Feb. 2, 2005) (discussing ongoing restoration efforts at the site).

82. SVARNEY & BARNES-SVARNEY, *supra* note 58, at 431.

83. *Id*. at 433.

84. *Id*. *See also* UNESCO, *Marine Biodiversity*, *supra* note 9, at 1 ("Over 70% of marine contamination comes from the mainland whether due to dumping of waste products, pesticides, hydrocarbons or toxic products. Even air pollution started on land is eventually deposited on the water surface.").

85. Knowlton, *supra* note 37, at A262.

Land-based air pollution can arise from both natural events, such as desert sand storms and dust storms, and human-caused events, such as forest fires and industrial air pollution. This pollution can acidify ocean waters, increase the concentration of heavy metals and other toxic pollutants in the oceans, and increase sedimentation of the oceans, blocking sunlight, interfering with photosynthesis, and smothering coastal ecosystems such as coral reef.[86] Land-based water pollution can also carry toxics and sediment into the seas, causing similar problems.[87] In addition, toxic pollutants, in combination with rising sea temperature, "are lowering the natural resistance of marine organisms to infections."[88] Thus, for example, organochloride pollution has been linked to "the mass mortality of Mediterranean monk seals off the coast of Mauritania, which died after becoming infected with a distemper virus of dolphins."[89]

In addition, land-based water pollution, especially from agriculture, carries nutrients (fertilizers) and pesticides into the ocean.[90] Excess nutrients, in turn, result in algal blooms in the ocean — relatively quick explosions in the concentrations of various kinds of algae.[91] With many species of algae, the result is Harmful Algal Blooms (HABs) that can lead to red tides and contamination of fish and shellfish as the algae produces neurotoxins.[92] A variety of kinds of HABs have occurred, and recurred, off of every United States coast since at least 1985, including the coasts of Alaska, Hawaii, and Puerto Rico.[93] In addition, after the algae dies, its decomposition uses up much of the oxygen available in the seawater, causing eutrophic conditions and, eventually, "dead zones" (or, more scientifically, hypoxic zones) void of all animal life.[94] "The number of oxygen-starved areas in oceans and bays

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86. *See generally* SVARNEY & BARNES-SVARNEY, *supra* note 58, at 431-34.

87. Craig, *supra* note 78, at 237.

88. Connor, *supra* note 32, at 3; *see also* Harvell et al., *supra* note 34, at 1505 ("In the North Atlantic, frequency of mass mortalities of marine mammals appears to be increasing, particularly along heavily polluted coastal areas, suggesting human activity as a factor in disease dynamics.").

89. Connor, *supra* note 32, at 3.

90. Zoë Chafe, *Ocean Dead Zones Multiplying*, 17:4 WORLD WATCH 10 (July/Aug. 2004); Anne Simon Moffat, *Global Nitrogen Overload Problem Grows Critical*, 279 SCI. 988, 988 (Feb. 13, 1998).

91. Chafe, *supra* note 90, at 10; Vitousek et al., *supra* note 29, at 495.

92. Moffat, *supra* note 90, at 988; Vitousek et al., *supra* note 29, at 495 ("A recent increase in the frequency, extent, and duration of harmful algal blooms in coastal areas suggests that human activity has affected the base as well as the top of marine food chains.").

93. U.S. Environmental Protection Agency, *Major Harmful Algal Bloom Events in the Coastal U.S. 1985-1997, at* http://www.epa.gov/owow/oceans/maps/hab.gif (last visited Feb. 2, 2005).

94. SVARNEY & BARNES-SVARNEY, *supra* note 58, at 444; Stephanie Joyce, *The Dead Zones:*

around the world ha[d] doubled [by 2003] to 246 since 1990,"[95] and by April 2004, UNEP had "identified 150 'dead zones' in the world's oceans as a result of sewage and agricultural pollution,"[96] the result of "an excess of nutrients — mainly nitrogen — being released into the sea."[97] Nitrogen pollution and the resulting hypoxia have been deemed the cause of "the collapse of the Baltic Sea cod fishery in the early 1990s . . . ."[98] In the United States, hypoxic zones began to develop in the 1970s and have since been recorded in at least 36 coastal locations.[99] The most dramatic of these zones is the dead zone in the Gulf of Mexico, which often covers an area the size of New Jersey and which scientists "have linked … to algae blooms caused by nitrogen fertilizer poured into the gulf by the Mississippi River."[100] Nitrogen pollution and hypoxia are affecting marine biodiversity, especially "in many estuaries, where a few phytoplankton species have flourished, choking out other species."[101]

The remaining 10 percent of ocean pollution comes from ocean dumping, that is, the disposal of wastes at sea.[102] Many different kinds of materials are dumped in the ocean, both on purpose, for disposal, and accidentally, such as when fishers lose nets. Many of these materials are obviously detrimental to marine biodiversity. For example, before 1972 in the United States, ocean dumping resulted in 100 million tons of petroleum products, 100,000 tons of organic chemical wastes, 38 million tons of dredged materials (often contaminated with toxics), 4.5 million tons of sewage sludge, 4.5 million tons of industrial wastes, two to four million tons of acid chemical wastes, a million tons of heavy metals, and 500,000 tons of construction materials being added to the offshore waters each

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Oxygen Starved Coastal Waters, 108 ENVTL. HEALTH PERSP. (Mar. 2000), *available at* http://ehp.niehs.nih.gov/docs/2000/108-3/focus.html.

95. Chafe, *supra* note 90, at 10; *see also* Knowlton, *supra* note 37, at A262 (noting that "[t]oxic algal blooms . . . are increasingly common in coastal areas worldwide") (citation omitted).

96. *UN Sounds the Alarm on Dead Zones in Ocean*, UTILITY WEEK, Apr. 23, 2004, at 12.

97. *Id.*; *see also* Chafe, *supra* note 90, at 10 ("Several types of pollution — including excess chemical fertilizers, human waste, airborne industrial waste, and traffic fumes — can cause nitrogen concentrations to reach damaging levels.").

98. Moffat, *supra* note 90, at 988.

99. PEW OCEANS COMMISSION, AMERICA'S LIVING OCEANS: CHARTING A COURSE FOR SEA CHANGE 22 (2003), *available at* http://www.pewtrusts.org/pdf/env_pew_oceans_final_report.pdf [hereinafter PEW OCEANS COMMISSION].

100. Moffat, *supra* note 90, at 988.

101. *Id*. at 989. In addition, HABs are detrimental to human health. "As with pollutants, the toxins from these blooms are concentrated as they move up the food chain, but they can also cause human health problems through skin and aerosol contact." Knowlton, *supra* note 37, at A262.

102. SVARNEY & BARNES-SVARNEY, *supra* note 58, at 433.

year.[103] In addition, between 1946 and 1970, dumpers disposed of over 55,000 containers of radioactive wastes into American waters.[104]

However, even more benign-appearing trash, especially plastics, can harm the creatures of the ocean. First, some creatures mistake trash for food. Sea turtles, for instance, normally eat jellyfish, and plastic sacks can look a lot like jellyfish. In addition, creatures can become physically entangled in marine trash and for creatures that need to breathe, like whales, birds, seals, and turtles, such entanglements can often lead to drowning or strangulation.[105] Marine debris can also physically damage or destroy the habitat that marine species need to live.[106] This problem is especially acute for coral reefs and delicate sea grass beds.[107] In fact, derelict fishing gear is the primary threat to the Northwestern Hawaiian Islands' coral reefs, which are arguably the most pristine coral reef ecosystems in the world.[108]

Finally, most recently, scientists have linked plastic debris in the oceans to colonizations by alien marine species, "one of the greatest threats to global biodiversity."[109] Noting that anthropogenic sources of marine debris, especially plastics, have been increasing dramatically recently —– "for example, the amount of debris doubled from 1994 to 1998 around the coastline of the United Kingdom, and in parts of the Southern Ocean it increased 100-fold during the early 1990s" — David Barnes reported in 2002 in *Nature* that "[m]any types of animal use marine debris as a mobile home" and that, "[c]ompared with boats, . . . man-made debris is longer lasting, more pervasive and travels more slowly, factors that could favour the survival of colonists."[110] He concludes that:

> Rubbish of human origin in the sea has roughly doubled the propagation of fauna in the subtropics and more than tripled it at high (>50?) latitudes,

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103. U.S. Environmental Protection Agency, *Ocean Regulatory Programs: Ocean Dumping before the MPRSA*, *at* http://www.epa.gov/owow/oceans/regulatory/mprsa/before.html (last updated July 29, 2004).

104. *Id*.

105. SVARNEY & BARNES-SVARNEY, *supra* note 58, at 435. *See* David K.A. Barnes, *Invasions by Marine Life on Plastic Debris*, 416 NATURE 808, 809 (Apr. 25, 2002).

106. National Ocean & Atmospheric Administration (NOAA), *Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve: the Region*, *at* http://hawaiireef.noaa.gov/region/region.html (last revised July 1, 2002).

107. *See id.*

108. *Id*.

109. SVARNEY & BARNES-SVARNEY, *supra* note 58, at 808.

110. *Id*.

> increasing the potential for alien invasions and adding to the problems already created by sea-borne plastic materials in the form of injuries and mortality among marine mammals and birds.[111]

C. The More Recent Explanation: Overfishing

While marine pollution, especially land-based marine pollution, remains a serious problem for marine biodiversity, scientists in the last decade have identified another threat that, historically, has almost certainly been more important in causing the loss of marine biodiversity: overfishing. "A threat to marine biodiversity, overfishing refers to the practice of commercial and non-commercial fishing which depletes a fishery by catching so many adult fish that not enough remain to breed and replenish the population."[112] However, "[w]ith the competing claims of deforestation, desertification, energy resource exploitation and other biodiversity depletion dilemmas, the magnitude of the problem of overfishing is sadly overlooked."[113]

Overfishing contributes to loss of marine biodiversity in several ways. Most obviously, overfishing depletes the species that are the targets of the fishing, especially given the capacities of modern commercial fishing vessels. In 1986, for example, a single Norwegian fishing boat could catch 120 million fish, and 12 Boeing 747s can fit in the largest trawl nets that commercial "factory ships" use in their operations.[114] As early as 1996, UNESCO reported that "[t]hanks to technological advances, fishing techniques are increasingly sophisticated, leading to the over exploitation of marine resources with devastating impact on important fishing grounds. It is estimated that no fewer than 9 of the world's 17 fishing grounds are already on the way to exhaustion."[115] A year later, scientists reported in the journal *Science* that "humans use about 8% of the primary production of the oceans, [and] that fraction grows to more than 25% for upwelling areas and to 35% for temperate continental shelf systems."[116]

Overfishing is having measurable effects on biodiversity. In 2002, according to the Pew Oceans Commission, the status of 655

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111. *Id*. at 809.
112. Udy Bell, *Overfishing: A Threat to Marine Biology*, XLI:2 UN CHRONICLE 17, 17 (2004), *available at* http://www.un.org/Pubs/chronicle/2004/issue2/0204p17.asp.
113. *Id*.
114. Worldwatch Institute, *Biodiversity Factors*, 16:1 WORLD WATCH 39 (Jan.-Feb. 2003).
115. UNESCO, *Marine Biodiversity*, *supra* note 9, at 2.
116. Vitousek et al., *supra* note 29, at 495.

of the 959 commercially fished stocks worldwide, or 68.3 percent of the stocks, was simply unknown.[117] Nevertheless, of the 304 stocks whose status *is* known, 93 (or 31.7 percent), are overfished, experiencing overfishing, or both.[118] The FAO's statistics are even more disturbing: it "has calculated that over 70 per cent of the world's fish species are either fully exploited or depleted."[119] As Nancy Knowlton has more colorfully summarized, "[w]e have already eaten about 90% of the big fish that live on continental shelves and the open ocean . . ., and in many coastal waters densities have been reduced to a far greater extent."[120]

The basic biology and life cycles of many targeted species exacerbate the effects of overfishing. For example, fishers quite rationally target the biggest fish. However, the biggest fish also produce the most gametes — sometimes *ten times* as many eggs and sperm as smaller fish.[121] Moreover, many commercially important species of fish go through a sex change as they mature.[122] Thus, in targeting the largest individuals, fishers effectively wipe out one entire sex.[123] As a result, ordinary fishing practices severely interfere with targeted species' abilities to reproduce and replenish their numbers.

In addition, most commercial fishing methods result in "bycatch" of non-target species, extending the biodiversity effects of overfishing too many other species.[124] In particular, indiscriminate fishing practices such as huge nets and trawling operations catch numerous individuals of a variety of species that the fishers do not want and cannot sell,[125] and the fishers generally just toss this dead and dying bycatch back into the ocean.[126] Bycatch represents, conservatively, 25 percent of the total fish caught, a total of 27 million tons of wasted biodiversity every year.[127]

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117. PEW OCEANS COMMISSION, *supra* note 99, at 37 fig. 1.
118. *Id*.
119. Bell, *supra* note 112, at 17.
120. Knowlton, *supra* note 37, at A262.
121. CALLUM M. ROBERTS & JULIE P. HAWKINS, FULLY-PROTECTED MARINE RESERVES: A GUIDE 17 (WWF Endangered Seas Campaign 2000), *available at* http://www.panda.org/downloads/marine/marinereservescolor.pdf.
122. *See id.* at 26.
123. *Id*.
124. THORNE-MILLER, *supra* note 44, at 18.
125. *See* KATE WING, NATIONAL RESOURCES DEFENSE COUNSEL, KEEPING OCEANS WILD: HOW MARINE RESERVES PROTECT OUR LIVING SEAS 3 (Apr. 2001), *available at* http://www.nrdc.org/water/oceans/kow/kow.pdf.
126. THORNE-MILLER, *supra* note 44, at 19.
127. Vitousek et al., *supra* note 29, at 495 (finding "commercial marine fisheries around the world discard 27 million tons of nontarget animals annually, a quantity nearly one-third as large as total landings"); *see also* Caroline Ash, *A Desktop View of Overfishing*, 305 SCI. 1242, 1242 (Aug. 27, 2004) (noting in a book review that the waste involved in commercial fishing

Certain fishing practices also destroy essential habitat for marine species, further reducing marine biodiversity. Bottom trawling is generally considered the most destructive fishing practice worldwide[128] and "has been compared to catching squirrels by cutting down forests. Bottom trawl nets scour and destroy an estimated global area of fish habitat the equivalent of 150 times the area of forests cut annually worldwide, and a great proportion of the catch — the so-called by-catch — is discarded."[129]

Numerous coastal nations — including, unfortunately, many developing nations — are already feeling the effects of this loss of biodiversity through commercial overfishing. Research indicates that nations that opened their ocean waters to foreign fishing fleets have experienced "eventual costs, in terms of loss of income for local fishermen, environmental damage and the depletion of native fish stocks, [that] can far outweigh the short-term financial gains generated from foreign Governments and fleets."[130]

In addition, recent studies have indicated that recreational fishing affects marine biodiversity — in some cases, especially where commercial regulation is in place, more than commercial fishing. An August 2004 study in the journal *Science*, suggested "that the millions of weekend fishermen who go out on party boats or stand along the sand with their rods are having a significant effect — and in some areas catching more fish than commercial crews."[131] The same study "found that although recreational fishing accounted for only 4 percent of the total catch nationwide, among 'species of concern,' or those species that the federal government classifies as overfished, recreational fishermen catch 23 percent."[132] Moreover, for specific species of concern in specific areas, that percentage can be even higher — up to 59 percent of eight species caught off of California, Oregon, and Washington, for example.[133]

One of the most important discoveries regarding marine biodiversity, however, is that overfishing can affect not just individual targeted and bycaught species but also the function of

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"is pitiful: even trawlermen will eat fish, especially a fat haddock, but they cannot consume all the nonquota fish they catch and these (dead on arrival at the surface) are flung to the kittiwakes and gannets"); UNESCO, *Marine Biodiversity*, *supra* note 9, at 2 ("What is even more alarming for marine biodiversity is that with the new fishing techniques using trawling and drift nets which capture anything indiscriminately, at times up to 70% of the catch has to be thrown away!").

128. Vitousek et al., *supra* note 29, at 495.

129. Ogden, *supra* note 32, at 33.

130. Bell, *supra* note 112, at 17.

131. Paul Rogers, *Overfishing Now a Problem for Recreational Fishermen, Study Says*, SAN JOSE MERCURY NEWS, Aug. 27, 2004, *available at* 2004 WL 59250901, at *1.

132. *Id*.

133. *Id*.

entire marine ecosystems. Even the so-called "simplest" marine ecosystems depend on complex interactions between species, and, together, the effects of overfishing destroy the "normal" interactions in a marine ecosystem, reducing biodiversity.[134] Moreover, because fisheries tend to target the largest apex predators in a given ecosystem — like tuna — overfishing distorts the balance of trophic levels within that ecosystem.[135] The composition of Jamaican coral reef ecosystems, for example, have changed dramatically over two centuries as a result of overfishing,[136] and as early as 1993 "overfishing was deemed one of the three most serious threats to reefs" one reason being that it "reduces species diversity on reefs."[137]

Some scientists — notably Jeremy B.C. Jackson — have used historical and geological records to argue that human overfishing has been disturbing marine ecosystems ever since humans learned to fish, causing a variety of biodiversity and other ecological effects.[138] For example, oysters in the Chesapeake Bay were once so plentiful that they could filter all the water in the Chesapeake Bay in less than a week.[139] Beginning in the 19th century, however, overfishing severely depleted the oyster population, and it now takes oysters 46 weeks to filter the water, severely affecting the water quality in the Bay.[140] In part as a result of this loss of ecosystem function, "[d]uring the 20th century, once very extensive meadows of seagrasses, oyster beds, clams, blue crabs, and fish declined precipitously, while abundance and production of phytoplankton, eutrophication, and episodes of hypoxia and anoxia correspondingly increased."[141]

Jackson has also tied other ecosystem collapses to overfishing of key species. For example, the collapse of Caribbean coral communities in the 1980s was most proximately caused by "overgrowth by macroalgae that exploded in abundance after an unidentified pathogen caused mass mortality of the enormously

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134. Ogden, *supra* note 32, at 29.

135. Vitousek et al., *supra* note 29, at 495 ("Many of the fisheries that capture marine productivity are focused on top predators, whose removal can alter marine ecosystems out of proportion to their abundance.").

136. PEW OCEANS COMMISSION, *supra* note 99, at 8 fig. 2.

137. Callum M. Roberts, *Effects of Fishing on the Ecosystem Structure of Coral Reefs*, 9:5 CONSERVATION BIOLOGY 988, 989 (Oct. 1995) (citations omitted).

138. *See generally, e.g.*, Jeremy B.C. Jackson et al., *Historical Overfishing and the Recent Collapse of Coastal Ecosystems*, 293 SCI. 619 (July 27, 2001); Ransom A. Myers & Boris Worm, *Rapid Worldwide Depletion of Predatory Fish Communities*, 423 NATURE 280 (May 15, 2003).

139. Jackson, *supra* note 33, at 5414.

140. *Id*.

141. *Id*. at 5413 (citation omitted).

abundant grazing sea urchin *Diadema antillarum* in 1983-1984,"[142] but the less proximate cause appears to be overfishing, which eliminated both the sea urchins predators and the "large herbivorous fishes that had competed with *Diadema* for algal food."[143] As a result, "[o]verfishing allowed *Diadema* to increase in abundance and conpensate for loss of herbivorous fishes that ate macroalgae before overfishing began. Then, when *Diadema* died out there were no other large grazers remaining to consume the algae."[144] In other words, loss of biodiversity, as a result of overfishing the large plant-eating fish in the 19th century, resulted in a loss of redundancy of ecosystem function which left the entire coral reef vulnerable to a disease in one species, the sea urchins. Because of this overfishing and other factors, "[t]he coral reefs of the Caribbean are close to extinction . . . . Just 10 per cent of the Caribbean's reefs remain inhabited by the species of hard coral that created them, compared with 50 per cent cover just 25 years ago."[145]

Other marine ecosystems are threatened with similar fates as a result of historical and continuing overfishing and the resulting disruption of ecosystem function. "Seagrasses along the Florida coast experienced mass mortality in the 1980s because of a wasting disease", in part as a result of the ecological extermination of green sea turtles since the times of Columbus; sea turtles eat the seagrasses, reducing the spread of disease and "reduc[ing] 20-fold the flux of detritus and nitrogen to seagrass sediments."[146] In the 1920s, introduction of mechanized fishing led quickly to overfishing of large cod in the Gulf of Maine's rich kelp forests, allowing sea urchins to reproduce unchecked and to consume "all of the kelp, which was replaced by structurally 'barren' substrata covered by encrusting coralline algae."[147] Loss of the kelp eventually reduced the population of sea urchin, as well, but while the kelp eventually returned, the ground fishes that it originally supported did not.[148]

Jackson notes five biodiversity-related trends in his historical studies of marine overfishing. First, "[l]arge, long-lived vertebrates such as manatees, sea turtles, large fishes, and sharks were the first to disappear from coastal ecosystems in response to human activities because of their life history characteristics and large body

142. *Id*. at 5412 (citation omitted).
143. *Id*. (citation omitted).
144. Jackson, *supra* note 33, at 5414.
145. Fred Pearce, *Extinction Looms for Caribbean "Rainforest of the Oceans,"* 179 NEW SCIENTIST 0262-4079 (July 26, 2003).
146. Jackson, *supra* note 33, at 5413.
147. *Id*. at 5414.
148. *Id*.

size that attracted the most attention."[149] Second, the elimination of "ecosystem engineers" — that is, "species that modify, maintain, or create habitats," including "[r]eef-building corals, seagrasses, oysters, and kelps" — through overharvesting results in loss of habitat structure, decreased growth and larval recruitment, increased mortality, and "precipitous" drops in "[d]iversity and abundance of associated species."[150] Third, the connections between human activities (overfishing) and biodiversity effects can be difficult to detect because of "[l]engthy time lags between initial harvesting and many of the resulting ecological consequences" — "time lags of decades to centuries" — resulting from, as in the examples above, initial redundancies in ecological function.[151] Fourth, overfishing of the large vertebrates leads to "[f]ishing [d]own [f]ood [w]ebs," with the result that "[s]maller and smaller fishes, sea urchins, lobsters, and shrimps are replacing large fishes, turtles, and sharks as the remnant fisheries in all of the coastal ecosystems discussed . . . ."[152] Finally, overfishing combined with land-based pollution "are resulting in increas[ed] abundance and widespread dominance of ecosystem processes by microbes."[153] Increasingly frequent invasions of exotic species also seem to accompany loss of species and normal ecosystem function.[154]

IV. THE INTERNATIONAL RESPONSE TO THE SCIENTIFIC EXPLANATIONS OF MARINE BIODIVERSITY LOSS

A. International Treaties Governing Marine Pollution

The international legal community "gets" that marine pollution is a problem, and a long series of international treaties govern various aspects of marine pollution. One of the first was the 1914 International Convention for the Safety of Life at Sea (SOLAS). The original version of SOLAS was adopted in 1914 in response to the *Titanic* disaster.[155] The parties substantially amended SOLAS in 1929, 1948, 1960, 1974, and 1978.[156] Most relevant to marine pollution issues, SOLAS's 1978 Protocol was adopted at the International Conference on Tanker Safety and Pollution

149. *Id*.
150. *Id*. at 5415.
151. Jackson, *supra* note 33, at 5415.
152. *Id*.
153. *Id*.
154. *Id*. at 5416.
155. International Maritime Organization (IMO), *International Convention for the Safety of Life at Sea (SOLAS), 1974, at* http://www.imo.org/conventions/contents.asp?topic_id=257&doc_id=647 (last visited Feb. 10, 2005).
156. *Id*.

Prevention in February 1978 and came into force on May 1, 1981.[157] This Protocol requires tankers carrying crude oil and other products to have substantial protections against spills.[158] For example, tankers over 20,000 dead weight tons must have an inert gas system to contain oil.[159]

A more important treaty governing maritime oil pollution is the International Convention for the Prevention of Pollution of the Sea by Oil. This Convention came into force on December 8, 1961, and addressed pollution resulting from routine tanker operations and from ships' discharges of oily wastes.[160] The Convention prohibited discharges of concentrated amounts of these materials within 50 miles of land and encouraged parties to provide facilities to handle and treat ships' oily wastes.[161]

One of the most important general international marine pollution treaties is the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, better known as the London Convention, which was adopted in London in November 1972 and came into force on August 30, 1975.[162] Its purpose is to "prevent the pollution of the sea by the dumping of waste and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the seas."[163] The 1972 Convention allows the parties to divide dumped materials into three categories: Annex I wastes, the dumping of which is completely prohibited; Annex II wastes, which cannot be dumped at sea without a prior special permit; and all other wastes, the dumping of which requires a prior general permit.[164] For example, in 1993, the parties instituted a ban on the ocean disposal of low-level radioactive wastes.[165]

Currently, the parties to the London Convention are debating whether to make it even more protective. The 1996 Protocol to the

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157. *Id*.
158. *Id*.
159. *Id*.
160. *See generally* International Convention for the Prevention of Pollution of the Sea by Oil, 1954 (May 12, 1954), T.I.A.S. No. 4900, 327 U.N.T.S. 3, 12 U.S.T. 2989 (entered into force Dec. 8, 1961).
161. *Id*. art. III.
162. IMO, Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972, at http:www.imo.org/Conventions/contents.asp?topic_id= 258&doc_id= 681 (last visited Feb. 2, 2005).
163. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Dec. 29, 1972, art. I, T.I.A.S. No. 8165, 26 U.S.T. 2403 (entered into force Aug, 30, 1975) [hereinafter London Convention].
164. *Id*. at art IV.
165. London Convention, *supra* note 163.

Convention, designed to replace the 1972 Convention, would reverse the 1972 presumption that dumping is allowed, adopt a precautionary approach, and forbid ocean dumping of *anything* unless the parties to the Convention specifically allow such dumping.[166] The 1996 Protocol will come into force 30 days after the 26th country ratifies it,[167] but so far only 21 countries have done so.[168]

The International Convention for the Prevention of Pollution from Ships, better known as the MARPOL Convention, was adopted in 1973 and, together with the 1978 Protocol, came into force on October 2, 1983.[169] The Convention was inspired by the 1967 *Torrey Canyon* tanker spill in the United Kingdom,[170] and its goal is to prevent and minimize pollution from ships.[171] The Convention's six Annexes address just about every kind of ship pollution possible:

- ANNEX I: Regulations for the Prevention of Pollution by Oil. Annex I entered into force on October 2, 1983, but a revised Annex I will enter into force on January 1, 2007.[172]
- ANNEX II: Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk. Annex II entered into force on April 6, 1987, but a revised Annex II will enter into force on January 1, 2007.[173]
- ANNEX III: Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form. Annex III entered into force on July 1, 1992.[174]
- ANNEX IV: Prevention of Pollution by Sewage from Ships. Annex IV entered into force on September 27, 2003.[175]
- ANNEX V: Prevention of Pollution by Garbage from Ships. Annex V entered into force on December 31, 1988.[176]

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166. 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping and Other Matter, 1972, Nov. 7, 1996, arts. 3.1, 4, 1996 WL 1056820.
167. *Id*.
168. IMO, *Summary of Status of Conventions*, *at* http://www.imo.org/Conventions/mainframe.asp?topic_id=247 (last updated Dec. 31, 2004).
169. IMO, *International Convention for the Prevention of Pollution from Ships*, 1973, *supra* note 79.
170. *Id*.
171. *Id*.
172. *Id*.
173. *Id*.
174. IMO, *International Convention for the Prevention of Pollution from Ships, 1973*, *supra* note 79.
175. *Id*.
176. *Id*.

- ANNEX VI: Prevention of Air Pollution from Ships. The parties to the Convention adopted Annex VI in September 1997, and it will enter into force on May 19, 2005.[177]

Annex I of the Convention also allows the parties to designate some regions of the ocean as "special areas," and since then the parties have so designated the Mediterranean Sea (1973), the Black Sea (1973), the Red Sea (1973), the Gulfs area (1973), the Gulf of Aden (1987), the North Sea (1989), Antarctica (1990), the Wider Caribbean Region (1991), and the Northwest European waters (1997).[178] "Special areas" "are considered to be so vulnerable to pollution by oil that oil discharges within them have been completely prohibited, with minor and well-defined exceptions."[179]

The International Convention on Oil Pollution Preparedness, Response and Cooperation was adopted in November 1990 and came into force on May 13, 1995.[180] However, before it actually came into effect, it was put into practice on a provisional basis in 1991 to respond to oil pollution in the Persian Gulf as a result of the first Gulf War.[181] The goal of the Convention is to prevent marine pollution by oil using a precautionary approach.[182] It requires parties to adopt adequate response measures for oil spills, to provide mutual assistance and cooperation in responding to oil spills, to craft oil pollution emergency plans, to stockpile oil pollution equipment, and to adopt reporting requirements for oil spills.[183]

Finally, and most recently, the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities is not a true treaty but rather a global agreement to take action to protect the oceans from land-based pollution.[184] It was adopted in 1995 by 108 countries and the European Commission at a UNEP conference in Washington, D.C.[185] The agreement

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177. *Id*.
178. *Id*.
179. IMO, *International Convention for the Prevention of Pollution from Ships, 1973, supra* note 79.
180. IMO, *International Convention on Oil Pollution Preparedness, Response, and Cooperation, 1990, at* http://www.imo.org/Conventions/mainframe.asp?topic_id=258&doc_id=682 (last visited Feb. 2, 2005).
181. National Ocean Service, NOAA, *International Convention on Oil Pollution Preparedness, Response, and Cooperation (OPRC), 1990, at* http://international.nos.noaa.gov/conv/oprc.html (last visited Feb. 3, 2005).
182. *Id*.
183. *Id*.
184. UNEP, *About the GPA Global Programme of Action, at* http://www.gpa.unep.org/about/default.htm (last updated Dec. 4, 2003).
185. *Id*.

encourages participants to adopt national programs of action to reduce land-based marine pollution.[186] The United States has already relied on the Global Programme to enter side agreements under the North American Free Trade Agreement to protect the California Bight and the Gulf of Maine.[187]

There is evidence that these international treaties and agreements have been effective in addressing various kinds of marine pollution, especially oil pollution and ocean dumping. According to the International Maritime Organization (IMO), which implements the MARPOL Convention, oil pollution from ships, from all sources, has decreased steadily worldwide since 1973.[188] As for ocean dumping, the IMO reports that "[u]nregulated dumping has largely been halted since" nations ratified the London Convention and similar regional treaties.[189] "In early 1991, incineration at sea operations came to a halt,"[190] and dumping of industrial wastes dropped from 17 million tonnes per year in the 1970s to 8 million tonnes per year in the 1980s; "[f]or the period 1992-1995 the total quantity dumped varied from 4.5 million to 6 million tonnes, most of which was dumped by Japan and the Republic of Korea."[191] Since 1996, moreover, none of the 80 parties to the London Convention has issued any permits for the dumping of industrial waste.[192] "Currently, only three Contracting Parties dump sewage sludge at sea: Japan, Philippines and Republic of Korea,"[193] and, as noted, a moratorium on the dumping of radioactive wastes has been in place since 1983.[194] As a result, currently, the largest component of materials dumped in the seas is relatively clean dredged material.[195]

Control of land-based ocean pollution remains more elusive, although even here some progress has been made. UNEP, for example, has focused on control of land-based water pollution, especially sewage, as part of its Millennium Development Goals and

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186. *Id*.

187. International Program Office, National Ocean Service, *Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities*, *at* http://international.nos.noaa.gov/conv/gpa.html (last visited Feb. 2, 2005).

188. *See* INTERNATIONAL MARITIME ORGANIZATION, MARPOL — 25 YEARS (Oct. 1998), *at* http://www.imo.org/includes/blast_bindoc.asp?doc_id=432&format=PDF.

189. IMO, *A Brief Description of the London Convention 1972 and the 1996 Protocol*, *at* http://www.londoncon vention.org/London_Convention.htm (last revised Dec. 16, 2003).

190. *Id*.

191. *Id*.

192. *Id*.

193. *Id*.

194. IMO, *A Brief Description of the London Convention 1972 and the 1996 Protocol*, *at* http://www.londoncon vention.org/London_Convention.htm (last revised Dec. 16, 2003).

195. *Id*.

to meet the Plan of Implementation goals developed at the 1992 World Summit on Sustainable Development.[196]

> Several countries and regions have already begun to take steps to limit the pollution that creates and aggravates dead zones. Near the Rhine River in Europe, where several countries have agreed to halve the levels of nitrogen they discharge, the quantities of nitrogen entering the North Sea have been reduced by 37 percent.[197]

In addition, "[w]aste treatment facilities in Europe and North America are using new technologies to reduce agricultural runoff."[198]

B. Dealing with Overfishing: International Treaties Encouraging Marine Protected Areas

Numerous treaties, like the International Convention for the Conservation of Atlantic Tuna, exist to regulate individual imperiled marine species. This focus on individual species, however, has proven largely ineffective at addressing the effects of overfishing on nontarget species, habitat, and marine ecosystems.[199] For example, for biodiversity purposes, one of the most important limitations of regulation directed specifically at fishing is that such regulation tends to focus exclusively on the targeted species, without consideration of the larger ecosystem on which it depends.[200] In addition, with respect to treaties directly addressing international overfishing, enforcement of catch limits is difficult, and certain fishers and entire nations have reputations for underreporting the amount of fish — and especially of bycatch — that they catch.[201]

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196. Chafe, *supra* note 90, at 10.
197. *Id*.
198. *Id*.
199. *See*, Ogden, *supra* note 32, at 29-30.
200. *See*, *e.g.*, *id.* at 29 (discussing the failure of the United States' Magnuson-Stevens Fisheries Conservation and Management Act); Brailovskaya, *supra* note 31, at 1240 (noting that the United States' Sustainable Fisheries Act, 16 U.S.C. § 1801, "continues to support the targeting of previously unexploited species of marine life for commercial use. Protection of non-commercial marine biodiversity is not within the scope of the act; it is unreasonable to expect it to be a Marine Biodiversity Protection Act" and that "protection of marine biodiversity should be a separate, primary goal rather than a by-product of fisheries management.").
201. Buck, *supra* note 1.

As a result, given the prevalence of overfishing and its side effects, and especially with a growing appreciation of the complexity of the ocean and its inhabitants, scientists increasingly recommend marine protected areas (MPAs), marine reserves, and national systems of MPAs and marine reserves as the best means of preserving and restoring marine biodiversity.[202] In general, an MPA is any area of the ocean set aside by law and protected from at least some uses.[203] The most protective kind of MPA is a marine reserve.[204] Marine reserves generally prohibit all extractive uses, such as fishing, within their boundaries, although they usually permit non-extractive uses such as diving and scientific research.[205] Marine reserves are thus often instrumental in promoting diving-based ecotourism as well as increased marine biodiversity.[206]

Neither international law nor the popular imagination has quite caught up with science in promoting MPAs, however. According to UNEP only about one percent of the oceans are currently protected through MPAs or marine reserves.[207] Nevertheless, a few helpful conventions and treaties do exist that coastal nations can rely upon in pursuing increased use of MPAs and marine reserves to protect and perhaps even restore marine biodiversity.

One of the first biodiversity-related treaties was the Convention Concerning the Protection of the World Cultural and Natural Heritage, better known as the World Heritage Convention, which was adopted in November 1972[208] and came into force on December

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202. Ogden, *supra* note 32, at 34 ("The recent rapid implementation of marine protected areas has pointed to the need for more comprehensive zoning of the oceans."); Brailovskaya, *supra* note 31, at 1239 ("Designating parts of the territorial sea as a national marine wilderness preservation system would enable the protection of marine biodiversity to occur in its own right, rather than allocating the whole marine environment to the commercial fishing industry for use as a source of products."); John C. Ogden, *Marine Managers Look Upstream for Connections*, 278 SCI. 1414, 1415 (Nov. 21, 1997) (noting that "reserves are being advanced all over the world by economic arguments").

203. Robin Kundis Craig, *Taking Steps Toward Marine Wilderness Protection? Fishing and Coral Reef Marine Reserves in Florida and Hawaii*, 34:1 MCGEORGE L. REV. 155, 167-68 (Winter 2003).

204. *Id*. at 169.

205. *Id*. at 169-70.

206. Geoffrey P. Jones et al., *Coral Decline Threatens Fish Biodiversity in Marine Reserves*, 101:21 PROCEEDINGS NAT'L ACAD. OF SCI. (PNAS) 8251, 8253 (May 25, 2004) *available at* http://www.pnas.org/ cgi/doi/10.1073/pnas.0401277101; Craig, *supra* note 203, at 192-96.

207. Bell, *supra* note 112, at 17; *see also* Ogden, *supra* note 32, at 33 ("Most people are astonished to learn that the total area of fully protected marine habitat in the United States is approximately 50 square miles."); Brailovskaya, *supra* note 31, at 1237 ("A comparison of protected-area coverage on land and sea in the United States shows that there is approximately 1500 times more designated protection for no-take wilderness on U.S. lands than for no-take protection in U.S. waters.").

208. UNESCO, *World Heritage: Brief History*, *at* http://whc.unesco.org/pg.cfm?cid=169 (last updated Mar. 5, 2005).

17, 1975.[209] The Convention links nature conservation and preservation of cultural sites and encourages parties to accord emergency and long-term protection to sites of "outstanding universal value."[210] As of January 2005, 788 sites had been designated under the Convention — 611 cultural, 154 natural, and 23 mixed — in 134 countries that are parties to the Convention.[211] While the World Heritage Convention does not specifically target marine sites, nations that are parties to it have designated a number of marine sites as World Heritage Sites, including the Great Barrier Reef in Australia and the Galapagos Islands in Ecuador.[212]

On December 10, 1982, the United Nations adopted the third version of the United Nations Convention on the Law of the Sea (UNCLOS III), which came into force on November 16, 1994;[213] the United States is not (yet) a party.[214] Several provisions of UNCLOS III strengthen coastal nations' abilities to establish MPAs, marine reserves, and systems of MPAs and marine reserves. First, the Convention establishes the jurisdiction of coastal nations over various areas of the sea.[215] For example, coastal nations can exercise nearly complete sovereignty in their territorial sea,[216] which can extend from shore baselines to 12 nautical miles out to sea.[217] Coastal nations can also claim a contiguous zone extending up to 24 nautical miles out to sea, which they can use primarily for law enforcement purposes.[218] Most importantly for marine biodiversity purposes, however, parties to UNCLOS III can claim a 200-nautical-mile Exclusive Economic Zone, or EEZ, off their coasts,[219] where they can exercise "sovereign rights for the purpose

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209. UNESCO, *World Heritage: The States Parties*, *at* http://whc.unesco.org/pg.cfm?cid=246 (last updated Mar. 5, 2005).

210. UNESCO, *World Heritage: Overview*, *at* http://whc.unesco.org/pg.cfm?cid=167 (last updated Mar. 5, 2005).

211. UNESCO, *World Heritage: New Inscribed Properties*, *at* http://whc.unesco.org/pg.cfm?cid=277 (last updated Mar. 5, 2005).

212. UNESCO, *World Heritage List*, *at* http://whc.unesco.org/pg.cfm?cid=31 (last updated Mar. 5, 2005).

213. United Nations, *United Nations Convention on the Law of the Sea of 10 December 1982: Overview and Full Text*, *at* http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm (last updated Jan. 5, 2005).

214. United Nations, *United Nations Convention on the Law of the Sea of 10 December 1982: Chronological list of ratifications*, *at* http://www.un.org/Depts/los/reference_files/chronological_lists_of_ratifications.htm (last updated Feb. 1, 2005).

215. United Nations Convention on the Law of the Sea, Dec. 10, 1982, art. 2, 21 I.L.M. 1261 (entered into force Nov.16, 1994), *available at* http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm.

216. *Id*.

217. *Id*. at art. 3.

218. *Id*. at art. 33.

219. *Id*. at arts. 55, 57.

of exploring and exploiting, conserving and managing the natural resources, whether living or nonliving, of the waters superadjacent to the sea-bed and of the sea-bed and its subsoil . . . ."[220] Such rights, moreover, include jurisdiction for "the protection and preservation of the marine environment . . . ."[221]

Several other provisions of UNCLOS III create duties to protect marine biodiversity, although these duties are often in tension with the parties' rights to exploit the marine resources and to promote their optimum utilization. Thus, for example, the Convention clearly gives coastal states the right to determine allowable catch rates in their EEZs,[222] and "[t]he coastal State, taking into account the best scientific evidence available to it, shall ensure through proper conservation and management measures that the maintenance of the living resources in the exclusive economic zone is not endangered by over-exploitation."[223] Nevertheless, parties also "shall promote the objective of optimum utilization of the living resources in the exclusive economic zone . . . ."[224] Similarly, while "[s]tates have the obligation to protect and preserve the marine environment,"[225] they also "have the sovereign right to exploit their natural resources pursuant to their environmental policies and in accordance with their duty to protect and preserve the marine environment."[226]

UNCLOS III thus gives the parties to it a clear international law basis for protecting marine biodiversity through MPAs and marine reserves, but it does not set any specific biodiversity-related goals. Instead, typical of the international focus in 1982, its sections on "Protection and Preservation of the Marine Environment" emphasize the prevention of marine pollution.[227]

More significantly, in 1992, at the Rio Conference on Sustainable Development, numerous nations of the world adopted

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220. United Nations Convention on the Law of the Sea, Dec. 10, 1982, art. 56.1(a), 21 I.L.M. 1261 (entered into force Nov.16, 1994), *available at* http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm.

221. *Id*. at art 56.1(b)(iii).

222. *Id*. at art. 61.1.

223. *Id*. at art. 61.2.

224. *Id*. at art. 62.1.

225. United Nations Convention on the Law of the Sea, Dec. 10, 1982, art. 192, 21 I.L.M. 1261 (entered into force Nov.16, 1994), *available at* http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm.

226. *Id*. at art. 193.

227. *See generally id*. Part V: Protection and Preservation of the Marine Environment, especially art. 194: Prevent, reduce, and control pollution; art. 207: Pollution from land-based sources; art. 208: Pollution from seabed activities; art. 209: Pollution from activities in the Area; art. 210: Pollution by dumping; art. 211: Pollution from vessels; and art. 212: Pollution from or through the atmosphere. Article 196, however, does address the prevention of alien species introductions. *Id*. at art. 196.

Agenda 21, a global program for achieving worldwide sustainable development.[228] Chapter 15 of Agenda 21 promotes conservation of biological diversity in general, including "in situ conservation of ecosystems and natural habitats,"[229] suggesting a prominent role for protected areas. Chapter 17, in turn, addresses the "protection of the oceans, all kinds of seas, including enclosed and semi-enclosed seas, and coastal areas, and the protection and rational use and development of their living resources."[230] Chapter 17 builds on UNCLOS III as the "international basis upon which to pursue the protection and sustainable development of the marine and coastal environment and its resources,"[231] but it more specifically promotes integrated management of marine areas[232] and the "[c]onservation and restoration of altered critical habitats."[233] Most explicitly, Chapter 17 encourages signatories to "undertake measures to maintain biological diversity and productivity of marine species and habitats under national jurisdiction," including the "establishment and management of protected areas."[234]

The participants at the 1992 Earth Summit in Rio de Janeiro also adopted the United Nations Convention on Biological Diversity, which came into force on December 29, 1993.[235] The United States signed the Convention in April 1993, but has not yet ratified it,[236] despite the Pew Oceans Commission 2004 report strongly urging that the United States ratify this Convention as part of the reformation of its national ocean policy.[237]

The Biodiversity Convention's general objectives are "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits

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228. United Nations Department of Economic & Social Affairs, *Agenda 21*: *Programme of Action for Sustainable Development*, United Nations Conference on Environment and Development (UNCED), 3-14 June 1992, Rio de Janiero, Brazil, *available at* http://www.un.org/esa/sustdev/documents/agenda21/index.htm (last updated Dec. 15, 2004).

229. *Id*. at ch. 15.5(g).

230. United Nations Department of Economic & Social Affairs, *Agenda 21*: *Programme of Action for Sustainable Development*, United Nations Conference on Environment and Development (UNCED), 3-14 June 1992, Rio de Janiero, Brazil, at ch. 17, *available at* http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21chapter17.htm (last updated Dec. 15, 2004).

231. *Id*. at ch. 17.1.

232. *Id*. at ch. 17.5.

233. *Id*. at ch. 17.6(h).

234. *Id*. at ch. 17.7.

235. Center for International Earth Science Information Network (CIESIN) Columbia University, "CIESIN Thematic Guides, The Convention on Biological Diversity," *at* http://www.ciesin.org/TG/PI/TREATY/b io.html (last visited Mar. 5, 2005).

236. Secretariat of the Convention on Biological Diversity, UNEP, *Parties to the Convention on Biological Diversity/Cartagena Protocol on Biosafety*, *at* http://www.biodiv.org/world/parties.asp (last visited Mar. 5, 2005).

237. PEW OCEANS COMMISSION, *supra* note 99, at 80-81.

arising out of the utilization of genetic resources."[238] Its basic principle is that "States have . . . the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."[239] Each party to the Convention is supposed to "[d]evelop national strategies, plans or programmes for the conservation and sustainable use of biological diversity" and to "[i]ntegrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies."[240] Finally, Article 8 of the Convention specifically requires the parties to "[e]stablish a system of protected areas or areas where special measures need to be taken to conserve biological diversity."[241]

While the Biodiversity Convention itself is fairly general in its terms, its biodiversity goals have been expressly extended to marine and coastal biodiversity since the 1995 second Conference of the Parties,[242] through the Jakarta Mandate.[243] Through the most recent decision of the parties implementing this mandate, adopted at the Seventh Conference of the Parties in February 2004, the parties noted "that marine and coastal biodiversity is under rapidly increasing and locally acute human pressure, such that globally, regionally and nationally marine and coastal biodiversity is declining or being lost."[244] Moreover, the decision specifically noted that marine and coastal protected areas contribute to biodiversity protection and sustainable use of biodiversity, and the parties agreed "that marine and coastal protected areas are one of the essential tools and approaches in the conservation and sustainable

238. United Nations Convention on Biological Diversity, June 5, 1992, art. 1, 31 I.L.M. 818, 1993 A.T.S. 32 (entered into force Dec. 29, 1993).

239. *Id*. at art. 3.

240. *Id*. at art. 6.

241. *Id*. at art. 8.

242. Secretariat of the Convention on Biological Diversity, UNEP, *Conference of the Parties – COP: Background and Status*, *at* http://www.biodiv.org/convention/cops.asp (last visited Feb. 2, 2005).

243. Secretariat of the Convention on Biological Diversity, UNEP, *Jakarta Mandate: Marine and Coastal Biodiversity — Introduction*, *at* http://www.biodiv.org/programmes/areas/marine/default.asp (last visited Feb. 2, 2005); *see also generally* CONFERENCE OF THE PARTIES, CONVENTION ON BIOLOGICAL DIVERSITY, DECISION II/10: CONSERVATION AND SUSTAINABLE USE OF MARINE AND COASTAL BIOLOGICAL DIVERSITY (NOV. 1995) (creating and implementing the Jakarta Mandate), *available at* http://www.biodiv.org/decisions/default.aspx?m=COP-02&id=7083&lg=0.

244. CONFERENCE OF THE PARTIES, CONVENTION ON BIOLOGICAL DIVERSITY, DECISION VII/5: MARINE AND COASTAL BIOLOGICAL DIVERSITY ¶ 11 (Feb. 2004), *available at* http://www.biodiv.org/decisions/default.aspx?m=COP-07&id=7742&lg=0.

use of marine and coastal biodiversity."[245] The Decision urges parties to adopt, as a high priority, national marine and coastal management frameworks that incorporate marine and coastal protected areas.[246] It also urges international cooperation to establish marine and coastal protected areas in international waters.[247]

More specific in application is the International Coral Reef Initiative (ICRI), announced at the First Conference of the Parties under the Biodiversity Convention in 1994.[248] The ICRI is a partnership, originally entered by Australia, France, Japan, Jamaica, the Philippines, Sweden, the United Kingdom, and the United States, to increase knowledge about, and protections for, the world's coral reefs.[249] These countries pursued the ICRI as a means of implementing section 86 of Chapter 17 of Agenda 21,[250] which requires participants to identify and protect marine ecosystems exhibiting high levels of biodiversity and productivity, including coral reefs.[251]

On August 4, 1995, parties to UNCLOS III adopted the Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks, which came into force on December 11, 2001,[252] in order to address in more detail issues relating to management of fish stocks that crossed jurisdictional boundaries or traveled across the high seas.[253] While the focus of the Agreement is thus somewhat narrow, it does command — as UNCLOS III itself does not — that parties shall "protect biodiversity in the marine environment."[254] Moreover, at least with respect to the fish subject to the Agreement, the Agreement requires parties to use a precautionary approach in

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245. *Id*. ¶¶ 12, 16.
246. *Id*. ¶ 23.
247. *Id*. ¶ 30.
248. Secretariat of the International Coral Reef Initiative (ICRI), *What is ICRI, at* http://www.icriforum.org/router.cfm?show=/html/about.htm (last visited Mar. 5, 2005).
249. *Id*.
250. *Id*.
251. *See generally* United Nations Department of Economic & Social Affairs, *Agenda 21*: *Programme of Action for Sustainable Development*, United Nations Conference on Environment and Development (UNCED), *supra* note 230, at ch. 17.
252. United Nations, *The United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks*, *available at* http://www.un.org/Depts/los/convention_agreements/convention_overview_fish_stocks.htm (last updated Jan. 5, 2005).
253. United Nations Department of Economic & Social Affairs, *Agenda 21*: *Programme of Action for Sustainable Development*, United Nations Conference on Environment and Development (UNCED), *supra* note 230, at ch. 17.1.
254. Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks, Aug. 4, 1995, art. 5(g) (entered into force Dec. 11, 2001), *available at* http://www.un.org/Depts/los/convention_agreements/texts/fish_stocks_agreement/CONF164_37.htm.

management.[255] This Agreement thus signals that biodiversity concerns are being imported into UNCLOS III's "[c]onstitution for the oceans."[256] A year after this Agreement took effect, moreover, as part of the ten-year anniversary of Agenda 21 and the Rio Conference, "[c]oncerns regarding overfishing were addressed at the World Summit on Sustainable Development, held in Johannesburg, South Africa in 2002, and the importance of restoring depleted fisheries was stressed."[257] The Summit led to an implementation plan that "call[s] for the establishment of marine protected areas (MPAs), which experts believe may hold the key to conserving and boosting fish stocks."[258]

The United Nations Convention on Biodiversity and the 2002 World Summit on Sustainable Development have inspired both large nations with a lot of coast, and relatively isolated island nations, to at least create individual MPAs and marine reserves and often to implement national systems of marine protected areas. For example, Australia implemented its National System of Representative Marine Protected Areas, in part, to comply with the United Nations Convention on Biodiversity and Agenda 21.[259] Bermuda,[260] Canada,[261] Cuba,[262] New Zealand,[263] and the European Union[264] are all similarly in the process of creating national and international systems of MPAs and marine reserves to better protect their marine biodiversity.

In addition, these biodiversity-related treaties have inspired MPA-oriented revisions to pre-existing marine treaties — marine treaties that often previously had a pollution focus. For example, the Northeast Atlantic Ocean is governed by the 16-party

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255. *Id*. at art. 6.

256. United Nations, *United Nations Convention on the Law of the Sea of 10 December 1982: Overview and Full Text*, *supra* note 213 (Title of remarks by Tommy T.B. Koh, of Singapore, President of the Third United Nations Conference on the Law of the Sea).

257. Bell, *supra* note 112, at 17.

258. *Id*.

259. Department of the Environment and Heritage, Australia, *About the National Representative System of Marine Protected Areas (NRSMPA), at* http://www.deh.gov.au/coasts/mpa/nrsmpa/about.html#policy (last updated June 20, 2004).

260. Bermuda Biological Station for Research, *Evaluating Bermuda's No-Take Zones*, *at* http://www.bbsr. edu/pubs/ar01/ar01mpa/ar01mpa.html (last visited Feb. 2, 2005).

261. Parks Canada, *National Marine Conservation Areas of Canada*, *at* http://www.pc.gc.ca/progs/amnc-nmca/system/system1_E.asp (last updated Apr. 1, 2003).

262. *See generally* ENVIRONMENTAL DEFENSE, THE NATIONAL SYSTEM OF MARINE PROTECTED AREAS IN CUBA (2004), *available at* http://www.environmentaldefense.org/documents/3692_mpasCubaIngles.pdf.

263. Department of Conservation, New Zealand, *Marine Reserves*, *at* http://www.doc.govt.nz/Conservation/ Marine-and-Coastal/Marine-Reserves/index.asp (last visited Feb. 2, 2005).

264. *Experts Set to Identify Marine Protected Areas for Europe*, CORDIS NEWS, July 2, 2003, EU Business, *available at* http://www.eu business.com/imported/2003/07/113979/.

Convention for the Protection of the Marine Environment of the North-East Atlantic, better known as the OSPAR Convention.[265] As adopted in 1992, it was a pollution-control treaty, requiring countries to reduce their pollution of the Northeast Atlantic Ocean.[266] However, in 1998 all 16 parties adopted Annex V to the Convention specifically to implement the U.N. Biodiversity Convention in the Northeast Atlantic.[267] As a result, the parties have committed to the creation of an ocean-wide system of marine protected areas and marine reserves by 2010.[268]

V. CONCLUSION: THE ENCOURAGING EMERGENCE OF A COMBINED APPROACH

The recognition of the role of overfishing in marine biodiversity decline, and the subsequent promotion of MPAs and marine reserves, has been a necessary corrective to international marine regulation, especially as losses of marine biodiversity become more evident. However, a complete switch in regulatory focus from marine pollution to overfishing would be as inappropriate as the non-recognition of overfishing's problems and the need for MPAs and marine reserves.[269]

Marine reserves are good at what they're good at: Setting aside portions of marine ecosystems and protecting the species that live there from exploitation. Studies have shown that fish and other species in marine reserves are bigger and more plentiful than outside marine reserves,[270] and there is increasing evidence that well-placed marine reserves can export fish and other species to other areas of the ecosystem and even other ecosystems, helping those other areas to maintain their biodiversity as well.[271] However, marine reserves cannot protect marine species from other kinds of threats, especially certain kinds of marine pollution.[272]

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265. Convention for the Protection of the Marine Environment of the North-East Atlantic, Sept. 22, 1992, 32 I.L.M. 1069.

266. *See generally id.*

267. OSPAR Commission, *Annex v: The Protection and Conservation of the Ecosystems of Biological Diversity of the Maritime Area*, 1998-15.1 (July 22-23, 1998), *at* http://www.ospar.org/eng/html/convention/ospar_conv10.htm.

268. Joint Ministerial Meeting of the Helsinki and OSPAR Commissions, Bremen, June 25-26, 2003, Declaration of the Joint Ministerial Meeting of the Helsinki and OSPAR Commissions ¶ 8, *at* http://www.os par.org/eng/html/md/joint_declaration_2003.htm.

269. *See, e.g.*, Jackson, *supra* note 33, at 5411 (noting that both "overfishing and human inputs from the land" have contributed to historical losses of marine ecological biodiversity).

270. Craig, *supra* note 203, at 171.

271. *Id.* at 170-71.

272. WING, *supra* note 125, at 23 ("Reserves alone will not address factors such as pollution, oil spills, or overfishing. Problems on land, such as poor septic systems and eroding sediments, must be solved or they will wash into the reserve."). For example, in May 2004,

Regarding coral reefs, for example, a group of Australian scientists recently concluded that:

> Although there is a large body of evidence that indicates that marine reserves can be an effective management strategy for protecting marine biodiversity, there is a growing recognition that such areas cannot protect reefs from large-scale pollution or global warming. Thus, although marine reserves are necessary to control the 'top-down' impact of human predation, they must be combined with management strategies that fundamentally address 'bottom-up' processes that appear to be a more likely path to extinction.[273]

More generally, Jeremy B.C. Jackson has argued that the combination of overfishing and land-based pollution has "result[ed] in increasing abundance and widespread dominance of ecosystem processes by microbes,"[274] a change in marine biodiversity that MPAs and marine reserves alone cannot address.

Given the multiple nature of the threats to marine biodiversity, one of the most promising developments in international law are regional treaties that combine marine pollution provisions with provisions that encourage or require parties to establish MPAs and marine reserves and to address other threats, such as alien species, to marine biodiveristy. The Seventh Conference of the Parties of the United Nations Convention on Biological Diversity, for example, encouraged "Parties to urgently address, through appropriate integrated marine and coastal management approaches, all threats, including those arising from the land (e.g., water quality, sedimentation) and shipping/transport, in order to maximize the effectiveness of marine and coastal protected areas and networks in achieving their marine and coastal biodiversity objectives . . . ."[275] Regionally, the 1983 Convention for the Protection and

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four scientists from James Cook University in Australia reported that marine reserves may be ineffective in protecting fish biodiversity in degrading habitats, such as when the coral reefs of Papua New Guinea experience a "devastating decline in coral cover . . . ." Jones et al., *supra* note 206, at 8251-52. One of the three causes of the coral's decline, moreover, was "a gradual increase in sedimentation from terrestrial run-off"; the other two were coral bleaching, generally caused by increased ocean temperatures, and outbreaks of the predatory crown-of-thorns starfish. *Id*. at 8252.

273. Jones, *supra* note 206, at 8253.

274. Jackson, *supra* note 33, at 5415.

275. CONFERENCE OF THE PARTIES, CONVENTION ON BIOLOGICAL DIVERSITY, DECISION VII/5, *supra* note 244, ¶ 26.

Development of the Marine Environment of the Wider Caribbean Region, also known as the Cartagena Convention, to which the United States is a party, came into force on October 11, 1986.[276] Article 4 of that Convention requires the parties to reduce and control marine pollution, including pollution from ships, ocean dumping, land-based sources of marine pollution, and airborne pollution.[277] At the same time however, the Convention imposes requirements on the exploitation of seabed resources and requires the parties to protect marine ecosystems and habitats in specially protected areas.[278] The 1986 Convention for the Protection of the Natural Resources and Environment of the South Pacific Region,[279] which came into force in 1990, and the 1985 Convention for the Protection, Management, and Development of the Marine and Coastal Environment of the Eastern African Region,[280] also known as the Nairobi Convention, which is not yet in force,[281] have similar combinations of requirements as the Cartagena Convention.

The threats to marine biodiversity are many. Only an international law regime that addresses *all* of those threats — pollution, overfishing and its associated problems, loss of habitat, and invasive species — both individually and collectively can effectively halt, and hopefully reverse, the increasing trend of marine species extinctions and loss of marine biodiversity at all levels. The next decades will be an important time in the evolution of the international law of the sea, but the regional treaties discussed above provide encouragement that the world will gradually comprehensively protect its most hidden, but arguably most important, natural resource.

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276. UNEP, *An Overview of the Cartagena Convention*, *at* http://www.cep.unep.org/law/cartnut.html (last updated Mar. 7, 2002).

277. Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Mar. 29, 1983), art. 4.1, T.I.A.S. No. 11085.

278. *Id*. at arts. 8, 10.

279. Convention for the Protection of the Natural Resources and Environment of the South Pacific Region, Nov. 25, 1986, arts. 4.1, 5 (pollution generally), 6 (pollution from vessels), 7 (pollution from land-based sources), 8 (pollution from sea-bed activities), 9 (airborne pollution), 14 (specially protected areas), 26 I.L.M. 38.

280. Convention for the Protection, Management, and Development of the Marine and Coastal Environment of the Eastern African Region, June 21, 1985, arts. 5 (pollution from ships), 6 (pollution caused by dumping), 7 (pollution from land-based sources), 8 (pollution from seabed activities), 9 (airborne pollution), 10 (specially protected areas) (1985), *available at* http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html.

281. Environmental Treaties & Resource Indicators, *Summary of Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region*, *at* http://sedac.ciesin.org/entri/register/reg-134.rrr.html (last visited Mar. 5, 2005).

FAIRNESS AND FARMLAND PRESERVATION: A RESPONSE TO PROFESSOR RICHARDSON

MARK W. CORDES*

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I. INTRODUCTION

In a recent article published in this Journal, Professor Jesse Richardson[1] attempted to refute the arguments proposed by myself and others that support the fairness of downzoning land without compensation to property owners.[2] As Professor Richardson noted, the issue of downzoning property to preserve farmland has become a particularly important one in recent years, especially with increased efforts by local governments to preserve farmland.[3]

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1. Jesse J. Richardson, Jr. is an assistant professor in the Department of Urban Affairs and Planning at Virginia Tech in Blacksburg, Virginia, and is an attorney. He received his B.S. and M.S. in agricultural and applied economics from Virginia Tech and holds a J.D. from the University of Virginia School of Law.

2. Jesse J. Richardson, Jr., *Downzoning, Fairness and Farmland Protection*, 19 FLA. ST. U. J. LAND USE & ENVTL. L. 59 (2003).

3. *Id.*, at 59-61. Several major studies in recent years have documented the loss of farmland and concluded that it presents a major societal problem. *See, e.g.*, A. ANN SORENSEN ET AL., FARMING ON THE EDGE (American Farmland Trust, Northern Illinois University 1997); NATIONAL AGRICULTURAL LANDS STUDY (U.S. Government Printing Office 1981). This perception is joined by a substantial amount of academic and popular commentary. *See, e.g.*, TOM DANIELS & DEBORAH BOWERS, HOLDING OUR GROUND: PROTECTING AMERICA'S FARMS AND FARMLAND (Island Press 1997); Lawrence W. Libby, *Farmland Protection for Illinois: The Planning and Legal Issues*, 17 N. ILL. U. L. REV. 425 (1997). A number of other commentators, however, have questioned whether farmland conversion is in fact a problem, or at least to the degree often stated by proponents of preservation. *See, e.g.*, Orlando E. Delogu, *A Comprehensive State and Local Government Land Use Control Strategy to Preserve the Nation's Farmland is Unnecessary and Unwise*, 34 U. KAN. L. REV. 519 (1986); William A. Fischel, *The Urbanization of Urban Land: A Review of the National Agricultural Lands Study*, 58 LAND ECON. 236 (1982).

Whatever the merits of this debate, all levels of government have perceived farmland conversion as a problem and have responded with a variety of programs to slow and control the rate of conversion. For instance, the federal government has initiated several actions

Central to most farmland preservation efforts is agricultural zoning, which typically involves downzoning farmland to agricultural use, precluding more intensive development. Although at times efforts are made to mitigate the economic impact of agricultural zoning — through purchase of development rights (PDRs) and transferable development rights (TDRs) — as a practical matter, both PDRs[4] and TDRs[5] have substantial restrictions and are of limited value at present. For this reason, many communities pursue agricultural zoning without providing compensation to regulated landowners. This means that the cost of preservation falls on property owners themselves, and often imposes substantial losses.

As I stated in a previous article, this issue raises two related concerns.[6] First, does the downzoning of agricultural land constitute an unconstitutional taking? Second, assuming downzoning does not constitute an unconstitutional taking, is it nevertheless unfair to impose substantial economic costs on landowners absent compensation? As that article suggests, the fairness concern is an important one, since fairness is an important component in the political acceptability of farmland preservation.

The answer I provide is that agricultural zoning will rarely constitute an unconstitutional taking under current Supreme Court takings jurisprudence.[7] This has been borne out by lower court decisions, which generally find agricultural zoning constitutional, even when downzoning is involved.[8] Moreover, my article gives

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directed toward farmland preservation, including passage of the Farmland Protection Policy Act in 1981, 7 U.S.C. §§ 4201-4209 (2004), and passage of the Federal Agriculture Improvement and Reform Act of 1996, Pub. L. No. 104-127, 110 Stat. 888 (1996) (codified as amended in 7 U.S.C. § 7201). All fifty states have enacted a variety of measures designed to preserve farmland, including tax incentive programs, right-to-farm laws, agricultural laws, and Purchase of Development Rights Programs. *See generally*, William L. Church, *Farmland Conversion: The View from 1986*, 1986 U. ILL. L. REV. 521 (1986); Mark W. Cordes, *Takings, Fairness, and Farmland Preservation*, 60 OHIO ST. L.J. 1033, 1045-50 (1999).

4. LINDA A. MALONE, ENVIRONMENTAL REGULATION OF LAND USE § 6:46 (2004); Vivian Quinn, *Preserving Farmland with Conservation Easements: Public Benefit or Burden?*, 1992 ANN. SURV. AM. L. 235 (1992-1993). An increasing number of states also have statutes specifically authorizing PDR programs. *See, e.g.*, ME. REV. STAT. ANN. tit. 5, §§ 6200-6210 (2004).

5. *See generally* John J. Costonis, *Development Rights Transfer: An Exploratory Essay*, 83 YALE L.J. 75; Julian Conrad Juergensmeyer et al., *Transferable Development Rights and Alternatives After Suitum*, 30 URB. LAW. 441 (1998).

6. Cordes, *supra* note 3, at 1050.

7. *Id*. at 1055 (discussing how current Supreme Court takings jurisprudence indicates "that agricultural zoning w[ill] rarely constitute a taking," even when substantial diminution in land value occurs).

8. *See, e.g.*, Christensen v. Yolo County Bd. of Supervisors, 995 F.2d 161 (9th Cir. 1993); Gardner v. N.J. Pinelands Comm'n, 593 A.2d 251 (N.J. 1991). *See generally* Cordes, *supra* note 3, at 1060-69.

three reasons why agricultural zoning should not be viewed as inherently unfair, even when a substantial diminution in value results: the concept of government giving, which enhances land value; recognition of general regulatory reciprocity, which mitigates fairness concerns; and the nature of property rights, which has long viewed private interests as being subject to broader public needs.[9]

Professor Richardson mainly disagrees on the issue of fairness, where he strongly rejects all three of my rationales supporting the fairness of downzoning farmland. His article is thoughtful and well-written, helping to identify some limitations of the fairness arguments that myself and others have used to justify farmland preservation along with other types of environmental land use controls. Ultimately, however, I believe that he misses the basic point of my analysis concerning the fairness of agricultural zoning as a farmland preservation method, even when landowners are not compensated for economic loss. The arguments concerning government giving, reciprocity, and the nature of property rights are not intended as legal concepts to be incorporated into a judicial analysis regarding the legality of a particular land use restriction. Rather, they are offered as general policy rationales that help explain why the balance drawn by the Supreme Court is a fair one, a balance that recognizes both individual property rights and broader community rights. On that basis, I believe my arguments remain quite valid, and provide a needed perspective on the fairness of downzoning farmland, even in light of Professor Richardson's criticisms.

In spite of these dichotomies of thought, Professor Richardson and I certainly agree on one point: the constitutionality and fairness of downzoning property to preserve farmland is a very important issue. By all accounts, the national movement to preserve farmland remains strong, with numerous communities grappling with issues of whether and how to preserve farmland.[10] Downzoning land to only agricultural use, a common component of many preservation efforts, has significant consequences for landowners. Moreover, the basic concerns of the constitutionality and fairness of downzoning land that results in substantial diminution in value apply to other types of environmental land use controls, such as those protecting

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9. Cordes, *supra* note 3, at 1072-81.

10. The last several decades have seen growing efforts by state and local governments to preserve farmland. The growing momentum of the "smart growth" movement, which often includes farmland preservation as a component of smart growth, will likely increase farmland preservation efforts. For commentary on the "smart growth" movement, see Richard Briffault, *Smart Growth and American Land Use Law*, 21 ST. LOUIS U. PUB. L. REV. 253 (2002); Oliver A. Pollard, III, *Smart Growth: The Promise, Politics, and Potential Pitfalls of Emerging Growth Management Strategies*, 19 VA. ENVTL. L.J. 247 (2000).

wetlands and coastal zones. Like agricultural zoning, such controls often result in substantial diminution in value and lack substantial "specific reciprocity." Thus, examining the constitutionality and fairness of downzoning farmland is relevant to broader environmental issues.

The rest of this article will briefly review the takings and fairness issues noted above. It will not attempt to rehash my initial analysis or Professor Richardson's critique thereof, which can be read elsewhere. It will, however, briefly respond to Professor Richardson's critique and attempt to clarify why downzoning farmland is not inherently unfair. Part II will briefly reiterate why downzoning of farmland should usually not be an unconstitutional taking under the Supreme Court's current takings jurisprudence. Part III will then try to clarify the government giving, reciprocity, and property rights analysis. Finally, Part IV will briefly comment on the role compensatory programs like PDRs and TDRs should play in effective farmland preservation programs.

II. TAKINGS

The primary legal challenge to downzoning farmland that results in substantial diminution in value is that it constitutes an unconstitutional taking. In his article, Professor Richardson also identifies five other legal challenges to downzoning, including spot zoning, substantive due process, and equal protection.[11] He is certainly correct that each of these challenges might be a basis to find downzoning invalid, depending on the particular facts of a case. As he notes, however, these will typically be unsuccessful, largely because of the deference given to a local government's land use authority. Moreover, their potential success typically turns on some factor other than the economic impact of the restriction, such as the arbitrary nature of the restriction, or bias against the landowner. Concerns about the economic impact of a restriction, which have been much of the focus of the debate about agricultural zoning, are typically addressed by a takings challenge.

The essence of the Supreme Court's current regulatory takings analysis is a two-part test drawn from *Lucas v. South Carolina Coastal Council*[12] and *Penn Central Transportation Co. v. New York City*.[13] A court first asks whether the restriction deprives the landowner of all economically beneficial use of the property.[14] If it

11. Professor Richardson also briefly discusses a "[d]irect [c]hallenge of the [a]ct" and §1983 actions. *See* Richardson, *supra* note 2, at 61-5.

12. 505 U.S. 1003 (1992).

13. 438 U.S. 104 (1978).

14. *See Lucas*, 505 U.S. at 1015-16.

does, it is a categorical taking, unless the restriction is designed to prevent a common law nuisance.[15] Second, if some economic viability remains, a court is to apply what is known as the three-prong *Penn Central* test, examining the character of the government act, the economic impact of the regulation, and the degree of interference with investment-backed expectations.[16]

As I have written elsewhere, agricultural zoning restrictions will rarely constitute a taking under this two-part test. First, the Supreme Court has indicated that the loss of all economic viability is an extremely rare occurrence, which is not met as long as some minimal economic benefit remains.[17] The only case in which the Court found this to occur was *Lucas*, in which land, worth nearly one million dollars based on potential residential development, was downsized to preclude any development or other economic activity altogether. In holding that this constituted a categorical taking, the Court characterized the loss of all economic viability as an "extraordinary circumstance."[18] The Court's sole focus in its discussion in *Lucas* was on the absence of any beneficial, economic, or productive uses left by the restriction, in several places italicizing words to make its point.[19] There was no suggestion in *Lucas* that severe economic impact itself would constitute a categorical taking. Indeed, the Court indicated in a footnote that even a ninety-five percent loss in property value would not be a categorical taking. It noted, however, that it might constitute a taking under the *Penn Central* balancing test.[20]

The Court's two most recent decisions involving takings, *Palazzolo v. Rhode Island*[21] and *Tahoe-Sierra Preservation Council*,

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15. *See id.* at 1027-31.

16. *See Penn Cent. Transp. Co.*, 438 U.S. at 124. This two-part test, in which a court is to first examine whether there is a categorical taking under *Lucas*, and if not, apply the *Penn Central* analysis, has been affirmed in three recent cases. *See* Tahoe-Sierra Pres. Council, Inc. v. Tahoe Reg'l Planning Agency, 535 U.S. 302, 330, 342 (2002); Palazzolo v. Rhode Island, 533 U.S. 606, 617-18 (2001); *Lucas*, 505 U.S. at 1019 n.8.

17. *See Tahoe-Sierra Pres. Council, Inc.*, 535 U.S. at 330; *Lucas*, 505 U.S. at 1017-18.

18. *Lucas*, 505 U.S. at 1017.

19. *Id.* at 1019 (explaining that "[s]urely, at least, in the extraordinary circumstance when *no* productive or economically beneficial use of land is permitted . . .). The Court went on to state that "there are good reasons for our frequently expressed belief that when the owner of real property has been called upon to sacrifice *all* economically beneficial uses . . ." *Id.*

20. *Id.* at 1019 n.8. In this footnote, the Court responded to an argument in Justice Stevens' dissenting opinion, in which he criticized the majority opinion as "wholly arbitrary" because a "'landowner whose property is diminished in value 95% recovers nothing,' while a landowner who suffers a complete elimination of value "recovers the land's full value.'" *Id.* at 1064. The majority appeared to agree that a ninety-five percent diminution in value would not constitute a categorical taking, but was quick to note that a taking might still be found under the *Penn Central* test. *Id.* at 1019 n.8. It further noted that at times a ninety-five diminution in value would not be a taking under *Penn Central*. *Id.*

21. 533 U.S. 606 (2001).

Inc. v. Tahoe Regional Planning Agency,[22] affirm the extremely rare nature of categorical takings based on loss of all economic viability. In *Palazzolo*, the regulated landowner had tried to make the case for a "total taking" by comparing the profit potential for the property, $3,150,000, with the minimum residual value left after regulation, $200,000. He argued that in that context, the state cannot "sidestep" *Lucas* "'by the simple expedient of leaving a landowner a few crumbs of value.'"[23] The Court rejected that comparison, however, focusing on what was left rather than what was taken, stating that the property was not "economically idle."[24] The Court in *Tahoe-Sierra* again took occasion to emphasize the need for a complete loss of economic use before a categorical taking could be found. In discussing the reach of a categorical taking under *Lucas*, it noted that the statute in *Lucas* had "'wholly eliminated the value'"[25] of the property, and stressed that *Lucas* requires a "'complete elimination of value.'"[26]

Under this standard, agricultural zoning would almost never constitute a categorical taking for the simple reason that farming is an economically viable activity.[27] This would be true no matter how great the economic loss in value, since the Court focuses on what is left, not what is lost.[28] As long as the property is suitable to be farmed, a court would certainly find enough minimal value and economic viability to meet the first prong of the *Lucas/Penn Central* test. The only exception would be where agriculturally zoned land is truly unsuitable for farming, perhaps based on parcel size or quality of the soil. In such an instance, there might be a loss of all economic viability and a taking, which a few courts have found.[29]

Even if some economic viability remains, the Supreme Court has made it clear that a court must also analyze whether a taking has occurred under the *Penn Central* test.[30] The first *Penn Central*

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22. 535 U.S. 302 (2002).

23. *Palazzolo*, 533 U.S. at 631 (quoting Petitioner's Brief on the Merits at 37, Palazzo v. Rhode Island, 533 U.S. 606 (2001) (No. 99-2047)).

24. *Id.* at 631 (quoting *Lucas*, 505 U.S. at 1019).

25. *Tahoe-Sierra Pres. Council, Inc.*, 535 U.S. at 330 (quoting *Lucas*, 505 U.S. at 1017).

26. *Id.* (quoting *Lucas*, 505 U.S. at 1019-20 n.8).

27. *See, e.g.*, Gardner v. N.J. Pinelands Comm'n, 125 N.J. 193, 213-14 (1991) (noting the economic viability of agriculture as a land use).

28. *Palazzolo*, 533 U.S. at 631.

29. *See* Petersen v. City of Decorah, 259 N.W.2d 553 (Iowa Ct. App. 1977) (determining that the land unsuitable for farming and had been unproductive for years); Kmiec v. Town of Spider Lake, 211 N.W.2d 471 (Wis. 1973) (finding the land unsuitable for farming, and would cost twice as much to put property into farming condition as the property would be worth as farmland).

30. *See Tahoe-Sierra Pres. Council, Inc.*, 535 U.S. at 342; Palazzolo v. Rhode Island, 533 U.S. 606, 617-18 (2001); *Lucas*, 505 U.S. at 1019 n.8.

factor to be examined is the nature of the government action. This factor largely distinguishes between physical invasions, which are per se takings, and mere regulations of property, which have a strong presumption of constitutionality.[31] The second factor, the economic impact of the regulation, examines the diminution in value of the restriction. Yet the *Penn Central* Court emphasized that diminution in value, no matter how great, is not by itself enough to constitute a taking.[32]

The third factor, interference with investment-backed expectations, is therefore the most significant. At first, this factor might appear to support the argument that downzoning of farmland is an unconstitutional taking, since it can be argued that by its very nature downzoning changes previous development rights, and thus interferes with landowner expectations based on those rights. But, the *Penn Central* case itself indicates that expectations are not as concerned with previous zoning status as with the original intent when property was acquired. To illustrate, Penn Central used the property in question for sixty-five years as a railroad terminal, but lost extremely valuable air development rights when the property was designated as a landmark under New York City's Landmark Preservation Law.[33] In concluding that the landmark restriction was not a taking, the Supreme Court stressed that the Landmark Preservation Law did "not interfere with what must be regarded as Penn Central's primary expectation concerning the use of the parcel."[34] Thus, even though the Landmark Preservation Law eliminated more intensive development that was previously permitted by its zoning, the assurance of some economic viability and continuation of previous uses that formed earlier expectations negated any takings concerns.

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31. *See* Penn Cent. Transp. Co. v. New York City, 438 U.S. 104, 124 (1978) (stating that "[s]o, too, is the character of the governmental action. A 'taking' may more readily be found when the interference with property can be characterized as a physical invasion by government, (internal citation omitted), than when interference arises from some public program adjusting the benefits and burdens of economic life to promote the common good.").

32. *See id.* at 131. As an example that substantial diminution in value is not enough by itself to constitute a taking, the *Penn Central* Court cited the seventy-five percent diminution in value in *Village of Euclid v. Ambler Realty Co.*, in which the Supreme Court nevertheless sustained the validity of the challenged zoning restrictions. 272 U.S. 365 (1926). Although *Euclid* is not generally considered a takings case, the Court's discussion of it in *Penn Central* suggests that broadly applied land use restrictions can impose substantial economic loss and still not constitute a taking. *Penn Cent. Transp. Co.*, 438 U.S. at 125-35. Lower courts have similarly stated that mere diminution in value is not enough, by itself, to constitute a taking. *See, e.g.*, Messer v. Town of Chapel Hill, 485 S.E.2d 269, 270 (1997); *Gardner*, 125 N.J. at 212.

33. *Penn Cent. Transp. Co.*, 438 U.S. at 115-18.

34. *Id.* at 136.

This analysis suggests that despite the substantial diminution in value that downzoning farmland often creates, it is unlikely to substantially interfere with investment-based expectations so as to constitute a taking. Almost all farmland subject to farmland preservation restrictions was originally acquired for agricultural use. As in *Penn Central*, the original investment reflects the permitted agricultural use; the downzoning only interferes with opportunities subsequent to investment. Although downzoning in such a situation clearly has an economic impact on the affected landowner, it does not interfere with investment-backed expectations as contemplated in *Penn Central*. Indeed, *Penn Central* itself essentially involved this same scenario, where previously permitted development opportunities were eliminated, resulting in significant economic impact, but it was held that the opportunities did not interfere with the original expectation of the property owner.[35]

Lower court decisions have consistently shown that establishing a taking under the *Penn Central* test is extremely hard, a point which Professor Richardson concedes.[36] As a general matter, courts have consistently upheld restrictions on environmentally sensitive land, even when diminutions exceeded fifty percent of the land value.[37] Indeed, a recent Court of Claims decision, *Walcek v. United States*,[38] reviewed a number of Supreme Court, Federal Circuit, and Court of Claims cases and stated that diminution in value needed to be "well in excess of 85 percent" for a taking to be found under *Penn Central*.[39]

Lower courts have also consistently found agricultural zoning restrictions constitutional, even when substantial diminution in

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35. *See id*. The Court has explicitly or implicitly considered the issue of interference with investment-backed expectations with regard to land use restrictions in several cases since *Penn Central*, without ever finding a taking on that basis. *See* Keystone Bituminous Coal Ass'n v. DeBenedictis, 480 U.S. 470, 493-94 (1987); Agins v. City of Tiburon, 447 U.S. 255, 262-63 (1980).

36. Richardson, *supra* note 2, at 68-69 (stating that "a downzoning would rarely amount to a taking of private property for public purposes under the *Penn Central* balancing test.").

37. *See, e.g.*, Nasser v. City of Homewood, 671 F.2d 432, 435, 438 (11th Cir. 1982) (finding a fifty-three percent diminution in value not a taking); Pace Res., Inc. v. Shrewsbury Township, 808 F.2d 1023, 1031 (3d Cir. 1987) (finding an eighty-seven percent diminution in value not a taking); Bernardsville Quarry, Inc. v. Borough of Bernardsville, 608 A.2d 1377, 1386-90 (N.J. 1992) (finding a ninety percent diminution in value not a taking).

38. 49 Fed. Cl. 248 (2001).

39. *Id*. at 271-72. In *Walcek*, the Court of Claims held that a 59.7 percent diminution in value was not a taking. *Id*. at 271. In its analysis, it noted that the Supreme Court several times has suggested "that diminutions in value approaching 85 to 90 percent do not necessarily" constitute a taking. *Id*. (citing Village of Euclid v. Ambler Realty Co., 272 U.S. 365, 384 (1926) (holding a zoning ordinance valid despite a seventy-five percent diminution in value); Hadacheck v. Sebastian, 239 U.S. 394, 395 (1915) (finding no taking despite an 87.5 percent diminution in value).

value occurs. Although these cases often blend state and federal laws together, they have generally approached takings claims consistently with the above Supreme Court standards, rejecting takings claims in the vast majority of cases.[40] In doing so, they have often noted that agricultural zoning permits economically viable use of property as long as it is suitable for farming. On occasion, courts have invalidated agricultural zoning restrictions, but this typically occurred in three situations: the land was unsuitable for farming, a unique state standard was applied, or the agricultural zoning restriction was arbitrary.[41]

None of this discussion is meant to suggest that downzoning farmland is never an unconstitutional taking. Takings analysis is necessarily fact sensitive, and at times, downzoning is unconstitutional. Moreover, as Professor Richardson discussed, downzoning farmland might violate other legal standards.

However, if done pursuant to good planning, agricultural zoning should rarely constitute a taking under the current Supreme Court takings analysis. This is true even if downzoning results in substantial diminution of land values, which means that local governments can pursue farmland preservation by putting the cost of regulation on affected landowners. The next section of this article will examine Professor Richardson's critique of the arguments made by myself and others advocating that placing the cost of preservation on affected landowners is not inherently unfair.

III. FAIRNESS

In addition to stating that agricultural zoning is rarely a taking, my previous writings have also argued that agricultural zoning is not inherently unfair, even when resulting in substantial diminution in property value.[42] The takings and fairness issues

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40. *See, e.g.*, Christensen v. Yolo County Bd. of Supervisors, 995 F.2d 161 (9th Cir. 1993); Barancik v. County of Marin, 872 F.2d 834 (9th Cir. 1988); Habersham at Northridge v. Fulton County, Ga., 632 F. Supp. 815 (N.D. Ga. 1985); Gilliland v. City of Palmdale, 179 Cal. Rptr. 627 (Cal. Ct. App. 1981); County of Ada v. Henry, 668 P.2d 994 (Idaho 1983); Wilson v. County of McHenry, 416 N.E.2d 426 (Ill. App. Ct. 1981); Vanderburgh County Bd. of Comm'rs v. Rittenhouse, 575 N.E.2d 663 (Ind. Ct. App. 1991); Bell River Assocs. v. Charter Township of China, 565 N.W.2d 695 (Mich. Ct. App. 1997); Gardner v. N.J. Pinelands Comm'n, 593 A.2d 251 (N.J. 1991); Eck v. City of Bismarck, 283 N.W.2d 193 (N.D. 1979); Smythe v. Butler Township, 620 N.E.2d 901 (Ohio Ct. App. 1993); Murray v. Columbia River Gorge Comm'n, 865 P.2d 1319 (Or. Ct. App. 1993).

41. *See* Petersen v. City of Decorah, 259 N.W.2d 553, 555 (Iowa Ct. App. 1977); Kmiec v. Town of Spider Lake, 211 N.W.2d 471, 476-77 (Wis. 1973).

42. See Cordes, *supra* note 3, at 1072-81. *See also* Mark W. Cordes, *Leapfrogging the Constitution: The Rise of State Takings Legislation*, 24 ECOLOGY L.Q. 187, 229-38 (1997) [hereinafter *Leapfrogging*] (arguing that environmental regulations that impose significant losses on landowners are not so inherently unfair so as to require compensation).

somewhat overlap, since the Supreme Court has often stated that fairness concerns are central to takings jurisprudence.[43] Yet there is little doubt that many people, especially affected landowners, often perceive that restrictions on farmland, though not a taking, are still unfair when there is a substantial economic impact. In that context, I have made several arguments as to why agricultural zoning should not be viewed as inherently unfair simply because there is a substantial drop in property values. It is on this issue that Professor Richardson is particularly critical of the arguments advanced by myself and others.

In making these arguments, I have been careful to state that I was not arguing that agricultural zoning is never unfair. To the contrary, I have stated that agricultural zoning, like any other land use control, might at times be unfair as applied to a particular parcel of land.[44] Similarly, I have supported modified use of PDR and TDR programs to provide some compensation to landowners to more evenly distribute the regulatory burden between affected landowners and society as a whole.[45] Indeed, in a perfect world, I would make generous use of both PDRs and TDRs to help mitigate the sometimes harsh effects of downzoning farmland. These would not only shift some of the cost of preservation to the public, but in the long run, might prove to be more effective preservation methods than agricultural zoning by itself.[46]

But, we do not live in a perfect world, and PDRs and TDRs both are of limited utility because of the cost of PDRs[47] and the necessity

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43. *See* Armstrong v. United States, 364 U.S. 40, 49 (1960) (stating that takings clause "was designed to bar Government from forcing some people alone to bear public burdens which, in all fairness and justice, should be borne by the public as a whole."); Palazzolo v. Rhode Island, 533 U.S. 606, 618 (2001) (quoting *Armstrong*); Dolan v. City of Tigard, 512 U.S. 374, 384 (1994) (quoting *Armstrong*); Penn Cent. Transp. Co. v. New York City, 438 U.S. 104, 123-24 (1997) (quoting *Armstrong*).

44. *See* Cordes, *supra* note 3, at 1072.

45. *Id*. at 1082-83. *See also* Mark W. Cordes, *Agricultural Zoning: Impacts and Future Directions*, 22 N. ILL. U. L. REV. 419, 453-55 (2002) [hereinafter *Agricultural Zoning*] (stating that effective farmland preservation programs should incorporate some use of PDRs and TDRs with agricultural zoning).

46. The conventional wisdom is that zoning by itself is often not a particularly effective farmland preservation method in the long run, primarily because of the inherent impermanence of any system based on political choice. In particular, commentators have noted that the opportunity to change zoning restrictions through variances and rezonings undermines agricultural zonings effectiveness as a long-term answer to the problem of farmland conversion. *See, e.g.*, Jeanne S. White, *Beating Plowshares into Townhomes: The Loss of Farmland and Strategies for Slowing its Conversion to Nonagricultural Uses*, 28 ENVTL. L. 113, 118-19 (1998); Sean F. Nolon & Cozata Solloway, *Preserving Our Heritage: Tools to Cultivate Agricultural Preservation in New York State*, 17 PACE L. REV. 591, 628 (1997). Pressure for zoning change should be substantially lessened when landowners are compensated to some degree by PDRs or TDRs and development rights are more explicitly transferred to local government.

47. The fiscal restraints of PDR programs have been noted by numerous commentators.

of certain conditions to make TDRs work.[48] Thus, although PDRs and TDRs both have a role to play in a comprehensive farmland system, most efforts at farmland preservation must rely heavily on agricultural zoning, without compensation, to succeed. Consequently, I have argued that use of uncompensated agricultural zoning is not inherently unfair, despite the substantial economic losses it sometimes imposes on landowners.

My basic argument that agricultural zoning is not inherently unfair is three-fold. First, any perceived unfairness based on decreased property value presumes that the entire value of land was based on the landowner's efforts; to the contrary, a substantial portion of private property value is often created by government "givings." Second, any concept of fairness must not only consider how burdens and benefits are distributed within a single government action, but must also focus on the reciprocal nature of burdens and benefits within society more broadly, a concept I label "general reciprocity." Third, the argument that agricultural zoning is unfair emphasizes the private development perspective of property rights, neglecting the social dimension of property rights long integral in our legal system.

Before examining each of these arguments and Professor Richardson's critique, it should be emphasized that these arguments are offered as general policy arguments as to why uncompensated agricultural zoning is not inherently unfair. Viewed another way, they are three rationales why the balance drawn by the Supreme Court's current takings jurisprudence, in which downzoning that results in substantial diminution in value is rarely a taking, is fair. However, none of the three rationales are intended to be incorporated in any takings analysis as such, a point that I think is very clear from the structure of my previous writings.[49]

See, e.g., MALONE, *supra* note 4, § 6:46; SARAH E. REDFIELD, VANISHING FARMLAND: A LEGAL SOLUTION FOR THE STATES 99-100 (D.C. Heath and Company 1984); William L. Church, *Farmland Conversion: The View from 1986*, 1986 U. ILL. L. REV. 521, 545-46 (1986).

48. To succeed, TDR programs require the right mix of market conditions, including appropriate "receiving areas" that are restrictive enough to make the TDRs valuable and which can easily absorb increased development. They also require stability of zoning restrictions so that the value of the TDRs are not undermined. *See* Jerold S. Kayden, *Market-Based Regulatory Approaches: A Comparative Discussion of Environmental and Land Use Techniques in the United States*, 19 B.C. ENVTL. AFF. L. REV. 565, 578 (1991-1992). The frequency with which zoning change requests are granted often makes this difficult to achieve.

49. In my primary article on farmland preservation, *Takings, Fairness, and Farmland Preservation*, I discuss takings issues and fairness issues in two completely different sections of the article. Cordes, *supra* note 3. Moreover, nowhere do I suggest that the arguments regarding givings, general reciprocity, and property rights should be incorporated into a takings analysis. Rather, I offer the arguments to show why the line drawn by the Supreme Court's takings jurisprudence, in which restrictions imposing substantial economic costs on

Moreover, the three arguments are not intended to be primarily applied on a case-by-case basis to determine the fairness of a particular land use restriction. Rather, they are offered as general considerations on why substantial diminution in value from agricultural zoning is not inherently unfair.

A. Givings

The idea of focusing on government "givings," and not just takings, has become a popular one in recent years.[50] Government "givings" are those actions by government entities which increase land values. As noted by others, much of the value of farmland is the result of government givings, which enhance the value of land.[51] For example, the very act of zoning regulation itself adds significant value to land. Specifically, the increased value of agricultural land in alternative, residential use exists in part because government zoning would protect any residential development from conflicting industrial and commercial uses. Any arguments based on loss of property value necessarily reflect property values largely enhanced by protective government regulatory schemes.

As I previously discussed, the most obvious example of government givings in regard to farmland subject to development pressure is basic infrastructure support that makes land developable in the first place. This is particularly relevant with regard to farmland preservation issues, where high land values reflect conversion pressure, which in turn reflects various government actions. Specifically, highway and road development greatly enhance land values by increasing accessibility to property for residential use. These programs are primarily paid for by general tax revenues; however, they often result in disproportionate financial benefit to undeveloped land, often farmland, in proximity to development.[52]

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landowners are usually not takings, is not inherently unfair.

50. *See* Daniel D. Barnhizer, *Givings Recapture: Funding Public Acquisition of Private Property Interests on the Coasts*, 27 HARV. ENVTL. L. REV. 295 (2003); Abraham Bell & Gideon Parchomovsky, *Givings*, 111 YALE L.J. 547 (2001); Cordes, *supra* note 3, at 1072-75; C. Ford Runge, *The Congressional Budget Office's Regulatory Takings and Proposals for Change: One-sided and Uninformed*, 7 ENVTL. L. & PRAC. 5 (1999); Donald L. Elliot, *Givings and Takings*, 48 LAND USE L. AND ZONING DIG. 1, 3 (1996); Edward Thompson, Jr., *The Government Giveth*, 11 ENVTL. FORUM 2, 22 (March/April 1994).

51. *See, e.g.*, Elliot, *supra* note 50, at 3; Thompson, *supra* note 50, at 22.

52. It is important to recognize that in recent years developers have been increasingly required to pay for some infrastructure costs through exaction requirements, typically in the form of land dedications and impact fees. *See generally* ALAN A. ALTSHULER & JOSE A. GOMEZ-IBANEZ, REGULATION FOR REVENUE 19-20, 35-39 (The Brookings Institution 1994). It might therefore be argued that through the practice of exactions, landowners themselves pay for the enhanced value of the land. This is subject to several limitations. First, land values

A variant of a simple example I have used elsewhere illustrates the potential impact of government givings on land values.[53] Assume a tract of farmland, somewhat remote and removed from major development, has a value of $50,000. The government then puts in a major highway near the property, making it far more accessible to several suburban areas. Over the course of several years, development begins to occur, more roads are put in, and the value of the farmland increases to $300,000. The local government then restricts the property to agricultural use, decreasing its value to $100,000. Although it might initially appear that government action diminished the property value by two-thirds, in fact the cumulative effect was to double its value.

Real life examples are not nearly this clear cut, but the example illustrates the basic point: government action often accounts for a substantial part of land value. In turn, agricultural and other land use regulations, which at first glance appear to be unfairly taking substantial economic value from landowners, in fact might be taking back values the government itself created. This is not meant to ignore or minimize the considerable role private enterprise often plays in enhancing land values. Further, it should not foreclose use of compensatory schemes, such as PDRs and TDRs, in preserving farmland. However, it does suggest that true land value loss is often not nearly as great as it might at first appear.

Professor Richardson had three criticisms of using government givings to help establish the fairness of downzoning. First, he said that it proves too much, since all landowners, not just owners of undeveloped farmland, benefited from government givings.[54] As he noted, the value of residential property and businesses in proximity to farmland also reflects givings by government acts. Recognizing that all property benefits from government givings raised two "equity issues." First, it is inequitable to recover givings from some landowners and not others. Second, recovering givings from

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are often substantially enhanced by government activities not typically financed by exactions, such as major highways. Second, exactions are designed to help pay for new infrastructure necessitated by development, whereas the givings argument focuses on the enhanced value of undeveloped land created by government infrastructure prior to any development. Third, the amount of exactions can only correspond to the burden imposed by new developments, not to enhanced land values. *See* Dolan v. City of Tigard, 512 U.S. 374, 391 (1994) (requiring "rough proportionality" between exaction and development impact). As a practical matter, the enhanced value of property through exactions imposed by government in its coordinating function far exceeds the cost of the exaction.

53. *See* Mark W. Cordes, *The Public/Private Balance in Land Use Regulation*, 1998 DETROIT C.L.. REV. 681, 698 (1998) [hereinafter *Land Use Regulation*]; *Leapfrogging*, *supra* note 42, at 235-36.

54. Richardson, *supra* note 2, at 76-78.

farmland owners creates an additional giving to nearby property owners.[55]

I certainly agree with Professor Richardson that all property values reflect government givings, but that is hardly fatal to the givings argument. First, when government entities preserve farmland, they are not intentionally seeking to recapture their givings from a few landowners. Rather, they are imposing controls to protect broader public interests, often resulting in loss of economic value to affected landowners. The givings argument is simply an explanation of why the resulting economic loss is not as unfair as it might at first appear. Other owners of undeveloped land might also be, and frequently are, subject to downzoning for the public good, and in such instances, recognition of government "givings" might also help explain why the loss in value is not as unfair as it might first appear. The givings analysis is by no means unique to farmland preservation, and indeed, to the extent necessary, it might be applied to downzoning other types of undeveloped land for the public good.

Second, although all land value reflects government givings, all land does not benefit to the same degree. The givings argument regarding farmland preservation is predicated on the fact that undeveloped land on the suburban fringe often receives disproportionate givings, which greatly increases the property value.

Finally, and this is very important, the discussion regarding givings and fairness is in the context of restrictions on undeveloped land, such as farmland. The law has long drawn a distinction between development expenditures on property, which is largely protected absent nuisance activity, and investment in undeveloped land, which is not protected. There are very strong policy reasons to protect actual development expenditures in land, which the law currently protects through the takings and vested rights doctrines. Thus, Professor Richardson's implicit suggestion that the givings analysis might be used as an excuse to place new restrictions on already developed property, such as homes, businesses, and industrial uses, is quite misleading.[56]

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55. *Id*.

56. Land use law has long provided substantial protection of actual development of land through its vested rights doctrine. *See generally* DANIEL R. MANDELKER, LAND USE LAW §§ 6.12-6.23 (5th ed. 2003). This body of law says that at a certain point in the development process, usually including issuance of a building permit together with some reasonable development expenditures, a landowner establishes vested rights in current permitted uses which cannot be subsequently restricted by government regulations. Although what is necessary to establish vested rights varies considerably from state to state, in no state is the mere purchase price of undeveloped land, even when reflecting then permitted land uses,

Professor Richardson's second argument against the givings analysis is that it proves too much, because if pushed to an extreme, it would justify elimination of all property rights. This is because land has no value absent "government regulations to specify and enforce property rights."[57] Richardson states:

> If the logic of the givings argument holds, the government may therefore confiscate all property without compensation. The givings argument asserts that what the government giveth, it may take away. Such a rule results in nonexistent property rights and valueless property. No government action constitutes a taking under this regime.[58]

Richardson is right that, *if* pushed to an extreme, the givings analysis might negate the takings analysis. However, no one is making that argument or anything like it. Current takings law reflects a balance between the protection of private property rights on the one hand, and recognition of broader community rights on the other, a balance which I strongly support. As noted earlier, the balance falls heavily in favor of private property rights once actual development expenditures are made on land.[59] Conversely, takings law leans heavily in favor of broader public interests regarding undeveloped land.[60] I have written elsewhere on why this balance makes sense and recognized the important role protection of private property plays in society.[61] The "givings" argument is simply one component as to why drawing a balance in favor of the public

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sufficient to establish vested rights.

In addition to the vested rights doctrine, the Supreme Court's takings jurisprudence would appear to apply with particular force when government interferes with established, rather than just potential, uses. Indeed, an argument can be made that this is the clearest example of the type of interference with investment-based expectations that would constitute a taking under *Penn Central*. The *Penn Central* Court, in finding no taking, emphasized there was no interference with the original use of the terminal, strongly suggesting that interference with established uses would be a different matter, absent a clear nuisance-like activity. *See* Penn Cent. Transp. Co. v. New York City, 438 U.S. 104, 136 (1978).

57. Richardson, *supra* note 2, at 78.

58. *Id*. at 79.

59. *See supra* note 56.

60. Commentators have often recognized this sharp distinction between restrictions on established uses, which are granted substantial protection, and restrictions on potential uses, which are often subject to substantial limitations in order to serve the broader public interest. *See, e.g.*, Eric T. Freyfogle, *The Owning and Taking of Sensitive Lands*, 43 UCLA L. REV. 77, 134 (1995-1996) (explaining that "[i]n the law of takings, a considerable difference exists between a regulation that interferes with a current land use and one that bans a prospective land use").

61. *See* Mark W. Cordes, *Property Rights and Land Use Controls; Balancing Private and Public Interest*, 19 N. ILL. U. L. REV. 629 (1998-1999); *Land Use Regulation*, *supra* note 53.

interest with regard to preserving farmland might not be as unfair as the drop in land value might initially suggest.

Professor Richardson's third argument against the givings analysis is that "the law simply fails to condone the givings argument," stating that the Federal Constitution, state constitutions, and eighty years of legal analysis lack reference to the idea of givings.[62] But again, Richardson misses the point. At least as presented in my writings, the givings argument is not intended to be incorporated into the takings analysis, but instead is simply an observation on why restrictions that result in substantial drop in property value, which are rarely takings, are also not inherently unfair. The fact that the Supreme Court has failed to discuss givings is irrelevant. Professor Richardson seems to suggest that unless the Supreme Court has given its imprimatur to an idea, it lacks validity. That makes little sense, especially when the idea is not intended to be directly incorporated into the takings analysis.

It is also somewhat ironic that Professor Richardson states that "[t]he reasoning behind the givings doctrine ignores the takings clause of the U.S. Constitution and over eighty years of legal case law."[63] The givings argument, as developed by myself and others, is in part intended to defend the basic fairness of the Court's current takings doctrine, which clearly permits restrictions on undeveloped land which result in substantial diminution in value. Givings proponents are quite cognizant of the Supreme Court's takings jurisprudence, including the substantial ability it gives local governments to preserve farmland without paying compensation.[64] It is Professor Richardson who appears to be quite bothered by the implications of the Court's current takings jurisprudence, with Richardson implicitly suggesting that downsizing without compensation is inappropriate.

Finally, Professor Richardson made the statement that "[n]owhere does the U.S. Constitution, nor any state constitution, prohibit givings."[65] That, of course, is true, but if he was suggesting that I am opposed to givings, nothing could be further from the truth. I strongly support government actions, such as provision of infrastructure, which enhance land values. Further, I do not believe that government entities should try to recapture those givings. My only point is that when the government pursues other actions for the good of society, such as environmental regulations or farmland

62. Richardson, *supra* note 2, at 79.
63. *Id*.
64. *See supra* notes 12-39 and accompanying text..
65. Richardson, *supra* note 2, at 79.

preservation, that decrease property values, people should be aware that much of the lost value often reflects government givings. As such, the perceived unfairness of the restriction is not as great as the drop in land value might suggest.

Givings arguments are not perfect, and they are subject to limitations, as Professor Richardson partially demonstrates. But their imperfection hardly means they are invalid. Taken for what they are, arguments showing that some of the decreased value resulting from downzoning farmland reflects value created by government givings, helps mitigate the perceived harshness and unfairness of downzoning. Although not drawn from judicial analysis, givings arguments are certainly consistent with and supportive of the basic balance drawn by the Supreme Court and lower courts in takings cases. Additionally, the givings argument does not pose the Hobbesean threat of potentially eliminating all property rights, as suggested by Professor Richardson. Takings jurisprudence has drawn a clear line to prevent elimination of property rights, and the givings analysis simply is one component in understanding why the line the Supreme Court has drawn is a sensible one.

B. General Reciprocity

Related to the idea of government givings is reciprocity, which is the idea that government regulations often bestow both reciprocal burdens and benefits to property owners. I have suggested that the concept of reciprocity can be viewed from two perspectives, "specific reciprocity" and "general reciprocity."[66] Specific reciprocity refers only to benefits and burdens flowing from the same regulation. This appears to be what the Supreme Court typically means when it refers to an "average reciprocity of advantage."[67] In the case of zoning, for example, individual landowners are burdened by restrictions placed on their land, but receive some benefits from neighboring property having similar burdens. Although benefits and burdens are not always evenly distributed, and burdens might

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66. Cordes, *supra* note 3, at 1075-77; *Leapfrogging*, *supra* note 42, at 236-37.

67. *See, e.g.*, Lucas v. S.C. Coastal Council, 505 U.S. 1003, 1017-18 (1992); Penn Cent. Transp. Co. v. New York City, 438 U.S. 104, 124 (1978); Pennsylvania Coal v. Mahon, 260 U.S. 393, 415 (1922). For general discussions of the Supreme Court's treatment of reciprocity of advantage, see Andrew W. Schwartz, *Reciprocity of Advantage: The Antidote to the Antidemocratic Trend in Regulatory Takings*, 22 UCLA J. ENVTL. L. & POL'Y 1 (2003-2004); Lynda J. Oswald, *The Role of the "Harm/Benefit" and "Average Reciprocity of Advantage" Rules in Comprehensive Takings Analysis*, 50 VAND. L. REV. 1449 (1997); Raymond R. Coletta, *Reciprocity of Advantage and Regulatory Takings: Toward a New Theory of Takings Jurisprudence*, 40 AM. U. L. REV. 297 (1990).

outweigh benefits, reciprocal benefits might at least partially offset the burdens imposed by a particular regulation.

I have also argued that reciprocity can be viewed from a broader perspective. Under this perspective, the reciprocal burdens and benefits of regulatory life are generally considered, as opposed to only those flowing from a specific regulation. Thus, although a particular regulation might decrease the value of an owner's property, that same owner might benefit from numerous other regulations that restrict other parties.[68] For example, an owner whose property is subject to particular land use restrictions might benefit from Clean Water Act restrictions over one neighbor, wetland controls over a second, and flood plain restrictions over a third. On a much broader level, various economic and social regulations may benefit the person economically.

As I state elsewhere, any serious argument about fairness must recognize the significant regulatory benefits that flow to landowners as a result of other regulations. Focusing only on the burden caused by a particular regulation distorts the regulatory equation, making the government accountable for burdens imposed, but not giving the government credit for the benefits created. For all practical purposes, it makes almost all government regulatory efforts vulnerable to charges of unfairness, because when viewed in isolation, most regulations will burden some parties more than others.[69] Viewing benefits and burdens from a broader perspective helps to mitigate perceptions of unfairness.

Professor Richardson was particularly critical of the concept of general reciprocity, stating that it lacks any basis in the law and that it would prove unworkable in practice.[70] Again, he misses the basic point. The idea of general reciprocity is not intended to be included in the takings analysis as such. Rather, it helps explain why downzoning property is not necessarily unfair and why regulations should not only be considered in isolation, but also viewed in a broader regulatory context.

Professor Richardson was partially correct when he stated that the idea of general reciprocity "is on shaky ground, at best,"[71] at least in terms of specific endorsement by the Supreme Court. Although the Supreme Court's use of reciprocity is a very loose one, requiring no quantification of actual benefits and making it clear

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68. *See* Cordes, *supra* note 3, at 1075-77; *Leapfrogging*, *supra* note 42, at 236-37.

69. Cordes, *supra* note 3, at 1076-77; *Leapfrogging*, *supra* note 42, at 237. *See also*, Lawrence W. Libby, *Property Rights — The Public — Private Balance?*, MSU LAND USE FORUM CONF., Jan. 9-10, 1996, at 93, 98 (noting that our tendency is to accept the benefits of a regulation as a given, but complain about the burdens as an infringement of rights).

70. Richardson, *supra* note 2, at 82-85.

71. *Id*. at 83.

that benefits need not equal burdens,[72] it nevertheless has been in the context of discussing benefits and burdens from the same regulation. But, as I continually note, I have never intended the concept of general reciprocity to be incorporated into the takings analysis. Rather, it is offered as a rationale as to why negative impacts from a particular regulation are not inherently unfair, since from a broader perspective, losers from one regulation might be winners in another.

Moreover, although the Supreme Court has not articulated the concept of general reciprocity as such, it has at times stated that most regulatory burdens must be borne "as concomitants of the advantage of living and doing business in a civilized community."[73] In stating this principle, the Court made no effort to identify reciprocal benefits from the challenged regulation, but instead put regulatory burdens in a broader context. This is reciprocity stated at the most general level possible, but the point is quite valid. There are enormous advantages and benefits gained from doing business in America's regulatory framework, and the burdens imposed by any particular regulation must be evaluated in that context. This applies to land development as well as other business activity.

The importance of viewing reciprocity from a broader perspective was also emphasized in a recent California Supreme Court decision, *San Remo Hotel v. City of San Francisco*,[74] where the court essentially endorsed the idea of general reciprocity. *San*

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72. *See, e.g.*, Keystone Bituminous Coal Ass'n v. DeBenedictis, 480 U.S. 470 (1987). The Court, in a footnote, stated:

> The Takings Clause has never been read to require the States or the courts to calculate whether a specific individual has suffered burdens under this generic rule in excess of the benefits received. Not every individual gets a full dollar return in benefits for the taxes he or she pays; yet, no one suggests that an individual has a right to compensation for the difference between taxes paid and the dollar value of benefits received.

Id. at 492 n.21.

73. This idea was first articulated by Justice Brandeis in a dissent in Pennsylvania Coal Co. v. Mahon, 260 U.S. 393, 422 (1922), where he identified a number of previous cases where a taking was not found despite the absence of any reciprocal advantage from the regulation, "unless it be the advantage of living and doing business in a civilized community." In more recent cases the Supreme Court has referred to this concept to indicate that most regulatory burdens must be viewed in light of "the advantages of doing business in a civilized society." *See* Ruckelshaus v. Monsanto Co., 467 U.S. 986, 1007 (1984) (stating that "such restrictions are the burdens we all must bear in exchange for 'the advantage of living and doing business in a civilized community'") (internal citation omitted); Kirby Forest Indus. v. United States, 467 U.S. 1, 14 (1984) (explaining that "most burdens consequent upon government action undertaken in the public interest must be borne by individual landowners as concomitants of 'the advantage of living and doing business in a civilized community'") (quoting Andrus v. Allard, 444 U.S. 51, 67 (1979)).

74. 27 Cal. 4th 643 (2002).

Remo Hotel involved a challenge to an ordinance requiring payment of an impact fee when residential hotels converted to tourist hotels. The fee was designed to help replace lost housing. The court held the ordinance constitutional, finding that imposition of the impact fee was a reasonable response to problems posed by hotel conversion.[75] The court rejected the argument that the ordinance lacked reciprocity of advantage, stating that:

> [T]he necessary reciprocity of advantage lies not in a precise balance of burdens and benefits accruing to property from a single law, or in an exact equality of burdens among all property owners, but in the interlocking system of benefits, economic and noneconomic, that all the participants in a democratic society may expect to receive, each also being called upon from time to time to sacrifice some advantage, economic or noneconomic, for the common good.[76]

It is also noteworthy that Professor Frank Michelman's highly influential article on takings, *Property, Utility, and Fairness: Comments on the Ethical Foundations of Just Compensation Law*,[77] also endorsed the idea of general reciprocity, although he did not call it by that name. Not only has this article greatly influenced the takings theory, but scholars have often noted that the article appeared to greatly influence the Supreme Court's thinking in *Penn Central*.[78] In that portion of the article primarily focusing on fairness as an underlying concern in takings jurisprudence, Professor Michelman noted that land use regulations will often diminish property values without compensation, which might appear unfair. He believes that this problem is addressed by considering the regulations from a broader perspective, stating:

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75. *See id.* at 672-73.

76. *Id.* at 675-76.

77. 80 HARV. L. REV. 1165 (1967).

78. *See, e.g*, JESSE DUKEMINIER & JAMES E. KRIER, PROPERTY 1165 (4th ed. 1998) (stating that "'the distinct investment-backed expectations' formulation is obviously drawn from Professor Michelman's influential essay on takings") (citation omitted); R.S. Radford & J. David Breemer, *Great Expectations: Will* Palazzolo v. Rhode Island *Clarify the Murky Doctrine of Investment-Backed Expectations in Regulatory Takings Law?*, 9 N.Y.U. ENVTL. L.J. 449, 449-55 (2001) (discussing how the factor described as "the degree to which a regulation interferes with 'distinct investment-backed expectations'" in *Penn Central* originated in the Michelman article).

> Efficiency-motivated collective measures will regularly inflict on countless people disproportionate burdens which cannot practically be erased by compensation settlements. In the face of this difficulty, it seems that we are pleased to believe that we can arrive at an acceptable level of assurance that *over time* the burdens associated with collectively determined improvements will have been distributed "evenly" enough so that everyone will be a net gainer.[79]

Whether one agrees with Michelman that over time everyone will be a net gainer from regulatory life in general, it is quite reasonable to believe that the harsh economic impacts from one regulation will often be offset by economic benefits from other regulations.

Finally, I would like to respond briefly to Professor Richardson's discussion of specific reciprocity. As he noted, this is what the Supreme Court is referring to when it mentions average reciprocity of advantage from time to time in its cases. Professor Richardson endorsed the need to account for such specific benefits when engaging in a takings analysis, stating that "the less specific reciprocity the regulation contains, the more likely the court will strike the regulation down."[80] This suggests that it is a significant factor in the takings analysis.

The Supreme Court has certainly mentioned "reciprocity of advantage" on a number of occasions, and at times suggested it was an important consideration. For example, in the early case of *Pennsylvania Coal v. Mahon*,[81] the Court struck down a statute prohibiting the mining of anthracite coal when subsidence damage would result. The Court held the statute an unconstitutional taking, focusing primarily on the statute's severe economic impact on the property interests of coal companies.[82] In doing so, however, it distinguished this case from an earlier one upholding a coal regulation. The Court stated that in the earlier case, the regulation was "secured [on] an average reciprocity of advantage" that the Pennsylvania statue in this case did not possess.[83] More recently, in *Agins v. City of Tiburon*,[84] the Court upheld a low density

79. Michelman, *supra* note 77, at 1225.
80. Richardson, *supra* note 2, at 83.
81. 260 U.S. 393 (1922).
82. *See id.* at 413-15.
83. *Id.* at 415. The earlier case was Plymouth Coal Co. v. Pennsylvania, 232 U.S. 531 (1914), where the Court said a law requiring coal companies to leave pillars of coal on the boundaries of adjacent property was constitutional.
84. 447 U.S. 255 (1980).

residential restriction on land, in part because other properties had similar restrictions, providing some reciprocity of advantage.[85] Thus, on occasion, the Court has appeared to give some weight to the presence or absence of specific reciprocity in its analysis.

Upon closer examination, however, in recent years the Court has generally not stressed the absence of substantial specific reciprocity in its analysis, or at least has been very generous in finding specific reciprocity. The most obvious example is *Penn Central* itself, where the Landmark Preservation Law restricted only isolated properties throughout the city, imposing substantial burdens on them that were not shared by neighboring properties. For all practical purposes, there was very little, if any, true reciprocity from the ordinance in question, a point strongly emphasized both by Penn Central Company and Justices Rehnquist and Stevens in dissent.[86] The majority, however, took a much more generous view of reciprocity, stating that Penn Central benefited from the other landmarks in the community.[87] This was somewhat of a stretch. Since Penn Central was one of only a very few properties affected, it would gain very little benefit compared to the substantial burdens imposed. Even more remarkable, the Court appeared to suggest that since the Landmark Preservation Law was designed to benefit all the citizens and structures of New York, Penn Central received some benefit from the law, which was all that was required.[88]

As Professor Richardson noted, I have acknowledged that agricultural zoning does not provide substantial specific reciprocity because most of the perceived benefits of farmland preservation, including food security and environmental amenities, go to the public more generally.[89] This is not to say that there are not some benefits to landowners flowing from the restrictions themselves. First, as members of society, landowners receive the above mentioned benefits like everyone else, and arguably to a somewhat

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85. *See id.* at 262.

86. *See* Penn Cent. Transp. Co. v. New York City, 438 U.S. 104, 147-49 (1977) (Rehnquist, J., dissenting).

87. *See id.* at 134.

88. The Court stated that:

> Unless we are to reject the judgment of the New York City Council that the preservation of landmarks benefits all New York citizens and all structures, both economically and by improving the quality of life in the city as a whole — which we are unwilling to do — we cannot conclude that the owners of the Terminal have in no sense been benefited by the Landmarks Law.

Id. at 134-35.

89. Cordes, *supra* note 3, at 1076.

greater degree than others.[90] More importantly, however, if restrictions are imposed as part of a comprehensive program, as they should be, then restricted landowners receive the benefits of agricultural zoning on surrounding property. Specifically, this insulates farms from the problems of conflicting residential use, including traffic problems, stormwater runoff damage to crops, and potential nuisance suits.[91] These types of reciprocal benefits are every bit as substantial, and probably more so, than the burdens the property owners received in *Penn Central*. Thus, although most of the benefits of agricultural zoning go to society in general and not to regulated landowners, there is certainly enough specific reciprocity from agricultural zoning to meet the rather loose standards that the Supreme Court has established for reciprocity of advantage.

C. Property Rights and Reasonable Expectations

A final argument for the fairness of downzoning farmland is predicated on the social dimension of property rights and landowner expectations. To a certain extent, perceptions about the unfairness of downzoning farmland are based on the view that property owners have a right to do what they want with property, and that downzoning forces landowners to forego opportunities that are interwoven into their rights as owners of private property. However, as noted by a number of scholars, such a perspective is neither the traditional nor the proper way to view property rights.[92] Rather, our legal system has long recognized that private property interests are subject to broader public interests, in which property ownership must be seen in a broader social setting with responsibilities as well as rights.[93] Thus, restricting property to

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90. *See Penn Cent. Transp. Co.*, 438 U.S. at 134-35.

91. *See* J. Dixon Essecks & Lela M. Long, *The Political Viability of Agricultural Protection Zoning to Prevent Premature Conversion of Farmland*, in CONFERENCE PROCEEDINGS, PROTECTING FARMLAND AT THE FRINGE: DO REGULATIONS WORK? Sept. 5-7, 2001, at 80-83 (discussing studies documenting variety of problems that non-farm land uses posed to farming, including trampling of crops, injury to livestock, vandalism of equipment and property, theft, trash and litter, damaged tile and drainage ditches, crop losses due to storm water runoff, traffic concerns, and potential nuisance suits).

92. *See generally* Myrl L. Duncan, *Property as a Public Conversation, Not a Lockean Soliloquy: A Role for Intellectual and Legal History in Takings Analysis*, 26 ENVTL. L. 1095 (1996); Carol M. Rose, *A Dozen Propositions on Private Property, Public Rights, and the New Takings Legislation*, 53 WASH. & LEE L. REV. 265 (1996).

93. *See* John F. Hart, *Colonial Land Use Law and Its Significance for Modern Takings Doctrine*, 109 HARV. L. REV. 1252 (1996) (discussing numerous public limitations on private property designated to further the public good); Leslie Bender, *The Takings Clause: Principles or Politics?*, 34 BUFF. L. REV. 735, 751-52 (1985) (discussing restrictions on perceived noxious activity in early America); Duncan, *supra* note 92, at 1133-37 (discussing types of restrictions on property use found in early America).

agricultural use does not necessarily involve the deprivation of property rights, but rather asserts a limitation inherent in the property itself.

This longstanding recognition that private property is subject to public interests flows from the fact that property is a social construct and society can legitimately define the extent of private property interests to be limited by social concerns.[94] Construing property interests in this way recognizes that the consequences of property use inevitably extend beyond land boundaries and will often conflict with other social needs, necessitating a reasonable accommodation of interests. This includes not only the avoidance of nuisance-like activity, but also protection of sensitive lands, including farmland, as a social resource. Although the need to encourage investment in property requires substantial protection of private property, which the law provides, it is reasonable to assume that these private interests end when they interfere with broader social interests.[95] This is particularly true when the restrictions are on future or potential uses, rather than established uses.

Because private property is subject to such inherent limitations to the public good, and because such restrictions are frequently imposed on undeveloped land, downzoning of farmland to serve such interests cannot usually be viewed as an unreasonable interference with landowner expectations. This is particularly true with regard to undeveloped property, such as farmland, which is often subject to newly enacted regulations to promote the public good. This relates to the idea of regulatory risk, the idea that property ownership always involves the risk of regulation, and therefore, any investment should take into account the possibility of regulation.[96] The Supreme Court has developed this idea in several cases, stating that the risk of regulation is part of economic

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94. Scholars have often noted that property is a social creation of the state. *See, e.g.*, Daniel W. Bromley, *Regulatory Takings: Coherent Concept or Logical Contradiction?*, 17 VT. L. REV. 647, 653- 55 (1993); Coletta, *supra* note 67, at 361-63; John A. Humbach, *Law and a New Land Ethic*, 74 MINN. L. REV. 339, 344-45 (1989).

95. The Supreme Court has frequently recognized this principle, stating that property ownership is limited by public needs. *See, e.g.*, Hadacheck v. Sebastian, 239 U.S. 394, 410 (1915) (stating that private property interests must at times "yield to the good of the community" for the sake of "progress"); Hudson County Water Co. v. McCarter, 209 U.S. 349, 355 (1908) (stating that private property limited by other public interests, including exercise of the police power "to protect the atmosphere, the water and the forests"); Mugler v. Kansas, 123 U.S. 623, 665 (1887) (stating that "all property in this country is held under the implied obligation that the owner's use of it shall not be injurious to the community.").

96. *See, e.g.*, Humbach, *supra* note 94, at 367-68; Daniel Mandelker, *Investment-Backed Expectations in Taking Law*, 27 URB. LAW. 215, 233-36 (1995); Frank I. Michelman, *A Skeptical View of "Property Rights" Legislation*, 6 FORDHAM ENVTL. L.J. 409, 415 (1995).

life, which includes the possibility of economic loss.[97] Thus, since reasonable expectations necessarily incorporate the possibility of land use restrictions, especially on undeveloped land, expectations are not unfairly interfered with when such restrictions are imposed.

Not surprisingly, Professor Richardson found the idea of regulatory risk and landowner expectations mitigating fairness concerns unpersuasive. First, he said that "reasonableness" must be based on available data, and the data available to owners of farmland shows a proliferation of suburban subdivisions, suggesting that farmers can also reasonably expect to develop.[98] Second, any concept of reasonableness should be incorporated into market prices, which typically reflect development potential, which "proponents of downzoning … fail to recognize … as an objective measure of reasonable expectations."[99] Third, he argued that the Supreme Court has endorsed a concept of "temporal equity" that "means that if your neighbors were allowed to develop their property in the past, it is unfair that you be denied that opportunity."[100] Finally, he argued that the regulatory risk argument presented perverse incentives for owners of farmland to prematurely develop property.[101]

The first two criticisms above, which have some merit, are partly answered by simply distinguishing between the "likelihood" and the "possibility" of future restrictions. The concept of regulatory risk is not based on the likelihood of future regulations; rather, it need only be based on the possibility of future restrictions. It is true that the available "data" might often suggest that land can likely be developed. However, the possibility of future restrictions exists as long as the property is undeveloped. Therefore, a landowner's expectations needs to incorporate that possibility, even if it is not a probability. This is particularly true in our legal system, which has long provided far greater protection to established uses than potential uses.[102] Further, the land use field is heavily regulated, and subject to frequent changes, thus providing some degree of

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97. *See* Lucas v. S.C. Coastal Council, 505 U.S. 1003, 1027 (1992); Connolly v. Pension Benefit Guar. Corp., 475 U.S. 211, 227 (1986) (explaining that "[t]hose who do business in the regulated field cannot object if the legislative scheme is buttressed by subsequent amendments to achieve the legislative end.") (quoting FHA v. The Darlington, Inc., 358 U.S. 84, 91 (1958)). *See also* Usery v. Turner Elkhorn Mining Co., 428 U.S. 1, 16 (1976) (stating that "our cases are clear that legislation readjusting rights and burdens is not unlawful solely because it upsets otherwise settled expectations"); Pension Benefit Guar. Corp. v. R.A. Gray & Co., 467 U.S. 717, 729-30 (1984).

98. Richardson, *supra* note 2, at 87.

99. *Id*.

100. *Id*.

101. *Id*.

102. *See* MANDELKER, *supra* note 56, §§ 6.12-6.23.

reasonable expectation of possible, though not necessarily likely, change.[103]

For similar reasons, current market prices should discount future market prices by the possibility of regulation. Thus, if property is worth $10,000 an acre if it can be developed, but only $5,000 an acre if zoned farmland, and there is a twenty percent chance that the property will be downzoned to farmland, the market should discount the $5,000 per acre difference by the twenty percent probability it will occur. That would result in a $1,000 per acre discount and thus a $9,000 per acre value. Admittedly, however, possibilities of future regulation are hard to determine, and thus, markets might inappropriately ignore them. Nevertheless, a rational market participant should discount for regulatory risk, and, indeed, it probably happens to some degree. As illustrated by this example, high value farmland on the suburban fringe, if zoned for development, does not necessarily signal that some discounting has not occurred.

Professor Richardson's third criticism of reasonable landowner expectations, concerning "temporal equity," has less merit, and, indeed, is just plain wrong. *Lucas* cannot be fairly read for the principle that "if your neighbors were allowed to develop their property in the past, it is unfair that you be denied that opportunity."[104] The finding of a taking in *Lucas* was based on the loss of *all* economic viability and the trial court's finding that the property was left with absolutely no value.[105]

The problem with the "temporal equity" argument, depending on how it is defined, is that it would lock land uses into the past, making it very difficult for local communities, as well as society in general, to respond to changing social conditions. As noted by Carol Rose, however, the nature of public interests that private property

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103. The dynamic, as opposed to static, nature of land use regulations, in which regulatory changes frequently occur, has been noted by numerous commentators. *See, e.g.*, ROBERT C. ELLICKSON & VICKI L. BEEN, LAND USE CONTROLS 104-05 (2d ed. 2000) (discussing the "dynamic" nature of zoning as practiced today, in which zoning map restrictions are essentially "first offers"); JULIAN C. JUERGENSMEYER & THOMAS E. ROBERTS, LAND USE PLANNING AND DEVELOPMENT REGULATION LAW 152 (2003) (noting "that the name of the zoning game is change.").

104. Richardson, *supra* note 2, at 87.

105. *See* Lucas v. S.C. Coastal Council, 505 U.S. 1003, 1015-20, 1030 (1992). Nowhere does the Court in its analysis suggest that being deprived a right others had in the past is relevant in the basic takings inquiry. The Court does suggest that once a loss of all economic viability is established, an extremely rare occurrence, then "[t]he fact that a particular use has long been engaged in by similarly situated owners" suggests that the restriction does not fall within the nuisance exception to the loss of all economic viability as a categorical taking. *Id.* at 1031. But, that fact does not become relevant until the landowner challenging the restriction first establishes the loss of *all* economic viability.

is subject to necessarily evolves over time.[106] What constitutes the broader public interest is not static, and neither should be restrictions on land to pursue those interests. This admittedly might interfere with expectations in the short term, but at a more general level, there is the expectation that since public needs might change over time, so must restrictions. Otherwise, there is a temporal domino effect, where new restrictions can never be imposed because someone was allowed to develop in the past. Indeed, in the seminal zoning case of *Village of Euclid v. Ambler Realty Co.*,[107] the Supreme Court recognized the principle that restrictions which might have been unconstitutional in one period will be constitutional at a later date because of changing societal needs.[108] This principle has been borne out repeatedly over the years, as courts have recognized the validity of new forms of land use controls that substantially interfered with pre-existing development opportunities.[109]

Professor Richardson's final point, that the regulatory risk argument creates perverse incentives for owners of farmland to prematurely develop their property, makes some sense. As stated by Richardson, "[i]f a landowner assumes that regulations will become more restrictive, then the landowner holds an incentive to develop his property immediately before the rules change. Given this incentive, land will be prematurely developed and the aim of farmland protection frustrated."[110]

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106. *See* Rose, *supra* note 92, at 274-84.

107. 272 U.S. 365 (1926).

108. The Supreme Court stated:

> Until recent years, urban life was comparatively simple; but with the great increase and concentration of population, problems have developed, and constantly are developing, which require, and will continue to require, additional restrictions in respect of the use and occupation of private lands in urban communities. Regulations, the wisdom, necessity and validity of which, as applied to existing conditions, are so apparent that they are now uniformly sustained, a century ago, or even half a century ago, probably would have been rejected as arbitrary and oppressive. Such regulations are sustained, under the complex conditions of our day, for reasons analogous to those which justify traffic regulations, which, before the advent of automobiles and rapid transit street railways, would have been condemned as fatally arbitrary and unreasonable. And in this there is no inconsistency, for while the meaning of constitutional guaranties never varies, the scope of their application must expand or contract to meet the new and different conditions which are constantly coming within the field of their operation. In a changing world, it is impossible that it should be otherwise.

Id. at 386-87.

109. *Id*. One obvious example is zoning itself, which was necessitated by the problems attendant to increasingly urbanization. Another example is wetland regulation.

110. Richardson, *supra* note 2, at 87.

I concede this is a potential problem. It is tempered, however, by several considerations. First, development itself requires the right set of market conditions, and as a practical matter, landowners cannot simply decide to develop their property. Thus, the threat of premature development will often fail to materialize, if for no other reason than that there is not yet a market. This is true even if the market value of the land is substantially higher if it can be developed, since markets often anticipate future opportunities and speculate. In fact, the law as currently developed certainly presents landowners with the threat of regulatory risk, whether expressing it as such or not, and communities have still been able to identify farmland for preservation. This indicates that the threat of regulatory risk, which is a very real one in our society, has not precipitated a premature rush to development.

Second, the problem of perverse incentives can in part be addressed by strategic use of PDRs and TDRs, when available. Although I do not believe that such compensatory programs are necessary for agricultural zoning to be fair, I support their use in appropriate situations. By targeting PDR and TDR use to properties that are likely to face substantial development pressure in the near future, but not using them for farmland more distant from development, a limited use of PDRs and TDRs can address the perverse incentive problem, to the extent it might exist. This will be examined more in the next section.

IV. A BRIEF COMMENT ON PLANNING, PDRS, AND EFFECTIVE FARMLAND PRESERVATION

Contrary to the impression created by Professor Richardson, I am not opposed to compensatory farmland preservation programs such as PDRs and TDRs. To the contrary, I have stated on several occasions that to be effective, farmland preservation must involve a comprehensive approach incorporating right-to-farm laws, differential taxation provisions, compensatory programs to the extent feasible, and agricultural zoning.[111] I do not believe, however, that the use of agricultural zoning should be dependent on accompanying compensatory programs in all instances. This is certainly not constitutionally required, and I do not believe it is mandated by fairness concerns.

I also do not believe that farmland preservation should be pursued at all costs, oblivious to other societal needs. The need to preserve farmland must be considered in the context of other public needs, most notably affordable housing and land for economic

111. *See* Cordes, *supra* note 3, at 1082-84; *Agricultural Zoning*, *supra* note 45, at 453-55.

development.[112] In theory, the market itself would arguably reflect societal preferences and needs through pricing mechanisms. Markets are imperfect, however, and fail to incorporate a number of external costs, a problem that is particularly true with regard to farmland.[113] Yet it is important to emphasize that farmland preservation itself must be viewed in a broader context, and it is undoubtedly in society's best interest that some farmland be converted to residential and other uses.

To the extent economically feasible, PDRs, and if possible, TDRs, should be used for two reasons. First, they admittedly address the perceived unfairness of substantial drops in property value and make preservation more politically acceptable. Second, they also are more likely to be effective in permanently restricting land to agricultural use rather than agricultural zoning. Zoning, as practiced today, tends to be a very dynamic system, in which upzoning changes are granted with ease, especially when subject to political or development pressure. For this reason, zoning is often viewed as an unstable control mechanism, especially when applied to undeveloped land subject to substantial development pressure.[114] In contrast, restrictions pursuant to PDR and TDR programs are

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112. *See Agricultural Zoning*, *supra* note 45, at 442-44. Farmland preservation, if not done correctly, is potentially in tension with efforts to provide affordable housing. This is because agricultural zoning might potentially raise the cost of new entry level development by limiting the supply of available land for new construction. All else being equal, when the supply of a commodity decreases, and demand remains the same, the price increases. Opponents of growth control measures have argued that such control will raise housing prices. *See* Clint Bolick, *Subverting the American Dream: Government Dictated "Smart Growth" is Unwise and Unconstitutional*, 148 U. PA. L. REV. 859 (2000); Paul J. Boudreaux, *Looking the Ogre in the Eye: Ten Tough Questions for the Antisprawl Movement*, 14 TUL. ENVTL. L.J. 171, 188-89 (2000). *See also* ELLICKSON & BEEN, *supra* note 103, at 996 (noting that most empirical studies conclude that growth controls raise housing prices). Other scholars, however, have suggested that efforts to combat sprawl need not increase housing costs, and indeed, sprawl itself has a negative impact on affordable housing. *See* Robert H. Freilich & Bruce G. Beshoff, *The Social Costs of Sprawl*, 29 URB. LAW. 183, 191 (1997).

As a practical matter, it would appear that the actual impact of agricultural zoning on the cost of new entry housing in part depends on whether there are concomitant plans for compact growth. To the extent government decreases the supply of land through agricultural zoning, but fails to pursue compact growth alternatives, the cost of new housing might increase. On the other hand, if effective efforts at compact growth accompany agricultural zoning, as advocates of smart growth suggest, the overall effect might well be to decrease housing costs. This is because compact growth reduces the percentage of housing cost attributable to new land and also reduces infrastructure costs.

113. The social costs of suburban sprawl, of which conversion of farmland is an integral part, have been well documented. *See, e.g.*, Henry R. Richmond, *From Sea to Shining Sea: Manifest Destiny and the National Land Use Dilemma*, 13 PACE L. REV. 327, 335-36 (1993); William W. Buzbee, *Urban Sprawl, Federalism, and the Problem of Institutional Complexity*, 68 FORDHAM L. REV. 57, 69-77 (1999); Robert H. Freilich & Bruce G. Peshoff, *The Social Costs of Sprawl*, 29 URB. LAW. 183 (1997).

114. *See* MALONE, *supra* note 4, § 6:48; White, *supra* note 46, at 118-19.

often more insulated from pressure, in part because compensation has been provided to the affected landowner.

For this reason, and to the extent feasible, PDRs should be used in conjunction with agricultural zoning, a point I have emphasized in several previous articles.[115] Assuming that the finances for PDRs are limited, they need to be used in a strategic fashion, balancing several competing concerns. On the one hand, they arguably should not be used too closely to rapidly growing areas with substantial development pressure, where development might be inevitable and possibly needed at some point. Conversely, use of PDRs too far out is a poor use of limited funds. Such land can be zoned agricultural without compensation, since the economic impact is likely to be more minimal. Instead, it makes most sense to use PDRs where a growth line should be formed, creating a buffer zone between more intensive uses and other farmland subject to just agricultural zoning.[116]

This potentially serves three purposes. First, it insulates the property most subject to development pressure from conversion, decreasing conversion pressure on agriculturally zoned land. Second, it targets use of PDRs to those landowners who face substantial economic loss by agricultural zoning, but whose property might still be realistically preserved as farmland. Third, the use of PDRs to create buffers helps the perception of farming stability, encouraging investment in farms.[117]

Communities might also consider use of TDRs as a compliment to agricultural zoning, which provide some compensation to affected landowners without the fiscal limitations of PDRs. For this reason, they have been successfully used as a compliment to agricultural zoning in a few instances, most notably Montgomery County in Maryland and the Pinelands in New Jersey.[118] In both cases, use of TDRs have provided a compensatory basis for zoning, helping to ensure its acceptability in the farming community, while also helping to provide for increased development density within designated growth areas. As noted earlier, however, to be successful, TDRs require the right mix of development conditions

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115. *See* Cordes, *supra* note 3, at 1082-84; *Agricultural Zoning*, *supra* note 45, at 453-55.

116. *See Agricultural Zoning*, *supra* note 45, at 454.

117. *Id*. Commentators have noted that the encroaching development problem undermines farming stability and viability because of increasing interferences with non-farm uses and the elimination of a critical mass to sustain a farm economy. Remaining farms thus become even more susceptible to conversion, even for those who desire to remain in farming. *See* Edward Thompson, Jr., *"Hybrid" Farmland Protection Programs: A New Paradigm for Growth Management?*, 23 WM. & MARY ENVTL. L. & POL'Y REV. 831, 839-40 (1999).

118. *See* DANIELS & BOWERS, *supra* note 3, at 179-86 (describing six different TDR programs designed to preserve farmland).

suitable to absorb transferred development, as well as stability of zoning controls within those areas, a relatively rare occurrence.[119] For that reason, few successful TDR programs have emerged, despite their significant popularity in academic literature.

Above everything else, farmland preservation, including agricultural zoning and compensatory programs, needs to be done pursuant to sound planning. This includes identifying farmland that perhaps should be considered for development at some future date in order to meet growth needs. At the same time, farmland targeted for preservation should be identified as early as possible to minimize the economic impact on affected landowners. Such early planning should substantially mitigate perceptions of unfairness, since most agriculturally zoned property will not yet reflect substantially higher value based on possible development.

V. CONCLUSION

There is little reason to believe that the debate surrounding the validity and fairness of farmland preservation and other environmental land use controls will abate any time soon. The "smart growth" planning movement is picking up steam and often includes farmland preservation as a central component.[120] At the same time, suburbs continue to expand, placing increased pressure on some of America's prime farmland.[121] Central to the discussion of fairness of farmland preservation methods is the nature of private property rights, and to what extent they should yield to the broader public interest.

American law does and should provide substantial protection to private property rights, while still recognizing broader public interests. The balance the law has drawn, and one implicit in the Supreme Court's takings jurisprudence, is that private rights in land are given substantial protection once actual development expenditures have occurred, absent nuisance-like activity. In such instances, there are strong policy reasons to protect expenditures, which are critical to societal well-being. In particular, unless owners and land developers have reasonable expectations of continued ownership and productive use, there is little reason to build housing and other land uses essential to society.

Conversely, the law leans more heavily in favor of public interests when regulating potential or future uses of property,

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119. *See* Kayden, *supra* note 48, at 578 and accompanying text.

120. *See generally* Briffault, *supra* note 10; Pollard, *supra* note 10.

121. *See* SORENSEN, *supra* note 3, at 8-20 (documenting increasing development pressure on some of America's prime farmland).

including restrictions on undeveloped land. Even here the law continues to provide some protection to private property interests, but to a much more limited degree. This is reflected in the Court's two-part *Lucas/Penn Central* test for regulatory takings, which permits government entities to place substantial restrictions on undeveloped land, often resulting in substantial diminution in value, without a taking being found. As applied to farmland, this current takings analysis should rarely result in a taking, a fact borne out by a number of lower court decisions.

To the extent possible, PDRs and TDRs should be considered as means to mitigate the economic impact of restrictions, but this is often unrealistic. The question then remains whether imposing agricultural zoning on farmland, absent compensation, is inherently unfair, and it is here that Professor Richardson and I disagree. He emphasized the individual status of the landowner in relation to the single restriction in question. In his world, landowners can frequently be regulatory winners, but not losers. Receiving from the government is expected, but not giving back. Further, individual property rights appear to take preeminence over broader social needs.

In contrast, I and many others see matters through a broader regulatory and social context. High land values near advancing development reflect not only private investment, but also substantial government expenditures, mitigating the perceived unfairness of restrictions that diminish those values. The fairness of a regulation must not only be evaluated by itself, in which some losers are almost inevitable, but also from a broader perspective in which other regulations benefit the same person. Most importantly, individual rights in potential or future land use are held in balance with broader social needs, a balance that has long been recognized in our legal system. This perspective is the one that most clearly corresponds with takings jurisprudence. I believe it is also one that corresponds with basic notions of fairness.

POST INDUSTRIAL REVOLUTION HUMAN ACTIVITY AND CLIMATE CHANGE: WHY THE UNITED STATES MUST IMPLEMENT MANDATORY LIMITS ON INDUSTRIAL GREENHOUSE GAS EMMISSIONS

LEAH H. MARTINEZ

I. INTRODUCTION

The issue of industry-based emissions of greenhouse gases (GHGs) has become a critically important environmental and political topic over the last decade. While the issue of GHG emissions and its connection to global warming has always been a controversial subject, there is little debate today in the scientific and political arenas that the mean global temperature is increasing. Much of the debate has now shifted to a discussion about the major factors causing this change, the environmental effects of climate change, and the stringency of measures necessary to regulate GHG emissions.

It is important to make the distinction between naturally-occurring GHGs and GHGs that are released from industrial plants and through vehicle emissions. Natural GHGs, such as water vapor, carbon dioxide, and other gases, exist in the atmosphere and act to catch some of the energy that is radiated back into space from the heat of the Earth's surface.[1] This natural "greenhouse effect" is beneficial because it maintains the Earth's average temperature around sixty degrees Fahrenheit, making the planet a hospitable environment.[2] However, excessive amounts of gases emitted from industrial sources and automobiles have increased the planet's ability to "trap" this energy, causing an increase in the average global temperature. This rise in global climate, and its impact on the Earth's ecosystem, will likely have far-reaching effects.

Certainly, an increase in temperature could have some positive effects: warmer temperatures would allow agricultural cultivation in some areas currently hindered by low temperatures; melting glaciers in the Arctic Ocean would increase accessibility into areas that are currently hard to explore; and warmer winter temperatures would reduce the demand for heating, and likely

1. U.S. Environmental Protection Agency, *Global Warming — Climate*, *at* http://yosemite.epa.gov/oar/globalwarming.nsf/content/climate.html (last modified Jan. 7, 2000) [hereinafter *EPA Climate*].

2. *See id.*

reduce the mortality rates during the cold season.[3] On the other hand, if atmospheric carbon dioxide concentrations and global temperatures continue to rise, there is a threat of several catastrophes, including a continued rise in sea level, flooding and droughts, and the spread of deadly diseases.[4] This is a global problem in which each region's actions affect the rest of the world. Therefore, it is imperative that every country implement the most aggressive regulations on GHG emissions that are economically feasible. It is particularly important that the United States join other industrialized nations in a binding international agreement to regulate GHG emissions. The United States represents around twenty-four percent of the world's carbon emissions, thereby making U.S. participation and cooperation essential for an effective global treaty.[5]

II. GHG INDUSTRY-BASED EMISSIONS — A GROWING PROBLEM

After the Industrial Revolution, productivity and efficiency increased dramatically as production of goods shifted from the home into factories. Unfortunately, along with the technological advances came an enormous increase in the amount of atmospheric concentrations of GHGs. Since the Industrial Revolution, concentrations of carbon dioxide have increased by nearly thirty percent, concentrations of methane have more than doubled, and nitrous oxide concentrations have risen by about fifteen percent.[6] These gases are released through the burning of fossil fuels such as oil, natural gas, and coal, which are used to operate cars and trucks, heat homes and businesses, and run factories.[7]

The Intergovernmental Panel on Climate Change (IPCC) was created in 1988 by the United Nations Environment Program and the World Meteorological Organization to assess scientific and technical research concerning climate change, and to evaluate potential impacts and possible options for adaptation and mitigation.[8] The IPCC was created partly as a response to U.S. concerns that there was not enough hard scientific evidence on global warming to warrant mandatory international regulation of

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3. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2001: IMPACTS, ADAPTATION, AND VULNERABILITY 83-84 (James J. McCarthy et al. eds., 2001) [hereinafter IMPACTS, ADAPTATION, AND VULNERABILITY].

4. Jasmine Abdel-khalik, *Prescriptive Treaties in Global Warming: Applying the Factors Leading to the Montreal Protocol*, 22 MICH. J. INT'L L. 489, 494 (2001).

5. Anastasia Telesetsky, *The Kyoto Protocol*, 26 ECOLOGY L.Q. 797, 813 (1999).

6. *EPA Climate*, *supra* note 1.

7. *Id.*

8. IPCC, *About IPCC*, *at* http://www.ipcc.ch/about/about.htm (last visited Oct. 5, 2004).

GHG emissions.[9] In 2001, the IPCC determined that the average global air temperature had increased one Fahrenheit degree over the last century.[10] The IPCC also predicted that the average global temperature would rise by another 2.5 to 10.4 degrees Fahrenheit by the year 2100,[11] and concluded that this temperature change has been caused primarily by human activities releasing GHGs into the atmosphere.[12]

III. ARE RISING TEMPERATURES CONNECTED TO GREENHOUSE GAS EMISSIONS OR IS THIS SIMPLY A NATURAL CLIMATE VARIATION?

It is not disputed that the mean global temperature is increasing. Both the IPCC and the U.S. Environmental Protection Agency (EPA) have reported that since the late nineteenth century a warming trend of about one degree Fahrenheit has been recorded, with warming occurring in both the northern and southern hemispheres, and over the oceans.[13] Many scientists predict that this global warming will have drastic effects on global ecosystems. In fact, climate variations in the distant past appear to have been traumatic for existing life. Research prepared for the United Nations Framework Convention on Climate Change (UNFCCC) noted that the history of the earth is "punctuated by so-called 'mass extinction events' during which a large fraction of the world's species are wiped out."[14] While there are many potential causes for mass extinctions, research suggests that many occurred coincidentally with relatively sudden changes in climate.[15] Abrupt changes in climate are generally considered significant when they persist for a year or longer, exceed normal climate variability, and affect sub-continental or greater regions.[16]

Natural variability in the climate has historically been the cause of extreme weather consequences. The modern problem is determining what extent the human enhancement of the natural greenhouse effect has on the planet. Since accurate records of temperature measurements do not exist before the mid-1800s, scientists must reconstruct temperature records using various

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9. DONALD A. BROWN, AMERICAN HEAT 87 (2002).

10. IPCC, CLIMATE CHANGE 2001: SYNTHESIS REPORT 5 (2001), *at* http://www.ipcc.ch/pub/SYRspm.pdf (Sept. 24-29, 2001) (last visited Oct. 5, 2004).

11. *Id.* at 8.

12. *Id.* at 4.

13. EPA, *Global Warming — Climate Uncertainties*, *at* http://yosemite.epa.gov/oar/globalwarming.nsf/content/ClimateUncertainties.html (last modified Jan. 7, 2000).

14. UNFCCC, *Climate Change Information Kit* (2002), http://unfccc.int/resource/iuckit/infokit2001.html (last visited Oct. 5, 2004) [hereinafter *Information Kit*].

15. *Id.*

16. NATIONAL RESEARCH COUNCIL, ABRUPT CLIMATE CHANGE 14 (2002).

indicators such as changes in coral reefs, volcanism, and sunspot activity.[17] A comprehensive study was completed in 1999 using 115 different indicators to track the Earth's average global temperature for the last one thousand years.[18] The study's climatologists concluded that the overall pattern actually demonstrated a steady decrease in temperature over the first 900 years, followed by a dramatic increase in the twentieth century.[19] The findings suggest that 1990 through the year 2000 was the warmest decade of the *whole millennium*, indicating that the temperature increase over the last century is not typical of normal climate variability.[20] The researchers also correlated their findings with factors known to affect climate and determined that solar variability and volcanism were the main influences during the first 900 years, but that human activity contributed to much of the variation in the twentieth century.[21] In general, most of the scientific community agrees with the findings of this study, and the viewpoint of the IPCC, that there is a connection between the increasing amounts of GHGs emitted into the atmosphere and the increasing global temperature.[22]

IV. EFFECTS OF INCREASED GLOBAL TEMPERATURES

While the threat of devastating impacts of global warming may seem alarmist, such concerns are not limited to radical environmental groups, but are supported by highly regarded scientific entities such as the EPA, the National Academy of Sciences, and the panel of experts comprising the IPCC.

A. Rise in Sea Level

Over the past century, an increase in temperature of only one degree contributed to a rise in sea level of four to eight

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17. Richard Wolfson & Stephen H. Schneider, *Understanding Climate Science, in* CLIMATE CHANGE POLICY 3, 5 (Stephen H. Schneider et al. eds., 2002).

18. *Id.* at 5-6.

19. *Id.* at 5.

20. *Id.*

21. *Id.* at 6.

22. There are some skeptics of this theory in the scientific community. *See* Richard S. Lindzen, *Global Warming: The Origin and Nature of the Alleged Scientific Consensus*, Regulation: The Cato Review of Business Government, *at* http://www.cato.org/pubs/regulation/reg15n2g.html (last visited Oct. 5, 2004) (arguing there is no substantive basis for predictions of sizeable global warming due to increases in greenhouse gases); *see also* John Carlisle, *Sun to Blame for Global Warming*, 203 NATIONAL POLICY ANALYSIS (June 1998), *at* http://www.nationalcenter.org/NPA203.html ("scientific evidence conclusively shows that the sun plays a far more important role in causing global warming and global cooling than any other factor, natural or man-made").

inches.[23] Based on current warming trends, the EPA has estimated an increase in sea level between two to five feet will occur within the next century.[24] UNFCCC research also predicts a rise in sea level over the next hundred years, but conservatively calculates the increase to be between four to thirty-five inches.[25] The UNFCCC believes the rise will be mainly due to the thermal expansion of the top layers of the ocean as they warm, along with some level increase from melting glaciers.[26] One obvious potential effect from rising sea levels is widespread coastal flooding. For island nations barely above sea level, such as the Maldives, these increases in ocean levels will be disastrous.[27] Residents living in coastal areas of the United States are particularly vulnerable because sea level is rising more rapidly along the U.S. coast than anywhere else worldwide.[28] A rise in sea level along the Atlantic and Gulf coasts has been estimated by the EPA to occur by 2050, and could possibly occur as early as 2025.[29] The EPA believes that coasts will be affected directly by flooding and the loss of barrier islands that help protect the mainland from storm surges.[30]

Another serious impact of rising sea levels is saltwater intrusion into the coastal estuaries. The EPA has determined that even a one foot rise in sea level will have major impacts on saltwater intrusion — which means that U.S. estuaries and aquifers are in jeopardy of salinity by the year 2100.[31] This contamination will result in a water supply too salty for drinking purposes, and the salinity of the water will damage existing pipes and equipment at a costly expense.[32] Encroachment of saltwater into the coastal estuaries could also destroy the wildlife habitats that these wetlands provide.[33]

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23. ALBERT K. BATES, CLIMATE IN CRISIS 45 (Albert W. Bates et al. eds., 1990).

24. EPA, *Global Warming — Coastal Residents*, *at* http://yosemite.epa.gov/oar/globalwarming.nsf/content/VisitorCenterCoastalResidents.html (last modified Jan. 7, 2000) [hereinafter *EPA Coastal Residents*]. See this website for a fascinating illustration of sea level rise through pictures taken of the North Beach, MD coastline in 1920 and 1996.

25. *Information Kit*, *supra* note 14.

26. *Id.*

27. *See* ANDREW REVKIN, GLOBAL WARMING: UNDERSTANDING THE FORECAST 128-30 (Susan Costello ed., 1992).

28. *EPA Coastal Residents*, *supra* note 24.

29. *Id.*

30. *Id.*

31. *See* EPA & THE DELAWARE RIVER BASIN COMMISSION, GREENHOUSE EFFECT, SEA LEVEL RISE, AND SALINITY IN THE DELAWARE ESTUARY 8 (C. H. J. Hall & James G. Titus eds., 1986).

32. *Id.* at 18.

33. *Id.* at 19.

B. Flooding and Droughts

As discussed above, a rise in sea level will become a significant problem for residents living in coastal areas. The danger of widespread flooding, however, is not limited only to regions along the coast. Additional flooding will likely occur inland since small changes in the ocean's temperatures can have enormous effects on a region's precipitation patterns.[34] General circulation models indicate that an increase in temperature will produce an increase in rainfall, causing lakes and rivers to swell and flood inland areas.[35] Even areas that do not experience an increase in rainfall could be affected by mountain snow that melts earlier and intensifies spring flooding.[36] Residents living in low-lying areas will be vulnerable to an early thaw. California will be particularly susceptible because more than seventy-five percent of its residents currently live in floodplains.[37]

It is not known exactly how the warming trend will affect weather patterns, but the connection between changes in the oceans and the weather is well accepted. For example, every couple of years an area of warming of the Pacific Ocean near the Equator, called El Niño, causes increased rainfall across the United States and in Peru. This shift in temperature has caused destructive flooding and drought in the West Pacific, and has even been associated with devastating brush fires in Australia.[38] Even if the climate change in the next hundred years is limited to conservative scientific estimates — an increase of about two degrees — the change will still have an impact on precipitation patterns. In fact, in 1212, a decrease in the average temperature by only one degree coincided with mass flooding in the Netherlands that drowned 300,000 people.[39] The effects of massive flooding have historically been devastating, particularly in developing countries which have poorly built housing and do not have the economic resources to respond to this type of catastrophe.

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34. *See* EPA, *Global Warming — Impacts*, *at* http://yosemite.epa.gov/oar/globalwarming.nsf/content/ImpactsWaterResourcesFloodControl.html (last modified Jan. 7, 2000).

35. *Id*.

36. *Id*.

37. Eleanor G. Turman, *Regional Impact Assessments: A Case Study of California*, *in* CLIMATE CHANGE POLICY, *supra* note 17, at 89, 93.

38. National Oceanic and Atmospheric Administration, *El Niño Page*, *at* http://www.pmel.noaa.gov/tao/elnino/el-nino-story.html (last visited Apr. 8, 2005).

39. Der Spiegal, *The Calamitous Cost of a Hotter World*, *in* GLOBAL WARMING: OPPOSING VIEWPOINTS 76, 78 (Tamara L. Rolef ed., 1997).

While precipitation increases have been measured every decade during the twentieth century in the Northern Hemisphere continents and tropical areas, there have actually been declines in precipitation in subtropical land areas.[40] The frequency and intensity of droughts have also worsened in parts of Africa and Asia.[41] Droughts can be demonstrated by rainfall shortages, low groundwater levels, moisture deficits in the soil, or low reservoir levels.[42] During the 1991-1992 Zimbabwe drought, the temperature was two degrees Celsius above the seasonal average.[43] An inspection of Zimbabwe's main water storage facility during the drought revealed an evaporation rate higher than thirty percent above normal, peaking at just below a ninety percent rate.[44] Due to the lack of stored water, the use of hydroelectric power was limited and Zimbabwe suffered over $100 million in economic losses.[45]

C. Spread of Deadly Disease

Changes in global temperatures can permit disease-carrying vectors, such as mosquitoes, to thrive in new areas. Public health scientists in the Netherlands have predicted that a three-degree increase in global warming could be accompanied by 80 million new cases of malaria each year.[46] In addition to mosquitoes, warmer and wetter temperatures will provide prime breeding grounds for ticks, mites, rodents, and the diseases that these vectors carry — plague, typhoid fever, encephalitis, hantavirus, and yellow fever.[47] The effect of these types of outbreaks will depend upon the public health policy and the economic status of the area affected.[48] Major factors that influence the probability and magnitude of an outbreak are population density, types of housing, sewage and waste management systems, and efficiency of vector control.[49]

In addition to infectious diseases spread by vectors, the flooded areas themselves are likely to result in public health problems. The relocation of people from flooded areas into crowded refugee sites, especially in areas with limited

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40. *Information Kit*, *supra* note 14.
41. *Id*.
42. IMPACTS, ADAPTATION, AND VULNERABILITY, *supra* note 3, at 206.
43. *Id*. at 499.
44. *Id*.
45. *Id*.
46. Der Spiegal, *supra* note 39, at 79.
47. Turman, *supra* note 37, at 104.
48. *Id*.
49. IMPACTS, ADAPTATION, AND VULNERABILITY, *supra* note 3, at 462.

resources, will increase the risk of infection and disease. The United States is certainly better equipped to handle public health emergencies than developing nations, but it is not immune from contamination outbreaks. Heavy rainfall events in the United States and Great Britain have caused outbreaks of cryptosporidiosis, giardia, and other infections from microbiological agents polluting drinking water supplies.[50]

For regions affected by drought, lack of access to safe drinking water may require the use of rivers and lakes as alternative sources of freshwater. The risk of disease-contaminated drinking water is particularly high in nations facing poor socio-economic situations because often the lakes and rivers are also used for bathing and washing laundry.[51] A restriction on water use will also decrease available water for hygiene and sewage systems, leading to an increase in pathogenic organisms.[52] The World Health Organization estimates that four million people die each year due to poor sanitation and a lack of access to safe drinking water.[53]

V. INTERNATIONAL ATTEMPTS TO REGULATE GREENHOUSE GAS EMISSIONS

Leaders from 106 countries met at the Earth Summit in Rio de Janeiro in June of 1992 to begin collaboration on the UNFCCC, which was entered into force in 1994.[54] The treaty divided the countries into three groups with "Annex I" being comprised of forty-one industrialized countries in economic transition, "Annex II" being comprised of the twenty-four members of the Organization of Economic Cooperation and Development, and the remaining countries being designated as "non-Annex I" countries.[55] The UNFCCC was actually disappointing to many environmentalists because its language did not legally bind the member countries to any specific emissions target, but simply required the developed countries to report detailed objectives and their anticipated emissions "with the aim of returning individually or jointly to their 1990

50. *Id*. at 471.
51. *Id*.
52. *Id*.
53. *Id*.
54. Richard A. Rinkema, *Environmental Agreements, Non-State Actors, and the Kyoto Protocol: A 'Third Way' for International Climate Action?*, 24 U. PA. J. INT'L ECON. L. 729, 735 (2003).
55. *Id*. at 736.

levels."[56] Nonetheless, it was at least a step towards global efforts to control industrial GHG emissions.

The long-term goal of the UNFCCC to stabilize "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system,"[57] is supported by all developed nations, including the United States. However, the United States was concerned because the protocol required only the thirty-eight developed nations to reduce GHG emissions, while allowing developing nations to simply set voluntary limits.[58] This reservation to the protocol became abundantly clear after the U.S. Senate voted 95-0 to adopt the Byrd-Hagel Resolution, which stated that the United States should not be a party to any treaty regarding the Climate Convention that would create emission limitation commitments for developed countries, unless it also mandated limits for developing countries.[59] Around the same time, an alliance of oil companies, automobile manufacturers, farm groups, and electric companies, launched a multi-million dollar advertising campaign to create public opposition to the Kyoto Protocol (Kyoto).[60] The campaign alleged that if developing nations were exempted, the protocol would have devastating impacts on the U.S. economy.[61]

The Kyoto Conference took place December 1-11, 1997, and was attended by 6,000 delegates from more than 160 nations.[62] Among industry representatives at the conference was the "Climate Change Coalition," which was partially comprised of representatives from Exxon, Mobil, Shell Oil, U.S. automobile manufacturers, and chemical producers.[63] In the words of one reporter, "[t]he petroleum lobbyists outnumbered the ecofreaks by a wide margin."[64] There was also a large congressional delegation in attendance headed by Republican Chuck Hagel, the senator who had introduced the Byrd-Hagel Resolution.[65] Amid intimidation by the industry

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56. UNFCCC, May 29, 1992, art. 4(2)(b), 31 I.L.M. 849, 856 (entered into force Mar. 21, 1994).

57. *Id.* at art. 2.

58. *See* Kyoto Protocol to the UNFCCC (adopted Dec. 10, 1997), 37 I.L.M. 22, *available at* http://unfccc.int/resource/docs/convkp/kpeng.pdf (last visited Oct. 5, 2004).

59. S. Res. 98, 105th Cong., 143 CONG. REC. S8138-39 (1997) (enacted).

60. BROWN, *supra* note 9, at 33.

61. *Id.*

62. *Id.*

63. *Id.*

64. ROBERT HUNTER, THERMAGEDDON 112 (2003).

65. BROWN, *supra* note 9, at 33.

representatives and a lack of flexibility by the U.S. delegation, it appeared that negotiations were going to fail.[66] Nevertheless, a compromise was eventually reached between the parties. A year later in Buenos Aires, Vice-President Al Gore signed Kyoto on December 11, 1998, indicating the intent of the United States to seek ratification.[67]

Many developing countries, supported by the European Union (E.U.), were asking the United States to commit to a fifteen percent reduction in 1990 levels, whereas the United States was firmly resolved to simply reducing down to 1990 levels.[68] Ultimately, the United States committed to a seven percent reduction below 1990 emission levels in exchange for an agreement to its "flexibility mechanisms." These flexibility mechanisms would allow the United States to meet half of its reduction target, not through reducing its actual emissions, but by financing emissions reductions in other countries.[69] The United States also negotiated flexibility regarding which gas reductions could be credited toward targets,[70] and a deadline ranging from 2008 to 2012.[71]

The United States committed to the UNFCCC's objective of reducing GHGs below 1990 levels, but President Bill Clinton did not send Kyoto to the U.S. Senate for consent — probably due to the unanimous vote on the Byrd-Hagel Resolution noted above — and the protocol was never ratified by the United States. The postponement of ratification led to congressional hearings focusing not on science, economics, or

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66. It is important to note that other countries were also impeding the negotiations. India and China were bargaining for a compromise over the emissions trading and did not want to defer rule making and guidelines. HUNTER, *supra* note 64, at 126-29. Russia, Ukraine, and New Zealand refused to reduce below their respective 1990 levels. *Id.* at 131. Norway, Australia, and Iceland were adamant in being allowed to increase from their 1990 levels, citing "special needs and problems." *Id.*

67. UNFCCC, *Kyoto Protocol Status of Ratification*, *at* http://unfccc.int/resource/kpstats.pdf (last modified Jan. 27, 2005) [hereinafter *Status of Ratification*].

68. HUNTER, *supra* note 64, at 118.

69. BROWN, *supra* note 9, at 34. Canada, representing only .5% of the world's population yet responsible for 2% of the world's carbon dioxide emissions, teamed up with the United States in support of these "emissions-trading mechanisms" that would allow both countries to meet 50% of their reductions targets. HUNTER, *supra* note 64, at 115-17.

70. BROWN, *supra* note 9, at 35. "National target reductions could be achieved through reductions in six greenhouse gases (carbon dioxide, methane, nitrous oxide, and three synthetic substitutes for ozone-depleting chlorinated fluorocarbons). . . rather than the three proposed by the European Union." *Id.* This would allow countries to reduce only the GHGs which they find the easiest to reduce, while allowing the others to remain at high levels. *Id.*

71. *Id.* at 36. Not only was this deadline later than the E.U.'s proposed target date of 2010, but the United States also negotiated that the emissions target need only be averaged over that five-year period, as opposed to the target being achieved in each individual year. *Id.*

political responses to climate change, but a partisan face-off between the Clinton administration and those opposed to the treaty.[72] By not sending the treaty to the Senate, it was obvious that Clinton did not intend to have Kyoto defeated during his tenure as president.

In the first few months of his presidency in early 2001, George W. Bush made a clear statement to the international community regarding the current U.S. stance on Kyoto by stating that the United States would not consent to its limitations.[73] Bush observed that the United States would suffer huge economic impacts under Kyoto and stated that he would not accept a plan that would hurt American workers.[74] In a nod to the perceived unfairness to the United States in the treaty, Bush noted that India and China are responsible for a majority of the world's GHG emissions. However, he failed to recognize that together India and China, having 2.3 billion people, produce *fewer* carbon emissions than the United States does with only 280 million people.[75] The United States has never been comfortable with regulation, and historically has been particularly uncomfortable with regulation by an international coalition. Thus, it is important to note that failure to ratify Kyoto was not directly a result of the George W. Bush Administration. The Bush Administration was simply less subtle regarding U.S. unilateralism and more direct about rejecting any mandatory limits on emissions.

The U.S. rejection of the treaty caused an international outcry, as the agreement can only enter into force if it is ratified by at least fifty-five nations that together account for at least fifty-five percent of the total carbon dioxide emissions for 1990.[76] In 1996, the United States led the world in per capita carbon dioxide emissions at 19.7 metric tons, with the Czech Republic at the next highest level with 12.3 metric tons.[77] Because the United States is such a significant contributor of industrialized emissions, U.S. participation in any treaty targeting emission reduction is vital. Because

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72. Kai S. Anderson, *The Climate Policy Debate in the U.S. Congress*, *in* CLIMATE CHANGE POLICY, *supra* note 17, at 235, 240.

73. Ann E. Carlson, *Federalism, Preemption, and Greenhouse Gas Emissions*, 37 U.C. DAVIS L. REV. 281, 289 (2003).

74. Armin Rosencranz, *U.S. Climate Change Policy*, *in* CLIMATE CHANGE POLICY, *supra* note 17, at 221, 227-29.

75. *Id*. at 229.

76. UNFCCC, *The Convention and Kyoto Protocol*, at http://unfccc.int/resource/docs/convkp/conveng.pdf (last visited Oct. 5, 2004).

77. *Information Kit*, *supra* note 14.

negotiations had been ongoing for almost a decade, the U.S. decision not to ratify was greatly disappointing to all parties involved.[78] The United States was criticized by the international community for unilateralism and abandonment for failing to align itself with the global agreement.

VI. WHERE DO WE GO FROM HERE?

While most political and environmental authorities accept that GHG emissions will have some type of significant environmental impact, there is major disagreement on how to proceed from here. The U.S. failure to ratify Kyoto led many to believe that the treaty would never have binding legal effect. However, on November 18, 2004, the Russian Federation made a surprising move by ratifying Kyoto.[79] Russia's ratification began a ninety-day countdown for Kyoto to enter into force, making the treaty effective on February 16, 2005.[80]

For the United States to be a party to any global implementation to reduce emissions, economic considerations must be addressed. An aggressive treaty like Kyoto is not likely to be ratified by the United States because industry lobbyists are too powerful. The United States would probably be more receptive to a plan to develop innovative technologies that produce lower emissions, rather than a plan requiring industry to meet emissions targets. Some analysts have argued that U.S. resistance to Kyoto could be due to its "cap-and-trade" system because it provides ambitious targets, but does not limit compliance costs.[81]

A. Current U.S. Federal Government Policy

i. Climate VISION

After rejecting Kyoto, the Bush Administration created the "Voluntary Innovative Sector Initiatives: Opportunities Now," also known as "Climate VISION." The voluntary, public-private partnership was created to reduce the U.S.

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78. *Id.*

79. *Status of Ratification*, *supra* note 67. Russia's ratification was surprising because it had previously announced that it would not ratify the treaty in its current form for the same reason that the United States rejected the treaty — finding the agreement an obstacle to economic growth.

80. UNFCCC, *Kyoto Protocol*, *at* http://unfccc.int/essential_background/kyoto_protocol/items/2830.php (last visited Jan. 28, 2005).

81. Rosencranz, *supra* note 74, at 230.

"greenhouse gas intensity — the ratio of emissions to economic output — by 18 percent during the next decade, and challenged American businesses and industries to undertake broader efforts to help meet that goal."[82] However, the biggest shortcoming of Climate VISION is that it has as its goal a reduction in the *ratio* of emissions to total gross domestic product, as opposed to the UNFCCC's *absolute target* to reduce overall emissions. The plan was implemented with economic protection as the priority because by allowing the permissible level of emissions to increase or decrease based on economic output, the economic impact of GHG emission regulation on industry is reduced. A regulatory policy based on such a ratio will, at the most, result in a negligible reduction in overall emissions. In reality, even though GHG intensity has fallen over the last two decades, there has actually been a continued total increase in overall emissions.[83] This is largely a result of advanced technology increasing energy efficiency and a shift from heavy industry towards service-oriented industries that require less energy.[84]

Another shortcoming of the Climate VISION is that it is a *voluntary* reporting program that will expand upon the existing Department of Energy (DOE) reporting program.[85] Under the current DOE "Voluntary Reporting of Greenhouse Gases Program," companies voluntarily submit information on their efforts to lessen GHG emissions.[86] Further, the organizations are given wide discretion in how they calculate their reductions, and the information submitted need only be self-certified by the company — no outside verification is required.[87] The only oversight DOE provides on the submissions is to verify the mathematic accuracy and the clarity of the information.[88] While a few socially-conscious companies have made significant reductions in their emissions, the program as a whole has not reduced the cumulative growth in U.S. emissions.[89] Essentially, companies are given a choice of whether to submit reports on

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82. EPA, *Bush Administration Launches "Climate VISION," at* http://www.epa.gov/newsroom/headline_021203a.htm (last modified Nov. 30, 2004).

83. Vicki Arroyo, *Climate Change: A Primer*, ALI–ABA 1, 19 (2003).

84. *Id*.

85. Climate VISION, *Program Mission, at* http://www.climatevision.gov/mission.html (last visited Oct. 5, 2004).

86. Arroyo, *supra* note 83, at 20.

87. *Id*.

88. *Id*.

89. *Id*.

their efforts to reduce emissions, and even if they choose to do so, the information is given practically no oversight and is readily susceptible to fraud and abuse. The DOE system has shown to be minimally effective. Compiled data shows that in 2000, the number of reported direct emission reductions represented only 2.7 percent of the total GHG emissions by the United States in that year.[90]

ii. Legislative Action

Fortunately, there does appear to be some effort in Congress to impose more rigorous limits on GHG emissions. In February 2003, Senator James Jeffords (I-VT) introduced the Clean Power Act to amend the Clean Air Act to achieve specified reductions in emissions of sulfur dioxide, nitrogen oxide, carbon dioxide, and mercury from power plants.[91] Public statements by such conglomerates as British Petroleum, Shell, Boeing, 3M, American Electric Power, and Toyota, acknowledging potential consequences from increased global temperatures, have also fostered some bipartisan efforts in Congress to regulate emissions.[92] Joseph Lieberman (D-CT) introduced the Climate Stewardship Act in January 2003, which was co-sponsored by Republican Senators Olympia Snowe and John McCain.[93] The bill was introduced to provide for a program of scientific research on abrupt climate change, accelerate the reduction of GHG emissions in the United States by creating a market-driven system of GHG allowances, and to reduce dependence upon foreign oil.[94] It remains to be seen whether these bills will ultimately be enacted by Congress.[95]

The federal government has also responded to the promising new area of hybrid electric vehicles by creating a tax incentive for consumers who purchase these "clean vehicles." Current qualifying vehicles are the Toyota Prius, the Honda Insight, and the Honda Civic Hybrid. The statute allows for a deduction against taxable income that is

90. *Id*.
91. S. 366, 108th Cong. (2003).
92. Anderson, *supra* note 72, at 241.
93. S. 139, 108th Cong. (2003).
94. *Id*.
95. The Climate Stewardship Act was considered by the Senate on October 29-30, 2003. Due to a strong backing of 43 votes, Senators Lieberman and McCain have pledged to bring the bill back to the floor for another vote as soon as possible. Senator Joseph Lieberman's website, *Issues and Legislation*, *at* http://lieberman.senate.gov/issues/environment.html#warming (last visited Oct. 5, 2004).

calculated depending on when the vehicle is first put into use.[96] For example, a maximum deduction of $4,000 is allowed for vehicles first put into use in 2003, however for new vehicles first put into use in 2004, the statute provides for a maximum deduction of only $2,000.[97] The current language of the statute provides that the benefit will decrease each successive year until it is completely phased by the end of 2006.[98]

B. Initiatives Taken by the States

Lack of significant federal action currently in place has prompted many state and local governments to implement their own policies. In fact, more than half of the states have either created programs to reduce emissions, or are in the process of doing so.[99]

i. Legislative Action

Several states have created legislation similar to the federal statute that encourages their citizens to purchase hybrid-electric and alternative fuel vehicles by allowing credits towards state taxes. For instance, Oregon enacted a statute that allows its business owners and residents who buy new electric-gasoline hybrid vehicles to credit up to $1,500 against state income taxes owed.[100] The state accepts the same three qualifying hybrid-electric vehicles required for the federal credit, and recently expanded its list to include the 2005 Ford Escape Hybrid.[101] Oregon also allows its residents a $750 tax credit for new vehicles fueled by electricity, natural gas, gasohol, methanol, propane, hythane, ethanol, or hydrogen.[102]

Colorado has a statute similar to the Oregon statute that provides its citizens and business owners a credit applied to state income tax for the purchase of a hybrid or alternative fuel vehicle, or for the conversion of an existing gasoline

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96. IRS, *Clean Fuel Tax Deduction For Hybrid Vehicles*, *at* http://www.irs.gov/newsroom/article/0,,id=107766,00.html (last visited Mar. 25, 2004).

97. 26 U.S.C. § 30(b) (2002).

98. *Id*. § 30(e).

99. J. Kevin Healy & Jeffrey M. Tapick, *Climate Change: It's Not Just a Policy Issue for Corporate Counsel—It's a Legal Problem*, 29 COLUM. J. ENVTL. L. 89, 98 (2004).

100. OREGON DEPT. OF ENERGY, *Hybrid Electric and Dual-Fuel Vehicles*, *at* http://oregon.gov/ENERGY/TRANS/hybridcr.shtml (last updated Sept. 11, 2004).

101. *Id*.

102. *Id*.

vehicle into a vehicle that uses an alternative energy source.[103] The credit cannot actually exceed the taxpayer's tax liability in any given year so, if necessary, the excess credit will be carried over to each of the next five income tax years.[104]

In an important shift from simply promoting these types of vehicles through tax credits, California has focused on actually implementing limits on vehicle emissions. Approximately 82 percent of GHG emissions in the United States are produced from the burning of fossil fuels to generate energy and power vehicles.[105] On July 22, 2002, California became the first state to create standards for vehicle emissions through a law enacted by former governor Gray Davis.[106] The enacted law mandates that, by January 1, 2005, the California Air Resources Board (CARB) "shall develop and adopt regulations that achieve the maximum feasible and cost-effective reduction of greenhouse gas emissions from motor vehicles."[107] The regulations adopted by CARB will be applied to vehicle models manufactured in the year 2009, and every year thereafter.[108]

CARB has extensive freedom to establish regulations, but is not permitted to impose fees or taxes on any motor vehicle or fuel, ban the sale of any type of vehicle category, or limit the speed limit on any street or highway in the state.[109] Under the federal Clean Air Act, the states are prohibited from adopting regulations to control emissions from new motor vehicles, but a waiver can be granted if the state adopted such standards prior to March 30, 1966.[110] Since California was the only state to enact standards prior to this date, it is the only state that can be exempted from this provision.[111] The new emissions standards developed by CARB will have a large impact nationwide. California consumers make up ten percent of the national automobile market, so manufacturers often update all of their cars in order to meet California's

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103. COLO. REV. STAT. § 39-22-516 (2004).
104. *Id*. § 39-22-516(3).
105. EPA, *Global Warming—Individual Emissions*, *at* http://yosemite.epa.gov/oar/globalwarming.nsf/content/emissionsindividual.html (last modified Jan. 7, 2000).
106. Rachel L. Chanin, *California's Authority to Regulate Mobile Source Greenhouse Gas Emissions*, 58 N.Y.U. ANN. SURV. AM. LAW 699, 699 (2003).
107. Cal. Health & Safety Code § 43018.5(a) (West 2004).
108. *Id*. § 43018.5(b)(1).
109. *Id*. §§ 43018.5(d)(1)-(4).
110. 42 U.S.C. § 7543(b)(1) (2004).
111. Chanin, *supra* note 106 at 712-13 n.79. The legality of Assembly Bill 1493 is beyond the scope of this paper, but for a detailed analysis, see Carlson, *supra* note 73, at 292-319.

requirements.[112] California's initiative to regulate a major source of GHG emissions is encouraging and will hopefully influence other states to enact the most aggressive legislation they can within the confines of the Clean Air Act.[113]

ii. Litigation

Many states have challenged the federal government's refusal to implement and mandate measures to reduce GHG emissions. On October 23, 2003, Attorney Generals from several states,[114] and representatives from New York City, Baltimore, and American Samoa, met to compel the Bush Administration to confront the growing problem of global warming.[115] The group filed challenges in the United States Court of Appeals for the District of Columbia Circuit in response to the EPA's ruling a couple of months prior that the agency had no legal authority to regulate GHG pollutants.[116] As stated by Connecticut Attorney General Richard Blumenthal:

> The EPA is ignoring the clear and growing evidence of real harm done by global warming.... [T]he Administration's own studies show how greenhouse gas pollution causes disease, extreme weather, destruction of shoreline and loss of critical wetlands and estuaries. Connecticut will not allow the Bush Administration to cast aside scientific fact as a concession to its friends and campaign contributors in the energy industry.[117]

Nine northeastern states[118] have also joined together to organize the Regional Greenhouse Gas Initiative to create a cap-and-trade program to reduce carbon emissions from power

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112. Tim Molloy, *Stricter Exhaust Rules Approved in California*, TALLAHASSEE DEMOCRAT, Sept. 25, 2004, at 7A.

113. Ironically, as discussed above, the so-called "Clean Air Act" actually restricts states in the extent of legislation they are legally able to pass in order to combat air pollution.

114. Massachusetts, Connecticut, Illinois, Maine, New Jersey, New Mexico, New York, Rhode Island, Vermont, and California.

115. Press Release, Office of New York Attorney General Eliot Spitzer, States, Cities, Environmental Groups Sue Bush Administration on Global Warming, Challenges EPA's Refusal to Reduce Greenhouse Gas Pollution (Oct. 23, 2003), *at* http://www.oag.state.ny.us/press/2003/oct/oct23a_03.html [hereinafter Spitzer Press Release].

116. *Id.*

117. *Id.*

118. Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont.

plants through integration of public participation and stockholder input.[119]

iii. State Programs

A few states have even created programs to target businesses and industry. New Jersey created its own target to reduce GHGs by setting voluntary corporate and state plans.[120] The voluntary program has the same shortcomings that the federal voluntary plan does, but it at least demonstrates willingness towards self-regulation. New Jersey also provided guidance to help the state school system reduce its GHG emissions by creating a manual that offered tips for lowering emissions and directing that teachers actively involve students in the "Doing Our Share" campaign.[121] The New Jersey Department of Environmental Protection developed its own goal to reduce New Jersey's GHG emissions by at least 3.5 percent below their 1990 levels by 2005 — which amounts to a total decrease of fifteen percent due to increased GHG emissions since 1990.[122] The state of Massachusetts also showed self-regulatory initiative when, in 2001, it placed a limit on GHG emissions from state power plants, requiring a fifty to seventy percent reduction in sulfur dioxide and nitrogen oxide, ten percent reduction in carbon dioxide, and a reduction in mercury releases.[123]

The state of Florida has responded, not through limits on emissions, but through education. The Pollution Prevention Act was created to promote the reduction of hazardous pollutants, including emissions, by educating businesses and local government offices that they can control the expenses associated with air emissions by eliminating the processes and raw materials that create them.[124] In the absence of federal or state mandated regulations, the effect that such an educational initiative will have on the quantity of GHGs emitted is not known.

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119. Spitzer Press Release, *supra* note 115.

120. Chanin, *supra* note 106, at 701.

121. NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION (2001), *Doing Our Share: Greenhouse Gas Reductions Manual for Schools*, *at* http://www.state.nj.us/dep/dsr/gcc/doingourshare.pdf.

122. *Id.* at 1.

123. Chanin, *supra* note 106, at 701-02.

124. FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION, *Pollution Prevention (P2)*, *at* http://www.dep.state.fl.us/air/programs/p2.htm (last modified Apr. 27, 2004).

VII. CONCLUSION

The planet's increasing average temperature is a phenomenon that is no longer disputed by any credible scientific agency. Advances in technology during the Industrial Revolution and the burning of fossil fuels have caused an excessive amount of GHGs to be released into the atmosphere. By enhancing the natural greenhouse effect, the planet is getting warmer and the damaging effects of human activity could be seen within the next twenty-five years. The major effects of a warmer planet will be higher sea levels, increased flooding and droughts, and an increase in infectious diseases. Many countries will be severely affected by these consequences, but countries with low socio-economic statuses will suffer the greatest detriment. Unfortunately, despite evidence of environmental disruption that coincides with abrupt climate change, economic concerns persuade many politicians to dismiss the obvious dangers.

An international treaty, such as Kyoto, is an ideal starting point to reverse some of the damage that human activity has already caused. Unfortunately, it is now obvious that the United States will likely never agree to mandatory regulations imposed by an international coalition. U.S. participation in some type of an international protocol to reduce emissions is important for both accountability purposes and a demonstration of flexibility that would encourage other countries that are hesitant to sign on.

Many states have shown initiatives that are promising, but a federally-mandated program that sets limits on industry emissions is absolutely necessary. The federal government must be responsible and implement a national plan to address industrial emissions because:

> Piecemeal approaches ignore important sources of the problem and thus neglect important opportunities to solve it. Moreover, they tend to be self-defeating because efforts to solve one aspect of a problem intensify other, neglected aspects. The history of pollution control in the United States offers an example. Our federal environmental statutes have focused on one medium at a time: separate laws for air, water, and land. Restrictions on one medium have induced disposal into other media. Like squeezing one end of a balloon, this approach

> shifts the problems elsewhere and delays attainment of the primary goal: a cleaner environment. An integrated approach would control pollution more comprehensively and effectively.[125]

State legislatures should be commended for attempting to regulate GHG emissions in the absence of any effective federal regulations, but it is inefficient, overly burdensome, and unrealistic to expect each state to implement and manage its own emissions policies. The federal government must devise a comprehensive national system that takes economic effects into consideration, but has emissions reduction as its primary goal. Climate VISION is a virtually worthless initiative because it is voluntary and does not aim to reduce actual emissions. In order for Climate VISION to be successful, corporations would have to voluntarily choose to reduce their emissions simply out of an ethical obligation — a virtue that is greatly lacking in many corporate entities today. The reality is that reducing emissions and creating cleaner energy technology will be expensive. However, if the federal government continues to apply a cost-benefit analysis to whether mandatory emissions control programs should be implemented, such programs will never be created. A mandatory reduction in emissions will initially be expensive, but if the United States neglects to implement mandatory limits on its emissions, the planet will eventually have to pay the ultimate cost.

125. Jonathan Baert Wiener, *Designing Global Climate Regulation*, *in* CLIMATE CHANGE POLICY, *supra* note 17, at 150, 154.

RESTRAINING YELLOWSTONE'S ROAMING BISON

ZACHARY L. LANCASTER

INTRODUCTION

The federal government is in the business of destroying *the* symbol of the American West - herds of bison roaming free across the Western landscape. This statement should not come as a surprise given the federal track record. Through federal action and inaction, Yellowstone's bison were almost driven to extinction despite primarily residing in the nation's oldest national park. The herd was reduced to a paltry twenty-five *individual* bison[1] despite numbering over sixty *million* at the time of European settlement.[2] The bison of the Greater Yellowstone Area (GYA)[3] are the last remnant of the free-roaming herds of plains bison.

The GYA has recovered when allowed to, but restraining the herd's ability to roam freely to forage for food has stifled restoration to natural historic levels. Sometimes this restraint is milder and in the form of hazing roaming bison back into the Yellowstone National Park (Yellowstone or the Park), but the current plan also allows for harsh restraint via Capture/Test/Slaughter (CTS).[4] Times change, but the basic conflict of interest remains the same: cattle ranchers want the land use rights to graze cattle, and conservationists want bison to solely occupy the same land.[5] The conflict between bison and livestock represents the broader conflict in the West when wildlife, people, and livestock all share the same land. Raising cattle is one of the economic powerhouses of the Mountain West region that includes the GYA, and has many advocates including its chief advocate — the State of Montana. The current power structure has led to cattle being protected at the expense of bison.

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1. Record of Decision for Final Environmental Impact Statement and Bison Management Plan for the State of Montana and Yellowstone National Park (Dec. 20, 2000), *at* http://www.nps.gov/yell/technical/planning/ [hereinafter Record of Decision].

2. *E.g.*, Dan Flores, *Making the West Whole Again: Historical Perspective on Restoration*, 18 J. LAND RESOURCES & ENVTL. L. 17, 20 (1998).

3. Robert B. Keiter, *An Introduction to the Ecosystem Management Debate, in* GREATER YELLOWSTONE ECOSYSTEM 3, 4 (Robert Keiter & Mark S. Boyce eds., 1991) (referring to the GYA as over 18 million acres of land in Wyoming, Idaho, and Montana).

4. Record of Decision, *supra* note 1, at 11 (citing one example of CTS, "[t]he agencies will use hazing, capture facilities, or shooting, if necessary, to prevent bison from leaving management Zone 2").

5. *See* Dean Leuck, *The Evolution of Property Rights: The Extermination and Conservation of the American Bison*, 31 J. LEGAL STUD. 609 (2002) (discussing bison and property rights in detail).

The issue of bison management became an issue of concern long ago, but its latest incarnation focuses on the current Bison Management Plan for the State of Montana and Yellowstone National Park (Joint Plan)[6] established in December 2000. Under the Joint Plan, bison are slaughtered.[7] Some are killed for wandering out of the national park boundaries, some are killed for testing positive for brucellosis, and some are killed indiscriminately because the herd is considered *too large* when left to current natural constraints.[8] Proponents (like the federal government, livestock industry, and Montana) of the current plan feel that it strikes a balance between the interests of ranchers to be free of the bison infringement. Opponents, like Greater Yellowstone Coalition and Fund for Animals, claim that it leaves bison severely unprotected and unable to behave naturally without being captured and/or killed.

The purpose of this paper is to evaluate the Joint Plan[9] for the Greater Yellowstone Area by testing its ecosystem management efficacy. The key inquiry will be whether the goals of ecosystem management are met. Furthermore, the paper will address whether an ecosystem management approach provides a viable solution. The answers to these questions are of paramount importance in determining the future preservation of "the largest wild, free-ranging population of bison in the United States."[10]

Part I is an overview of the history of bison management in the GYA. It traces the path toward a long-range bison management plan from the stage when bison were afforded almost no protection to the circumstances leading up to the current Joint Plan. Since the staggering failure to protect bison levels reached the historic low of twenty-five, federal management and protection has greatly improved. However, the inherent conflict of different federal agencies with different purposes produced a piece-meal approach to bison management. Montana's legal action against the federal regulation during this period proved to be a staunch obstacle to a more ecosystem-based approach to management.[11] Accordingly,

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6. Record of Decision, *supra* note 1.

7. *Id*.

8. *Id*. at 26 ¶10b (referring to population cap for bison).

9. Notice of Record of Decision for Final Environmental Impact Statement and Bison Management Plan for the State of Montana and Yellowstone National Park, 66 Fed. Reg 6665, 6665 (Jan. 22, 2001) [hereinafter Notice of Record of Decision].

10. *See, e.g.*, *id*.

11. For example, "in 1995, the State of Montana sued the National Park Service and [Animal and Plant Health Inspection Service], complaining of both NPS management of bison and the possibility that APHIS would change the state's brucellosis class-free status." Record of Decision, *supra* note 1, at 4.

bison were managed very differently depending on what legal jurisdiction they fell under. This led to the strong sentiment by all involved for a comprehensive bison management plan.

Part II describes the legal compromise and conflict between the federal agencies and the state of Montana. In addition, this part will examine the cooperation and tension between the different federal agencies — National Park Service (NPS), United States Forest Service (USFS), and Animal and Plant Health Inspection Service (APHIS) — with a stake in the bison management issue. Lastly, Part II will describe the economically driven rationale behind Montana's power within its jurisdiction to defend its interests through the use of force and its position against free-roaming bison within the borders of the state.

Part III is an in-depth discussion of the current Joint Plan, which was the product of a ten-year process to determine how best to accommodate all of the parties. Proponents of the plan would argue that it is a step in the right direction and a solid compromise that accommodates all interests to the extent possible under the current federal-state framework in which it must operate. Furthermore, they would argue that bison cannot be allowed to freely roam due to the risk of brucellosis infection and the grave threat it poses to the health of cattle, and the subsequent economic ramifications. Thus, the policy of capture/test/slaughter is warranted. In contrast, opponents claim that bison restraint still relies on artificial boundaries that do not correspond with the natural behavior of the bison within the GYA ecosystem. Furthermore, the methods for restraining migration and roaming are unnecessarily harsh and arbitrary, especially the indiscriminate slaughter of bison once the artificial population cap for total herd size is reached. Lastly, Part III will conclude with a discussion of the legal challenges to the Joint Plan.

Part IV is an analysis of the Joint Plan. It begins with a discussion of ecosystem management and its goals. Furthermore, an evaluation of where human use and ecological integrity fall within the hierarchy of interests is made. Next, Part IV focuses on the Joint Plan's foundation: threat of brucellosis transmission from cattle to bison in the wild. This discussion examines the viability of the foundation and alternative interests that may be at play, due to the lack of any scientifically documented evidence of transmission from bison to cattle in the wild.[12] In addition, the Joint Plan's focus on managing bison rather than cattle leads to an

12. National Research Council, Brucellosis in the Greater Yellowstone Area 67 (1998) [hereinafter NRC Report].

inquiry as to whether the focus is on the wrong ungulate. Lastly, the arguably excessive management of the Joint Plan and its artificial population cap on bison are analyzed under an ecosystem management approach.

Part V gives recommendations based upon the shortcomings of the Joint Plan to provide an effective ecosystem-based solution to management of Yellowstone's roaming bison. The recommendations will focus on real-world viable solutions rather than idealistic solutions that are unachievable given the current legal, economic, political and social framework surrounding this issue and land use issues in the West. In particular, the "free roam zone"[13] needs to be extended to all federal lands. A change in the focus of management toward an emphasis on cattle rather than bison is needed. Cattle, rather than bison, can be managed to protect them from brucellosis transmission through buffer zone separation and vaccination to avoid any potential commingling and brucellosis transmission. This "free roam zone" could be extended to private leases on federal land and private land neighboring federal land by utilizing the variety of techniques discussed in Part V. In addition, Montana state lands could be included if the state is given the proper incentives and assurances.

Obviously, the Joint Plan's purpose to reduce the risk of brucellosis transmission would become moot if an effective brucellosis vaccine was developed. The NPS could then administer the vaccine to the bison. If everyone's brucellosis concerns were sincere, the elimination of the disease would leave opponents of free-roaming bison no reason for continued opposition. Lastly, Part V will examine the possibility of having the genetically and behaviorally distinct Yellowstone herd listed as an endangered species by virtue of it being a distinct population segment within the meaning of the Endangered Species Act (ESA).[14] This protection may not be imminent, but is worth examining given the enormous potential effect it would have on the future of bison management in the GYA and its value as a bargaining asset.

PART I: HISTORY OF BISON MANAGEMENT: THE PATH TOWARD A LONG-TERM PLAN

The history of bison management in the GYA is a tragic one. It has seen the once common sight of large bison herds roaming free across the picturesque landscape reduced to a memory. Bison management has become more protective since the historic lows at

13. Record of Decision, *supra* note 1, at 26 (referring to Zone 1).
14. 16 U.S.C. § 1531 (2004).

the turn of the 20th century. However, Montana's pursuit of state's rights led to a divergence of priorities and management philosophies between it and the NPS, USFS, and APHIS, which incidentally have a similar gap amongst them.

A. The Herd of 25

Yellowstone's bison herd was "nearly eliminated" within the boundaries of the park in 1901, due to "market hunting and poaching".[15] Another reason for the sharp decline was the federal government's desire to weaken the Native American tribes by killing bison, their main source of sustenance, in order to force them onto reservations.[16] This stark reduction of population occurred despite the establishment of Yellowstone as the nation's first national park in 1872, with the purpose to "provide for the preservation, from injury or spoliation . . . natural curiosities, or wonders within said Park, and their retention in their natural condition."[17]

The Park responded to the harsh reality of the herd of twenty-five by adopting a protectionist approach which included augmenting the herd with two captive herds, enforcement of poaching laws, and protection from predators and harsh environmental conditions.[18] As a result of these efforts, the Yellowstone herd grew to over 1,000 bison by 1930.[19] However, the recovery of the Yellowstone herd came at the cost of it losing its identity to some degree. Bison were no longer a completely independent, wild, free-roaming herd, but rather reduced to a form of livestock in that they were branded, fed, and otherwise treated accordingly.[20] This treatment included human implementation of slaughter as a means of reducing the herd size to the tune of 9,016 slaughtered bison between 1925 and 1967.[21]

Since the late 1960's, the NPS shifted away from artificial population controls in favor of allowing natural forces to affect and

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15. *See, e.g.*, Record of Decision, *supra* note 1, at 3.

16. *Sole Survivors: The Bison of Yellowstone* (Animal Planet television broadcast, 2004) [hereinafter Animal Planet].

17. 16 U.S.C. § 21 (2004).

18. Record of Decision, *supra* note 1, at 3.

19. *See* National Park Service, U.S. Dept of the Interior, Draft Environmental Impact Statement for the Interagency Bison Management Plan for the State of Montana and Yellowstone National Park 145 (1998) [hereinafter DEIS].

20. *Id*. at 12.

21. *See* Margaret E. Meyer & Mary Meagher, *Brucellosis in Free-ranging Bison in Yellowstone, Grand Teton, and Wood Buffalo National Parks: A Review*, 31 J. WILDLIFE DISEASES 579, 580 (1995).

determine herd size.[22] Due to this shift in managerial philosophy away from direct management, the herd increased population to over 4,000 bison.[23] As of the Record of Decision in December 2000, the herd population was down to "about 3,000 bison, due in large part to actions by NPS and the State of Montana to control the bison when they roam outside the park, and due to winterkill inside the park."[24] Currently, estimates place the herd's population somewhere between approximately 3,000-4,500 bison.[25]

B. Brucellosis and Bison

Brucella abortus is a non-indigenous bacterial organism that infects some of Yellowstone's wildlife, including bison, and causes the disease brucellosis.[26] It is also commonly found in domesticated livestock, such as cattle. It can cause abortion, birth of non-viable calves, and infertility.[27] It is transmissible from livestock and wildlife to humans, but only through consumption of milk or contact with contaminated parts of an infected carcass.[28] It can cause undulant fever, which despite being difficult to treat is not typically fatal.[29]

Park managers identified brucellosis at the turn of the 20th century.[30] Early on, Park managers placed emphasis on the potential of the disease being transmitted to cattle, because cattle share much of the same grazing areas.[31] Cattle grazing is permitted on USFS lands adjacent to Yellowstone under federal permits, as well as on private lands.[32] Bison occasionally migrate from the Park onto these lands, especially during the winter.[33] The potential economic effect on the cattle industry led Congress, in

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22. *See* Record of Decision, *supra* note 1, at 3.
23. Record of Decision, *supra* note 1, at 3.
24. *Id*.
25. *See* Allison A. Freeman, *Montana Agency Recommends Limited Bison Hunt*, LAND LETTER (June 10, 2004) (stating, "in May 2003, Montana Gov. Judy Martz (R) signed a bill to authorize bison hunting as a means of controlling the size of Yellowstone's herd of more than 4,200.").
26. *See, e.g.*, Record of Decision, *supra* note 1, at 3; E. Tom Thorne, Mary Meagher & Robert Hillman, *Brucellosis in Free-Ranging Bison: Three Perspectives, in* GREATER YELLOWSTONE ECOSYSTEM, *supra* note 3, at 284; Robert B. Keiter & Mark S. Boyce, *Greater Yellowstone's Future: Ecosystem Management in a Wilderness Environment, in* GREATER YELLOWSTONE ECOSYSTEM, *supra* note 3, at 280-85.
27. DEIS, *supra* note 19, at 15-16.
28. NRC Report, *supra* note 12, at 2.
29. *Id*.
30. *E.g.*, Record of Decision, *supra* note 1, at 3.
31. *E.g.*, *id*. at 3-4.
32. *E.g.*, *id*. at 3.
33. *E.g.*, *id*.

1954, to appropriate funds for a coordinated effort to eradicate the disease in cattle.[34]

The transmission of brucellosis is generally thought to occur through the ingestion of bacteria contained in the birth materials at the time of calving or abortion from an infected female.[35] However, there is no scientific evidence of the disease being transmitted from bison to cattle in the wild.[36] Furthermore, research has failed to prove definitively how the bacteria are transmitted among wild ungulates, and the Record of Decision states only that "[w]ithout agency actions to minimize the risk, transmission *could* occur."[37] One thing the research has proven is that some of the elk of the GYA are also infected with the disease.[38] However, the Record of Decision claims that behavioral differences between elk and bison during calving make transmission from elk a lesser threat.[39]

C. Recent Conflict: Montana's Clear Stance

Public controversy over the intentional killing of thousands of bison as a management tool over the years, coupled with Montana's desire to protect their cattle-ranching constituency from brucellosis, led to an unresolved conflict of interests.[40] In 1990, the conflicting parties — NPS, USFS, and Montana — formally recognized the need to cooperate in the preparation of a long-range bison management plan.[41] At that time, the parties filed a "Notice of Intent" to prepare an environmental impact study (EIS)[42] under the NEPA[43] to create and examine alternatives for bison management. Two years later, the federal agencies signed a "Memorandum of Understanding" with the state of Montana to "work together" to develop a plan that addresses their "varying and sometimes contradictory objectives."[44]

From 1990 through 1995, three interim plans called for the shooting of bison that migrated from Yellowstone into Montana by

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34. *E.g.*, *id*.
35. *E.g.*, *id*.
36. *See* NRC Report, *supra* note 12, at 42-43.
37. *See* Record of Decision, *supra* note 1, at 3.
38. *E.g.*, *id*.; Peter Morrisette, *Is There Room for Free-Roaming Bison in Greater Yellowstone?*, 27 ECOLOGY L.Q. 467, 482-87 (2000).
39. Record of Decision, *supra* note 1, at 3.
40. *Id*. at 4.
41. *Id*.
42. 42 U.S.C. § 4332(c) (2004).
43. *Id*.
44. Record of Decision, *supra* note 1, at 4.

agency personnel from Montana and the NPS.[45] "In 1995, the State of Montana sued the National Park Service and APHIS, complaining both of NPS management of bison and the possibility that APHIS would change the state's brucellosis class-free status."[46] Class-free status means that the State has successfully eradicated the disease from its livestock. The parties settled the suit by adopting a "schedule for the completion of the long-term bison management plan and [EIS]."[47] The settlement included a provision that "the court would dismiss the suit upon the issuance of the records of decision or if a party terminated the Memorandum of Understanding, whichever occurred first."[48]

After the settlement, a fourth interim plan was issued in 1996 by NPS and Montana.[49] This plan provided for slaughter of bison outside the park in West Yellowstone and even un-tested (for brucellosis) bison within the Park near the north boundary in the Stephens Creek area.[50] The only pro-bison concession provided that bison would not be removed from the Eagle Creek/Bear Creek area northeast of Gardiner, Montana.[51] However, it is arguably not a concession being that those "lands are not grazing areas for domestic cattle."[52]

The fourth interim plan also called for the capture and testing of bison captured within the Park and Gallatin National Forest and subsequent slaughter of pregnant and positive-testing bison.[53] "Two lawsuits challenged the legal basis for the agency implementation of the interim plan."[54] However, the actions of the NPS under the interim plan were held to be within the authority and discretion of the agency.[55]

In 1998, the agencies released the Draft Environmental Impact Study (DEIS) that received public comment.[56] Following the analysis of the DEIS and subsequent comments, the federal agencies adopted a new strategy that would allow "greater tolerance" for bison roaming outside the Park under "stringent conditions that would continue to control the risk of transmission

45. *Id*.
46. *Id*.
47. *Id*.
48. *Id*.
49. Record of Decision, *supra* note 1, at 4.
50. *Id*.
51. *Id*.
52. *Id*.
53. *Id*.
54. Record of Decision, *supra* note 1, at 4.
55. *Id*.
56. *Id*. at 5.

of brucellosis from bison to cattle."[57] This strategy was known as "a possible modified preferred alternative for the final EIS" (FEIS) that provided for "a larger bison population than the preferred alternative in the DEIS."[58]

PART II: COMPROMISE AND CONFLICT BETWEEN FEDERAL AGENCIES AND MONTANA

Following the submission of the modified preferred alternative for the FEIS, the federal agencies debated Montana's agencies about the various aspects and provisions of the strategy for several months.[59] Both sides dug in and an understanding could not be reached regarding "the ages and classes of bison to be vaccinated, the criteria used to decide when bison would be allowed outside the park, and how to use spatial and temporal separation in an adaptive management approach to managing the risk of transmission of brucellosis."[60] In fact, the only thing they agreed on was that "the agency discussions had reached an impasse."[61]

In December 1999, federal agencies informed the governor of Montana that they were withdrawing from the Memorandum of Understanding.[62] This action terminated the Memorandum of Understanding, which triggered the dismissal of the 1995 suit under the terms of the settlement.[63] Montana objected to the federal agencies' request to dismiss the case, but the court agreed with the federal position that they could terminate the Memorandum of Understanding.[64] However, the parties agreed on mediation before formal dismissal of the suit, which occurred during the spring, summer and fall of 2000.[65] The mediation "slightly altered" the modified preferred alternative into what is now referred to as the Joint Plan that "initiates the long-term management of Yellowstone bison."[66]

A. Federal Regulatory Conflict

The NPS, USFS and APHIS all have very different purposes.[67] These differing purposes and interests inherently cause

57. *Id.*
58. *Id.*
59. *Id.*
60. Record of Decision, *supra* note 1, at 5.
61. *Id.*
62. *Id.*
63. *Id.*
64. *Id.*
65. Record of Decision, *supra* note 1, at 5.
66. *Id.*
67. *See* Karen J. Budd, *Ecosystem Management: Will National Forests be "Managed" into*

contention and conflict between them. The dispute over bison management in Yellowstone is a perfect illustration of the conflict caused when these federal agencies are all attempting to further their respective purposes and accomplish their goals. The National Environmental Policy Act (NEPA)[68] is a welcome go-between in the process and sets up the framework for minimizing conflict.[69] Here, the NEPA's EIS requirement facilitated the final resolution, where previously the parties had reached impasse.[70]

1. National Park Service

The NPS, which is organized under the U.S. Department of the Interior, is mandated with managing park resources in a manner that will leave them "unimpaired for the enjoyment of future generations"[71] while at the same time is prohibited from "managing units of the National Park System in derogation of the values and purposes for which the various areas have been established . . . ."[72] The values and purposes for which Yellowstone were established are clear; "preservation, from injury or spoliation . . ." of all the natural wonders of the park "and their retention in their natural condition."[73] Thus, the NPS operates under a dual non-impairment, non-derogation mandate, which is essentially a preservation mandate that should be prescriptive regarding its approach to bison management.

2. United States Forest Service

The USFS, which is organized under the U.S. Department of Agriculture, has a much different purpose than the NPS in that it is not conservation centered, but rather economically based. The

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National Parks?, *in* GREATER YELLOWSTONE ECOSYSTEM, *supra* note 3, at 65 (referring to the different management styles, objective and agendas of the NPS and USFS due to the NPS's emphasis on a more ecosystem-based approach under its protection of natural resources mandate unlike the USFS's multiple use mandate in which it grants leases for timber, oil, gas, mineral exploration and open pasture grazing). Also, the APHIS is solely concerned with the eradication of brucellosis in livestock in this context. APHIS, *at* http://www.aphis.usda.gov (last visited Apr. 9, 2005).

68. 42 U.S.C. §§ 4321-4370e (2004).

69. NEPA section 102(c) requires the preparation of an environmental impact statement for "major Federal actions significantly affecting the quality of the human environment." 42 U.S.C. § 4332(c) (2004).

70. Record of Decision, *supra* note 1, at 5 (stating "eventually, the federal agencies and the governor of Montana agreed that the agency discussions had reached an impasse").

71. National Park Service Organic Act, 16 U.S.C. § 1 (2004) (citing Record of Decision, *supra* note 1, at 9).

72. General Authorities Act, 16 U.S.C. § 1a-1 (2004) (citing Record of Decision, *supra* note 1, at 9).

73. 16 U.S.C. § 21 (2004).

USFS is mandated to manage the National Forests under the Multiple-Use Sustained-Yield Act of 1960, which provides for utilization of renewable surface resources.

> Multiple use means the management of all the various renewable surface resources of the national forests in the combination that best meets the needs of the American people. Sustained yield means the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of various renewable resources of the national forests without impairment of the productivity of the land.[74]

This management includes the use of National Forest for timber extraction, cattle grazing, outdoor recreation, et cetera.[75] Obviously, the USFS's Multiple-Use Sustained-Yield mandate conflicts with the NPS's dual purpose mandate to preserve such resources through non-impairment and non-derogation.[76] Bison management poses a problem because bison do not heed jurisdictional boundaries of the two agencies. Furthermore, how each agency manages bison affects the other.

3. Animal and Plant Health Inspection Service

The APHIS, which is organized under the U.S. Department of Agriculture, has pursued the eradication of brucellosis from livestock for more than sixty years.[77] "Federal law requires the APHIS to control and prevent the spread of communicable and contagious diseases of livestock."[78] The APHIS exerted powerful influence in the process and led to the Joint Plan's commitment to the "eventual elimination of the disease."[79] However, the agencies' claim that the Joint Plan is not "a plan for the eradication of brucellosis"[80] is questionable given the profound impact the threat of the disease had on shaping the new policy. The economic potency of a APHIS certification of brucellosis class-free standing combined with the "billions of dollars spent by federal, state and the [livestock] industry"[81] undoubtedly made the APHIS such a strong

74. 16 U.S.C. § 528 (2004) (citing Record of Decision, *supra* note 1, at 9).
75. Budd, *supra* note 67, *in* GREATER YELLOWSTONE ECOSYSTEM, *supra* note 3, at 65.
76. *See id.*
77. APHIS, *supra* note 67 (citing Record of Decision, *supra* note 1, at 14).
78. *Id.* (citing Record of Decision, *supra* note 1, at 6).
79. *Id.* (citing Record of Decision, *supra* note 1, at 14).
80. *Id.*
81. *Id.*

player despite the somewhat preservationist setting under the NPS and NEPA.

B. Montana's Power and Position

Montana has made it clear that it has a purely economic interest in protecting its ranching constituency from roaming bison.[82] Bison typically migrate during the harsh winter months along the natural corridors that the Yellowstone and Madison Rivers provide to search for areas to graze.[83] Most of the roaming bison follow the Yellowstone River in the direction of Gardiner, Montana,[84] however some follow the Madison River towards West Yellowstone, Montana.[85] In addition, some bison have begun to follow the winter-groomed snowmobile/snowcat trails out of the Park's boundaries.[86] When bison roam out of the Park's boundaries or off USFS land into Montana, "the management responsibilities and authorities change."[87] Montana has an exceptionally poor track record with its use of that authority and its cavalier disregard for its responsibility as a steward of native bison.[88]

Montana game wardens and authorized public hunts are the tool used to keep roaming bison from grazing on state lands.[89] The numbers taken under Montana jurisdiction have varied over the years, but two winters — 1988-89 after the fire and harsh winter of 1996-97 — are of note for the devastating effect on herd population.[90] During the post-fire winter of 1988-89 the herd's food sources were depleted due to the extent of the fire.[91] Accordingly, more bison left the park to search for additional food sources.[92] This gave Montana hunters the opportunity to kill 569 bison.[93] This number was so upsetting that the public outcry shamed the Montana legislature to repeal its authorization of the bison hunt in 1991.[94] During the winter of 1996-97, Montana officials killed a truly grotesque number of bison, which totaled 1,084 individual

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82. *See* Record of Decision, *supra* note 1, at 4 (referring to Montana's suit against the NPS for its bison management and the APHIS for the possibility changing its brucellosis class-free status).
83. DEIS, *supra* note 19, at 15; Morrisette, *supra* note 38, at 476.
84. Morrisette, *supra* note 38, at 476.
85. *Id*.
86. *Id*.
87. Record of Decision, *supra* note 1, at 6.
88. *See* Morrisette, *supra* note 38, at 468-71.
89. *See id*. at 476-80.
90. *Id*.
91. *Id*.
92. *Id*.
93. *Id*.
94. *See* Morrisette, *supra* note 38, at 468-71.

bison. The onslaught of slaughter combined with a harsh winter, reduced the herd by 40% in those 5 months — November 1996-April 1997 — and left the herd with only 2,000 bison.[95] Despite these past failures, Montana's FEIS and bison management plan (MT's Plan) contained some significant anti-bison protection differences — dealing with the retention of public hunting rights — from the Federal FEIS and Joint Plan (that will be addressed in Part III), even though the plans are largely the same.

PART III: THE CURRENT JOINT MANAGEMENT PLAN FOR BISON

The current last-word on bison management in the GYA is the federal Joint Bison Management Plan (Joint Plan).[96] Montana adopted its own bison management plan (MT's Plan), but it originated from the federal FEIS and is virtually the same as the Joint Plan. The Joint Plan was the product of a ten-year process to finally solve the bison management problem in a manner that was acceptable by all. The Joint Plan aspires to be a collaborative effort between the parties but maintains many of the disparate jurisdictional treatments of bison. Bison protection is put on a type of sliding scale where inside the Park they are given the most protection digressing to Montana state lands in which they are the least protected with other federal lands, like USFS lands, falling somewhere in between.[97] In addition, the Joint Plan sets a target population for the whole herd at 3,000 bison.[98] This target is effectively an artificial cap on population being that "if the late-winter/early-spring bison population is above the 3,000 target, specific management actions may be undertaken at the Stephens Creek capture facility or outside the park in the western boundary area to reduce its size."[99] An example given for specific management actions is the slaughtering of bison rather than hazing them back into the Park.[100]

A. The Joint Management Plan's Zones of Management

The Joint Plan controls all federal agency management of bison on federal lands and was extremely persuasive in the formation of Montana's slightly altered version. The Joint Plan created three management "Areas" — Western Boundary Area (WBA), Northern

95. *Id*.
96. Record of Decision, *supra* note 1.
97. *Id*. at 21-34.
98. *Id*. at 32 ¶28.
99. *Id*.
100. *Id*.

Boundary Area-Reese Creek to Yankee Jim Canyon (NBA-RC), and Northern Boundary Area-Eagle Creek to Bear Creek (NBA-EC) — and three different management "Zones" within the WBA and NBA-RC in which bison have varying levels of protection while roaming within each particular zone. The Zones have "progressively more intense management to ensure temporal and spatial separation between bison and cattle."[101] Accordingly, the management in Zone 1 is less excessive than Zone 2, which is less excessive than Zone 3. Thus, bison management differs greatly depending on the management area and zone.

The Joint Plan also contains three "Steps" for the progression of the plan that employ a limited form of adaptive management over the space of one or two years.[102] This includes continuing research during Step 1 regarding the viability brucellosis transmissibility in the environment that "will last one to two years."[103] This research will be "sufficient to allow agencies to determine an adequate temporal separation period."[104] Other details included in the Steps deal with bison levels in each Zone at different time periods in the inception of the plan over its first four years.[105]

1. Western Boundary Area

Bison come to the WBA along the Madison River and groomed winter roads towards the town of West Yellowstone, Montana. Here, "[b]ison will be hazed back into the park . . . by May 15, and captured or shot after May 15 to ensure none remain outside the Park . . . during the applicable temporal separation period,"[106] which lasts from May 15 until cattle are removed in the fall.[107] While winter migration to this area is not as extensive as the northern migration, it still provides a critical habitat.

The WBA contains three management Zones with varying degrees of bison protection. Zone 1 consists of Yellowstone Park habitat where bison are always allowed, but subject to "limited hazing" back into the Park during the pre-fall removal period.[108] This Zone is clearly the most bison-friendly Zone in the WBA, in contrast to Zone 3 in which bison are always "subject to lethal

101. Record of Decision, *supra* note 1, at 26 ¶7.
102. For a detailed discussion refer to Record of Decision, *supra* note 1, at 21-34.
103. Record of Decision, *supra* note 1, at 23 ¶3.
104. *Id*. at 26 ¶6a.
105. *Id*. at 21-34.
106. *Id*. at 26 ¶7.
107. *Id*. at 26 ¶10a.
108. Record of Decision, *supra* note 1, at 26 ¶10a-c.

removal."[109] Zone 2 falls between Zones 1 and 3 in terms of how excessive management is employed.[110] It consists of "USFS winter habitat with some private property."[111] Zone 2 has a bison tolerance limit of 100 upon which bison are subject to lethal removal, which is also employed if Park bison size exceeds the population cap of 3,000.[112] Each of these triggers for lethal removal are independent, which means that even if there are less than 100 bison in Zone 2, but the population in the Park exceeds 3,000, all of the bison in Zone 2 are subject to lethal removal.[113] However, the Record of Decision frequently states that management actions in Zone 2 "*could* include tolerating, hazing, capturing and testing, vaccinating . . . or removing for use in jointly approved research as set forth in this plan."[114]

2. Northern Boundary Area-Reese Creek to Yankee Jim Canyon

The NBA-RC contains some of the most used winter habitat for foraging bison in the GYA. The Zones of the NBA-RC contain more variation depending on the Step of implementation of the Joint Plan than the WBA. Zone 1 in the NBA-RC's has the most variation of management depending on which step of the Joint Plan is being implemented. Zone 2 is composed of the "[a]rea north of the park boundary in the Reese Creek Area, West of Yellowstone River, and South of Yankee Jim Canyon.[115] Zones 2 and 3 have the same management techniques as their counterparts in the WBA, including Zone 3 being a Zone of no refuge that utilizes lethal removal.[116]

Zone 1 is composed of "[Yellowstone National Park] winter habitat in the Reese Creek vicinity that bison normally occupy."[117] During Step 1, bison are subject to every management technique — "hazing, capture, testing and vaccination, or lethal removal"[118] — *other than tolerating* if attempting to exit the Park.[119] During Step 2, bison are only subject to the aforementioned available management techniques if the number of brucellosis negative bison

109. *Id*.
110. *Id*.
111. *Id*. at 26 ¶10b.
112. *Id*.
113. Record of Decision, *supra* note 1, at 26 ¶10b.
114. *Id*.
115. *Id*. at 30-31 ¶23a-c.
116. *Id*. at 30-31 ¶23b-c.
117. *Id*. at 30 ¶23a.
118. Record of Decision, *supra* note 1, at 26 ¶23a..
119. *Id*.

tolerated in Zone 2 exceeds 25 bison in the first year (increasing to 50 tolerated bison if agencies are able to successfully manage — "enforce temporal and spatial separation" — with the 25 or less). "During Step 3, bison attempting to exit the Park . . ." are also subject to those techniques after the threshold number of 100 untested bison in Zone 2 is reached.[120]

3. Northern Boundary Area-Eagle Creek to Bear Creek

"In all steps of [the Joint Plan], agencies would allow untested bison into [this] region of the northern boundary area."[121] Bison in this Area will be allowed up to the Little Trail Creek/Maiden Basin hydrographic divide boundary.[122] This boundary is maintained through hazing bison that approach the divide and subjecting those bison that actually cross the divide to lethal removal.[123]

4. Contingency Measures

The Joint Plan contains various contingency measures that deal with Montana not following the plan, to ineffectiveness of the "in-Park vaccination program" and the possibility of brucellosis being spread to more cattle herds. Should Montana not tolerate bison outside the Park in Zone 2 in both the WBA and NBA during the designated times, "the federal agencies will cease endorsing and participating in activities leading to lethal control measures and may withdraw from other joint management actions outside the Park . . . ."[124] Montana has its own recourse, if it deems the in-Park vaccination program as inadequate, to cease tolerating untested bison outside the park and its withdrawal from other joint management actions.[125]

Another interesting contingency measure deals with the scenario in which brucellosis is actually discovered in a cattle herd and traced back to bison within a management area. "Upon disclosure of (1) brucellosis-affected cattle herd in a management area, [Zone 2 plus 5 miles within Montana,] or (2) a brucellosis-affected herd outside the management areas . . . that the source is traced back to the management area, the agencies will implement

120. *Id*.
121. *Id*. at 31 ¶25.
122. *Id*.
123. Record of Decision, *supra* note 1, at 31 ¶25.
124. *Id*. at 34 ¶34.
125. *Id*.

modified management measures."[126] The modified management measures are thus an implementation of adaptive management at that point.[127]

B. Montana's Version of the Joint Bison Management Plan

Montana's plan is almost entirely the same as the Joint Plan, as is illustrated in its incorporation by reference of volumes 1-3 of the federal FEIS. However, Montana's Plan is based on its FEIS, which is not based on the final version of the Joint Plan, but rather "analyzes [it] as it existed at one point during the federal-state mediation."[128] The most important difference between the two plans is "[Montana's] intent possibly to request the [state] legislature to authorize . . . the public hunting of bison"[129] in an area and manner inconsistent with the Joint Plan. If approved by the Montana legislature, a public hunt could undermine the Joint Plan. For example, if the public hunt amounted to Montana not tolerating untested bison under the Joint Plan's contingency measures it could lead to federal agencies withdrawing from the plan and not cooperating with Montana on lethal control measures.[130]

PART IV: ANALYSIS

The title of the agencies efforts, the *Bison* Management Plan for the State of Montana and Yellowstone National Park, is really on point, being that bison are managed instead of cattle. The Joint Plan is positive in that it is a step towards cooperative bison management, but it falls short in providing a bison management plan that conforms to the boundaries of the Yellowstone ecosystem in which the bison roam. The Joint Plan even missed the opportunity to merely extend the "free roam zones" to encompass all federal lands, which would not even include the entire winter habitat. Furthermore, the Joint Plan under-utilizes adaptive management and over-utilizes traditional front-loaded management. Lastly, it is based upon the perceived threat of brucellosis despite no documented cases of transmission from bison to cattle in the wild.

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126. *Id*. at 32-33 ¶32.
127. *Id*. at 32-33 ¶32-33.
128. Record of Decision, *supra* note 1, at 15.
129. *Id*.
130. *Id*. at 33-34 ¶34.

A. Goals of Ecosystem Management

Virtually everyone involved with the Joint Plan says they support and utilize ecosystem management,[131] but they are clearly not all referring to the same thing. The distinction between the different versions can be reduced to where their respective emphasis is placed: human use/resource extraction or maintenance of the integrity of the ecosystem. In other words, where in the hierarchy of interest is human use? This is the key inquiry, because there is inevitably a point where human use is in conflict with ecosystem integrity.

R. Edward Grumbine states: "Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term."[132] In Grumbine's hierarchy of interests, human use and occupancy must be accommodated *within* the constraints of maintaining ecological integrity.[133] In contrast, the Forest Service's concentration on sustaining the "processes of ecosystems for the benefit of future generations, while providing goods and services for each generation"[134] under its "multiple-use/sustained yield" mandate, implies a human use being further up the hierarchy than in Grumbine's paradigm.

If the overall goal of ecosystem management is really sustaining ecological integrity, it is difficult to believe that preservation of ecological integrity must be accommodated *within* the constraints of human use. Such a limitation would significantly impair accomplishment of the goal, because the human use interest would be superior. Many scenarios present zero-sum games; occasionally, there are only winners and losers. At this point, human use must be subordinate to the overall goal of sustaining the integrity of the ecosystem.

Within the context of bison management, it is evident that the agencies have a different hierarchy of interests. The Joint Plan constrains the interests of bison within the human interest in raising livestock. The plan is clearly a victory of human use over ecological integrity. Bison, a native species, have been forced to accommodate cattle, a non-native species, even on federal lands.

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131. *Id*. at 8 (stating "[c]ooperative management of Yellowstone bison requires an ecosystem approach" and a goal of the Joint Plan is the "maintenance of a viable population of wild bison in Yellowstone National Park from biological, genetic, and ecological terms.").

132. *What is Ecosystem Management?*, 8 CONSERVATION BIOLOGY 27, 31 (1994).

133. *Id*.

134. *Id*. at 32 (citing USDA Forest Service, East Side Forest Ecosystem Health Assessment (1993)).

Furthermore, the Yellowstone herd, which is the only genetically and behaviorally wild herd of bison left in America, is being subjugated to the existence of cash cattle in the bison's ecosystem. The functional effect of these actions underlines the priorities of the Joint Plan and calls into question where the "[maintenance of] a viable, free-ranging population of Yellowstone bison"[135] really falls within the plan's hierarchy of interests.

B. Brucellosis: the Foundation of the Policy

The main argument given by proponents for limiting bison's ability to roam has been the threat of spreading brucellosis to livestock.[136] The Joint Plan's stated objective is the following:

> This plan is not intended to be a brucellosis eradication plan, but rather is a plan for the management of bison, intended to prevent the transmission of brucellosis from bison to cattle. Nevertheless, it sets forth actions to address brucellosis within the bison herd.[137]

Furthermore, brucellosis seems to be the sole justification given by state or federal agencies for restraining bison from their natural roaming behavior.[138]

Brucellosis' prominent position in the policy behind the Joint Plan would lead a reasonable person to the conclusion that the science behind the threat must be overwhelming. A reasonable person would conclude that there must have been scientific studies showing that brucellosis-positive bison transmit the disease to the livestock in the wild via common grazing territory. Furthermore, that the rate of wild transmission is significant enough to restrain native wildlife at the expense of domesticated cash cattle. Furthermore, that there is scientific evidence that clearly prescribes the differential treatment of bison and elk under the Joint Plan, despite the fact that both are carriers for brucellosis and both share grazing territory with livestock.[139]

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135. *See* Mark Derr, *Genetically, Bison Don't Measure up to Frontier Ancestors*, N.Y. TIMES, Apr. 23, 2002, at F2.

136. Record of Decision, *supra* note 1, at 8 (stating "goals [of Joint Plan] include . . . eventual elimination of brucellosis in bison; protection of livestock from the risk of brucellosis; actions to help protect the brucellosis class-free status of Montana . . . .").

137. *Id*. at 22.

138. *Id*. at 8.

139. *Id*. at 3 (stating "Brucellosis also occurs in elk . . . [but] the risk of transmission from those elk to cattle is lower than that of bison.").

Proponents of the Joint Plan are quick to point to the study of transmission in captivity that showed bison could transmit brucellosis to cattle in that setting.[140] However, there is an ongoing debate in the scientific community about brucellosis transmission among ungulates in the wild and there is currently no scientific evidence of brucellosis transmission from bison to cattle in the wild.[141] Furthermore, the Joint Plan itself implicitly acknowledges the lack of evidence of transmissibility in its contingency section that modifies the plan *if* bison within management areas are shown to be the trace of a *single* cattle herd infection.[142]

Clearly, brucellosis may seriously injure the livestock industry of Montana if the state were to lose its brucellosis class-free status under the APHIS, which incidentally cannot occur solely because wildlife that carry the disease are present in the state.[143] Montana's fear and conservative attitude are somewhat justified by the devastating economic impact that a brucellosis outbreak would have on the livestock industry. However, the lack of scientific support leads to the conclusion that brucellosis was the only thing that Montana and the federal agencies could agree on with the regard to bison management. Furthermore, the basis of the policy may be any number of things including, but not limited to, an old-fashioned state land use/property rights issue or the general nuisance bison can pose to private property.[144] Regardless of Montana's real interest, its use of fear surrounding the threat of brucellosis allowed it to accomplish its goal of exerting control over bison within its borders as it sees fit with limited federal interference. Furthermore, if it was stipulated that brucellosis really is the foundation of the policy behind the Joint Plan, elimination of the disease could be approached differently with an emphasis on adaptive management to be discussed in the next section.

C. Excessive Management, the Artificial Population Cap and the Wrong Ungulate

Yellowstone's bison have proven to be extremely resilient when allowed to operate under natural conditions. The herd recovered from virtual oblivion at the turn of the 20th century.[145] Their initial survival following the low of twenty-five bison in the herd was in

140. Morrisette, *supra* note 38, at 484 (citing NRC Report, *supra* note 12, at 42-45).
141. *See id.*
142. *See* Record of Decision, *supra* note 1, at 32-33 ¶32.
143. APHIS, *supra* note 67.
144. *See* Leuck, *supra* note 5.
145. Record of Decision, *supra* note 1, at 3.

large part due to human aid.[146] However, once the herd was re-established and allowed to roam wildly, the human interference did not stop. This excessive management is clearly seen in the artificial population caps — currently 3,000 bison[147] — that have been placed on total herd population throughout the idioms of bison management over the years. The cap has restrained bison from existing at the natural levels dictated by the environmental conditions of the GYA ecosystem, which includes infamously harsh winters, fires that destroy habitat, and predators — including the reintroduction of wolves — among other factors. Even the Park Service believes that these natural conditions "would maintain the population within the natural range of 1,700 and 3,500 animals."[148]

PART V: RECOMMENDATIONS

The Joint Plan can be salvaged, as it has already provided a framework for the inter-agency and inter-jurisdictional cooperation between the federal government and the State of Montana. Both sides know that bison management cannot be handled by any of them alone, but requires a cooperative effort. Furthermore, each agency's management of bison affects the others' interests. A more ecosystem management-based approach could accomplish this with incentives for state and private parties to cooperate.

An ecosystem management approach would strike a far better balance between the natural range and needs of the bison to migrate during the winter and the needs of cattle ranchers than the existing Joint Plan. This approach would focus on the bison's natural range along the Madison River towards West Yellowstone and along the Yellowstone River into the area around Gardiner, Montana and the Gallatin National Forest. This approach could be implemented through the extension of "free roam zones" to all federal lands and across some state and private lands. The federal government could accomplish this through attrition of private leases on federal land, acquiring bison easements over otherwise state or private land through purchases, land swaps or other incentives, and assurance from the APHIS that these bison easements will not affect Montana's brucellosis class-free status.

Despite the emphasis on bison management in the Joint Plan, cattle management is more effective. It is more effective because cattle roam less than bison and are more likely to graze under one entity's jurisdiction. Furthermore, cattle are already contained,

146. *See id*.
147. Record of Decision, *supra* note 1, at 26 ¶10b.
148. DEIS, *supra* note 19, at 73.

being domesticated livestock, unlike wild bison. Therefore, separating cattle from bison is logically an easier proposition than separation of bison from cattle.

Some solutions for modifying the Joint Plan could be made easily under the framework, while others would be a hard-sale for some of the federal or state agencies. Extension of the "free roam zone" would be difficult, but hesitance could be overcome with proper compensation through federal incentives. Likewise, more management of cattle would face opposition if the economic burden were placed upon the livestock industry. Thus, changes to the Joint Plan must provide real-world benefits to those afforded incentives in return for the concessions necessary to foster a more ecosystem management-based version of the Joint Plan.

A. Less, Adaptive, Ecosystem Management of Bison

It is interesting that adaptive management is truly only utilized upon a finding of brucellosis transmission from bison in a management area to a cattle herd.[149] The agencies could better utilize the immense potential of adaptive management, if implemented at the outset before potentially unjustified restraint and slaughter of bison. Instead, the agencies participated in a typically front-loaded evaluation that only re-evaluates the plan over its first four years. Although the plan states that "future management actions could be adjusted, based on feedback from implementation of the proposed risk management actions."[150]

A better solution would have been to protect bison during their natural winter migration and evaluate if brucellosis transmission could be scientifically documented in the wild. The agencies could then use the millions of dollars spent on hazing, capture, testing and slaughtering to compensate the owners of any subsequently infected cattle herds.[151] Furthermore, adaptive management could be used to change the plan to restrict roaming on a dynamic basis. This would ensure the plan only restricts the areas identified as possible transmission points rather than bison restraint with an overly broad impact.

Excessive management also has a negative impact on other wildlife. Currently the effect of bison management helicopters on the some of the endangered and threatened species of the GYA is

149. *See* Record of Decision, *supra* note 1, at 32-33 ¶32.
150. Record of Decision, *supra* note 1, at 22.
151. *See* Morrisette, *supra* note 38, at 483 (stating "[t]he NRC estimates that since 1934, the national effort to eradicate brucellosis has cost $3.5 billion"). The NPS spends millions on bison management in Yellowstone. *See id*.

being studied.[152] Clearly, less management of bison would be a welcome change from the excessive management of past and current bison management plans that are only effective if intrusive on the ecosystem.

1. Extension of the Free Roam Zone

The "free roam zone" under the current plan overly restrains bison movement because it does not correspond with their natural behavior within the ecosystem. Thus, the logical next step is to extend to the match their natural range to the extent possible. However, this is somewhat difficult to ascertain.

The "free roam zone" could be extended to include all federal lands, especially all of the Gallatin National Forest just north of the Park. This may be done fairly easily because the USFS is already a participant in the Joint Plan and has jurisdiction over that area. Any area that is within the bison's winter range and not held by private lease could be immediately included in the "free roam zone" under the Joint Plan.

One often cited problem is private grazing leases and islands of private land ownership. Many of these conflicts between private citizens and the federal government could be rectified with purchase easements to allow bison to roam along their natural winter range. Another solution is to merely buy the land altogether and add it to Yellowstone or Gallatin National Forest. Government purchases like these are not uncommon. In 1999, $13 million from the Federal Land and Water Conservation Fund was used by the federal government to purchase over 7,800 acres of private land along the west side of the Yellowstone River, north of the Park.[153]

Private leases for grazing and other uses on federal land could also be bought out or compensated for a bison easement until completely eliminated along bison range through attrition. It is remarkable that bison protection on federal land has been so compromised by the presence of private grazing leases, especially in the Gallatin National Forest. These leases could be bought out or condemned under eminent domain, if the lease-holders are unwilling to participate in bison easement compensation incentives. The remaining leases along bison range could then be eliminated through attrition.

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152. Eryn Gable, *Bison: Enviros Ask Judge to Stop Use of Helicopters to Control Yellowstone Herd*, *in* GREENWIRE (Jan. 9, 2003) (stating that use of helicopters to haze bison back into the park harms bald eagles, trumpeter swans, and their habitat in violation of their protection under the ESA).

153. Morrisette, *supra* note 38, at 501-02.

Land and lease swaps could also be used. This can be an effective alternative to all out attrition on leases or land purchases because it gives land owners and lease holders an ability to swap their bison range land for non-range land, if they do not want to participate in bison easement compensation or incentives. Anecdotally, my family's private land lease on USFS land, which was used for a cabin just outside West Yellowstone, expired in one location due to conservation demands but the USFS offered another lease in a nearby area. This swap of locations left a much better taste than an all out attrition of our ability to occupy, use and enjoy USFS land. Obviously, my family is not the multi-million dollar livestock industry, but the concept has some transferability.

The "free roam zone" obviously cannot be extended infinitely. Thus, some limited management in the form of hazing may be needed to keep bison within this expanded range. However, the correspondence of this new zone with the bison's natural range should greatly reduce the need for management to a small fraction of the level currently needed to restrain bison under the artificial jurisdiction of the Joint Plan. Furthermore, bison levels will be dictated by natural factors to establish the natural equilibrium dictated by the environmental conditions of the GYA ecosystem.[154] Thus, it could potentially lead to a more functional ecosystem with greater ecological integrity than under the excessive management and artificial population cap imposed by humans under the Joint Plan.

2. More Management of Cattle

The agencies have chosen the wrong ungulate to manage. The threat of brucellosis transmission could be more easily pacified through management of domesticated cattle rather than bison. The agencies could isolate livestock from bison grazing lands with both spatial and temporal separation. In contrast, the Joint Plan does the exact opposite. It places artificial boundaries that restrain bison rather than restricting livestock. This policy does not makes sense given the fact that bison have a natural inclination to roam

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154. Leuck, *supra* note 5, at 610.

> Bison, like many species, exhibit density-dependent population dynamics; that is, as a population increases within a well-defined environment, the rate of population growth declines. Because of this characteristic, bison can be usefully described by a logistic growth function. This population model makes it possible to generate historical population estimates and understand the details of the bison's extermination and conservation.

Id.

while foraging for food in the winter, as opposed to cattle that are already subject to artificial restrictions. This is the classic example of the boundaries of an ecosystem not matching artificially human-created borders. The bison's ecosystem overlaps and crosses the artificially created jurisdictional boundaries between government entities.

Montana could clearly isolate livestock, which is under their complete control, rather than bison that roam in and out of their jurisdiction. The only thing missing is what is in it for them. Proper federal incentives could sway their cooperation and would benefit all involved. The risk of brucellosis transmission would be even less than under the current plan if cattle were managed and separated from bison, because cattle are much more controllable. Thus, management of livestock would be more effective since the framework for containing cattle already exists in the livestock industry, unlike the ineffective containment of free-roaming bison. Furthermore, if Montana and the livestock industry were persuaded to abandon their perceived attack on bison, while still remaining profitable, they could shed the negative image that surrounds their position on bison management, which would greatly enhance their good will with both consumers and wildlife conservationists at the same time.

B. Brucellosis Vaccine

The development of a brucellosis vaccine would greatly lessen the risk of transmission. Delivery of the vaccine may prove difficult, however the current NPS staff is already familiar with tranquilizing bison to fit them with radio collars to track their movement. This training and experience would allow them to vaccinate the large majority of the bison population. However, even if all bison are vaccinated, elk also carry the disease and may have to be vaccinated if brucellosis is still found in the bison population. Vaccination of bison and elk would only be necessary if the brucellosis vaccines used on cattle remained ineffective as they are currently, despite the Fund for Animals claiming that vaccinated cattle are "unlikely to develop an infection even if exposed to the *Brucella abortus* organism."[155]

Vaccine development is being done in coordination with Russian biochemical-military scientists.[156] These scientists are

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155. Fund for Animals, *Response to Record of Decision for the Final EIS and Bison Management Plan for Montana and the Yellowstone National Park*, *at* http://www.fund.org/library/documentviewer.asp?ID=271&table=documents (last accessed Dec. 7, 2004).

156. Animal Planet, *supra* note 16.

familiar with the *Brucella abortus* bacteria due to their utilization of it in USSR's chemical weapons of mass destruction program during the Cold War.[157] During their development of *Brucella*-based chemical weapons, the former-Soviet scientists also developed five different vaccines for brucellosis.[158] These vaccines are in the process of being adapted to eradicate brucellosis in the bison population.[159]

The development of a viable brucellosis vaccine would likely be able to address the concerns of the brucellosis transmission from roaming bison to grazing cattle that are shared by ranchers, the State of Montana, and the APHIS. In addition, this is a better means of eradicating brucellosis, which is the goal of the APHIS, but not the Joint Plan. However, one of the purposes of the Joint Plan is to "ensure that brucellosis is not transmitted from bison … to brucellosis-free cattle" and "its activities demonstrate a commitment to the eventual elimination of the disease in the bison of Yellowstone National Park."[160] That purpose would be greatly furthered by the development and delivery of a brucellosis vaccine. Thus, a vaccine is one of the most desirable solutions to the perceived problem of roaming bison, due to its ability to strike at the core of the stated reasons behind the Joint Plan.

C. Are Yellowstone's Bison a Distinct Population Segment?

If Yellowstone's herd were to be held a distinct population segment under the Endangered Species Act (ESA),[161] it would provide a new solution for protection of Yellowstone's bison and their right to roam freely across jurisdictional boundaries.[162] This new managerial philosophy would be completely out of the current Joint Plan framework and frankly would be much more effective at protecting bison and their habitat. Getting listed under the ESA is a difficult process.[163] Thus, even if listing is not readily or immediately attainable, perhaps the mere fight over listing and possible victory by conservationists, like the Greater Yellowstone

157. *Id*.
158. *Id*.
159. *Id*.
160. Record of Decision, *supra* note 1, at 14 ¶3.
161. 16 U.S.C. § 1531 (2004).
162. *See, e.g.*, Joshua M. Duke & Laura A. Csoboth, *Increased Scientific Capacity and Endangered Species Management: Lessons from the Red Wolf Conflict*, 8 DRAKE J. AGRIC. L. 539, 545 (2003) (stating "[d]istinct population segments have been a popular vehicle for offering enhanced protection for species").
163. *See, e.g., id*.

Coalition (GYC),[164] the Fund for Animals[165] or the Buffalo Field Campaign,[166] could be used as a bargaining chip to bolster protection of bison under the Joint Plan.

The definition of species in the ESA differs from some other definitions[167] in that it includes subspecies and distinct population segments.[168] The definitions of "species" and "subspecies" are not found in the ESA.[169] The lack of these definitions is further complicated by the option of creating distinct population segments.[170] An oft-cited example of distinct population segments is "the grizzly bear, which has several separate 'species' listings for various distinct population segments."[171]

Wood bison are protected under the ESA,[172] but plains bison are no longer considered threatened as a result of protection efforts and domestication measures undertaken prior to the enactment of the ESA.[173] However, Yellowstone's bison are the only genetically and behaviorally distinct population segment that remains true to the free roaming plains bison ancestors.[174] The large numbers of domesticated bison are vastly different from their free-roaming counterparts that occupy the GYA in both behavior and genetic structure.[175]

The evidence of behavioral and genetic dissimilarity between the bison of the GYA and domesticated bison bolsters the argument that they should be protected under the ESA as a distinct population segment. This would mark a radical shift in bison management policy, because the capture/test/slaughter regime, as

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164. http://www.greateryellowstonecoalition.com.

165. http://www.fund.org.

166. http://www.buffalofieldcampaign.org.

167. *See, e.g.,* JOHN COPELAND NAGLE & J.B. RUHL, THE LAW OF BIODIVERSITY AND ECOSYSTEM MANAGEMENT 125-29 (Robert C. Clark et al. eds., Foundation Press 2002); Holly Doremus, *Listing Decisions Under the Endangered Species Act: Why Better Science Isn't Always Better Policy*, 75 WASH. U. L.Q. 1029, 1130 (1997); Holly Doremus & Joel E. Pagel, *Why Listing May be Forever: Perspectives on Delisting Under the U.S. Endangered Species Act*, 15 CONSERVATION BIOLOGY 1258 (Oct. 2001); Philip Kline, *Grizzly Bear Blues: A Case Study of the Endangered Species Act's Delisting Process and Recovery Plan Requirements*, 31 ENVTL. L. 371, 371-73 (2001).

168. 16 U.S.C. § 1532(16) (1994) (stating "[t]he term 'species' includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature . . . .").

169. *See* NAGLE & RUHL, *supra* note 167, at 126.

170. *See id.* at 127.

171. Kline, *supra* note 167, at 380.

172. *See* 50 C.F.R. § 17.11(h) (2004).

173. Omar N. White, *The Endangered Species Act's Precarious Perch: A Constitutional Analysis Under the Commerce Clause and the Treaty Power*, 27 ECOLOGY L.Q. 215, 240 (2000).

174. *See, e.g., supra* note 135.

175. *See, e.g., id.*

well as the limitations on bison movement out of the park, would be eliminated. For bison protectionists, this is the Holy Grail, given the potent effect of an ESA listing. However, the threat of listing could be used by one of the bison protectionist groups as a bargaining chip to alter the current Joint Plan to a more palatable form. The use of the *in terrorem* effect of a listing suit has greater real-world plausibility of success than listing of bison as a distinct population segment given the strong opposition from ranchers and the state of Montana that are already upset about the reintroduction and protection of wolves in the GYA under the ESA.[176]

CONCLUSION

The capture/test/slaughter method employed by the NPS over the years and carried on in the Joint Plan is not the most effective way to manage Yellowstone's roaming bison. The artificial population cap that limits the total bison population to 3,000 disregards the principles of ecosystem management. In addition, the Joint Plan fails to extend the "free roam zones" to correspond with the bison herd's natural behavior in the winter to migrate out of the park to seek food sources due to harsh conditions inside the Park. The Joint Plan places too much emphasis on bison management at the expense of exploring cattle management options that would be easier to implement, because cattle are domesticated and contained, unlike free-roaming wild bison that do not heed artificial jurisdictional boundaries.

Instead, the Joint Plan should be changed to comply with less and adaptive management of bison according to the principles of ecosystem management. Following the above recommendations would allow the bison to behave naturally without penalty and operate within the natural conditions of the ecosystem. This would allow bison to aid in ensuring that the ecological integrity of the GYA ecosystem is viable for the use and enjoyment of future generations. With a more ecosystem-based approach, the iconic image of bison roaming free across the landscape of the West could be restored from memory to reality.

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176. *See, e.g.*, Daniel R. Dinger, *Throwing Canis Lupus to the Wolves:* United States v. McKittrick *and the Existence of the Yellowstone and Central Idaho Experimental Wolf Populations Under a Flawed Provision of the Endangered Species Act*, 2000 B.Y.U.L. REV. 377 (2000).

"WHISKEY IS FOR DRINKING…": RECENT WATER LAW DEVELOPMENTS IN FLORIDA

DREW MELVILLE*

A. INTRODUCTION

The past few years have seen a flurry of significant events carrying implications for the Florida's future in myriad ways that have been centered on water law and policy. From the Florida Bay to the Apalachicola River, issues dealing with water have with issues of development and growth, property rights, and agricultural policy to name a few. The Everglades system and its ongoing restoration has provided a number of high profile developments in its relation to the federal judiciary, at the same time prompting some meaningful legislative and executive activity. The issue of water allocation and use has likewise provided headlines and lobbyist lines as economic and regional interests contend for what some predict will end up a more privatized and prioritized resource in Florida and the eastern states in general, but which many others consistently assert should remain a public resource as it has long been recognized. The following article is meant to shed light on these developments and how they affect the regulation of water quantity and quality in Florida.

B. WATER QUANTITY DEBATES: CONSUMPTIVE USERS, THE ENVIRONMENT, AND INTERREGIONAL CONFLICT

1. The Council of 100 Brings Water Supply to the Fore

On August 10, 2003, Craig Pittman wrote an article in the St. Petersburg Times entitled, "North has it, South wants it," referring to the Florida Council of 100 water supply report that was about to be released, a report that allegedly recommended transferring surface water out of northern surface waters such as the Suwannee River to feed growth plans of South Florida developers and growth managers.[1] When the report was released on September 25, the

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1. Craig Pittman, *North has it, South wants it*, ST. PETERSBURG TIMES, August 10, 2003, at 1A. Pittman cited Lee Arnold, Chairman of the Council's Water Supply Task Force which conducted the research and contacted many experts on the issue, who said that 80 percent of the consumption was South of I-4 while 80 percent of the available supplies were north of I-4. Arnold singled out the Suwannee River region as a potential donor area and expressed that in return for their water, they could get money for schools. Pittman also cited a former Pinellas County Commissioner who, during the water wars between thirsty Pinellas

exact growth projections forecasted a 25 percent increase in population and concluded that from this projection, a 26.4 percent increase in billions of gallons of water per day would be needed to sate the demands of this population.[2] Areas south of I-4 were growing, claimed the Council, and Florida needed to find a way to supply the projected demand, which would overwhelmingly be concentrated in the South and Southwest Florida Water Management Districts, with a little less demand in the St Johns, but with almost no increase in demand for the Northwest Florida and Suwannee River Districts.[3] In addition, the demand of agricultural, domestic self supply, and industrial/commercial/ electric users would stay about the same or be reduced while public supply and recreation would be increased in all five water management districts.[4]

The report had other, less explosive, recommendations like creating a state water supply commission, establishing a water data center and a science advisory committee, and encourage public-private partnerships, but in the days following Pittman's article speculation was rampant, and northern counties were already rushing to adopt resolutions opposing water transfers and expressing support for the "local sources first" policy that was written into the Florida Statutes in 1998.[5] That policy is written into Chapter 373 of the Florida statutes and requires a Water Management District or DEP to consider seven factors to be evaluated using district water supply assessments and regional water supply plans as the basis of their decisions where applicable.[6] Other county commissions in similarly threatened "water rich"

County and water affluent Pasco County said "Keep the Suwannee River cold, because we're coming for it."

2. Improving Florida's Water Supply Management Structure: Ensuring and Sustaining Environmentally Sound Water Supplies and Resources to Meet Current and Future Needs, A Report of the Florida Council of 100, (September 2003). Available online at www.fc100.org. [hereinafter *Report*].

3. *Id*. at 10

4. *Id*.

5. *See,* for example, Archana Pyati, *County Braces for a New Water War*, CITRUS TIMES, August 14, 2003, at pg. 1. Citrus County Commission members expressed disdain for any attempt to sell the *transportation* of water, (water cannot actually be sold in this manner) despite any benefits the County might receive. They also had worries that if the Council's water transfer recommendations were followed, that Citrus County's own prospects for development and growth would be jeopardized, turning developers away because of a depleted water supply.

6. Fla. Stat. §373.223(3). In order to pass the local sources first legislation, concessions in the form of statutory exemptions had to be made to satisfy legislators in an area of the Northwest Florida Water Management District and water bottlers in other areas of the state. This is what State Senator Nancy Argenziano stated in a letter to the editor of the St. Petersburg Times. *See* Nancy Argenziano, Letter Writer Misreads Local Water Statutes, ST. PETERSBURG TIMES Letters to the Editor, October 10, 2003.

regions made similar gestures, perhaps indicating a stronger sense of alarm than that conveyed by the typical North Florida local campaign stand against outside meddling with County water supply, but the extent of public outrage over long distance water transfers had implications beyond local politics.

Public outrage seemed more apt a description for the response of North Floridians in the autumn of 2003. In late November of 2003, for example, over a thousand people tried to gain entrance into the Chiefland High School auditorium to express their outrage to the Florida Senate Natural Resources Committee, who held a public meting there over the Report. Those who could not fit into the auditorium were led into the gymnasium, where the stands and floor were also filled with people who watched the meeting on television.[7] Senate President Jim King said three days before the report's release that "this is as close as North vs. South you're going to get since the Civil War."[8] Four days later he tempered his outlook, saying he had "some initial concerns" about taking water from one part of the state to another, but wanted a full discussion.[9] At the same time, however, Council of 100 members themselves began to back down form the idea of north south water transfers, with Charlie Ohlinger, the Council's executive director, claiming "we're not proposing stealing any water from the Suwannee River… we're just trying to get the conversation started."[10] Even in Southeast Florida, where the Council's water transfer recommendations might have seemed palatable, citizens and County commissions rejected the idea, with many in the region claiming that the state had a growth problem and not a water problem.[11]

Criticism from the environmental community was quickly forthcoming, as leading environmental advocates framed the report as a wish list for the development community. Eric Draper, conservation director for Audubon of Florida, said that the Council was "creating and inventing" the problem of a needed water supply increase of 26.4 percent, while David Guest of Earthjustice stated that "they inflated the numbers tremendously in an effort to try to

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7. Amy Wimmer Schwarb, Plan *to Transfer Water Meets Sea of Protest*, St Petersburg Times, November 21, 2003, online at www.sptimes.com.

8. Robert P. King, *Battle Lines Form over Water Law Rewrite*, PALM BCH. POST, September 22, 2003, at page 1A.

9. Craig Pittman, *Developers Tout Water Plan as Environmental Protection*, ST PETERSBURG TIMES, September 26, 2003, at page 5B.

10. *Id*. King at note 8.

11. Tal Abbady, *South Florida Opposes State Water Plan; Problem is Growth, Local Environmentalists and Residents Tell Senators*, SUN SENTINEL PALM BEACH EDITION, October 15, 2003, at page 3B; *See also* Robert P. King, *Lawmakers, Residents Reject Idea of Creating Statewide Water*, PALM BCH. POST, October 15, 2003, at page 8C.

demonstrate alternate sources of water aren't adequate."[12] Indeed, this criticism was repeated against the Council' report when Lee Arnold, Eric Draper, and former Southwest Florida Water Management District Executive Director Sonny Vergara sat on the water supply panel of the 10th Public Interest Environmental Conference, (PIEC) in February of 2004.[13] Lee Arnold did not back down from the Council's numbers, but by this time it was apparent that the idea of transferring water from North to South was out of the question for the moment, and Arnold downplayed that particular recommendation.[14]

At the same time, other groups had spoken out on Florida's water problems by releasing official reports. One of which, the Florida Water Coalition, included Earthjustice and Florida Audubon, David Guest's and Eric Draper's organizations respectively. The Coalition's report stressed the need for a water policy that supported the environment and did not promote growth.[15] A central idea to this policy proposal was that of establishing reservations for water bodies which would go beyond the minimum flows and levels by affirmatively setting aside water for the environment.[16] This process is ongoing; with some claiming that minimum flows and levels are adequate and others insisting that reservations are necessary to protecting the resource. Nonetheless, the panelists at the water supply panel of the10th PIEC suggested that despite growing pressures on water resources in Florida, reservations are likely to grow in number and in popularity as a means of protecting and restoring water bodies.[17]

The agricultural community has also been a consistently visible stakeholder in water quantity issues, with the Department of Agriculture and Consumer Services, (DACS) Office of Agricultural Water Policy, (OAWP) releasing a report in June of 2003 detailing the contribution of agriculture to the state's water resources and outlining its policy positions on the issues.[18] In its report, the OAWP stressed the value of agricultural land for its functions of recharge

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12. Neil Johnson and Allison North Jones, *Water Recommendations Flow to Governor*, TAMPA TRIB., September 26, 2003, at page 4.

13. Eric Draper, Remarks at the UF College of Law's 10th Annual Public Interest Environmental Conference Water Supply Panel (February 20, 2004). *Hereinafter* Water Supply Panel.

14. Lee Arnold, Remarks at the Water Supply Panel.

15. Water Policy for Protecting Nature, not Growth, A Report of the Florida Water Coalition. Available online at www.fladefenders.org/WaterCoalitionPositionPaper.pdf

16. *Id*. at 9-11.

17. Sonny Vergara, Remarks at Water Supply Panel, *supra* at note 13.

18. Florida's Agricultural Water Policy: Ensuring Resource Availability, A Report of the Florida Department of Agriculture and Consumer Services Office of Agricultural Water Policy, (June 2003). Available online at www.floridaagwaterpolicy.com.

maintenance and floodwater storage,[19] with 52% of Florida's 35 million acres covered by mostly non impervious agricultural land.[20] This is extremely important when considering how these essential hydrologic functions are to contribute to a sustainable water supply in Florida if development is to occur mostly on agricultural land. For this reason, local and state governments should be aware of the need for urban infill and community redevelopment, with the focus on agricultural lands being preservation of both the land and the economic viability of maintaining agricultural operations.

In conclusion, intra-state water supply and development are issues that will dominate in the 21st Century as decades of growth and consumption have set a trajectory for Florida that it may be hard to escape, considering the relative importance of real estate development to the state's economy. Luckily, however, Florida also has an active and organized environmental community advocating for natural systems while agriculture also remains a dominant force in state politics. At the same time, other industries such as nature tourism and aquaculture may come to more prominence as the battles over water wage. In the end, the most viable alternatives might look something like what the water management districts are now undertaking with the identification of alternative supply projects such as surface water instead of groundwater and desalinization,[21] providing water that may be more expensive for development than the Council of 100's proposed sources, but which become the compromise between building moratoria on the one hand and long distance north to south water transfers on the other.

2. Water for the Everglades

Indeed, Chapter 373 of the Florida Statutes allows the DEP and Water Management Districts to establish reservations for certain water bodies.[22] Reservations for the Everglades have been the source of much contention with different stakeholders wrangling over exactly how they are to be implemented without running afoul of an additional requirement in the relevant 373 provision that existing "legal uses" be protected so long as not contrary to the public interest.[23] Another wrinkle arises when the state law and federal law are combined, as the $8 billion Comprehensive Everglades Restoration Project, (CERP)[24] whose cost was supposed

19. *Id*. at pp. 4-6.
20. *Id*. at p. 4.
21. See www.sjrwmd.com/programs/watersupply.html.
22. Fla. Stat. §373.223(4)
23. *Id*.
24. See www.evergladesplan.org.

to be split even by the state and federal government, is also governed by both state law and federal law, specifically the Water Resources Development Act of 2000, (WRDA 2000) on the federal side, which requires reservations to be established before any federal funding for the project can be received.[25]

While Florida has to reserve water for the environment under state law to receive federal funding, it also must abide by WRDA 2000's "savings clause," which is similar to the protection of "existing legal uses" under Chapter 373.[26] Under this provision the federal and state CERP administrators are prohibited from eliminating or transferring any "existing legal source" of water until a source of water supply of comparable quantity and quality as that available on the date of enactment of WRDA 2000 is available to replace the water to be lost as a result of implementation of the Plan.[27] The combination of these similar state and federal law provisions has given rise to not a small amount of confusion over what the difference is between "existing legal uses" and "existing legal sources". At a CERP panel during the 9th Annual PIEC in 2003, the then General Counsel of the South Florida Water Management District explained that "sources" in federal law was a broader term than "uses" in state law.[28] From this viewpoint, it can be understood that "uses" denotes an actually permitted supply of water whereas "sources" refers to the collective supply of permittable water available in the system at the time of WRDA 2000's enactment.

Despite Florida's failure as of the start of 2005 to establish a rule for the reservation of water to the Everglades, the state has still received some $200 million from the federal government for CERP projects, but this is still a paltry sum compared to the $1 billion kicked in by the state so far.[29] Perhaps as a partial result of the as yet un-adopted Everglades reservations rule, there were a number of federal projects that by 2004 were being neglected under federal oversight. In October of 2004, Governor Jeb Bush announced the "Acceler8" program, which includes a $1.5 billion bond program to fund the completion of eight of these priority CERP projects

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25. Pub. L. No. 106-541, Title VI, §601(h)(4)(B).

26. Pub. L. No. 106-541, Title VI, §601(h)(5).

27. *Id.*

28. John Fumero, former General Counsel of the South Florida Water Management District, Remarks at the UF College of Law's 9th Annual Public Interest Environmental Conference CERP Panel (February 28, 2003). *See also* John Fumero, *Florida Water Law and Environmental Water Supply for Everglades Restoration*, 18 J. LAND USE & ENVTL. LAW 379 (2003)

29. *Everglades: Fla. stuck with more than its share of restoration bill, enviros say*, GREENWIRE, January 14, 2005.

whose federal funding is lacking.[30] In effect, the state has stepped into the shoes of the federal government for these projects, and it has not been without criticism, for example some have called to attention the fact that funding for the $1.2 billion Indian River Lagoon restoration is now lacking and that this was supposed to be an initial step in what will be a decades long process of Everglades restoration.[31] Meanwhile, other issues such as water quality and growth management are necessarily ancillary to the problem of how to allocate sufficient quantities of water to the system.

3. The Apalachicola Chattahoochee Flint River Basin

The conflict between Florida, Georgia, and Alabama over how water quantity should be regulated has been going on for years, but nonetheless represents a growing trend towards a situation more commonly seen in the west, where water scarcity necessitates a more careful analysis of how the resource is to be apportioned among competing states, and conflict is more endemic to the landscape. The west also has seen majority of costly court battles ending in allocation by equitable apportionment in the Supreme Court.[32] The failed compact between Florida, Georgia, and Alabama over the Appalachiacola-Chattahoochee-Flint (ACF) River System has recently reminded the eastern states that resorting to the original jurisdiction of the Supreme Court over water is possible anywhere that water scarcity is a problem.

Clashes over the Potomac between Virginia and Maryland, who recently invoked the Court's original jurisdiction, have been ongoing since the 17th Century, when two conflicting royal charters and a royal patent all granted the entire River to two Virginia grantees and one Maryland grantee.[33] The issue was a subject of both states' constitutional conventions in 1776, and in 1785 they went to Mount Vernon to have George Washington arbitrate their dispute.[34] Connecticut and Massachusetts contended in the Supreme Court in 1931 over the latter's right to use the waters of the Swift River to provide water for the Boston area,[35] and in that same year New

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30. *Id.*

31. *From Saving Everglades to Subsidizing Growth*, PALM BCH. POST, Editorial Section, November 26, 2004, at 14A

32. *See*, for example *Kansas v. Colorado*, 206 U.S. 46; *Wyoming v. Colorado*, 259 U.S. 419 (1922), later modified by *Wyoming v. Colorado*, 260 U.S. 1 (1922) and vacated in *Wyoming v. Colorado*, 353 U.S. 953 (1957); *See also*: *Nebraska v. Wyoming*, 325 U.S. 589 (1945); *Arizona v. California*, 373 U.S. 546 (1963); *Texas v. New Mexico*, 462 U.S. 554 (1983); *Colorado v. New Mexico*, 467 U.S. 310, 324 (1984).

33. *Virginia v. Maryland*, 540 U.S. 56, 60-63 (2003).

34. *Id.*

35. *Connecticut v. Massachusetts*, 282 U.S. 660 (1931).

York battled New Jersey and Pennsylvania before the Court over its use of the Delaware River.[36] Thus, water conflict is not new to the east, albeit not as ubiquitous as in the west. Whether other regions within the eastern riparian states will see such interstate conflict is yet to be seen.

Tri-state conflict over the waters of the ACF system has its origins in the Army Corps of Engineers' construction of the Buford Dam and Lake Lanier north of Atlanta, which was part of a congressionally approved development project for the ACF basin, completed in 1958.[37] One of the Corps' purposes for operating the dam is to provide municipal and industrial water for Atlanta, and in 1972 they began to conduct a congressionally approved study of water supply alternatives in response to pressure from the city.[38] In 1989, after three major droughts and no finding of sufficient alternatives, the Corps issued a draft Post-Authorization Change report recommending the reallocation of 20 percent of the Buford project's hydropower storage to supply, intending to slake Atlanta until 2010.[39] This prompted Alabama to sue the Corps in 1990, claiming the agency was favoring Georgia over other states in the basin.[40] Florida and Georgia were soon to intervene, along with a host of smaller organizations, but the parties agreed to attempt settlement in late 1990.[41] In 1992 the parties agreed to conduct a three year study of water resources in the basin which would be used to guide future negotiations.[42] The resulting *Comprehensive Water Resource Study* covers four main subjects: water resource demands, water resource availability, flood and drought management strategies, and coordination mechanisms.[43]

As the study was being conducted, the states entered into the ACF Compact to agree on an allocation of water between the three states.[44] The ACF Basin Commission was created by the compact to set up a formula for allocation, and any decision or action by its members, which included the governors of the three states and a non-voting federal member, required a unanimous vote, a major flaw in the compact according to commentators.[45] The deadline for

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36. *New Jersey v. New York*, 283 U.S. 336 (1931).

37. Roy R. Carriker, *Water Wars: Water Allocation Law & the Apalachicola-Chattahoochee-Flint River Basin*, Univ. of Fla. Coop. Extension Serv., Doc. FE 208 (2000). Available online at edis.ifas.ufl.edu/BODY_FE208.

38. *Id.*

39. *Id.*

40. *Ala. v. Corps of Engineers*, CV90-BE-1331-E (filed June 28, 1990).

41. Carriker, *supra* note 37.

42. *Id.*

43. *Id.*

44. *Apalachiacola-Chattahoochee-Flint River Basin Compact*, Pub. L. No. 105-104, (1997).

45. *See* Josh Clemons, *Interstate Water Disputes: A Roadmap for States*, 12

the allocation formula was December 31, 1998, but a number of extensions were provided, and the last deadline of August 31, 2003 was not extended, ending the compact. Florida refused to agree to an allocation formula that only gave minimum flows for the Apalachicola River, whose fresh water flows into the Apalachicola Bay and creates a delicate balance of nutrients and salinity that is needed for aquaculture in the bay, which accounts for ninety percent of the state's $70 million a year oyster industry.[46] Alabama's concerns in the dispute include higher hydropower costs, reduced pollution dilution, and the possibility of being unable to attract industry to the state.[47] Georgia's interest, as already stated, is in water supply for growing Atlanta, and it claims that it can do what it wished with waters under its sovereign authority.[48]

The next venue for the dispute is most likely to be the Supreme Court, as the other alternative besides negotiations and compacts is congressional apportionment, which has only been done twice and is avoided by Congress because of the regional nature of the disputes.[49] Going by other cases where the Supreme Court exercises original jurisdiction to engage in equitable apportionment, a Special Master will likely be appointed to make factual findings based on complicated scientific data, and those findings will then be used by each side to argue its position.[50] The Court will likely use its other equitable apportionment cases as a guide, particularly the ones involving eastern states. Florida and Alabama will have to prove by clear and convincing evidence that they have suffered injury form Georgia's water withdrawals, and will face the more daunting task of proving future industry, the weight of which will depend on the Special Master's findings.[51] The court will consider economic, social and environmental factors, and Florida also may argue that withdrawals will violate other federal laws including the Endangered Species Act and the Clean Water Act.[52] It has been said that Florida's biggest challenge in the dispute will be in proving up the importance of its aquaculture industry relative to Georgia's need to supply water for growth in Atlanta. Florida State University law

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SOUTHEASTERN ENVTL. L.J. 115, 139 (2004).

46. Dustin S. Stephenson, *The Tri-State Compact*: Falling Water and Fading Opportunities, 16 18 J. LAND USE & ENVTL. LAW 83 (2000).

47. Clemens, *supra* note 45, at 136.

48. *Id*.

49. *Id*.

50. C. Hansel Watt, IV, *Who Gets the Hooch?: Florida, Georgia, and Alabama Battle for Water from the Apalachicola-Chattahoochee-Flint River Basin*, 55 Mercer L. Rev. 1453, 1483-1485 (2004).

51. *Id*.

52. *Id*.

professor and water law expert J.B. Ruhl has recently described Florida as "an epicenter of the eastern version of water wars,"[53] and argues that the fight over the ACF basin signifies a movement east for western water conflict.[54] As he also points out, Georgia's economic interest should be balanced against the ecological injuries of Florida and Alabama, and those injuries eventually compound into economic injury.[55] In the end, it seems that Florida will have to be on the side of sound ecological management in order to advocate its position effectively in what will be a very unique equitable apportionment.

C. WATER QUALITY AND THE EVERGLADES

The Everglades has seen a flurry of activity concerning water quantity in connection with restoration, and these issues are not easily separated from water quality issues. At the same time, the Everglades presents a unique situation legally and administratively as it requires coordination and concurrency among the local, state, and federal governments as well as the Seminole and Miccosukee Indian Tribes. It can be seen how this situation would bring complications, but added to the mix is the panoply of stakeholders, including environmentalists, sugar growers, builders, the water works industry, and others, including the governmental interests named above. Between the Tribes, the different federal and state agencies, and the stakeholders, the Everglades and its continuing restoration is a virtual maelstrom of judicial and legislative activity.

1. Judge Hoeveler, the Everglades Forever Act, the Removal, and the Result

In 1988, Judge William Hoeveler got his judicial hands wet in the Everglades when then acting U.S. Attorney Dexter Lehtinen sued the South Florida Water Management District and the

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53. J.B. Ruhl *Equitable Apportionment of Ecosystem Services: New Water Law for a New Water Age*, 19 J. Land Use & Envtl. Law 47 (2003). Professor Ruhl describes the ACF conflict a "classic interstate water allocation fight between urban, agricultural, and rural areas of several states," *Id.* at 48. He also predicts that an equitable apportionment by the Supreme Court is likely, but that it would be unique in it possibly being the first major interstate apportionment case they have heard in the "age of mature statutory environmental law." *Id.* at 48-49. Professor Ruhl also argues that Florida's interest in natural stream flows

54. *Id.* at 47-48.

55. *Id.* at 53. Ruhl presents evidence to show that the economic value of the Apalachicola River and its floodplain basin are is equal or greater to that of Lake Lanier's recreational economy. The total economic value of the River and its basin is $5 billion in terms of recreation and other ecosystem services such as healthy estuaries, flood control, and nutrient regulation. *Id. See also* Gregory W. Garrett, *The Economic Value of the Apalachicola River and Bay* (Jan. 6, 2003) (unpublished masters degree paper).

Department of Environmental Regulation, (DER) now the Department of Environmental Protection, alleging violations of state water quality standards generally and phosphorous standards specifically in the Everglades National Park and Loxahatchee National Wildlife Refuge.[56] By 1991, a settlement was reached between the SFWMD, the DER, and the Department of Justice which was approved by Hoeveler and adopted as a consent decree.[57] The settlement eventually led to the passage of the Everglades Forever Act (EFA) in 1994 by the Florida legislature.[58] The EFA set the framework for implementation of Everglades restoration, and included the entire Everglades in its purview, not just the Everglades National Park and Loxahatchee National Wildlife Refuge, which were the subject of the original suit.[59]

The Act also authorized projects and funding for restoration with an original deadline of 2006, but in May of 2003 an amendment to the EFA was fast tracked through the Florida legislature by sugar interests that pushed the deadline for Everglades restoration up to 2016.[60] The bill was lambasted by U.S. Representative Clay Shaw, who asserted that the move would "cost Florida billions of dollars" in federal funding for the 8.4 billion CERP program.[61] Judge Hoeveler also criticized the bill publicly and scheduled a hearing on the issue at which the Miccosukee Tribe alleged that passage of the bill would destroy the EFA's goal of compliance with lower pollution standards by 2006.[62] Dexter Lehtinen, who brought the first Everglades suit in 1988 as U.S. Attorney General, was and is now advocating the tribe's position in Everglades cleanup. Judge Hoeveler, however, was taken off the case in September 2003 after a concerted effort by the sugar industry to have him removed.[63] In spite of what many considered to be a huge setback for the Everglades, however, his removal did not have the results that the sugar industry presumably wanted. His successor, Judge Federico Moreno, ruled in favor of the Miccosukee Tribe by appointing a Special Master to resolve technical disputes, which is in accordance

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56. *U.S. v. South Florida Water Management District*, Case No. 88-1886 CIV-HOEVELER (S.D. Fla. 1988)

57. *U.S. v. South Florida Water Management District*, 847 F. Supp. 1567 (S.D. Fla. 1992).

58. Fla. Stat. 373.4592

59. Keith Rizzardi, *Alligators and Litigators: A Recent History of Everglades Regulation and Litigation*, 75 Fla. Bar J. 18 (2001).

60. Fla. Stat. 373.4592.

61. Linda Kleindienst, Neil Santoriello, and Mark Hollis, *$4 Billion for 'Glades in Jeopardy: Shaw Sounds Alarm on State Bill*, SUN SENTINEL, April 24, 2003, at page 1A.

62. *Id.*

63. Scott McCabe and Robert P. King, *Judge Backs Tribe, Will Name Overseer on Everglades*, PALM BEACH POST, October 30, 2003, at page 2A.

with what Hoeveler himself would have done.[64] Also, while the EFA amendment saga was playing out, the environmentalists secured a victory in the legislature with the passage of a 10 parts per billion phosphorous standard in the Everglades, [65] although commentators have expressed reservations over whether the passage of the standard will actually lower phosphorous levels.[66]

2. South Florida Water Management District v. Miccosukee Tribe of Indians

On March of 2004, the Supreme Court reached a decision on one issue in *South Florida Water Management District v. Miccosukee Tribe of Indians*, 124 S. Ct. 1537 (2004), but remanded on another issue.[67] The case arose out of the segmented environment of South Florida and carries implications for a number of policy and legal issues, such as the interpretation of the word "point source" in the Clean Water Act and the future of water management policy for the state agencies. More importantly, however, the case deals with cultural survival and livelihood of the Miccosukee people, who live in the Everglades and depend on its ecological health for their own well being. Recent commentators have framed the case as a social and environmental justice question that was unfortunately neglected by the Supreme Court.[68]

The Miccosukee reservation lies on the west side of a major north-south running levee which separates their land and the surrounding Everglades from the immense urban development of Southeast Florida which encompasses most of Dade, Broward, and Palm Beach Counties. On the Miccosukee side of the levee are the Water Conservation Areas, (WCA's) which are state owned lands and remnants of the original Everglades, maintained by SFWMD for the purposes of conserving fresh water from running out to the ocean and protecting wetland habitat.[69] On the east side of the

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64. *Id.*

65. Fla. Stat. 373.4592(4)(e)(2).

66. Robert Malinoski, *The Phosphorous Standard and Everglades Restoration: Will this Standard Lower Phosphorous in the Everglade or id the Proposed Standard a Hollow Promise?* 12 U. MIAMI BUS. L. REV. 35 (2004).

67. *South Florida Water Management District v. Miccosukee Tribe of Indians*, 124 S. Ct. 1537 (2004).

68. *See* Casey Tippens Delaney, *Everglades, Dirty Water, and the Miccosukee Tribe: Will the Supreme Court Say Enough is Enough?* 28 AM. INDIAN L. REV. 349 (2003); Kristin Carden, *Case Comment: U.S. Supreme Court Environmental Case, October 2003 Term: South Florida Water Management District v. Miccosukee Tribe of Indians*, 28 HARV. ENVTL. L. REV. 549 (2004). Carden frames the issue in terms of environmental justice, pointing out that the case represents a fundamental problem of a majority population benefiting from disposal of waste water at the expense of a minority population. *Id.* at 555.

69. 124 S. Ct. at 1540.

levee, the SFWMD manages the Central and South Florida Project, which encompasses a series of canals and impoundments whose purpose is flood control. Ironically enough, the original goal was to divert water out to the ocean to achieve the goal of flood control.[70]

As part of its management of the canals of western Broward County, SFWMD operates pump station S-9, which pumps excess water out of the C-11 canal when its water reaches above a set level. [71] The water is the pumped across the levees and into WCA-3, and the canal water is of a different chemical composition than that of WCA-3 as it collects runoff from agricultural activities and urban runoff.[72] Of particular concern in the case are C-11's elevated levels of phosphorous, which causes growth of algae and foreign plants to the Everglades via WCA-3, which has lower phosphorous levels.[73]

The tribe's allegations were (1) that the pump was a "point source" requiring a National Pollutant Discharge Elimination System (NPDES) permit under Section 402 of the Clean Water Act[74] and (2) that C-11 and WCA-3 were separate water bodies for the purposes of the Act.[75] The court accepted the tribe's first argument, and held that the S-9 pump station was a "point source."[76] On the second issue, however, the Court remanded for further development of the record.[77] The SFWMD and its *Amici Curiae* argued that the two water bodies were not distinct, presenting before the Court a theory of "unitary waters" whereby point source discharges as set out in Section 402 did not apply to discharges within the same water body.[78] The issue of whether C-11 and WCA-3 are indeed distinct water bodies will be decided on remand, and if answered in the affirmative, will put an extra regulatory burden on the SFWMD, as it will have to get NPDES permits for every pump station it operates in the same manner. Ultimately, when the economic and social factors are weighed, the actual and potential cultural, social, and economic injury to the historically disadvantaged Miccosukee Tribe ought to outweigh the extra regulatory burden on the Corps. In the larger picture, this issue is just as prescient in the environmental justice arena as it is in the water regulation arena.

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70. Everglades Digital Library, Online at everglades.fiu.edu/library
71. 124 S. Ct. at 1540.
72. *Id*. at 1541.
73. *Id*.
74. 33 U.S.C. §1362
75. 124 S. Ct. 1542.
76. *Id*. at 1543
77. *Id*. at 1547.
78. *Id*. at 1543-47.

D. CONCLUSION

The last few years in Florida have brought new eastern life to the old western adage, "Whiskey is for drinking and water is for fighting," as regions, states, and cultures clash over an increasingly scarce resource. The conflicts are broad in scope now, affecting the state's growth, environment, and economy. The sustainable future of Florida depends on the availability of a sufficient quantity and quality of water, and that availability in turn depends on how different regional interests and stakeholder groups can come together and reach decisions that benefit the state environmentally, economically, and socially. These issues are now making it necessary for governmental entities from the federal down to the local level to pay closer attention to water resources, plan for their future use, and provide for the ecological health of entire systems, from the Everglades up to the Apalachicola Bay. In time, human infrastructure and capital may be able to transform the errors of the past into hope for the future.

ENVIRONMENTAL QUALITY AND HEALTH GOT MERC? REGULATING, MITIGATING AND LITIGATING MERCURY LEVELS FOR THE FISH WE EAT

Approaches of Public Health and Regulatory Agencies for Establishing Safe Levels of Exposure to Methylmercury

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I. BACKGROUND

Anthropogenic sources of mercury in the environment are primarily released from fossil-fuel power plants, especially coal-fired utility boilers. It is estimated that these plants release 40 tons of mercury annually in the United States.[1] Globally, coal-fired power plants and waste incinerators release about 1,500 tons of mercury annually.[2] Once introduced to the environment, the conversion of inorganic mercury to methylmercury occurs primarily in microorganisms especially in aquatic systems. Once in the methylated form, mercury bioaccumulates up the food chain; fish consume the microorganisms, and larger predatory fish consume the smaller fish (See Figure 1). But, mercury is not only found in fish but also other man-made materials, like dental amalgam. Thus, human exposure to mercury may be in the form of methylmercury *via* consumption of contaminated fish — particularly large predatory fish species such as tuna, swordfish, and shark[3] - or as elemental mercury released from dental amalgam — which may contain approximately 50% mercury.[4] In the absence of fish consumption, the mean concentration of mercury in whole blood is of the order of 5 – 10 mg/L (5 – 10 ppb);[5] this concentration is likely due to dental amalgams, since inorganic mercury is not readily retained in the body compared to methylmercury and elemental mercury.[6] Furthermore, human exposure to methylmercury from non-fish sources is very low.[7]

Once methylmercury is consumed, the estimated total body half-life is 70 – 80 days.[8] Methylmercury is primarily eliminated from the body via feces (~90%) with the remainder excreted in the urine as mercuric mercury.[9] Methylmercury that reaches the brain is slowly biotransformed to inorganic mercury, as is elemental mercury.[10],[11] However, it is not clear whether the deleterious effects of methylmercury at the cellular level in the central nervous system are caused by methylmercury or its metabolite.[12] If the toxicity of

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1. National Research Council (NRC), *Toxicological effects of methylmercury*, 1, 1 (2000), http://www.nap.edu/books/0309071402/ html/.
2. M. Cone, *High levels of toxin seen at 9 chlorine plants*, LOS ANGELES TIMES A20, (January 26, 2005).
3. NRC, *supra* note 6, at 13.
4. *Id*. at 41.
5. *Id*.
6. *Id*.
7. *Id*.
8. *Id*. at 50.
9. *Id*. at 49.
10. *Id*. at 52.
11. *Id*. at 56.
12. *Id*. at 56-57.

methylmercury is in fact due to its inorganic metabolite, then the risks of toxicity from mercury from fish and dental amalgams may be cumulative.[13]

The deleterious effects of methylmercury on the central nervous system were tragically revealed with the mass poisonings that occurred in Minamata Bay, Japan in the 1950s and 1960s and Iraq in 1974.[14] Both of these mass poisonings were attributed to the consumption of methylmercury either from fish that fed on microorganisms tainted with mercury-laden industrial effluent or grain dusted with methylmercury as a fungicide, respectively.[15] These tragedies revealed the susceptibility of both the adult and fetal brain to methylmercury, although the developing nervous system was shown to be more sensitive.[16] Differences in susceptibility have also been observed based on gender. For instance, in the Iraqi epidemic, neurological sequelae were observed with three times as many females as males.[17] Opposite gender-specific effects have been noted among infants and children with males exhibiting greater effects than females.[18] Moreover, the clinical manifestations of methylmercury-induced neurotoxicity varied with the degree of exposure and the age of the victims.[19] In adults, the most prominent sites of injury were to areas of the brain controlling vision and voluntary muscle control.[20] In children, especially those exposed *in utero*, the damage to the central nervous system was widespread and resulted in mental retardation and paralysis.[21],[22]

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13. *Id.* at 57.

14. D. C. Anthony et al., CASARETT & DOULL'S TOXICOLOGY: THE BASIC SCIENCE OF POISONS, 544 (Curtis D. Klaassen ed., 6th ed., McGraw-Hill 2001).

15. *Id.*

16. NRC, *supra* note 6, at 53.

17. *Id.* at 74.

18. *Id.*

19. Anthony et al., *supra* note 19, at 544.

20. *Id.* (Massive degeneration to the neurons of the visual cortex and the small internal granular cell neurons of the cerebellar cortex lead to blindness and marked ataxia, respectively.)

21. *Id.*

22. L. G. Costa et al., *Developmental neuropathology of environmental agents*, 44 ANNU. REV. PHARMACOL. TOXICOL. 87, 88 & 90 (2004). (The susceptibility of the developing brain is based on the timing of neuronal development, the rapid growth that occurs in the third trimester and early infancy, and the lack of a protective barrier early in life. In the cerebellum, Purkinje cells develop early, weeks 5-7 in humans, whereas granule cells are generated much later, gestational weeks 24-40 in humans. The developing brain is distinguished by the absence of a blood-brain barrier. The development of this barrier is a gradual process, beginning *in utero* and complete at approximately six months of age. Because the blood-brain barrier limits the passage of substances from blood to brain, in its absence, toxic agents can freely enter the developing brain.)

Due to the public health concerns over levels of methylmercury and adverse health effects, several studies have been conducted to monitor the levels of methylmercury in readily obtainable samples. Typically, monitoring for methylmercury is performed using scalp hair, blood, or both.[23] Methylmercury incorporated into hair can serve as a historical record by comparing the segment of growth with an approximated time period of exposure.[24] About 90% of the mercury present in hair is in the form of methylmercury; however, external deposition of mercury compounds can pose one source of error, and requires adequate washing of the hair sample to minimize this source or error.[25] During late gestation, the level of mercury in umbilical cord blood is expected to most closely correlate with fetal-brain mercury concentrations, although umbilical cord blood is expected not to correlate as well with mercury intake compared to maternal hair mercury concentration.[26]

Three large epidemiological studies have been conducted in populations that consume fish as a regular part of their diets. Two of these studies, one conducted in the Faroe Islands[27] and one in New Zealand[28], found an association between prenatal exposure to methylmercury and decrements in tests used to measure neurological development; however, a third major study conducted in the Seychelles Islands[29] did not find an adverse association.[30] These studies have formed the basis for establishing safe levels of exposure to methylmercury. However, controversy has shrouded this process because of the studies selected (*e.g.*, Faroe Islands versus Seychelles Islands) and the levels of uncertainty applied to deriving safe levels by different agencies. This article will provide an overview of the most frequently used studies for deriving safe levels of methylmercury and will address the process used by different agencies in study selection and addressing areas of uncertainty.

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23. NRC, *supra* note 6, at 38.
24. *Id.*
25. *Id.*
26. *Id.* at 7.
27. Group of islands between the Norwegian Sea and the North Atlantic Ocean; geographic coordinates: 62° 00' N, 7° 00' W.
28. Island country located in the South Pacific Ocean, southeast of Australia; geographic coordinates: 36° 51' S, 174° 46' E.
29. Group of islands in the Indian Ocean, northeast of Madagascar; geographic coordinates: 4° 35' S, 55° 40' E.
30. NRC, *supra* note 6, at 4.

II. EPIDEMIOLOGY STUDIES USED BY DIFFERENT AGENCIES

In evaluating the adverse health effects due to prenatal (*in utero*) exposure to methylmercury for the establishment of a reference dose, three major study cohorts are often cited: the Faroe Islands birth cohort, Seychelles Child Development Study (SCDS), and a study focusing on a sample of children from New Zealand. These longitudinal studies[31] all focus on prenatal exposure to methylmercury *via* fish and marine animal consumption by pregnant women. Methylmercury levels have also been measured in different populations worldwide including pregnant women in the Madeira Islands (Portugal),[32] residents around the St. Laurence River Basin (Quebec, Canada),[33] and mother-infant pairs along the Upper Madeira River (Brazil)[34] and Mancora (Peru).[35] Additionally, reports have been cited on high-level exposures to methylmercury in Iraqi children, residents of Minamata Bay (Japan), and in animal studies. However, the Faroe Islands, Seychelles, and New Zealand studies are preferred by regulatory agencies for determining safe levels of exposure because they are more reflective of low-level exposures to methylmercury that may occur in the general population.

Briefly, the Faroe Islands cohort study consisted of 1,022 births assembled between 1986 and 1987. Prenatal exposure was measured by cord blood[36] collected at birth with subsequent methylmercury exposure measured *via* hair samples collected from children at ages 7 and 14 years. In the most recent assessment,[37] at age 14 years, 878 of the children from the original cohort were evaluated for neurodevelopment effects.[38] Study findings were consistent with a previous evaluation[39] — of the same cohort at age

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31. A study in which an individual or group of individuals is followed over a period of time to discover changes that may be attributable to exposure in the form of a treatment or environment, or influenced by maturation.

32. A. Renzoni et al., *Mercury levels along the food chain and risk for exposed populations*, 77 ENVIRON. RES. 68, 68-72 (1998).

33. K. R. Mahaffey & D. Mergler, *Blood levels of total and organic mercury in residents of the upper St. Lawrence River Basin, Quebec: association with age, gender, and fish consumption*, 77 ENVIRON. RES. 104, 104-14 (1998).

34. A. A. P. Boischio & E. Cernichiari, *Longitudinal hair mercury concentration in riverside mothers along the Upper Madeira River (Brazil)*, 77 ENVIRON. RES. 79, 79-83 (1998).

35. D. O. Marsh et al., *Fetal methylmercury study in a Peruvian fish-eating population*, 16 NEUROTOXICOLOGY 717, 717-26 (1995).

36. Also referred to as umbilical cord blood; blood collected from the umbilical cord of a fetus or newborn.

37. K. Murata et al., *Delayed brainstem auditory evoked potential latencies in 14-year-old children exposed to methylmercury*, 144 J. PEDIATR. 177, 177-83 (2004).

38. Details of the rationale for exclusion of the remainder of the original cohort were not provided.

39. P. Grandjean et al., *Cognitive performance of children prenatally exposed to "safe" levels*

7 years — that claim prenatal exposure to methylmercury may result in neurotoxic effects as indicated by prolonged III-IV interpeak latencies.[40]

The SCDS originally enrolled 779 mother-infant pairs from 1989 to 1990 with maternal hair samples collected at time of birth to determine the level of prenatal methylmercury exposure.[41] Children were enrolled into the study at six months of age with evaluations of neurodevelopmental effects performed at ages 0.5, 1.3, 2.4, 5.5, and 9 years. The most recent evaluation[42] of this cohort of 643 children at age 9 years,[43] reported an association with decreased performance in the grooved pegboard test using the non-dominant hand in males, and improved scores on the hyperactivity index of the Conner's teacher rating scale - both tests are designed to detect neurodevelopmental deficits. These findings are consistent with previous studies[44] in this cohort in which the results do not provide evidence to support an association between prenatal exposure to methylmercury and neurodevelopmental effects.

The New Zealand study compared children of mothers with high hair mercury levels (> 6 ppm) during pregnancy with children whose mothers had lower hair mercury levels.[45] Hair samples were collected from 10,970 new mothers between 1977 and 1978. Sixty-one children with mothers that originally reported high fish consumption and had high hair mercury levels, were matched with three controls each, at 6-7 years, to evaluate the potential neurodevelopmental effects of methylmercury exposure from maternal fish consumption. A statistical association was found between high prenatal exposure and decreased neurodevelopment test performance.

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of methylmercury, 77 ENVIRON. RES. 165, 165-72 (1998).

40. Brainstem auditory evoked potential (BAEP) is measured by a four-channel electromyograph with peaks used to reflect volume-conducted electric activity from the acoustic nerve (Peak I), pons (Peak III), and midbrain (Peak IV). Peak latencies correspond to the conduction time from the retina to the visual cortex.

41. Exposure was determined by assuming a hair growth rate of 1.1 cm/month and a delay of 20 days between current blood concentrations and appearance of mercury in the first cm of scalp hair.

42. G. J. Myers et al., *Prenatal methylmercury exposure from ocean fish consumption in the Seychelles child development study*, 361 LANCET 1686, 1686-92 (2003).

43. Of the original 779 children, 717 (92%) were still eligible at age 9 years. Of the eligible children an additional 74 children were not tested with details of exclusion not provided. Final sample size: 643 children.

44. P. W. Davidson et al., *Effects of prenatal and postnatal methylmercury exposure from fish consumption on neurodevelopment: outcomes at 66 months of age in the Seychelles Child Development Study*, 280 JAMA 701, 701-7 (1998).

45. K. S. Crump et al., *Influence of prenatal mercury exposure upon scholastic and psychological test performance: benchmark analysis of a New Zealand cohort*, 18 RISK ANAL. 701, 701-13 (1998).

Findings from these cohorts and subsequent extrapolations of reference doses for methylmercury, especially between the Faroe Islands studies and the Seychelles studies, have been controversial. The crux of controversy has been the discrepancy in findings between the two studies, *i.e.*, studies from the Faroe Islands cohort have found an association between prenatal methylmercury exposure and neurodevelopmental effects in children, while studies rooted in the Seychelles cohort do not support this hypothesis. A side-by-side comparison of findings from these cohorts is a not a straightforward process, as the study logistics for each cohort differs in a marker for prenatal exposure and measurement of neurodevelopmental effects as well as a number of other confounding factors.[46] In the assessment of neurodevelopmental effects, a series of tests are performed to evaluate neurocognitive and behavioral function as well as language, memory, motor and perceptual motor skills (Table 1).

As the two main studies, *i.e.*, the Faroe Island and Seychelles studies, are longitudinal in design, they are both subject to the same general shortcomings such as the lack of a proper comparison group, as all persons in the studies had some level of exposure to methylmercury. To obtain a more accurate reflection of the true relationship between methylmercury exposure during pregnancy and neurological development, a proper comparison group is necessary. Ideally, the comparison group would be as similar as possible to the exposed mother-child pairs with the exception of being exposed to methylmercury. Such a comparison group would rule out cases with neurolodevelopmental effects that were independent to methylmercury exposure and adjust for factors such as level of fish consumption, socioeconomic status, and demographics.

Some of the specific issues relating the Faroe Islands and Seychelles cohorts are outlined in Table 2. Among these is the use of cord blood and maternal hair samples as markers of prenatal exposure. In studies of methylmercury exposure in Minamata, Japan, where prenatal effects from ingestion of mercury-contaminated fish was first recognized, umbilical cord samples were used to estimate exposure. Such samples were attainable because of the Japanese tradition to keep part of the umbilical cord after birth.[47] It should be noted that data derived from the Japanese cohort is thus subject to bias, as only mothers that practiced the tradition and were willing to participate in the study were included.

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46. An unknown or unaccounted factor in a study that may cause bias.

47. H. Akagi et al., *Methylmercury dose estimation from umbilical cord concentrations in patients with Minamata disease*, 77 ENVIRON. RES. 98, 98-103 (1998).

Cord blood samples, collected at birth, served as the prenatal biomarker for estimating methylmercury exposure in the Faroe Islands studies. Cord blood use is criticized because of its 50-day half-life and the inability to adequately measure methylmercury exposure that might result from binge eating during the first trimester of pregnancy.[48] Maternal hair samples, as used in the Seychelles studies, have been frowned upon due to the uncertainty of the dose that may be delivered to the fetus[49] and the lack of evidence to confirm that such samples are adequate biomarkers for *in utero* exposure. Maternal hair sample use is further scrutinized because the Seychelles studies have, thus far, failed to produce evidence to support the notion of neurodevelopmental risk from prenatal exposure to methylmercury.[50] Currently, there is no consensus on the most appropriate biomarker for assessing prenatal exposure to mercury.

Another major controversial issue between the Faroe Islands study and the SCDS is the form of methylmercury exposure. Methylmercury exposure among Seychellois is primarily *via* ingestion of contaminated fish. The most recent study of this population found a positive association between methylmercury exposure and better performance on one of the neurodevelopmental tests.[51] This finding could be a confounder in which increased methylmercury exposure serves as a marker for increased fish consumption and better nutrition. Proponents of the Seychelles studies claim that the predominant exposure to methylmercury is *via* fish consumption, and thus the study findings are more reflective of potential health events in the general population. In addition to fish consumption, whale meat and blubber comprise a significant proportion of the Farose diet. Whale meat and blubber have been found to have higher levels of methylmercury (up to 3 ppm).[52] A further confounder with consumption of whale meat is the exposure to other environmental contaminants such as PCBs and dioxins,[53] both of which have potential for adverse human health effects, including developmental neurotoxicity.[54],[55]

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48. D. R. Palumbo et al., *Association between prenatal exposure to methylmercury and cognitive functioning in Seychellois children: a reanalysis of the McCarthy Scales of Children's Ability from the main cohort study*, 84 ENVIRON. RES. 81, 81-8 (2000).

49. Grandjean et al., *supra* note 44.

50. Myers et al., *supra* note 47.

51. Murata et al., *supra* note 42.

52. Palumbo et al., *supra* note 53, at 87.

53. *Id*.

54. G. Winneke et al., *PCB-induced neurodevelopmental toxicity in human infants and its potential mediation by endocrine dysfunction*, 181-182 TOXICOLOGY 161, 161-165 (2002).

55. M. Kakeyama & C. Tohyama, *Developmental neurotoxicity of dioxin and its related compounds*, 41 IND. HEALTH 215, 215-230 (2003).

The issues raised in discussing the most cited reports from the Faroe Islands and Seychelles studies, in conjunction with the discrepancies in comparative diets, possibly containing other contaminants, add to the uncertainty in determining a safe level of methylmercury in the diets of pregnant or lactating women and have been addressed with various approaches from different agencies for the establishment of safe levels of exposure.

III. HEALTH ASSESSMENTS FOR METHYLMERCURY

The recommended acceptable levels of methylmercury exposure by federal and state governments as well as by international organizations are summarized in Table 3. Two federal agencies are responsible for regulating mercury in the United States. The U.S. Environmental Protection Agency (U.S. EPA) monitors mercury levels in the environment and regulates industrial releases to the environment. The U.S. Food and Drug Administration (U.S. FDA) ensures levels of mercury in commercially sold seafood and fish do not exceed its action level. In addition, the U.S. FDA also regulates the use of mercury compounds in the cosmetics industry. The U.S. Agency of Toxic Substances and Disease Registry (U.S. ATSDR), although not a regulatory agency, also assesses the health effects of environmental pollutants.

The U.S. EPA derived the reference dose (RfD) for methylmercury using a series of benchmark dose analyses by the National Research Council (NRC) of the National Academy of Sciences.[56] Three longitudinal prospective studies were evaluated and adverse effects were identified in the Faroe Islands and the New Zealand studies but not in the Seychelles study. U.S. EPA evaluated all three studies for the purpose of deriving an RfD. That is, they were all considered as critical (principal) and supporting studies. U.S. EPA defines a critical (principal) study as the study that contributes most significantly to the qualitative and quantitative assessment of risk, and supporting studies as those studies that contain information that are useful for providing insight and supporting conclusions.[57]

The RfD was derived based on developmental neurological abnormalities in human infants. A summary of this derivation is available in several public domains.[58] Briefly, five endpoints from

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56. U.S. EPA, *Methylmercury (MeHg) (CASRN 22967-92-6)* (2001), http://www.epa.gov/iris/subst/0073.htm#bib.

57. U.S. EPA, http://www.epa.gov/iris/gloss8.htm#c. (Critical Study: The study that contributes most significantly to the qualitative and quantitative assessment of risk. Also called Principal Study.)

58. U.S. EPA, http://www.epa.gov/IRIS/subst/0073.htm; See also: Rice et al., *Methods and*

the Faroe Islands study were performed by benchmark dose analysis (BMD) to converge potential RfDs of 0.1 µg/kg-day, as did the integrative analysis of all three studies. The endpoint is defined by U.S. EPA as n observable or measurable biological event or chemical concentration (*e.g.*, metabolite concentration in a target tissue) used as an index of an effect of a chemical exposure. [59]A total uncertainty factor of 10 was applied for intrahuman toxicokinetic [60]nd toxicodynamic [61]ariability and uncertainty. The uncertainty (or variability) factor is defined as "one of several, generally 10-fold, default factors used in operationally deriving the RfD and RfC from experimental data. The factors are intended to account for (1) variation in susceptibility among the members of the human population (*i.e.*, interindividual or intraspecies variability); (2) uncertainty in extrapolating animal data to humans (*i.e.*, interspecies uncertainty); (3) uncertainty in extrapolating from data obtained in a study with less-than-lifetime exposure (*i.e.*, extrapolating from subchronic to chronic exposure); (4) uncertainty in extrapolating from a lowest observed adverse effect level (LOAEL) rather than from a no observed adverse effect level (NOAEL); and (5) uncertainty associated with extrapolation when the database is incomplete.[62]In more details, benchmark doses (BMDs) were calculated for a number of endpoints for all three studies and the lower limit on the 95% confidence interval of the BMD (the BMDL) was calculated accordingly. In other words, a benchmark response (BMR) of 0.05 was chosen which could result in a doubling of the number of children with a response at or below the 5th percentile in an unexposed population. By U.S. EPA definition, BMR is n adverse effect, used to define a benchmark dose from which an RfD (or RfC) can be developed. The change in response rate over background of the BMR is usually in the range of 5-10%, which is the limit of responses typically observed in well-conducted animal experiments. These[63] BMDLs were considered as potential points of departure (PODs), as for a NOAEL for example,

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rationale for derivation of a reference dose for methylmercury by the US EPA, 23 RISK ANAL. 107, 107-115 (2003).

59. U.S. EPA, *http://www.epa.gov/iris/gloss8.htm#e.* (Endpoint: An observable or measurable biological event or chemical concentration [*e.g.*, metabolite concentration in a target tissue] used as an index of an effect of a chemical exposure.)

60. U.S. EPA, *http://www.epa.gov/iris/gloss8.htm#t.* (Toxicokinetics: The determination and quantification of the time course of absorption, distribution, biotransformation, and excretion of chemicals [sometimes referred to as pharmacokinetics]).

61. *Id.* (Toxicodynamics: The determination and quantification of the sequence of events at the cellular and molecular levels leading to a toxic response to an environmental agent [sometimes referred to as pharmacodynamics]).

62. U.S. EPA, *http://www.epa.gov/iris/gloss8.htm#u.*

63. U.S. EPA, *http://www.epa.gov/iris/gloss8.htm#b.*

for the RfD derivation. POD is "the dose-response point that marks the beginning of a low-dose extrapolation. This point can be the lower bound on dose for an estimated incidence or a change in response level from a dose-response model (BMD), or a NOAEL or LOAEL for an observed incidence, or change in level of response.

The California Environmental Protection Agency (CalEPA) developed Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986) safe harbor levels no significant risk levels (NSRLs) for carcinogens and maximum allowable daily levels (MADLs) for chemicals that cause developmental and reproductive toxicity.[64] The MADL is the level at which the chemical would have no observable adverse reproductive effect assuming exposure at 1,000 times that level. The NSRLs and MADLs are promulgated in Title 22, California Code of Regulations, (CCR) Sections 12705 and 12805, respectively, to assist interested parties in determining whether discharges to sources of drinking water are prohibited. For the purpose of Proposition 65, a NOEL of 5 μg/kg-day was derived based on an animal study. The dose level was calculated by multiplying the selection NOEL by the assumed female human body weight of 58 kilogram per CCR 12803. (a)(7)(b). Using the NOEL, the MADL microgram per day dose level was calculated to be 290. [65] To derive the Proposition 65 MADL, the converted NOEL was derived by a scientifically undefined factor of 1,000. Using the 290 μg/day NOEL, the MADL for methylmercury was calculated to be 0.3 μg/day, for both oral and inhalation routes of exposure.

The U.S. FDA established the action level of 1 ppm for methylmercury in the edible portion of fish. The level was established to limit consumers' methylmercury exposure to levels 10 times lower than the lowest levels associated with adverse effects (paresthesia) observed in the poisoning incidents.

The U.S. ATSDR chronic oral minimal risk level (MRL) of 0.3 μg mercury/kg-day was based on the neurodevelopmental effects in a study where children were exposed *in utero* to methylmercury from maternal fish consumption. In more detail, the MRL is based on the results of the SCDS, which followed over 700 mother-infant pairs and tested from parturition through 66 months of age (however, more recent data on this cohort in now available).[66] The SCDS testing used maternal hair mercury as the index of fetal exposure. Developing fetuses were exposed *in utero* through maternal

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64. *Id*.

65. M. Bornhausen et al., *Operant behavior performance changes in rats after prenatal methylmercury exposure*, 56 TOXICOL. APPL. PHARMACOL. 305, 305-310 (1980).

66. Davidson et al., *supra* note 49; U.S. Agency of Toxic Substances and Disease Registry (U.S. ATSDR), 509 (1999), http://www.atsdr. cdc.gov/toxprofiles/tp46.html.

consumption of fish before and during pregnancy. None of the tests in the study indicated an adverse effect of methylmercury. Hence, the highest exposure in the study (1.3 μg/kg-day) is considered a NOAEL by U.S. ATSDR and formed the basis for derivation of the chronic oral MRL for methylmercury. An aggregate uncertainty factor of 4.5 was based on three components with two being interrelated and the other being independent. The two interrelated values were added to give a composite uncertainty factor of three, *i.e.*, 1.5 + 1.5 = 3.0, to account for the full range of variability (including human pharmacokinetic and pharmacodynamic variability) to be conservative. The independent factor of 1.5, which was used to address the domain-specific findings, as in the Faroe study but not in the SCDS study, was then multiplied by the aforementioned uncertainty factor of three (for uncertainty attributable solely to the SCDS) to yield an uncertainty factor of 4.5. Thus, the chronic oral MRL for methylmercury was set at 0.3 μg/kg-day (1.3 μg/kg-day / 4.5 (UF) = 0.3 μg/kg-day).

A meeting of the Joint Food and Agriculture Organization of the United Nations/WHO Expert Committee on Food Additives (JECFA) was held in Rome, Italy, from 10 to 19 June 2003. The committee established a Provisional Tolerable Weekly Intake (pTWI) based on two epidemiological studies (Faroe Islands birth cohort and SCDS) that investigated the relationship between maternal exposure to mercury and impaired neurodevelopment in their children. The committee considered the update pTWI of 1.6 μg/kg-week (see below for previous pTWI information) sufficient to protect the developing fetus, the most sensitive subgroup of the population. For pTWI derivation, a steady-state intake of 1.5 μg/kg-day was estimated to represent the exposure that would be without appreciable adverse effects in children, and a total uncertainty factor of 6.4 (2 x 3.2) was applied. Detailed descriptions regarding how the steady-state intake and uncertainty factors were calculated and decided, respectively, are provided in Table 3. It should be noted that the JECFA previously derived a pTWI of 3.3 μg/kg body weight per week (JECFA June 1999 meeting), and the NRC established an intake limit of 0.7 μg/kg body weight per week.

The Canadian provisional tolerable daily intakes (pTDIs) are based on the previous JECFA pTWI in adults of 3.3 μg/kg body weight per week (June 1999 JECFA meeting). For adults, a pTDI of 0.5 μg/kg-day (3.3 / 7.0) was recommended. And for women of childbearing ages and children, a pTDI of 0.2 μg/kg-day was based on a qualitative assessment of available data.

IV. CONCLUSIONS

Public health-based risk guidance numbers are traditionally developed by selecting a critical study that is relevant with regards to exposure levels and sources of exposure to the population of concern. Epidemiological studies that are well-designed and executed, are preferable to animal studies. Additionally, studies that identify the most sensitive or conservative measure (*e.g.*, the NOAEL, LOAEL, or BMDL) provide public health and regulatory agencies with the greatest confidence in developing safe levels of exposure.[67]

As discussed in Section III, different agencies have used different studies for calculating their respective safe level values for methylmercury. For example, CalEPA utilized an animal study, whereas the U.S. ATSDR chose a longitudinal epidemiology study. It is likely, however, that CalEPA will update their value given the body of information available on human subjects, *i.e.*, the Faroe Islands, Seychelles, and the New Zealand studies (personal communications). These studies contribute a substantial amount of knowledge to understanding the effects of chronic low-level methylmercury exposures.

The similarities and differences between the Faroe Islands and Seychelles studies have stirred much debate as to which is more appropriate as a critical study. For instance, maternal exposure levels to methylmercury are similar in both studies, yet the disparate findings may be reflective of differences in cohort characteristics or differences in study design. Further items of controversy include differences in the pattern of exposure and co-exposures to other neurodevelopmental toxicants in the Faroe Islands cohort (*i.e.*, PCBs). Though it has been deemed a shortcoming in the Faroe Islands cohort, it is interesting to note that one re-analysis of this data found an association between mercury exposures and language and verbal deficits, regardless of PCB level. [68]

Despite the aforementioned differences, these studies, as compared to the high-level exposures observed in the Iraqi outbreak and the disaster in Japan, represent exposure scenarios that are more consistent with potential exposure in the United States. [69] However, the differences present a distressing choice when choosing a critical study, applying uncertainty factors, and establishing a safe level of exposure. Though the Seychelles study is well designed and

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67. NRC, *supra* note 6.
68. Winneke et al., *supra* note 59.
69. NRC, *supra* note 6, at 312-313.

it is possible to derive a lower limit approximation of a NOAEL or BMD, the choice of a negative study to derive guidance numbers when well-designed positive studies are available would be contrary to the conservative nature of risk assessment guidelines. In addition, there is no consensus in the application of uncertainty factors within agencies in the United States or worldwide. Scientific policy judgment governs the selection and application of uncertainty factors, and ultimately the calculation of risk-management guidance numbers.

In summary, a conservative approach in establishing guidance numbers for methylmercury is warranted because the time at which neurological damage might manifest is uncertain, and thus may appear later in life in those children who display modest changes in neuropsychological performance tests. The issue of "silent" neurotoxicity is similar to that of carcinogenicity; whereby a chemical-exposure may seem to be innocuous over many decades, yet ultimately result in the development of cancer. Because of this, the basic tenet of risk assessment must be followed in that the values established by regulatory and public health agencies protect, rather than predict adverse neurodevelopmental outcomes.[70]

70. Costa et al., *supra* note 27, at 99.

V. FIGURES

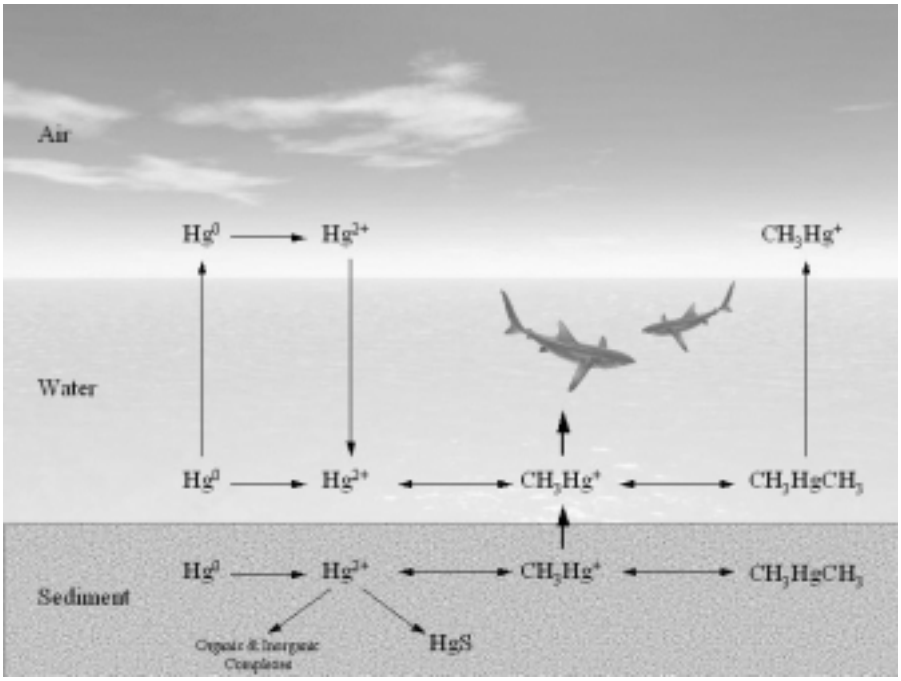

Figure 1. Fate and Transport of Mercury in the Environment. Mercu[71]y has three valence states (elemental mercury, Hg^0; mercurous mercury, Hg^{1+}; and mercuric mercury, Hg^{2+}). Metallic mercury and various inorganic and organic complexes can be found in the environment. Degassing of elemental mercury occurs at the surface of soils and bodies of water. Once in the environment, the interconversion of different species of mercury can occur («). Mercuric mercury can be converted to insoluble complexes of mercury sulfide (HgS) or into methylmercury (CH_3Hg^+) and dimethylmercury (CH_3HgCH_3) by microorganisms in aquatic systems. The microorganisms may then be consumed by fish, which are consumed by larger fish, and eventually by large predatory fish, like shark. This results in an accumulation of methylmercury up the food chain.

71. NRC, *supra* note 6, at 17.

VI. TABLES

TABLE 1. OVERVIEW OF STUDY COHORTS IN SEYCHELLES, FAROE ISLANDS AND NEW ZEALAND

Table 1. Overview of study cohorts in Seychelles, Faroe Islands and New Zealand

	Seychelles (SCDS)[72]	Faroe Islands[73]	New Zealand[74]
Size of original cohort	779 mother-infant pairs	1022 births	237 children[a]
Exposure	Fish and shellfish	Whale meat and blubber; fish and shellfish	Fish and shellfish
Measurement of prenatal exposure	Concentration of MeHg in maternal hair collected upon delivery	Concentration of MeHg in cord blood	Concentration of MeHg in maternal hair
Level of prenatal exposure	Mean (SD): 6.9 ppm (4.5 ppm)	Up to 174 μg/L	Range: 0 mg/kg - > 6 mg/kg
Measurement of neurodevelopmental effects	Series of tests including: • CBCL • CTRS hyperactivity index • Finger tapping • Grooved pegboard • VMI • W-J applied problems • WJ letter/word recognition	Series of tests including: • Bender copying errors • Brainstem latency measurements • Boston naming test • CPT reaction time • CVLT: delayed recall • Finger tapping	Series of tests including: • TOLD language development • McCarthy perceptual performance • McCarthy motor test • WISC-R: Performance IQ • WISC-R: Full-scale IQ
Children age at assessment	5.5. years, 9 years	7 years, 14 years	4 years, 6-7 years
Exclusion	Mothers and children with disorders highly associated with adverse neurodevelopment, *e.g.*, epilepsy, traumatic brain injury *etc.*	Children with neurological disorders thought to be independent of MeHg exposure, *e.g.*, epilepsy, Tourette syndrome *etc.*	Not listed.

CBCL = children's behavior checklist; CPT = Neurobehavioral Evaluation System (NES2) Continuous Performance Test; CTRS = Connors Teachers Rating Scale; CVLT = California Verbal Learning Test; IQ = intelligence quotient; MeHg = methylmercury; ppm = parts *per* million; SD = standard deviation; TOLD = test of language development; VMI = visual motor integration; W-J = Woodcock-Johnson test of achievement; WISC-R = Wechsler Intelligence Scale for Children-Revised. [a] Children of mothers with MeHg hair levels > 6ppm and reported high fish consumption were matched with children of mothers with lower MeHg hair levels.

72. Myers et al., supra note 47.
73. Murata et al., supra note 42
74. Crump et al., supra note 50.

TABLE 2. SHORTCOMINGS AND ADDITIONAL ISSUES LEADING TO DISCREPANCIES IN THE SEYCHELLES AND FAROE ISLAND STUDIES

Study	Shortcomings and Additional Issues
Faroe Islands cohort[75],[76]	
	Consumed whale meat and blubber, in addition to fish and shellfish. MeHg level in cord blood used as prenatal exposure measurement. Socioeconomic status might influence study findings. Advisory issued to pregnant women about fish consumption and pregnancy - fish consumption may be lower as a result. Unadjusted/ unmeasured confounders (details not mentioned). Exposure to other pollutants including PCBs and dioxins due to consumption of whale meat. 50-day half-life of cord blood may influence MeHg level detected. Binge eating during 1st trimester may not be reflected by cord blood.
SCDS[77],[78]	
	Primarily consumed fish and shellfish. MeHg level in maternal hair as prenatal exposure measurement. Socioeconomic status might influence study findings. Demographics of high and low consumers not provided. Length of breastfeeding not addressed. Nutritional practices, housing and lifestyle may influence study findings. Fish consumption might be a confounder-may serve as a marker for nutrition. Sequelae may not have manifested at the age children were evaluated (younger age than Faroe cohort). Cellular mechanisms that detoxify methylmercury may differ in mammals Recall bias about information relation to pregnancy, birth and feedings due to children enrollment at age 6 months.

MeHg = Methylmercury.

75. Grandjean et al., supra note 44.
76. Murata et al., supra note 42
77. Myers et al., supra note 47.
78. Davidson et al., supra note 49.

TABLE 3. SUMMARY OF HEALTH ASSESSMENTS FOR METHYLMERCURY

Agency	Critical Effects	Point of Departure	Uncer-tainty/ Safety Factor	Uncertainty parameters/ factors	Chronic Accep-table Level	
U.S. EPA	Developmental neuropsycho-logical impairment	BMD[79]: $BMDL_{05}$[80] range of maternal daily intake: 0.857-1.472 µg/kg-day[81]	10	intrahuman toxicokinetic; toxicodynamic variability; uncertainty (3 for each).	RfD[82]: 0.1 µg//kg-day	Grandjean et al. (1997)[83]
California EPA	Developmental effects	NOEL[84]: 5 µg/kg-day	1000	Not an uncertainty factor but used for MADL per California Code of Regulation 12801. (b)(1)[85]	MADL: 0.3 µg/day[86]	Bornhausen et al. (1980)[87]
U.S. FDA	Overt neurological symptoms in adults [88]	LOAEL: 4.3 µg/kg-day[89]	10[90]		Action level in fish, 1 ppm in edible portion (equivalent to 0.5 µg/kg-day)[91]	
U.S. ATSDR	Developmental neurotoxicity[92]	NOAEL: 1.3 µg/kg-day[93]	4.5[94]		MRL: 0.3 µg/kg-day[95]	
JECFA[96]	Impaired neurodevelopment from *in utero* exposure[97]	Average of NOEL and BMD: 1.5 µg/kg-day[98]	6.4[99]		pTWI: 1.6 µg/kg-week (equivalent to 0.2 µg/kg-day)[100]	
Health Canada	Developmental neurotoxicity[101]	BMD: 1 µg/kg-day[102]	5[103]		pTDI: 0.5 µg/kg-day for adults and 0.2 µg/kg-day for women of childbearing ages and children[104]	

U.S. ATSDR = U.S. Agency for Toxic Substances and Disease Registry; BMD = Benchmark dose; $BMDL_{05}$ = A statistical lower confidence limit on the dose or concentration at the BMD or BMC, respectively; U.S. EPA = U.S. Environmental Protection Agency; U.S. FDA = U.S. Food and Drug Administration; JECFA = Joint FAO/WHO Expert Committee on Food Additives; LOAEL = Lowest observed adverse effect level; MADL = Maximum allowable daily level; MRL = Minimal risk level; NOEL = No observed effect level; pTDI = Canadian provisional tolerable daily intakes ; pTWI = Provisional tolerable weekly intake; RfD = Reference dose.

79. BMD: An exposure due to a dose of a substance associated with a specified low incidence of risk, generally in the range of 1% to 10%, of a health effect; or the dose associated with a specified measure or change of a biological effect, http://www.epa.gov/NCEA/bmds_training/appendices/glossary.htm.

80. BMDL: A statistical lower confidence limit on the dose or concentration at the BMD, http://www.epa.gov/iris/gloss8.htm#b.

81. Calculated from a range of 46-79 ppb in maternal blood for different neuropsychological effects in the offspring at 7 years of age.

82. RfD: a numerical estimate of a daily oral exposure to the human population, including sensitive subgroups such as children, that is not likely to cause harmful effects during a lifetime. RfDs are generally used for health effects that are thought to have a threshold or low dose limit for producing effects, http://www.epa.gov/iris/gloss8.htm#r.

83. P. Grandjean et al., *Cognitive deficit in 7-year-old children with prenatal exposure to methylmercury*, 20 NEUROTOXICOL. TERATOL. 1, 1-12 (1997); E. Budtz-Jørgensen et al., *Methylmercury neurotoxicity independent of PCB exposure*, 107 ENVIRON. HEALTH PERSPECT. A236, A236-237 (1999).

84. NOEL: An exposure level at which there are no statistically or biologically significant increases in the frequency or severity of any effect between the exposed population and its appropriate control, http://www.epa.gov/iris/gloss8.htm#n.

85. MADL: the level at which the chemical would have no observable adverse reproductive effect assuming exposure at 1,000 times that levels per the Safety Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65 of the Act) in California state, page 1 of http://www.oehha.org/prop65/policy_procedure/pdf_zip/Feb2001StatRpt.pdf.

86. California EPA, Proposition 65 status report. Safe harbor levels: no significant risk levels for carcinogens and maximum allowable dose levels for chemicals causing reproductive toxicity, 16 (2004), http://www.oehha.ca.gov/prop65/pdf/June2004StatusRpt.pdf.

87. Bornhausen et al, supra note 70.

88. Swedish Expert Group, Methylmercury in fish: a toxicological-epidemiologic evaluation of risks, Suppl. 4 NORD. HYG. TIDSKR. 19, 19-364 (1971).

89. LOAEL: lowest exposure level at which there are biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control group, http://www.epa.gov/iris/gloss8.htm#l.

90. Safety Factor (SF): another term of UF, http://www.greenfacts.org/glossary/tuv/uncertainty-factor-safety-factor.htm; http://www.atsdr.cdc.gov/glosssary.html#Uncertainty%20Factor.

91. U.S. FDA, Action levels for poisonous or deleterious substances in human food and animal feed, http://www.cfsan.fda.gov/~lrd/fdaact.html.

92. Measured by neurological evaluation, behavioral, psychological tests. Davidson et al., supra note 49.

93. NOAEL: The highest exposure level at which there are no biologically significant increases in the frequency or severity of adverse effect between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered adverse or precursors of adverse effects, http://www.epa.gov/iris/gloss8.htm#n.

94. The following uncertainty factors were applied: 1.5 for human pharmacokinetics variability, 1.5 for human pharmacodynamic variability, and 1.5 for domain-specific findings in the Faroe study (Grandjean et al., supra note 88). In more details, WHO defined the -kinetic and -dynamic components of intrahuman variability as being equal contributors to, and collectively constituting the total of, human variability. To ensure a conservative approach, these two interdependent components, the first two 1.5 in the previous sentence, were added to give a composite uncertainty of three (i.e., 1.5 + 1.5 =3) to account for the full range of variability attributable to mercury in the Seychelles Study (Davidson et al., supra note 49). The domain-specific effects were considered to be independent events; the modifying factor of 1.5 was then multiplied by the uncertainty factor of 3 to yield an aggregate uncertainty factor of 4.5 [U.S. ATSDR, Toxicological profile for mercury (update) (1999), U.S. Department of Health and Human Services, ATSDR, Atlanta, GA].

95. MRL: A U.S. ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects, http://www.atsdr.cdc.gov/glossary.html.

96. A meeting of the Joint Food and Agriculture Organization of the United Nations/WHO Expert Committee on Food Additives (JECFA) was held in Rome, Italy, from 10 to 19 June 2003. The provisional tolerable weekly intake (pTWI) for methylmercury of 3.3 µg/kg body weight per week was revised to 1.6 µg/kg body weight per week. The Committee considered that the updated pTWI was sufficient to protect the developing fetus, the most sensitive subgroup of the population, and reaffirmed its position that fish are an important part of a

balanced nutritious diet and that this has to be appropriately considered in public health decisions when setting limits for methylmercury concentrations in fish, http://www.chem. unep.ch/mercury/Report/JECFA-PTWI.htm.

97. Grandjean et al., supra note 88; G. J. Myers et al., A pilot neurodevelopmental study of Seychellois children following in utero exposure to methylmercury from a maternal fish diet, 16 NEUROTOXICOLOGY 629, 629-638 (1995)

98. Estimates of maternal hair concentrations associated with the NOEL and BMDL for neurotoxicity associated with in utero exposure. A NOEL of 15.3 mg/kg maternal hair was identified for neurobehavioral effects for the Seychelles Islands study (U.S. ATSDR, supra note 99). A BMDL of 12 mg/kg maternal hair was determined for the Faroe Islands study (Budtz-Jørgensen et al., supra note 88; NRC, supra note 6 at 1-368; Rice et al., supra note 63). The committee (JECFA) subsequently averaged these two points of departure to get 14 mg/kg maternal hair-mercury as an estimate of the level in maternal hair reflecting exposures that would be without appreciable adverse effects in the offspring of these two populations. Finally, a steady-state ingestion of 1.5 µg/kg-day was calculated by converting the concentration in maternal hair to that in maternal blood and then maternal blood concentration into maternal intake.

99. A factor of 2 was decided to allow for the likely inter-individual variability, which is indicated by the differences in study means (more precisely, per hair:blood ratio data) and by the limited available individual data, and a combined factor of 3.2 was recommended to account for the total human inter-individual variability for dose reconstruction (converting maternal blood concentration to a steady-state dietary intake).

100. pTWI is an endpoint used for food contaminants such as heavy metals with cumulative properties. Its value represents permissible human weekly exposure to those contaminants unavoidably associated with the consumption of otherwise wholesome and nutritious foods, http://jecfa.ilsi.org/section1.htm. The committee (JECFA) considered this to be sufficient to protect the developing fetus, the most sensitive subgroup of the population.

101. Grandjean et al., supra note 88; Davidson et al., supra note 49; T. Kjellstrom et al., Physical and mental development of children with prenatal exposure to mercury from fish. Stage 1: Preliminary test at age 4, NATL .SWED. ENVIRON. PROTEC. BD. Rpt. 3080 (1986); T. Kjellstrom et al., Physical and mental development of children with prenatal exposure to mercury from fish. Stage 2: Interviews and psychological tests at age 6, NATL .SWED. ENVIRON. PROTEC. BD. Rpt. 3642 (1989)

102. An approximate benchmark dose was estimated qualitatively based on available data.

103. This is an arbitrary value.

104. The Canadian provisional tolerable daily intakes (pTDIs) are based on the previous provisional tolerable weekly intake (pTWI) in adults of 0.5 µg/kg-day [JECFA 53rd meeting, Rome, 1-10 June 1999, http://www.who.int/pes/jeta/jeta.htm]. A TDI is an estimate of the amount of a substance in air, food, or drinking water that can be taken in daily over a lifetime without appreciable health risk. TDIs are calculated on the basis of laboratory toxicity data to which uncertainty factors are applied. TDIs are used for substances that do not have a reason to be found in food (as opposed to substances that do, such as additives, pesticide residues, or veterinary drugs in foods), http://www.greenfacts.org/glossary/tuv/TDI-tolerable-daily-intake.htm. Uncertainty factors are also used when deriving a TDI from the most sensitive endpoint in the most relevant study. In addition, Canada has a pTDI for women of childbearing ages and children.

BOOK REVIEW

MELANIE SHOEMAKER*

James A. Kushner, *The Post-Automobile City: Legal Mechanisms to Establish the Pedestrian-Friendly City* (Carolina Academic Press 2004).

I. INTRODUCTION

Henry Ford, founder of Ford Motor Company and innovator of the first manufacturing assembly line to produce affordable vehicles, once said, "I do not believe a man can ever leave his business. He ought to think of it by day and dream of it by night."[1] Ford's zeal for the car made a lasting impression on American society and today, the United States imports approximately one quarter of the world's crude oil output in order to power 200 million automobiles.[2] As a result, the automobile is a significant actor in American life and has shaped the way our nation has designed our communities, infrastructure, and daily lives.[3]

To illustrate, the United States is one of the leading industrialized nations to build roads, highways, and parking lots at the expense of investing resources in an efficient public transit system.[4] This massive pattern of roadway combined with the "American dream" single-family detached home has led to low density development on the outskirts of urban population.[5] Accordingly, most American cities have insufficient resources to establish and maintain an efficient public transit system and traveling from one destination to another often requires ownership of an individual vehicle.[6]

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1. Brainy Quote, *at* http://www.brainyquote.com/quotes/authors/h/henry_ford.html (last visited Mar. 25, 2005).

2. PIETRO S. NIVOLA & ROBERT W. CRANDALL, THE EXTRA MILE: RETHINKING ENERGY POLICY FOR AUTOMOBILE TRANSPORTATION 5-6 (1995).

3. *See* JAMES J. FLINK, THE AUTOMOBILE AGE (The MIT Press 1988).

4. Clay Fong, Comment, *Taking it to the Streets: Western European and American Sustainable Transportation Policy and the Prospects for Community Level Change*, 7 COLO. J. INT'L L. & POL'Y 463, 463-67 (1996).

5. James A. Kushner, *Urban Transportation Planning*, 4 URB. L. & POL'Y 161, 162, 170 (1981) (explaining that only New York, Chicago, and Philadelphia have populations adequate to support an efficient public transit system).

6. JAMES A. KUSHNER, THE POST-AUTOMOBILE CITY: LEGAL MECHANISMS TO ESTABLISH THE PEDESTRIAN-FRIENDLY CITY 6 (Carolina Academic Press 2004).

Opposite American auto infatuation, many European countries have constructed cities that tailor to the pedestrian and public transport.[7] Consequently, Europeans depend less on expansive highway systems and instead show a devotion to urban life that encourages communities centered on parks, town squares, piazzas, and other cultural settings.[8] It is this system providing a public alternative to the individual automobile that supplies the impetus for James Kushner's *Post Automobile City*. Throughout the work, Professor Kushner presents a compelling case against individual reliance on the automobile; however, he takes a pragmatic approach to his analysis of the negative impact of vehicles by recognizing that most readers of his work may not share his vision.[9] As a result, *Post Automobile City* is an easy-to-read piece of literature that provokes its audience to think about how American transportation systems and urban planning could be changed to positively impact future generations.

II. ORGANIZATION

This book is divided into five chapters. Chapter one, entitled "The Automobile in American Society: Political Economy and Geography," theorizes why the United States is a country dependent on individual, as opposed to public, transport. Professor Kushner posits that "America was a transit-based society prior to the Great Depression and the New Deal," but that The Public Utilities Divesture Act of 1935, which required power companies to divest themselves of trolley transit, was "a conspiracy by auto manufacturers, tire manufacturers, and oil companies to destroy the efficient public transport transit systems," and symbolized the end of an American efficient public transit system.[10] Professor Kushner also cites transportation funding priorities, subsidies for automobile use, beneficial tax treatment for automobiles, community design based on automobile accommodation, and lack of a viable national resource conservation policy as reasons why the United States is auto-dependent.[11]

Chapters two and three are a contrasting pair in that chapter two outlines "Advantages of the Automobile"[12] and chapter three details "Disadvantages of the Automobile."[13] Professor Kushner

7. *Id*. at ix.
8. *See id*.
9. *Id*. at 149.
10. *Id*. at 8-10.
11. *Id*. at 11-30.
12. *Id*. at 31-36.
13. *Id*. at 37-59.

praises the automobile for its mobility, convenience, access to preferential living settlements, support of economic development, and satisfaction of psychic needs including control, status, and membership in the social majority.[14] However, he counters these positive attributes by highlighting that vehicles create pollution, are prone to collisions, foster urban sprawl furthering loss of urban life, result in congestion, have increasing political implications, are high costs to operate and maintain, and infringe on public space.[15]

Chapter four entitled "Toward the Post-Automobile City,"[16] serves as a preface to chapter five, "Post-Automobile Implementation Strategies."[17] Both chapters present ways in which non-automobile infrastructure can be expanded and policy initiatives executed to make society less dependent on individual vehicles. Some of the methods discussed to accomplish these goals include the revival of urban centers, smart growth that curtails unplanned urban sprawl, creation of pedestrian-oriented communities, regional tax sharing, and car-free housing developments.[18]

III. DISCUSSION

The Post-Automobile City: Legal Mechanisms to Establish the Pedestrian-Friendly City is a visionary book that presents a balanced analysis of, and viable solution to, what Professor Kushner considers a growing problem in American society, negatively impacted quality of life due to expanding reliance on individual vehicles. Unfortunately, the author's discussion of conspiracy theories in the beginning of the book may give the reader an impression that a skewed argument is going to be presented and cause the reader to continue on with a critical eye. However, the reader who perseveres will discover that the remainder of the book actually presents a fair treatment of the issue at hand. While the author is a definite advocate of efficient public transport, he includes advantages of the automobile and potential legal constraints of his policy proposals and acknowledges the fact that many Americans may not share his enthusiasm for a car-free society. The end result is a realistic piece that leaves the reader thinking environmentally rather than incited that the author proposed an over-zealous approach to a potentially controversial issue.

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14. *Id*. at 31-36.
15. *Id*. at 37-59.
16. *Id*. at 61-69.
17. *Id*. at 71-148.
18. *Id*. at 61-148.

The book's prospective use as an authoritative resource is also strengthened by the fact that Professor Kushner has actually lived in a car-free community.[19] Because the author has first-hand knowledge of the issue he is presenting, he is able to effectively articulate his vision and explain how it may be implemented. Further, the author has extensively researched the subject, which is illustrated by the five hundred plus footnotes supporting the one hundred and fifty pages of text. These references to hundreds of cases, law review articles, and other sources of environmental authority not only allow the reader to delve further into the book's topic if he or she so desires, but also give the book's audience confidence that *The Post-Automobile City* is a reliable piece of environmental work and not just an author's single vision of the impact the automobile is having on American society.

While a good follow-up to *The Post-Automobile City* may be a piece on how to convince Americans to part with their treasured vehicles, this book lays a solid foundation for sensible ways to transition from an auto-dependent nation to one which thinks more ecologically and has the resources necessary to sustain an efficient public transport system. Accordingly, it is a concise read that may ignite a new trend in American way of life.

19. *Id*. at x.