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The Right of Nonuse

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Humankind is on a path of inefficient and unsustainable resource use and exploitation. As a result, the earth and its resources are now facing irreversible disruptions that have the potential to affect multiple generations.[1] These disastrous global effects are not only caused by excessive resource use. Rather, accelerated human use of resources also has the devastating consequence of impairing the purely ecocentric benefits that follow when humans do not use resources. When resources are left alone by humans, when they are not exploited or developed, their nonuse is beneficial for the entire biosphere, of which humans are only a part.

In this Article, we show how the destruction of this critical nonuse component of natural resources is creating many of the alarming environmental changes that are so disturbing to the planet. Then, through a series of analytical arguments founded in economic game theory, we illustrate that sustainable resource use can only be achieved if legal rights are bestowed upon not just human resource users, or humans who benefit themselves from resource nonuse, but also upon the resource itself. We define this legal right as the resource's "right of nonuse." Establishing a "right of nonuse" effectively privatizes a resource, facilitating a cooperative game that is between three kinds of players: human resource users, humans who selfishly prefer resource nonuse, and the resource itself. An analysis under this three-player game, which at last includes the natural resource itself as a critical actor, provides a framework for moving toward an efficient, sustainable path of resource conservation.

1 Among the most obvious of these disruptions are diminishing energy supplies and usable natural resources, adverse climate change, and accelerating loss of biodiversity. THOMAS L. FRIEDMAN, HOT, FLAT, AND CROWDED 37–47 (2008); *see also* P.C.D. Milly et al., *Stationarity is Dead: Whither Waste Management*, 319 SCIENCE 573, 573 (2008) (arguing that the customary belief that natural systems fluctuate within a narrow, predictable range is no longer true, due to "substantial anthropogenic change" of the Earth's climate); Robert J. Diaz & Rutger Rosenberg, *Spreading Dead Zones and Consequences for Marine Ecosystems*, 321 SCIENCE 926, 926 (2008) ("Dead zones in the coastal oceans have spread exponentially since the 1960s [and are] . . . fueled by riverine runoff of fertilizers and the burning of fossil fuels.").

I
DEFINING NATURAL RESOURCE USE AND NONUSE

A. Natural Resource Use and Nonuse Values

Resources consist of both a use and nonuse component, summarized in Table 1.[2]

The use dimension in turn is divided into two classes: direct use and indirect use. Direct use occurs when humans utilize, exploit, or otherwise disturb a resource. We value this direct use component when we extract, develop, cultivate, or change some natural raw material for human ends.[3] The use component of resources is exploited when we deposit our waste directly into the natural environment, using the atmosphere, hydrosphere, and the earth's soils as sinks for our pollutants.[4] Returns from direct use can be measured rather easily through market activity, such as price and quantity sold or other economic measures. Direct uses may also include nonconsumptive uses, such as visiting a national park for wildlife viewing.[5] These uses may not appear to be outwardly destructive, but human visitation in great enough numbers can harm both wildlife and the benefit humans experience from viewing animals in the wild. Many direct uses are quasi-public or congestible public goods. They are nonrivalrous and nonexclusive at low levels of consumption, but become congested at high levels of use. Resource use may also encompass "indirect uses" derived from a resource or an ecosystem,

2 Information in Table 1 is adapted from IAN HODGE, JESSICA DUNN & ECONOMIC AND SOCIAL RESEARCH COUNCIL, RURAL CHANGE AND SUSTAINABILITY: A REVIEW OF RESEARCH 139 (1992) and JONATHAN A. LESSER, DANIEL E. DODDS & RICHARD O. ZERBE, JR., ENVIRONMENTAL ECONOMICS AND POLICY 268–82 (1997).

3 *See generally* JAN G. LAITOS, SANDRA B. ZELLMER, MARY C. WOOD & DANIEL H. COLE, NATURAL RESOURCES LAW 724–1158 (2006) (discussing laws applying to the human uses of land, timber, minerals, and water).

4 John R. McNeill, *Resource Exploitation and Over-Exploitation: A Look at the 20th Century*, *in* EXPLOITATION AND OVER-EXPLOITATION IN SOCIETIES PAST AND PRESENT 51, 55 (Brigittta Benzing & Bernd Herrmann eds., 2003); *see also* JOHN S. APPLEGATE, JAN G. LAITOS JEFFREY GABA & NOAH SACHS, THE REGULATION OF TOXIC SUBSTANCES AND HAZARDOUS WASTES (forthcoming 2d ed. 2011) (manuscript at ch. 5) (on file with authors) (discussing regulatory definitions and regulations of hazardous waste under the Resource Conservation and Recovery Act).

5 Ruth DeFries & Stefano Pagiola, *Analytical Approaches for Assessing Ecosystem Condition and Human Well-Being*, *in* ECOSYSTEMS AND HUMAN WELL-BEING: CURRENT STATE AND TRENDS 54 (Rashid Hassan, Robert Scholes & Neville Ash eds., 2005).

Table 1: Examples of Use, Option, and Existence Values

Use Values	
Direct Use	**Indirect Use**
Harvesting plants Extraction of petroleum Extraction of minerals	Carbon sequestration Clean air Clean water Uncontaminated soils
Nonconsumptive uses	
Wildlife viewing Passive recreation	
Nonuse Values	
Option Values	**Existence Values**
Conservation of topsoil Grasslands preservation Petroleum reserves Future recreation Ecosystems	Natural areas (intrinsic value) Pristine wilderness Natural wetlands Wild and scenic waters Intrinsic value for natural objects Wildlife Historical objects

such as carbon sequestration, clear air, or clean water.[6] Indirect uses can provide life-giving services and functions to this planet (including its humans) when humans do not directly use the resource.[7]

In contrast, nonuse benefits arise when humans want to maintain the option of using a resource in the future (otherwise known as *option value*), or preserve a resource for the sake of its existence

6 For the sake of clarity, throughout this Article and unless otherwise mentioned, the term *use* refers strictly to direct resource use. We distinguish *indirect use* when relevant.

7 J. B. RUHL, STEVEN KRAFT & CHRISTOPHER LANT, THE LAW AND POLICY OF ECOSYSTEM SERVICES 27–32 (2007).

(otherwise known as *existence value*).[8] Nonuse values can also produce global ecosystem services that permit sustainable life on the earth, even if there are no humans or if a resource is untouched by humans.[9] Resource nonuse provides for the indirect resources that are received and enjoyed by humans. Both indirect use and existence nonuse values can also be measured, but it can be tricky to do so.[10]

Within each resource on the earth, the use and nonuse components exist within a closed system;[11] this means that if humans "use" a resource, then that use diminishes the resource's nonuse potential.[12] We maintain that the human rate of resource use has changed over

8 John V. Krutilla, *Conservation Reconsidered*, 57 AM. ECON. REV. 777, 779–82 (1967). There are differences in opinion among economists as to whether option value is a subcategory of nonuse or whether it should comprise a third category by itself. *See also* LESSER ET AL., *supra* note 2 at 268–82.

9 *See generally* NATURE'S SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS (Gretchen C. Daily ed., 1997) (providing an overview of the services nature provides that benefit humans, as well as those that sustain life in general); HERMAN E. DALY & JOSHUA FARLEY, ECOLOGICAL ECONOMICS: PRINCIPLES AND APPLICATIONS 77–110 (2004) (describing the relationship between resources, their consumption and nonconsumption, the economy, and ecology); Gordon B. Bonan, *Forests and Climate Change: Forcings, Feedbacks, and the Climate Benefits of Forests*, 320 SCIENCE 1444 (2008) (explaining the beneficial effects of forests, when not removed by humans, on climate). On the other hand, human overuse of resources can dramatically adversely affect the earth's nonuse value. *See generally* Richard A. Kerr, *How Urgent is Climate Change?*, 318 SCIENCE 1230 (2007) (explaining that human-produced greenhouse gases could transform forty percent of existing global ecosystems by the year 2100).

10 LESSER ET AL., *supra* note 2, at 268–82.

11 Resource economists generally agree that there is a finite resource base of exhaustible resources. *See, e.g.*, DALY & FARLEY, *supra* note 9, at 77–88; JOHN E. TILTON, ON BORROWED TIME? ASSESSING THE THREAT OF MINERAL DEPLETION 101–23 (2003). Although the base itself is finite, economically viable reserves of exhaustible resources such as oil frequently increase with improvements in technology. *See, e.g.*, DALY & FARLEY, *supra* note 9, at 78; TILTON, *supra*, at 101–05. Price signals rise to indicate presence of scarcity, which will mean that oil extraction will become prohibitively expensive before the last drop of oil is actually extracted. However, mineral economists have had difficulty projecting when these reserves will become uneconomical to maintain. *See* TILTON, *supra*, at 101–23. Renewable resources require more sophisticated modeling, and the success of replenishing these resources depends upon a number of variables, including initial stock, rate of use, regeneration rate, and resource carrying capacity. For an excellent depiction of renewable resource modeling, readers are recommended to consult JON M. CONRAD, RESOURCE ECONOMICS (1999) and JON M. CONRAD & COLIN W. CLARK, RESOURCE ECONOMICS: NOTES AND PROBLEMS (2002 reprt. ed.).

12 All natural resources conform to the laws of thermodynamics. Consistent with the first law—the law of conservation of matter—any activation of a resource's use dimension will also have a depressing effect on that resource's nonuse qualities. And, consistent with the second law—the law of increased entropy—human use of a resource converts usable energy into unusable energy, deteriorating the resource's ability to generate nonuse benefits. *See generally* DONALD HAVME, BIOLOGICAL THERMODYNAMICS (2001).

time, and that the current levels are unsustainable to humankind in the long run. Central to our thesis is the belief that a resource's nonuse value can directly facilitate the resource's indirect uses that are necessary for human life.[13]

When hominids first emerged, demands on the resource nonuse component dominated because these early humans were not yet sufficiently numerous or technologically sophisticated to directly affect the earth's resource use base.[14] Indeed, some resource features, such as naturally-occurring abrupt climate changes, threatened our species' very survival during the Pleistocene Epoch.[15] But, from the Pleistocene-Holocene boundary about 11,500 years ago[16] to the present time, anthropogenic use decisions have created a significant human footprint, which has in turn diminished the nonuse value and indirect use value of the planet's resources.[17] As a result, we face an unprecedented time when human exploitation of the use component of resources so degrades the nonuse component that the extinction of these human users is now a realistic possibility.[18]

13 For example, the nonuse value of air is the following: When it is not polluted by humans, air provides critical components to the biosphere, such as oxygen, that confer on humans and other species an important indirect use value. Humans may place value on the existence of clean air for the support of species other than humans.

14 Leendert P. Louwe Kooijmans, *Archaeological Approaches to the Long-Term History of the Landscape*, *in* EXPLOITATION AND OVER-EXPLOITATION IN SOCIETIES PAST AND PRESENT, *supra* note 4, at 63, 64, 69 (explaining that early hunters and foragers had little impact on the environment, surviving with subsistence activities).

15 Harvey Weiss, *Beyond the Younger Dryas: Collapse as Adaptation to Abrupt Climate Change in Ancient West Asia and the Eastern Mediterranean*, *in* ENVIRONMENTAL DISASTER AND THE ARCHAEOLOGY OF HUMAN RESPONSE 75, 75 (Garth Bawden & Richard Martin Reycraft eds., 2000).

16 The Pleistocene-Holocene boundary is generally considered a major transitional point in human social evolution. *See id.*; Rolf Peter Sieferle, *Sustainability in a World History Perspective*, in EXPLOITATION AND OVER-EXPLOITATION IN SOCIETIES PAST AND PRESENT, *supra* note 4, at 123, 128. Prior to that boundary, highly variable climates and environments made agriculture impossible, while afterwards more complex and coordinated agricultural societies could emerge. Sieferle, *supra*, at 128.

17 *See* Mark Serreze & Julienne Stroeve, *Standing on the Brink*, NATURE REPS. CLIMATE CHANGE (Oct. 8, 2008), http://www.nature.com/climate/2008/0811/full /climate.2008.108.html; Richard A. Kerr, *Global Warming Is Changing the World*, 316 SCIENCE 188, 188 (2007).

18 *An Epidemic of Extinctions: Decimation of Life on Earth*, INDEPENDENT (May 16, 2008), *available at* http://www.independent.co.uk/environment/nature/an-epidemic-of-extinctions-decimation-of-life-on-earth-829325.html; Kenneth R. Weiss, *25% of Mammals May Face Extinction*, DENV. POST, Oct. 7, 2008, at 13A, *available at* http://www.denverpost.com/search/ci_10654051.

This Article provides a taxonomy of the influences that have guided our choices about resource use and nonuse. Initially, human survival behaviors, organizing institutions, changing legal regimes, and assumptions about relative resource abundance drove human decisions that eventually caused inefficient use of resources. These humans, past and present, then realized that their ability to improve their quality of life with respect to resources depended on what other humans wanted to do with these same resources. This interdependence means that human choices to use or not use resources became, in effect, a game of strategy.[19] The outcome of this resource game depended on how the players acted in response to the actions of other players. This Article therefore relies on game theory to examine how and why the relevant resource players, and their assumptions about resource use and nonuse, have affected the earth's resource base over time in different ways.

As different resource players emerged throughout human history, so did the outcome of their "games," as well as their likelihood of achieving equilibrium among the players. At first the games were between two classes of resource users—those who owned the right to use the resource and those who did not yet possess such a use right, but who wanted to acquire it. Then, as these user-use games created havoc in the resources market, a new non-player emerged—the person or group of people who believed they would be better off if resources were not used. Their interests increasingly needed legal recognition and official "resource player" status before there could be an optimal outcome. When laws and legal institutions granted resource nonusers the right to assert their anthropocentric interests in resource nonuse, the user and nonuser players strategized against each other over time in a different resource game between resource users and nonusers.

It is the central thesis of this Article that this game, which characterizes virtually all resource disputes in the twenty-first century, is doomed to fail. It will never achieve an optimal level of sustainable resource use, or an adequate protection of resource nonuse values, or a cooperative game among the critical resource players. This failure is because the current resources game excludes a key player—the natural resource itself. Only that resource can adequately assert its own non-anthropocentric interests in not being used by

19 DOUGLAS G. BAIRD, ROBERT H. GENTNER & RANDAL C. PICKER, GAME THEORY AND THE LAW 21 (1994).

humans. The resource nonuse values that are now asserted in resource games are primarily interests raised by human players who themselves would benefit anthropogenically by the resource nonuse. The natural resource's purely ecocentric interests in nonuse—in being left alone by humans—are not part of these resource games. This Article argues that the creation of a legally acknowledged right of nonuse, held by the natural resource itself, would permit resource games to become cooperative games, and achieve an optimality that is impossible when the only players with legal rights are human users and nonusers.

B. Natural Resource Use and Nonuse Over Time

We have so far experienced four distinct "eras" of resource use and nonuse. The first of these eras, which can be called the Age of Human Survival, occurred tens of thousands of years ago during the Pleistocene Epoch. During Era I, the players were semi-autonomous, and their relationship to resources was simply one of trying to survive in the face of nature's raw and threatening power.[20] The second era ran from the time human populations organized themselves into complex societies until roughly the eighteenth century, as the decentralized free market gradually emerged as the chief resource production allocating mechanism.[21] In Era II, which can be called the Age of the Market, resource users were the primary players. Their goal was to quickly tap the seemingly endless resource use benefits before another competing user did so. In this race for resources, any rudimentary resource games were either between those who wished to use the same resource for the same purpose, or between those who wished to use a given resource for different purposes.

From the eighteenth century until the middle of the twentieth century, the concept of a property right in a resource allowed owners to fully control and exploit the use component of their resources. Property interests became the engine for distributing diminishing resources in the face of escalating demands.[22] During this time there

20 David S. Gutzler, *Human Response to Environmental Disruption*, *in* ENVIRONMENTAL DISASTER AND THE ARCHAEOLOGY OF HUMAN RESPONSE, *supra* note 15, at 213, 215–16 ("[G]igantic pre-Holocene warming and cooling events . . . must have had profound effects on life (including humans).").

21 *See generally* ADAM SMITH, AN INQUIRY INTO THE NATURE AND CAUSES OF THE WEALTH OF NATIONS (Kathryn Sutherland ed., Oxford University Press 1993) (1776).

22 Leonard Zobler, *An Economic-Historical View of Natural Resource Use and Conservation*, 38 ECON. GEOGRAPHY 189, 190 (1962). At the beginning of Era III, the

was also an emerging movement for "resource conservation," which in the United States established federal agencies to ensure a sustainable path of resource use on public lands. Although agencies such as the U.S. Forest Service, which was created in 1905, and the National Park Service, founded in 1916, eventually grew to protect nonuse values,[23] the charter of these agencies was to ensure the availability of resources for future human use.[24] During Era III, the Age of Property, the players were primarily resource users of competing uses who had no interest in the nonuse component of the resource they exploited. The two classes of players during Era III resource games were users with a property interest in the resource—both public and private owners—and would-be users without a property interest.

In Era IV, from the 1950s until the present, human anthropogenic decisions and activities resulted in dramatic reductions in the natural resource base, as well as increasing rates of pollution.[25] These human actions so affected the use component of resources that the very nature of the earth's biosphere not only became controlled by one

specter of a depleted European resource base led to the exploration and colonization of North America, South America, and Africa. *See id.* at 189–90.

23 *About Us*, U.S. NAT'L PARK SERVICE, http://www.nps.gov/aboutus (last visited Nov. 16, 2010).

24 *See* Organic Administration Act of 1897, ch. 2, 30 Stat. 11 (codified as amended at 16 U.S.C. §§ 473–482, 581) (2006). Era III also witnessed an early movement for preservation and advocacy of resource nonuse, as opposed to conservation. Prominent activists during this era included the naturalist John Muir, and Aldo Leopold (founder of the Wilderness Society). Muir's conflict with the first chief of the U.S. Forest Service, Gifford Pinchot, and advocacy of sustainable managed forestry became legendary. John M. Meyer, *Gifford Pinchot, John Muir and the Boundaries of Politics in American Thought*, 30 POLITY 267, 267–68 (1997).

25 Wangari Maathai, *World in Focus: The Seeds of Peace*, 2006 WLNR11744115 (July 8, 2006) ("[E]nvironmental degradation . . . and over-consumption continue to threaten the planet . . . ."); Tini Tran & John Heilprin, BROWN CLOUDS A GROWING RISK, DENV. POST, Nov. 14, 2008, at 14A, *available at* http://www.denverpost.com/headlines/ci_10978201 (commenting on "atmospheric brown clouds" covering vast areas of Asia, the Middle East, and Southern Africa). Of course, human damage to resource nonuse services did not first begin in the 1950s. Anthropogenic actions had been devastating landscapes and ecosystems long before the twentieth century. *See* David Rains Wallace et al., *Not How, But Why? Beyond Proximate Cause for Environmental Degradation*, 6 CONSERVATION IN PRACTICE 42, 42–43 (2005) (reviewing JARED DIAMOND, COLLAPSE: HOW SOCIETIES CHOOSE TO FAIL OR SUCCEED (2005)); Malcolm Gladwell, *The Vanishing*, NEW YORKER, Jan. 3, 2005, at 70–73, *available at* http://www.newyorker.com/archive/2005/01/03/050103crbo_books (reviewing DIAMOND, *supra*). What occurred in the twentieth century is that we first began to realize the scope and extent of these nonuse damages.

species, its integrity and sustainability was also compromised.[26] This realization, combined with loss of natural areas untouched by humans, led to laws that legitimated a new third player—humans who value resource nonuse.[27] These Era IV laws that address the harmful impact of excessive resource use and loss of nature tend to focus on the use's impact on individual humans, rather than on the resource or its environment.[28] Indeed, the new third player empowered by these laws—the nonuser—often champions indirect and nonuse interests primarily because of the anthropocentric benefits that result from leaving resources alone.[29]

Humans now so thoroughly dominate the earth, and are so pervasively the beneficiaries of its institutions, that our current Era IV may be termed the "Anthrocene" Age.[30] This Article argues that there will not be a socially optimum equilibrium among three players (users, nonusers, and resource and land managers)[31] to adequately

26 For example, anthropogenic emissions of greenhouse gases seem to be a contributing factor as to why the earth has entered a new period of significant climate change. Richard B. Alley et al., Intergovernmental Panel on Climate Change*, Summary for Policymakers*, *in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS 10 (Susan Solomon et al. eds., 2007) *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf.

27 *See* Clean Air Act, 42 U.S.C. § 7401(b)(1) (2006) ("[T]he purposes of [this Act] are . . . to protect . . . the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population."); Ocean Dumping Act, 33 U.S.C. § 1401(b) (2006) ("[I]t is the policy of the United States to regulate the dumping of all types of materials into ocean waters . . . to prevent . . . any material which would adversely affect human health or…economic potentialities."). Also, Era IV witnessed the emergence of subdisciplines of economics—such as environmental economics, resource economics, and experimental economics—which allowed us to better understand human interactions with, and preferences for, the environment and natural resources. *See*, *e.g.*, JOHN VON NEUMANN & OSKAR MORGENSTERN, THEORY OF GAMES AND ECONOMIC BEHAVIOR (3rd. 1953); John F. Nash, Jr., *The Bargaining Problem*, 18 ECONOMETRICA 155 (1950).

28 *See, e.g.*, Friends of the Earth, Inc. v. Laidlaw Envtl. Servs., 528 U.S. 167, 181 (2000) ("The relevant showing for purposes of Article III standing, however, is not injury to the environment but injury to the plaintiff."); National Environmental Policy Act, 42 U.S.C. § 4331(a) (2006) ("[T]he continuing policy of the Federal Government . . . [is] to use all practicable means and measures . . . in a manner calculated to . . . maintain conditions under which man and nature can exist in productive harmony, and fulfill the . . . requirement of . . . future generations of Americans."); *see also* Gunther Handle, *Human Rights and Protection of the Environment*, *in* ECONOMIC, SOCIAL AND CULTURAL RIGHTS 303, 304–05 (Asbjørn Eide, Catarina Krause, and Allan Rosas eds., 2d rev. ed. 2001).

29 In 1997, the economic benefit of the nonuse "ecosystem services" provided to humans by productive natural systems unaffected by human interference was valued at between sixteen and fifty-four trillion dollars. Robert Constanza et al., *The Value of the World's Ecosystem Services and Natural Capital*, 387 NATURE 253, 259 (1997).

30 ANDREW REVKIN, GLOBAL WARMING: UNDERSTANDING THE FORECAST 55 (1992).

31 AVIWASH K. DIXIT & BARRY J. NALEBUFF, THINKING STRATEGICALLY: THE COMPETITIVE EDGE IN BUSINESS, POLITICS, AND EVERYDAY LIFE 77 (1991) (explaining

sustain the human population in the future in Era IV games.[32] This is because resource use is competitive, which can be modeled as a non-cooperative game that yields a Nash Equilibrium. In other words, each resource player maximizes his welfare given the best predicted strategy of the others. In the case of resource use, this results in a poor outcome for all.[33] As a specific example, the suboptimal allocation of resources is due in part to government provisioning of public goods such as wildlife habitat or open space that may crowd out the altruistic behavior of private individuals, who might be willing to supply such non-market goods.[34] Era IV laws give individuals, organizations, and governments the ability to raise their interests in resource nonuse or indirect uses. Even though nonuse values may be prioritized by some players, the resulting noncooperation leads to suboptimal resource use at a high rate.

This Article urges that a natural resource's nonuse component should be given legal stature—a right of nonuse—so that the resource can act as its own player, or agent, in resource games. When the resource is actually given legal rights, we will enter Era V, a new Age of Ecocentrism, where a sustainable social outcome can be reached. In Era V, a resource's own nonuse interests can be considered credible by the three other resource players—owner-users, nonowner would-be users, and nonusers wishing to protect resource nonuse for their own anthropocentric objectives. And because the four players represent virtually all the relevant resource interests on this planet, establishing a right of nonuse effectively facilitates a cooperative game that will lead to an efficient, sustainable path of resource conservation.[35]

that even if some equilibrium is reached among the players that may be best for those players, that result may not necessarily be best for society as a whole).

32 *See* Roger B. Myerson, *Nash Equilibrium and the History of Economic Theory*, XXXVII J. OF ECON. LITERATURE 1067, 1069–70 (1999).

33 *Id.*

34 An excellent summary of this literature is presented in a seminal article by Theodore Bergstrom, Lawrence Blume & Hal Varian, *On the Private Provision of Public Goods*, 29 J. PUB. ECONS. 25, 25–49 (1986), exploring the implications of private provisioning of public goods through a descriptive model and comparative statics.

35 These four players would not necessarily be engaged in a simultaneous four-player game. Rather, it will be seen below that all resource players throughout the various eras have typically participated in a series of separate two-player, and occasional three-player, simultaneous and sequential games. Since owner-users and nonowner would-be users are essentially users of resources, most of the games in Era IV, the current time, have been between two players: users and nonusers, where the nonusers wish for the resource to be left alone for their own anthropocentric ends. Era V would introduce a critical third player,

II
ERA I—THE AGE OF HUMAN SURVIVAL

Modern humans emerged during a time called the Pleistocene Epoch, roughly tens of thousands of years ago. The first few early humans struggling to exist then were rather sparsely distributed and had little aggregate impact on the use component of resources.[36] Our ancestors exploited easily accessible natural resources in order to gain a toehold in an environment that was harsh and threatening to this new species.[37] Small groups of hunter-gatherers eked out a tenuous existence in highly variable environments and climates. The earth's natural dimension proved to be a two-edged sword. On the one hand, resource stress was so frequent and dramatic that these populations constantly had to alter their behavior and locations to survive.[38] On the other hand, their very survival depended on nature's ecosystem services and benefits that provided them with the essentials of life.[39]

During this time, humans depended upon group cooperation for individual survival. Since competition for resources was maladaptive, hunter-gatherers emphasized resource sharing between and within groups.[40] The social rule among these hunting and gathering societies was egalitarianism, so as to ensure that no individual or group appropriated a disproportionate share of food. However, nomadic societies living in scattered small groups with limited cooperation could never enjoy the level of resource reliability and population

the resource itself. The games that would emerge in Era V would be between users, human nonusers, and the resource.

36 *See generally* Peter J. Richerson & Robert Boyd, *Built for Speed: Pleistocene Climate Variation and the Origin of Human Culture*, in PERSPECTIVES IN ETHOLOGY vol. 13, at 1, (Francois Tonneau & Nicholas S. Thompson eds., 2000).

37 Catherine Delano Smith, *Late Neolithic Settlement, Land-Use and* Garigue *in the Montpellier Region*, France, 7 MAN 397, 404 (1972) (addressing forest clearance and vegetation degradation); Coralie M. Mills et al., *Neolithic Land-Use and Environmental Degradation: A Study From the Western Isles of Scotland*, 78 ANTIQUITY 886, 892–93 (2003) (discussing stripping of turf for shelter insulation and removal of peat for fuel).

38 Brian Hayden, *Research and Development in the Stone Age: Technological Transitions Among Hunter-Gatherers*, 22 CURRENT ANTHROPOLOGY 519, 520 (1981). This cultural instability meant that larger, more organized and cooperative societies could not yet arise.

39 The ecosystems that were not yet affected by human use built the planet's biomass (vegetation and wildlife) and abiotic resources (soil and water) that supported the sustainability of human life. *See generally* Norman L. Christensen et al., *The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management*, 6 ECOLOGICAL APPLICATIONS 665 (1996).

40 *Hayden*, *supra* note 38, at 527, 542.

organization necessary to create stable, complex social institutions with relatively minor, dispersed environmental impacts.[41]

At the end of Era I, roughly 11,500 years ago, the climate became much less variable, permitting agricultural subsistence systems to emerge over a large fraction of the earth's surface.[42] This marks a major transition point in human social evolution. The formation of institutions had previously been impossible because of dramatically changing climate conditions. With climate stability came resource reliability, domestication, and agriculture, as well as human cooperation, coordination, and division of labor.[43] The greater efficiency of agriculture also meant that agricultural populations competed with, and eventually overwhelmed, hunter-gatherer populations.

As agriculture and plant-intensive resource strategies became dominant in all but the most marginal environments, human population densities rose and more complex social organizations developed.[44] Because resources needed for survival seemed plentiful, these communities tolerated, for the first time in human experience, status competition, wealth control, and social ranking.[45] Humans no longer lived in small, atomized egalitarian groups where resources were shared. Instead, new social institutions evolved, and resources for the most part were allocated by barter and trade, and commodity money, which reflects value inherent in the good itself.[46]

The human relationship to resources during Era I can be understood by reference to individual decision theory. A fundamental principle of economics is that individuals maximize their own welfare. With the assumption that individuals were rational decision makers who chose actions regarding resources with the aim of furthering individual interests, the limited resources during Era I meant that individual decisions revolved around basic human

41 *See* Peter J. Richerson & Robert Boyd, *Institutional Evolution in the Holocene: The Rise of Complex Societies*, *in* THE ORIGIN OF HUMAN SOCIAL INSTITUTIONS 197, 197–204 (W.G. Runciman ed., 2000), *available at* http://www.des.ucdavis.edu/faculty/Richerson/evolutioninstitutions.pdf.

42 BRUCE D. SMITH, THE EMERGENCE OF AGRICULTURE 19–20 (1995).

43 *See generally* Weiss, *supra* note 15, at 75; Richerson & Boyd, *supra* note 41, at 197; Hayden, *supra* note 38, at 523, 530.

44 *See generally* RICHARD MANNING, AGAINST THE GRAIN: HOW AGRICULTURE HAS HIJACKED CIVILIZATION (2004).

45 PETER A. CORNING, THE SYNERGISM HYPOTHESIS: A THEORY OF PROGRESSIVE EVOLUTION (1983). *See generally* MANNING, *supra* note 44.

46 Zobler, *supra* note 22, at 191; Richerson & Boyd, *supra* note 41, at 202.

survival.[47] The crux of most Era I decisions was that an individual chose only one action toward a resource—for example, to plant crop A or crop B, to harvest now or delay until later, or to completely deforest the land or halt timber cutting. The choice had to be made in light of the consequences of alternatives and the chances of these consequences occurring. Typically, Era I humans did not need to take into account the actions of other humans. Over time, humans could successfully predict the likely immediate outcomes that would play out when decisions were made to use and exploit resources.[48]

During the Age of Survival, early humans had little understanding and limited control over nature's production processes. There existed a huge stock of relatively untouched natural resources, but humans still lacked the skills to tap the use potential of these resources. The discount rate was very high—humans were necessarily more concerned about their survival in the moment, rather than maintaining resources for future use. With a seemingly endless supply of resources, forests were burned to increase grazing areas,[49] turf was stripped to remove peat,[50] and soils were exhausted, degrading the natural nutrients of the soil system.[51] There were no laws or legal institutions to regulate these resource use decisions, or their impact on future uses.[52] But a new organizing institution, the market, was slowly beginning to emerge.[53]

In Era I, bartering was a common means for transactions to occur, but other basic market transactions also evolved, including the recording and repayment of debts through various forms of accounting, commodity money, and fiat money such as shells and beads.[54] The market eventually became the chief mechanism influencing the resource use decisions of growing numbers of people who formed egalitarian communities, and who enjoyed the returns that followed from agricultural subsistence. These populations, with

47 *See* MICHAEL D. RESNIK, CHOICES: AN INTRODUCTION TO DECISION THEORY 4 (1987); J. MORGAN JONES, INTRODUCTION TO DECISION THEORY 2, 5 (1977).

48 *See generally* DAVID RINDOS, THE ORIGINS OF AGRICULTURE: AN EVOLUTIONARY PERSPECTIVE (1984).

49 Hayden, *supra* note 38, at 519.

50 Mills, et al., *supra* note 37, at 893, 894.

51 Kooijmans, *supra* note 14, at 73.

52 *See* MARSHALL SAHLINS, STONE AGE ECONOMICS 1–39 (1972).

53 *See generally* SMITH, *supra* note 21.

54 *See generally* Rafael Gasson, *Quiripas and Mostacillas: The Evolution of Shell Beads as a Medium of Exchange in Northern South America*, 47 ETHNOHISTORY 581, (Summer-Fall 2000).

their agriculture and their complex, market-based social organizations, increasingly settled many parts of the world, overwhelming native populations with less efficient subsistence and less complex social institutions. A new era arose, lasting thousands of years—the Age of the Market.

III
ERA II—THE AGE OF THE MARKET[55]

As humans gradually organized themselves into increasingly complex social systems, they realized that interconnection among other humans often led to a status that was superior to what resulted when they remained isolated from each other. Although international trade was known to exist for thousands of years, as time progressed and human population centers began to build, exchange and transactions between individuals became more common. The institution that seemed to best reflect these interchanges was the classic free market associated with Adam Smith.[56]

Societies, especially after 1000 AD, were characterized by extreme decentralized governments compared to previous eras, and they formed the foundation of today's market system. Markets evolved from predominant bartering and commodity money to formalized monetary systems. Price discovery processes enabled more exchanges, trades, and agreements among resource users. When buyers and sellers receive more information on the scarcity of the good, its relative value to society, and the prices that the other side of the market is willing to pay (or accept), more transactions may occur. Perhaps most important, these transactions can take place without the intervention of government or a third-party negotiator.[57] In Era II, natural resources seemed limitless, and technological advances improved access to these resources. Use of this abundant resource base helped bring about the rise of Western European nations as

55 We characterize the Age of the Market as the time period between ancient times, roughly the second century BC, through the early modern times of the late 1700s. This is the period of time in world history before property laws became dominant, where goods were exchanged among resource actors, and contract law was the primary legal mechanism for ensuring that bargains, exchanges, and deals could be credible.

56 SMITH, *supra* note 21; *see* Arun Agrawal, *Common Resources and Institutional Sustainability*, *in* THE DRAMA OF THE COMMONS 41, 42 (Elinor Ostrom et al., Committee on the Human Dimensions of Global Change eds., 2002).

57 *See generally* RONALD H. COASE, THE FIRM, THE MARKET AND THE LAW 15 (1988); ROBERT C. ELLICKSON, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES (1991).

global economic powers. These nations dominated the planet's economy between 1500 AD and the Industrial Revolution two and a half centuries later.[58]

As resource users consumed vast quantities of raw materials, they found that they increasingly had to compete among themselves to secure the riches of the world's resource base. Era I decisions involved humans seeking resources, while Era II decisions involved humans competing with other humans for resources. This shift brought about an important behavioral change, both economically and legally. With the advent of markets, individual decisions about resources were slowly replaced with group decisions.[59] Individual resource users realized that they could form groups for mutual benefit. The expectation was that by working together, they might be able to improve their results overall and the payoffs to the members of the group.[60] These kinds of interactive decisions among resource users are understood in light of one branch of game theory—cooperative games.[61]

During Era II, potential resource users had a choice—appropriate the resource as an individual, or cooperate with other potential users, so that the group of individual users would arrive at a better resource allocation. Appropriation was redistributive; one user benefitted at the expense of another. Cooperation assumed that individuals would accept and commit to offers or exchanges by other users that would make them better off than they would have been by individual action. However, for cooperative games to succeed, agreements and promises among resource users in a market had to be enforceable. Legal doctrine needed to arise in the form of contract law that enabled market players to have the capacity for credible commitment.

Exchanges occurring over time involve more risk to both players, especially when the completion of the transaction depends on both parties promising to complete the exchange. Repetitious exchanges do not necessarily lead to cooperation or an optimal equilibrium because players may have incentives to cheat, particularly if a player knows

58 *See generally* KENNETH POMERANZ, THE GREAT DIVERGENCE: EUROPE, CHINA, AND THE MAKING OF THE MODERN WORLD ECONOMY (2000).

59 *See generally* Roderick M. Kramer & Marilynn B. Brewer, *Effects of Group Identity on Resource Use in a Simulated Commons Dilemma*, 46 J. PERSONALITY AND SOCIAL PSYCHOL. 1044 (1984).

60 ALLEN W. JOHNSON & TIMOTHY EARLE, THE EVOLUTION OF HUMAN SOCIETIES: FROM FORAGING GROUPS TO AGRARIAN STATE (1987).

61 VON NEUMANN & MORGENSTERN, *supra* note 27, at 15.

that his opponent is not likely to cheat. For example, if one player makes an investment based on a second player's promise to deliver goods in exchange, the promise maker may not feel compelled to complete the transaction after the investment is made. The investing player may therefore be better off not to invest because there is no consequence to the other player for simply appropriating that investment. Under these circumstances, a cautious player may not invest for fear of loss without a remedy. No market transaction will then occur.

This normal form game scenario is reflected below in Figure A. This matrix summarizes the bargaining possibilities where there is no contract or enforceable agreement between players who have complete information about one another's payoffs and how the game is played.[62] By receiving the investment, Player 2 possesses the dominant strategy[63] because that player acquires the investor's money in exchange for a mere promise of delivery at a later date, which is referred to as a "deferred exchange." Because the exchange is deferred, the dominant strategy for Player 2 is to appropriate the investment and not to deliver to the investing player, Player 1. In other words, Player 2 profits from not delivering on a promise. Therefore, in the absence of a cooperative and enforceable agreement, Player 1 will not invest, and will not enter into the arrangement knowing that it is credible and likely for the other player to appropriate the investment. However, if Player 1 does not invest, neither player can benefit. In this case, both players will receive a payoff of zero.

62 ROBERT COOTER & THOMAS ULEN, LAW AND ECONOMICS 197–98 (4th ed. 2004).

63 Dominant strategies provide the highest payoff compared to any other strategies for any other players. PHILIP D. STRAFFIN, GAME THEORY AND STRATEGY 3–31 (6th prtg. 2006).

		Player 2	
		Cooperate/invest	Defect/appropriate
Player 1	Initiate transaction	0.5 0.5	-1.0 1.0
	Do not initiate transaction	0 0	0 0

Figure A. Without contract.

Note that the number in each box on the left is Player 1's payoff; the number on the right is Player 2's payoff. The box containing the solution is highlighted.

Figure A illustrates that both players will reach the optimal result only when they cooperate. If both players cooperate, then each will receive a payoff of 0.5 (top left box) because both actors will split the profits (1.0/2=0.5). If Player 2 defects and takes payment but does not deliver goods, then the payoff is 1.0, while Player 1 loses the entire investment (top right box). Since Player 1, the investor, is aware of Player 2's dominant strategy, a higher payoff for defection, Player 1 will decline to enter into an agreement. Neither gain from this activity and each receive a payoff of zero because there is no transaction.

The addition of an enforceable agreement changes the payoffs and benefits for both players. Only if the cautious investor can be assured that the other player will perform will that investor initiate the transaction. An enforceable contract ensures a remedy if Player 2 appropriates and keeps the goods. Because Player 1 is assured compensatory payment if Player 2 defeats and appropriates, both will cooperate and divide the payoffs evenly. Cooperation thereby produces productivity: When both parties cooperate with each other, then they share in the transaction and both benefit. The enforceable contract transforms a game with a noncooperative solution into a game with a cooperative solution.

Figure B highlights the outcomes for players when they enter into a binding contract. Players 1 and 2 will form a contract where there is complete information, and when Player 2 agrees to cooperate with

Player 1, in exchange for investment. When both cooperate, they each receive an equal payoff of 0.5 (top left box). In contrast to the scenario presented in Figure A, if Player 2 appropriates the investment, the agreement made between the parties is enforced and the investing player, Player 1, is awarded the contract payoff of 0.5. Player 2 then pays for the breach, making Player 2 worse off than simply fulfilling the contract. If Player 2 breaches, this will yield a payoff of -0.5 (top right box). Player 1, the investing player, now has the assurance needed to enter into a contract, and if Player 2 appropriates the investment, then Player 1 receives a payoff of 0.5. The contract facilitates productivity and the players' participation in a cooperative game. If neither player enters into a contract, the first player will not initiate the transaction and the payoffs remain zero for both players. The best solution is therefore to enter into a contract and engage in a productive transaction.

		Player 2	
		Cooperate/invest	Defect/appropriate
Player 1	Initiate transaction	0.5 0.5	0.5 0.5
	Do not initiate transaction (because no contract)	0 0	0 0

Figure B. With contract.

Note that the number in each box on the left is Player 1's payoff; the number on the right is Player 2's payoff. The box containing the solution is highlighted.

A. The Rise of the Market as an Organizing Institution

In Era II, after the transition to agricultural societies, global economic development appeared to remain at a standstill for many centuries. This long period of little economic growth had two

causes—exceptionally modest population expansion and diminishing factors of production, such as natural resources. This time of stalled population growth, lasting until around 1000 AD, has been called the period of "Malthusian stagnation."[64] Some regions experienced a resource collapse stemming from human exploitation and eventual exhaustion of natural resource use potential, which concomitantly destroyed the natural systems that had enabled early human civilizations to arise.[65]

Sometime after 1000 AD, expanded international trade, primarily by various Islamic states and the Sung Dynasty in China, ushered in a period of global population growth that lasted through the sixteenth century.[66] With increased international trade, Western Europe, which had at best performed only a peripheral role in the initial emergence of the new world economy, slowly rose to become the dominant player of Era II global trade.[67] There were two reasons why Western Europe was able to leap ahead of competing world economic powers—first, the discovery, acquisition, and use of cheap natural resources, and second, the formalization of an expanded international economy.

Initially, demand rose for indigenous resources with high immediate utilitarian value, such as timber, wool, fish, grain, and minerals, which catered to a rising population. The discovery and use of coal as a cheaply available energy resource in eighteenth century Northwestern Europe also helps explain why Europe, and not China, was the epicenter of the industrial revolution and eventual world economic dominance.[68] But it was the historical accident of the discovery of the New World, with its cornucopia of natural resources that permitted Western Europe to become the world's central power by the end of Era II. The ability to tap new resources in the Americas

64 Oded Galor & David N. Weil, *From Malthusian Stagnation to Modern Growth*, 89 AM. ECON. REV. 150, 150–54 (1999).

65 *See, e.g.*, James A. Brander & M. Scott Taylor, *The Simple Economics of Easter Island: A Ricardo-Malthus Model of Renewable Resource Use*, 88 AM. ECON. REV. 119, 121–22, 131–32 (1998) (describing the collapse of the Mayan civilization due to deforestation and soil erosion, the demise of the Mesopotamian civilizations due to soil salinization, and the decline of the Chaco Anasazi in the southwestern United States due to soil degradation).

66 Richerson & Boyd, *supra* note 36, at 19.

67 *See generally* Ronald Findlay, *The Emergence of the World Economy*, *in* CONTEMPORARY ECONOMIC ISSUES: PROCEEDINGS OF THE ELEVENTH WORLD CONGRESS OF THE INTERNATIONAL ECONOMICS ASSOCIATION, TUNIS, at 82 (1998).

68 *See generally* Pomeranz, *supra* note 58.

with high use potential allowed Western European states to thrive long after their own natural resources had been spent.[69]

Europe had another enormous advantage. Throughout much of Era II there existed no uniform authority that could halt bourgeoning trade and commercial development taking place. As a result, decentralized, unsupervised markets arose, providing order and organization for the trades, exchanges, and transactions that were occurring, largely in natural resources.[70] Gradually, most of the regimes of Europe adopted a market economy. They provided the market with protection, legitimation, and nonarbitrary laws such as the law of contract, so that market players could make enforceable bargains and agreements. The efficient use of money and other commercial tools were also a hallmark of Era II markets.[71] The use of money replaced exchanges in a barter system, which lowered the considerable transaction costs involved in trade.[72]

The dominant market system that emerged in Era II swiftly replaced Era I community, tribal, and cultural norms.[73] Moreover, government regulation and centralized planning were not necessary for this economic system to function in an orderly way.[74] Instead, individuals and groups were free to make their own choices about the production, use, distribution, and consumption of natural resources,

69 Ronald Findlay, *The Roots of Divergence: Western Economic History in Comparative Perspective*, 82 AM. ECON. REV. 158, 158–61 (1992); Guido di Tella, *Economics of the Frontier*, *in* ECONOMICS IN THE LONG VIEW: ESSAYS IN HONOUR OF W.W. ROSTOW 210–27 (W.W. Rostow, Charles Poor Kingleberger & Guido di Tella eds., 1982).

70 PAUL KENNEDY, THE RISE AND FALL OF THE GREAT POWERS: ECONOMIC CHANGE AND MILITARY CONFLICT FROM 1500–2000, at 20–21 (1988).

71 DOUGLAS C. NORTH & ROBERT PAUL THOMAS, THE RISE OF THE WESTERN WORLD: A NEW ECONOMIC HISTORY 54–55 (1973).

72 A person wishing to buy something in a barter system has to find someone who has the sought-after item and who wishes to convey it away, and who also wants something processed by the buyer. This is referred to as a "double coincidence of wants." Sreekala Kochugovindan & Nicolaas J. Vriend, *Is the Study of Complex Adaptive Systems Going to Solve the Mystery of Adam Smith's "Invisible Hand"?* 3 IND. REV. 53, 53–66 (1998). A search for that exact combination is not only costly, it will prevent many beneficial exchanges from occurring at all. The use of money, by contrast, facilitates the drawing up of contracts, and reduces the quantity of goods that need to be held for purposes of exchange.

73 *See generally* KARL POLANYI, THE GREAT TRANSFORMATION: THE POLITICAL AND ECONOMIC ORIGINS OF OUR TIME (2001).

74 When Era II cultures attempted to manage resources through central planning, the result too often was cultural and resource collapse. Vernon L. Scarborough, *Resilience, Resource Use, and Socioeconomic Organization*, *in* ENVIRONMENTAL DISASTER AND THE ARCHAEOLOGY OF HUMAN RESPONSE, *supra* note 15, at 195, 205.

where economic decisions were made by buyers and sellers of goods and services. In such a competitive system, production tended to flow toward what societies valued most, which was resource use and development.[75] This drive to use resources occurred either when individuals acted alone, or when they discovered the synergistic potential of cooperation, coordination, and division of labor. Natural resources were exploited because entrepreneurs and other market participants sought to maximize profits, wealth, and individual welfare in the short run, often at an unsustainable rate for the long run.[76]

Basic economic theory dictates that private landowners have an incentive to use resources at a rate that will allow them future use.[77] However, during Era II, market failures contributed to resource depletion. Imperfect information resulting from gaps in scientific knowledge and awareness of resource regeneration rates led to suboptimal resource use, and in some cases, species extinction.[78] Price information must be allowed to clearly communicate scarcity, so that rational actors can adjust their consumption accordingly.

Dispersed populations did not always facilitate the adequate transfer of price information. Another market failure, open access—also known as the commons problem—reflected the fact that most resources were not owned by any one person (*res nullius*), and were therefore subject to capture and use by those who somehow were able to seize control of natural goods.[79] Open access leads to inadequate resource allocation because there are diminishing marginal returns to each individual who subsequently uses the resource. Individuals have incentive to use more of a resource than what may be desirable for the

75 Richerson & Boyd, *supra* note 41, at 18; Tom Tietenberg, *The Tradable Permits Approach to Protecting the Commons: What Have We Learned*, *in* THE DRAMA OF THE COMMONS, *supra* note 56, at 197, 200; Zobler, *supra* note 22, at 192.

76 Alan M. Taylor & Jeffrey G. Williamson, *Capital Flows to the New World as an Intergenerational Transfer*, 102 J. POL. ECON. 348, 348–49 (1994).

77 *See generally* WILLIAM J. BAUMOL & WALLACE E. OATES, THE THEORY OF ENVIRONMENTAL POLICY (2d ed., Cambridge Univ. Press 1998).

78 The hunting of whales nearly into extinction for the use of whale oil for energy is one such example of resource overuse. Ugo Bardi, *Prices and Production over a Complete Hubbert Cycle: The Case of the American Whale Fisheries in the 19th Century*, ENERGY BULL. (Nov. 24, 2004), http://www.energybulletin.net/node/3338.

79 *See* Pierson v. Post, 3 Cai. 175, 178 (N.Y. Sup. Ct. 1805); Carol M. Rose, *Possession as the Origin of Property*, 52 U. CHI. L. REV. 73, 73–74 (1985).

greater good.[80] Resource overuse results when individuals cannot be excluded from using a resource. In other words, the resource is rivalrous, meaning no one can be excluded from using the resource, but there is competition for the resource itself. Examples of open access, or commons, prevalent during Era II included grazing livestock, harvesting timber, and catching fish. Such open access problems can be corrected by predictable and transferable property rights for all relevant commodities in the market place.[81] Throughout Era II, property rights in natural resources were non-existent or ill-defined.[82]

B. The Theory of Games: Cooperative Games in the Age of the Market

When trying to capture the dynamics of a time when individuals by and large seemed to rely on the marketplace as an organizing institution for their resource choices, it is important to articulate the assumptions that must be made to understand market behavior and the rationale for the persistence of market failures. Under a classic Adam Smith *Wealth of Nations* market model, individuals make calculations based on the assumption that all agents behave rationally. The market model then presumes that if "societal" rules do not interfere with such individual actions, the so-called "invisible hand" will promote the larger interests of the individual's society and the amount of a good consumed will be efficiently allocated for the future.[83]

However, if everyone in a relevant market does what is best for the individual, they might wind up with the worst result from their collective viewpoint. This is the lesson from the standard "prisoner's dilemma game," where self-interest and an inability to coordinate behavior or enforce prior agreements yields an outcome for each prisoner that is inferior compared to a strategy of mutual cooperation.[84] In a similar fashion, during Era II, it became

80 Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968); Shi-Ling Hsu, *What* is *a Tragedy of the Commons? Overfishing and the Campaign Spending Problem*, 69 ALB. L. REV. 75, 77 (2005).

81 Myerson, *supra* note 32, at 1080; Dixit & Nalebuff, *supra* note 31, at 223–25.

82 *See generally* Terry L. Anderson & Peter J. Hill, *The Race for Property Rights*, 33 J.L. & ECON. 177, (1990).

83 SMITH, *supra* note 21, at 292 ("And he is in this led by an invisible hand to promote an end which was no part of his intention. By pursuing his own interest, he frequently promotes that of the society . . . .").

84 In the familiar prisoner's dilemma game, there are two prisoners and each is informed that the prisoner will receive a modest sentence if neither prisoner informs on the

increasingly apparent that the outcome for any individual actor depended not only on that actor's own rational and self-interested actions, but also on the independent actions of others. Simply put, individuals maximize their own welfare, given the predicted behavior of other players.[85] Since game theory concerns the rational behavior of decision makers or players[86] whose decisions affect one another, it has been suggested that "interactive decision theory" might be a more descriptive name for the dynamic that became prominent in Era II—individuals dealing with other individuals with an interest in resources. This multi-party dynamic contrasts with Era I, where individuals usually made non-interactive—that is, unilateral—decisions about resources.[87]

Era II players had choices when confronting other players interested in using resources. A player attempting to maximize self-interest could independently compete for the resource to achieve individual control. Or, when there was more than one player coveting a resource, players could coordinate their strategies and form coalitions. Players choosing cooperation over appropriation were, in effect, deciding that the outcome of cooperation would yield more than acting alone.[88] By contrast, acting alone in order to appropriate

other; that the prisoner will be let free if that prisoner alone informs on the other prisoner, while the other prisoner will get a maximum sentence; and that both will receive a significant sentence short of the maximum if both inform on the other. Behaving rationally and selfishly, each will become an informant because, regardless of what the other prisoner does, each can reduce their sentence by being an informant. But, the potential superior outcome is that both remain silent, and thus both receive modest sentences. This outcome is not possible because the two prisoners cannot coordinate their behavior. This game was first defined by Merrill Meeks Flood and Melvin Dresher as part of a 100-trial game experiment at RAND Laboratories. MERILL. M. FLOOD, A PREFERENCE EXPERIMENT (SERIES 2, TRIALS 2, 3, 4) (1952). In the 1950s, mathematician Albert Tucker coined the game "prisoner's dilemma," a name by which it is known today. T. Kippenberger, *The Prisoner's Dilemma*, 2 THE ANTIDOTE 8, 8–11 (1997).

85 Baird et al., *supra* note 19, at 11. Game theory is the general analytical framework for doing rational choice analysis without the traditional market structures of goods and prices. A rational player in a game will choose an outcome that that player prefers, given what that player expects the other players in the game to do. Myerson, *supra* note 32, at 1068.

86 The *decision theory model* assumes that individuals are rational decision makers who make decisions with the aim of furthering individual interests. *See* RESNIK, *supra* note 47, at 5 and accompanying text.

87 Robert Aumann, *Game Theory*, *in* VOLUME 3, THE NEW PALGRAVE 529 (Steven N. Durlauf & Lawrence E. Blume eds. 2008).

88 A cooperative game is akin to a branch of decision theory that focuses on individuals making group decisions. With a group decision, an effort is made to not simply reflect what an individual does in a game to further that individual's own goals; but also to

the resource for just one player was redistributive—the player who acquired the resource was benefitted at the expense of competing players. Throughout Era II, and up to the present time, players for resources sometimes collaborated, cooperated, and made agreements with others out of self-interest.[89] When they did so, they were engaged in what game theoreticians call a "cooperative" game.[90]

Many Era II interactions can be characterized as cooperative games because first, the players were able to make credible agreements. Second, the cooperating players arranged themselves according to the amount of value each placed on a particular strategy. Third, stable resource use groups arose because the players realized that they would not do better by defecting to individual strategies.[91]

Such cooperative games required the players to make commitments to carry out particular strategies. Any commitment made in a cooperative game needed to be considered credible—that is, binding and enforceable—to the other players in the game. Credible agreements can be made if strong social norms were in place to urge players to keep their promises.[92] The invention of contracts, enforceable by a third party, such as a court, helped the participants in

develop a policy that is applicable to all the participants. RESNIK, *supra* note 47, at 5 ("Unfortunately, it is frequently difficult to tell . . . when several individuals are choosing, whether they are involved in a [cooperative] game or in a group decision.").

89 *See* Peter J. Richerson, Robert Boyd & Brian Paciotti, *An Evolutionary Theory of Commons Management*, *in* THE DRAMA OF THE COMMONS, *supra* note 56, at 403, 404–06; ROBERT L. HEILBRONER, THE WORLDLY PHILOSOPHERS 27, 174–75 (6th ed. updated 1992) (discussing Francis Edgeworth's realization in the nineteenth century that people did not always behave according to market theory—in a purely independent competitive fashion—but instead formed groups that made agreements among their members). For a modern example of resource users entering into a cooperative game, see Sandra Zellmer, *The Anti-Speculation Doctrine and Its Implications for Collaborative Water Management*, 8 NEV. L.J. 994 (2008).

90 CONTRIBUTION TO THE THEORY OF GAMES 13–42 (R.D. Luce & A.W. Tucker eds., 1959) (providing a translation of John von Neumann's introduction to cooperative games).

91 *See generally* Theodore L. Turocy & Bernhard von Stengel, *Game Theory*, *in* ENCYCLOPEDIA OF INFORMATION SYSTEMS (2002); VON NEUMANN & MORGENSTERN, *supra* note 27. During Era II, cooperative games were perhaps best reflected by the amount of trade in natural resources that emerged. Before trading could occur, participants in the trade needed to cooperate as part of the transaction. *See generally* Ronald Findlay, *The Terms of Trade and Equilibrium Growth in the World Economy*, 70 AM. ECON. REV. 291 (1980); CARLO CIPOLLA, BEFORE THE INDUSTRIAL REVOLUTION: EUROPEAN SOCIETY AND ECONOMY 1000–1700 (1976).

92 LEE BOLDEMAN, THE CULT OF THE MARKET: ECONOMIC FUNDAMENTALISM AND ITS DISCONTENTS, 245–68 (Austl. Nat'l Univ. Press 2007); ALAN WATSON, ROMAN LAW AND COMPARATIVE LAW 127–28 (1991).

a cooperative game to make truly credible commitments to cooperative strategies.[93]

Games in which the participants can make credible, enforceable agreements can yield a "cooperative solution," where the outcome of the game is best for all of the players who participate in the game. For an individual player, the agreement with the other players should not place that player in a position inferior to the position the player would be in absent the agreement. For the group, the agreement should maximize the total possible utility produced by the agreement.[94] In other words, the outcome of the agreement should represent some Pareto optimal condition in which no party can be made better off without adversely affecting another party.[95]

We illustrate how a cooperative game can be used to overcome an open access market failure when two users access a resource for the same purpose.[96] In this game, two shepherds each have a flock of sheep that graze on an unowned open access pasture. Each shepherd grazes sheep as often as possible and increases the size of the flock as frequently as possible. Initially, the two shepherds incur no additional cost for each sheep added to the flock, so both have an incentive to increase their respective flocks in order to increase their profits. The shepherds are not concerned about the other's flock until the total number of sheep grazing exceeds the feeding capacity of the pasture. Once the pasture is overgrazed, each sheep gains less weight because less feed is available, making the sheep less valuable at market.

Both shepherds eventually realize that the additional sheep reduced the grass available for the sheep each already owns. To improve the value of their flocks, the shepherds will realize that the number of sheep has to decrease. However, since neither shepherd has the right to exclude the other from the pasture, one shepherd is unlikely to reduce flock numbers unless the other shepherd does the same. They

93 ROBERT COOTER & THOMAS ULEN, LAW & ECONOMICS 198 (4th ed. 2004) ("The first purpose of contract law is to enable people to cooperate by converting games with noncooperative solutions into games with cooperative solutions.") (emphasis omitted).

94 JULES L. COLEMAN, MARKETS, MORALS AND THE LAW 102–03 (1988); STEVEN SHAVELL, FOUNDATIONS OF ECONOMIC ANALYSIS OF LAW 293 (2004).

95 Different negotiated agreements in a cooperative game may achieve a Pareto optimal result and maximize the total possible utility between the players, but distribute different amounts of gain among them. There is likely no one preferred negotiated distributional outcome between bargaining players achieving Pareto optimality in a cooperative game. 1 BRIAN BARRY, A TREATISE IN SOCIAL JUSTICE: THEORIES OF JUSTICE 33–41 (1989).

96 *See* Daniel H. Cole & Peter Z. Grossman, *Institutions Matter! Why the Herder Problem Is Not a Prisoner's Dilemma*, 69 THEORY & DECISION 219, 224–29 (2010).

will therefore agree to a maximum number of sheep in each flock that will not deplete the pasture grass. There may be temptation to breach the agreement between the shepherds. However, neither should breach if both shepherds communicate and each knows if the other breaches. In other words, if both shepherds have complete information, there should be no breach because user defection by both parties destroys the pasture, which is the resource each user needs to raise marketable sheep and to maintain livelihood. Since each realizes that the breach of one will bring about the breach of the other, leading to an overgrazed pasture, each shepherd's payoff will remain highest if neither breaches the agreement to limit the number of grazing sheep.

Figure C illustrates this cooperative game. If both users share the resource, both will benefit by receiving payoffs equal to 100. When one defects at the expense of the other, the defecting user gains more than a fair share, 110, while the non-defecting user loses, receiving -1, because the defecting user's sheep will eventually reduce the value of the herd of the non-defecting user, driving the herder from the pasture. When both defect, neither user profits because overuse destroys the resource. Such mutual defection results in a payoff of zero for both players. When both users cooperate according to the agreement, both receive the highest possible payoff; when neither cooperates the ultimate payoff is zero. Although the equilibrium value is for both shepherds to defect, the Pareto optimal solution is cooperation. A Pareto optimal solution is also likely because this game, often described as the Herders' Problem, can be iterative and take place over multiple time periods. The iterative nature allows herders to communicate and reach this solution.[97]

97 ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION 58–102 (1990).

		Shepherd Two	
		Use/cooperate	Defect
Shepherd One	Use/cooperate	100 100	-1 110
	Defect	110 -1	0 0

Figure C. Open access resource use: competitive grazing.

Note that the first shepherd's payoff is listed on the left of each box, while the second shepherd's payoff is listed on the right of each box. The box containing the Pareto optimal solution is highlighted.

The other common resource situation during Era II occurred when users had an interest in utilizing a resource for differing purposes. Similar to the game above, the users can cooperate and agree to share the resource, defect on the agreement and try to get more of the resource than the other user, or refuse to cooperate and try to use as much of the resource as possible, leading to the resource's destruction. Of the possible solutions to the problem, the users are better off if they choose to cooperate and share the land between them. When the users keep this agreement, Pareto optimality can be achieved and the users attain the highest collective payoff.

In this game, there is one parcel of unowned land. One user would like to graze livestock, while the other would like to grow wheat. One cannot graze livestock where the other is growing wheat. Both users want to maximize their production from the parcel of land in order to increase profit, and each user would therefore like to use the whole parcel of land. If one postpones using the resource for a season, the other user will use the unowned land for personal economic gain. Conflict between the two users arises when both express the desire to exploit the land resource for different purposes—grazing and wheat growing. Both users have an incentive not to cooperate with each other. Each user wants to take as much of the open land as fast as possible to maximize profit from either growing wheat or grazing. However, since neither user can exclude the other from the land, they may decide to share it. Both will then have the certainty of some profit at market.

Alternatively, with no agreement to cooperate, the users risk reducing the land's productivity by simultaneously overgrazing on the wheat fields and destroying grazing land to grow wheat. Since the payoff for cooperation is better than the payoff for mutual defection, the users cooperate. Mutual defection destroys the land for both users, so by cooperating the users accomplish the best outcome.

In Figure D, cooperation among the wheat grower and the livestock producer yields a Pareto optimal outcome (100 and 100). If one defects and tries to use more resource than the agreed amount, one user will then lose and the other will gain, but the payoff is not optimal (110 for the one defecting, and -1 for the one abiding by the agreement, since the defecting user destroys the non-defecting user's share of the land). Since one player's overuse is the other's loss, when both overuse, neither attains any payoff because the resource becomes depleted.

		Player 2: Livestock Producer	
		Use/cooperate	Defect
Player 1: Wheat Grower	Use/cooperate	100 100	-1 110
	Defect	110 -1	0 0

Figure D. Resource use for different purposes.

Note that the number in each box on the left is the wheat grower's payoff; the number on the right is the livestock producer's payoff. The noncooperative solution is highlighted.

C. The Problem of Open Access and the Law of the Rush

Although cooperative games in the Age of the Market were an efficient way for resource players to allocate land and stock commodities among competing users, there were serious impediments that prevented such games from becoming the dominant structure of allocation. Cooperative games form spontaneously through ad hoc

contracting where parties renegotiate inefficient entitlements to achieve an optimally efficient allocation.[98] Such collective action is more likely when the property rights are clearly defined, when the number of parties is small, when the parties have similar expectations regarding the net gains of agreement, when there is little uncertainty regarding the size and distribution of costs and benefits, and when the aggregate gains of taking action are large relative to the costs.[99] This is often referred to as a "Coasian bargain."[100] Perhaps even more important, the sought-after common resource was likely to be of high value, subject not only to contract law, but also to a system of predictable property rights, whether informal or formal, group or individual.[101]

During the Age of the Market, resources were often commodities such as forage and grasslands that were part of open access or common pool regimes.[102] When there is a lack of clear property rights to resources, open access tends to prevail. In such a situation, resource users do not bear the full costs of their actions, aggregate short-term production and use levels are too high, and competing users inflict costs on one another with externalities.[103] Cooperation gives way to a competitive rush to exploit the resource, before another user gets there and uses it first. As group size grows, transaction, information, and compliance and enforcement costs rise, and resource users find that they cannot negotiate with each other to constrain wasteful behavior. In "tragedy of the commons" settings, there are few price signals to reveal opportunity costs, and free riding and other forms of strategic behavior that prevent efficient bargains become common.[104] It is one striking characteristic of open access—the inability of any

98 *See generally* Ronald H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960).

99 *Id.*

100 These conditions characterize successful negotiating efforts among relatively homogeneous small groups. Elinor Ostrom, *Self-Governance of Common-Pool Resources*, *in* 3 THE NEW PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW, at 424–32 (Peter Newman ed., 1998).

101 Steven N. S. Cheung, *The Structure of a Contract and the Theory of a Non-Exclusive Resource*, 13 J.L. & ECON. 49, 52–54 (1970).

102 S.V. Ciriacy-Wantrup & Richard C. Bishop, *"Common Property" as a concept in Natural Resources Policy*, 15 NAT. RESOURCES J. 713, 718–19 (1975).

103 Hsu, *supra* note 80, at 77.

104 Hardin, *supra* note 80, at 1244–46; Amitai Aviram, *A Paradox of Spontaneous Formation: The Evolution of Private Legal Systems*, 22 YALE L. & POL'Y REV. 1, 10 (2004).

user (or group of users) to enforce their management decisions against any other user—that prevents conservation of the resource for future use.[105]

During Era II, when property rights to natural resources were unformed or incomplete, there often was a race to capture previously unclaimed land and resources.[106] Moreover, when many individuals are competing to establish some kind of possessory use interest in a natural resource, these individuals typically incur high costs in claiming and securing their possessory rights. Distracted by the need first to capture land and resources, and then to enforce boundaries, Era II resource players likely often failed to consider the advantage of cooperation and coordination as an alternative to the "law of the rush." Resource quality problems associated with the resulting resource overuse—e.g., declining productivity of an estuary, increased soil erosion due to unchecked grazing practices, or damage to public goods such as watershed quality—were also prominent.[107]

As a consequence, Era II was a time when natural resource entrepreneurs both consumed vast quantities of stock natural resources and accelerated consumption rates of renewable resources.[108] So great was the alteration of the natural world during this time that some have recommended that we speak of a "second nature" that occurred at the end of Era II: a time when the interactions of humans with the natural environment were so profoundly anthropogenic that the pristine nature of our collective imagination was forever transformed.[109] For example, deforestation was rampant during Era II, in part because of a growing need for agricultural land

105 JAMES WILLARD HURST, LAW AND THE CONDITIONS OF FREEDOM IN THE NINETEENTH CENTURY UNITED STATES 7 (1956); Ciriacy-Wantrup & Bishop, *supra* note 102, at 718–19; DANIEL H. COLE, POLLUTION AND PROPERTY 6 (2002).

106 Poorly defined property rights, as existed during Era II, are classically viewed as a contributing factor to open access resources. *See, e.g.*, James A. Brander & M. Scott Taylor, *International Trade and Open-Access Renewable Resources: The Small Open Economy Case*, 30 CAN. J. ECON. 526, 529 (1997).

107 C.C. Gibson & C.D. Becker, *A Lack of Institutional Demand: Why a Strong Local Economy in Western Ecuador Fails to Protect its Forest*, *in* PEOPLE AND FORESTS: COMMUNITIES, INSTITUTIONS AND GOVERNANCE, 135–61 (Clark C. Gibson et al. eds., 2000).

108 Zobler, *supra* note 22, at 192.

109 *See generally* Alan L. Kolata, *Environmental Thresholds and the "Natural History" of an Andean Civilization*, *in* ENVIRONMENTAL DISASTER AND THE ARCHAEOLOGY OF HUMAN RESPONSE, *supra* note 15, at 163.

and timber for fuel and building.[110] Equally, there was regional depletion of essential natural resources—such as minerals, arable land, and fresh water—which caused out-migration and the collapse of established civilizations.[111]

It increasingly became apparent that there was a need to update rules and applicable laws in order to adapt to changing needs and expectations for natural resources. The law of contract had limited benefit for increasing social coordination in this respect. Gradually, resource overuse and depletion by growing populations unable to solve the effects of open access conditions by cooperative games alone led to an endogenous process of property rights establishment.[112]

Where people lived and worked together and shared a sense of identity and belonging, and where they shared some level of dependence on a natural resource, collective action was possible and common property regimes initially arose.[113] As contrasted with non-property or open access situations, where a resource initially has no owner and no one has a right to exclude anyone else, *common property* refers to collective ownership arrangements. With common property, the owners cannot exclude each other from the commons but can exclude outsiders.

Eventually, as new market actors gained access to resources, including common pool resources, they began to seek to privatize such resources to ensure the value of their claims.[114] By the end of Era II, the privatization of the commons and the conversion of resources into valuable saleable commodities was becoming the norm. A new body of law developed to protect such individual resource claims—the law of private property. Individuals with private property held rights to use, to dispose, and to exclude others from the resource.

110 Mark G. Macklin, Clive Bonsall, Fay M. Davies & Mark Robinson, *Human-Environment Interactions During the Holocene: New Data and Interpretations from the Oban Area, Argyll, Scotland*, HOLOCENE, Jan. 2000, at 118–19 (2000), *available at* http://hol.sagepub.com/content/10/1/109.full.pdf.

111 Linda Cordell, *Aftermath of Chaos in the Pueblo Southwest*, in ENVIRONMENTAL DISASTER AND THE ARCHAEOLOGY OF HUMAN RESPONSE, *supra* note 15, at 179, 189.

112 *See generally* Terry L. Anderson & Peter J. Hill, *The Race for Property Rights*, 33 J.L. & ECON. 177 (1990).

113 *See* Michael Taylor & Sarah Singleton, *Common Property, Collective Action and Community*, 4 J. THEORETICAL POL. 309 (1992); OSTROM, *supra* note 97, at 68–98.

114 *See generally* William Ascher & Robert Healy, NATURAL RESOURCE POLICY MAKING IN DEVELOPING COUNTRIES: ENVIRONMENT, ECONOMIC GROWTH, AND INCOME DISTRIBUTION (1990).

With the advent of private property, the tragedy of the commons had been partially corrected, although this type of market failure continued within some groups.

Era I was a time when there were, in effect, a series of one-person games, or games where a single player made decisions about survival in nature and the use of natural resources. Formal laws were largely nonexistent, and societal norms and customs guided behavior. Individual Era I decisions about resources could be analyzed using decision theory.[115] In Era II, individuals continued their acquisitive relationship with natural resources, but their interactions increasingly involved other individuals engaged in making strategic decisions about resources. Sometimes arrangements between individuals interested in resources could be negotiated by contract and bargain, where the resulting agreement could be likened, in game theoretic terms, to a cooperative game.[116]

Despite the fact that such games could yield a collectively optimal result, implementation problems drew Era II individuals away from the cooperation that would have, in the long run, served them best. With open access resources such as land, timber, minerals, fish, and wildlife, if the costs of cooperating with competing users were high[117] then rational self-interest encourages independent noncooperative behavior.[118] The assumption becomes that any one user can do better either by not cooperating initially, or by defecting from a cooperative agreement.[119] When natural resources are overconsumed or exploited, the indirect and nonuse values are compromised.[120]

115 *See generally* RESNIK, *supra* note 47.

116 *See* NORTH & THOMAS, *supra* note 71, at 9 ("In one sense [Era II] may be defined as an arrangement of society based on contract, expressed or implied.") (quoting C.W. PREVITE ORTON, THE SHORTER CAMBRIDGE MEDIEVAL HISTORY 418–19 (1952)).

117 *See* OSTROM, *supra* note 100, at 424–32; Cheung, *supra* note 101, at 52–54.

118 *See* H. Scott Gordon, *The Economic Theory of a Common-Property Resource: The Fishery*, 62 J. POL. ECON. 124, 128–35 (1954); Hardin, *supra* note 80, at 1244–47; Hsu, *supra* note 79, at 77. LEN FISHER, ROCK, PAPER, SCISSORS: GAME THEORY IN EVERYDAY LIFE 4–5 (2008).

119 FISHER, *supra* note 118, at 4–5.

120 For example, if the earth's atmosphere is not polluted by anthropogenic greenhouse gases, the resulting indirect use value associated with an unpolluted atmosphere moderates temperatures, sea levels, precipitation patterns, glacial and sea ice melting, and so forth. Human use of that open access resource in the form of atmospheric emissions has likely adversely impaired the naturally occurring indirect uses of atmospheric gases. *See* Peter M. Vitousek, Harold A. Mooney, Jane Lubchenco & Jerry M. Melillo, *Human Domination of Earth's Ecosystems*, 277 SCIENCE 494 (1997). However, our efforts to resolve this threat of climate change and global warming will be hampered by the same logic that

IV
ERA III—THE AGE OF PROPERTY

Competitive natural resource use, coupled with a rudimentary awareness of suboptimal consumption, ultimately led to a paradigm shift that ushered in a new era, Era III. This era witnessed the rise of legally protected ownership rights to the natural world and the emergence of the Age of Property. Although the idea of property in land and natural resources had been manifested in different European countries for centuries,[121] the practice became firmly embedded as an integral part of successful economies, including the United States, by the nineteenth century.[122] From the early nineteenth century through the middle of the twentieth century, the concept of a property right in a resource both moderated the effect of the open access tragedies experienced in Era II, and allowed the owner to fully exploit the use component of the resource now under the owner's control.[123]

During the Age of Property, there was no single, centralized decision maker. Instead, there were many asset owners and entrepreneurs who released the use potential of resources by exercising their individual use choices through the market. In such a system, legal rights needed to be assigned to market actors who could use the resources most productively, and the costs of transfers needed to be low enough to encourage exchanges that placed the resource in the hands of one who would optimize use. This result could occur only if there was an appropriate system of property rights.[124]

Although the advent of property helped to stem the rush to exploit unowned open access resources, other laws and legal institutions

encouraged resource overuse and noncooperation during Era II—polluting nations will logically believe there is little incentive to control their carbon emissions so long as other nations with access to the resource continue to pollute. *See* Geoffrey Lean, *A World Dying, But Can We Unite to Save It?* THE INDEPENDENT U.K., Nov. 18, 2007, *available at* http://www.independent.co.uk/environment/climate-change/a-world-dying-but-can-we-unite-to-save-it-400847.html. Even Garrett Hardin recognized that the absence of property rights can lead to pollution and the degradation of resource nonuse values. Hardin, *supra* note 80, at 1245.

121 NORTH & THOMAS, *supra* note 71, at 19–24.

122 David Feeny, *The Development of Property Rights in Land: A Comparative Study*, *in* TOWARD A POLITICAL ECONOMY OF DEVELOPMENT: A RATIONAL CHOICE PERSPECTIVE 272 (Brain Barr et al. eds., 1988); Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347, 350–53 (1967).

123 Zobler, *supra* note at 22, at 190.

124 Ronald H. Coase, Nobel Prize Lecture: The Institutional Structure of Production (Dec. 9, 1991), NOBEL LECTURES, ECONOMICS 1991–1995 (T. Persson ed., 1997).

increased the discount rate, which in turn encouraged resource exploitation.[125] As a result, resource development slowly intensified during Era III. The rate of exploitation was often greater than regeneration rates, and resource substitutes were often available, as was the case for substituting coal for wood as a source of energy.[126] While property rights could facilitate an efficient Coasian bargain, such rights were often not clearly defined for large resources such as watersheds or air space. As a result, resource use also created negative externalities for large groups, where users imposed costs upon a larger group that had a stake in the resource. For example, water pollution and soil erosion resulting from unsustainable agricultural practices or acid mine drainage often contaminated the indirect use and ecological qualities of water.[127] Other resources were exploited because they were public goods incapable of being owned, such as the atmosphere, where individual firms could pollute the good's indirect use and natural nonuse capacities.[128] Some resources were prone to overuse because they were congestible goods, such as rangelands, capable of being shared at a low marginal cost until a certain congestion point was reached.[129] The reality is, then, that the development of property in Era III did not bring about conservation of resources; resources were still used, and overused, despite the removal of most open access conditions.

Another collateral consequence of property regimes is that conflicts emerged among competing classes of property interest. Resources became owned by individuals and groups subject to two basic property regimes: common property (*res communes*) refers to collective ownership situations, in which the owners of the resource cannot exclude each other but can exclude outsiders. Private property

125 Hurst, *supra* note 105, at 7 ("[Nineteenth century Americans] had in common a deep faith in the social benefits to flow from a rapid increase in productivity; all shared an impatience to get on with the job by whatever means seemed functionally adapted to it, including the law.") (footnote omitted).

126 CAROL A. DAHL, INTERNATIONAL ENERGY MARKETS: UNDERSTANDING PRICING, POLICY, AND PROFITS 16–37 (2004).

127 *See, e.g.,* PIERS BLAIKIE, THE POLITICAL ECONOMY OF SOIL EROSION IN DEVELOPING COUNTRIES (1986). The alarm over human impairment of nature's nonuse benefits was raised much earlier, in Era III, in George Perkins Marsh, MAN AND NATURE: OR, PHYSICAL GEOGRAPHY AS MODIFIED BY HUMAN ACTION (1864).

128 DANIEL H. COLE & PETER Z. GROSSMAN, PRINCIPLES OF LAW & ECONOMICS 316 (2005).

129 *See generally* Terry L. Anderson & Peter J. Hill, *The Evolution of Property Rights: A Study of the American West*, 18 J.L. & ECON. 163 (1975).

(*res privatae*), on the other hand, describes resources owned by individuals who can use, transfer, and exclude others.[130] When these different regimes had an interest in the same resource, such as water or land in the New World, some system needed to arise to sort out relative priorities among them.

A parallel property rights conflict occurred when private property interests were created. Private ownership of a resource meant that two classes of interests in a resource were necessarily created—owners who could exclude others from using the resource, and nonowners. Nonowners, in turn, were comprised of two groups. First, a nonowner could be one who might have wished to use the resource now controlled by the owner, for either a similar or different purpose, but as a nonowner was precluded by law from doing so. Second, a nonowner could be one who did not wish to directly use the resource, but who could receive indirect use benefits, such as clean water, from the owner's property, but could not because of the owner's use. Such a nonowner was harmed by the use, and would have benefitted from the owner's nonuse.

When owners and nonowners conflicted over the appropriate or preferred use or nonuse of resources, "resource popularity conflict" emerged.[131] Such a conflict might arise if a resource was deemed valuable for uses similar to the owner's, for uses different than the owner's, or for being not used at all. A system needed to be created to permit owners and nonowners to work through their different—and sometimes clashing—interests in land and resources.

In the Age of the Market, resource players were sometimes able to make enforceable agreements with other players, resulting in a cooperative game. If the transaction costs were sufficiently low to permit a cooperative game, then players could as a group fully commit themselves to specific resource use strategies. In contrast, in the Age of Property, holders of legally protected property interests in land and resources usually had no need to make a collective

130 DANIEL W. BROMLEY, ENVIRONMENT AND ECONOMY: PROPERTY RIGHTS AND PUBLIC POLICY 31 (1991).

131 *See* Jan G. Laitos & Rachael Gamble, *The Problem With Wilderness*, 32 HARV. ENVTL. L. REV. 503, 506, 527–31 (2008) (explaining that a resource popularity conflict exists when there is more than one group that wishes to use an area, the groups wish to use it—or not use it—in different and incompatible ways, and applicable law permits one group of users but excludes others); *see, e.g.*, PAUL GATES, HISTORY OF PUBLIC LAND LAW DEVELOPMENT 466–68 (1968) (discussing conflicts between stockmen who acquired a property right in rangelands for their cattle and settlers who wanted to use that same land to homestead and farm).

commitment to some resource strategy. The process of making resource use or nonuse choices was relatively simple for those with a private property interest—the choices were made out of their own self-interest, irrespective of the interests of other property owners, or nonowners—especially nonowners who were somehow harmed by the owner's use. The resulting games were noncooperative, and an understanding of Era III resource strategies is best studied in light of noncooperative game theory.[132]

A. The Rise of Property

In Europe, and then in America, the idea of property was grounded in several assumptions. One was advanced by John Locke, who argued that ownership over a resource—particularly land—could arise through individual labor.[133] But perhaps the most central assumption involves the workings of a market-based economic system. One may presume that such a system will permit market actors to exercise rights to perform certain actions with resources—and to negotiate exchanges regarding resources—but only if there are zero or de minimis transaction costs. In a real world of positive and often high transaction costs, individuals in the market can take steps to increase the value of resources and of resource production if rights are assigned to those who can use them most productively, with incentives that induce them to do so, and the costs of rights

132 DIXIT & NALEBUFF, *supra* note 31, at 70–76; Alvin E. Roth, *Editor's Introduction and Overview*, *in* GAME-THEORETIC MODELS OF BARGAINING 1–2 (Alvin E. Roth ed., 1985).

133 WILLIAM B. SCOTT, IN PURSUIT OF HAPPINESS: AMERICAN CONCEPTIONS OF PROPERTY FROM THE SEVENTEENTH TO THE TWENTIETH CENTURY 31 (1977). Locke also advocated the position that property was not necessarily something exclusively created by government, and that, indeed, property rights existed prior to government. JOHN LOCKE, TWO TREATISES OF GOVERNMENT (Peter Laslett ed., 1988). Of course, other Era III philosophers, such as Jeremy Bentham, did not share Locke's views on the origin of property. Bentham, for example, insisted that property cannot exist without government. ELLEN FRANKEL PAUL, MORAL REVOLUTION AND ECONOMIC SCIENCE 50 (1979). Debates about the true origins of property rights continue to this day. *See, e.g.*, Saul Levmore, *Two Stories About the Evolution of Property Rights* 31 J. LEGAL STUD. S421 (2002); Katrina Miriam Wyman, *From Fur to Fish: Reconsidering the Evolution of Private Property*, 80 N.Y.U. L. REV. 117 (2005). Irrespective of the exact source of property rights, only rights to resources that have been given official recognition by formal legal instrumentalities will likely be sustained if challenged in an administrative or judicial setting. Edella Schlager & Elinor Ostrom, *Property-Rights Regimes and Natural Resources: A Conceptual Analysis*, 68 LAND ECON. 249, 252 (1992) (contrasting *de jure* property rights, which are acknowledged by government institutions, with *de facto* rights that originate among property owners who cooperate to define rights themselves).

transference to others are relatively low. Only an appropriate system of property rights, legitimized and enforced by the law, can bring about this result.[134] The kind of property interest that is most consistent with a perfectly functioning market is a private property right to land and resources, encompassing the right of the owner to use this property to the exclusion of others, with the ability to transfer it to another.[135]

Private property was not necessarily the first type of property interest to rise out of open access. Common or communal property, involving the exclusion of all but a group of insiders from access to some common resource, was probably the first kind of property regime to emerge.[136] There were, however, several problems with common property systems. If the multiple owners did not have any internal structure of governance, they competed with one another for resource appropriation, resulting in an overuse of the resource similar to what had occurred on a smaller scale when open access was the norm. Although the owners could have agreed upon some rules of use by engaging in a cooperative game, there was always a tendency to defect from any agreement, especially if individual self-interest suggested a better short-term outcome.[137] Even if the initial transaction costs of cooperation were surmountable, post-agreement enforcement and monitoring costs must have been considerable. Moreover, trespassing from outsiders would have increased the uncertainty about appropriate use levels for joint owners.[138]

Common property regimes typically were successful when the resource was a common pool resource such as a pasture or a fishery.[139] Even then, certain contextual and historic conditions had to be present before the communal property was enduring.[140] What

134 Ronald H. Coase, *The Institutional Structure of Production*, *in* NOBEL LECTURES: ECONOMIC SCIENCES 1991–1995, at 11–20 (Torsten Persson ed., 1997).

135 NORTH & THOMAS, *supra* note 71, at 91.

136 Thráinn Eggertsson, *Open Access Versus Common Property*, *in* PROPERTY RIGHTS: COOPERATION, CONFLICT, AND LAW 74–82, 84–85 (Terry L. Anderson & Fred S. McChesney eds., 2003).

137 FISHER, *supra* note 118, at 4–5.

138 *See* Ciriacy-Wantrup & Bishop, *supra* note 102; Michael Taylor, *The Economics and Politics of Property Rights and Common Pool Resources*, 32 NAT. RESOURCES J. 633 (1992).

139 *See, e.g.,* Robert McC. Netting, *Of Men and Meadows: Strategies for Alpine Land Use*, 45 ANTHROPOLOGICAL Q. 132, 139–41 (1972); Wyman, *supra* note 133, at 126.

140 OSTROM, *supra* note 97, at 90–102; DANIEL H. COLE, POLLUTION & PROPERTY 112–20 (2002).

instead distinguished the Age of Property was the balkanization and privatization of land, resources, and natural assets. Ownership in Era III became individual, not shared, and the dominant property interest became private, not common.[141]

The division of a commons or open access resource into individual parcels occurred in different ways in different parts of the world. In America, the law of property tended to reward individual initiative; ownership went to those who seized and claimed the resource. This notion of capture, similar to Locke's labor theory, slowly transformed open access conditions into a multitude of private ownership interests. Individuals acquired, by possession and use, property rights in land,[142] and to natural resources such as minerals,[143] water,[144] forage,[145] and even wild game.[146] Applicable laws legitimated these interests, providing their owners with security and enforcement mechanisms should claim jumpers and competitors emerge.[147]

For most natural resources, especially land, the property interest consisted of several operational rights held by the owner. Among the most important were the right to defined *boundaries* around the owned interest, the right to *access* and *use* the resource, the right to *exclude* others from it, and the right of alienation, i.e., sale, transfer, and lease. In common property regimes, different individual owners could possess some, but not all, of these rights.[148] With private

141 *See* Yoram Barzel, *Property Rights in the Firm*, *in* PROPERTY RIGHTS: COOPERATION, CONFLICT, AND THE LAW 43, 43–57 (Terry L. Anderson & Fred S. McChesney eds., 2003); Demsetz, *supra* note 122, at 355–57.

142 *See, e.g.*, Homestead Act of 1862, ch. 75, 12 Stat. 392 (repealed 1976).

143 John Umbeck, *Might Makes Rights: A Theory of the Formation and Initial Distribution of Property Rights*, 19 ECON. INQUIRY 38, 40–43 (1981); General Mining Act of 1872, ch. 152, 17 Stat. 91.

144 Anderson & Hill, *supra* note 129, at 176–178.

145 *See generally* TERRY L. ANDERSON & PETER J. HILL, THE NOT SO WILD, WILD WEST: PROPERTY RIGHTS ON THE FRONTIER (2004).

146 William T. Hornaday, *The Extermination of the American Bison*, *in* U.S. NATIONAL MUSEUM: ANNUAL REPORT 493 (1887) *microformed on* Western Americana: Frontier History of the Trans-Mississippi West, 1550-1900 No. 2661; 4 Ernest T. Seton, Lives of Game Animals 451 (1937).

147 NORTH & THOMAS, *supra* note 71, at 7 ("[G]overnments [in Era IV] were able to define and enforce property rights at a lower cost than could voluntary groups, and . . . these gains became even more pronounced as markets expanded.").

148 Ostrom, *supra* note 97, at 250–54.

property, an owner typically held all of these rights, with the rights of use and exclusion being the most critical.[149]

Since a private property owner was not only given the right to exclude all others, but also the exclusive use of the property interest, two implications followed. First, with private property came two classes of individuals interested in natural resources—owners and nonowners. Second, the exact nature and extent of the resource use was subject to the sole discretion of the owner. In Era III, where resource use was to dominate, owners and nonowners typically agreed that a resource should be used. If there was disagreement, it would likely have been over competing uses, not over whether the resource should be used at all. Similarly, since ownership and resource use were basically coterminous, there were little or no limits within the property right itself to deter overuse.

B. Resource Overuse and Large Group Externalities

It is an irony of private property that its creation was in part based on the assumption that open access resources would be unsustainably exploited unless some property regime was imposed for their protection.[150] However, rational property owners in Era III not only failed to conserve resources, they tended to knowingly exploit them.[151] There were, and still are, several reasons for an owner's urge to use land and resources. First, most property rights are inherently use rights, giving the owner the freedom to exploit the resource's use component for his or her own benefit.[152] Second, consistent with standard economic theory, it would be entirely rational for owners of renewable resources, e.g., range, pasture, timber, fish, or game, to use

149 Barzel, *supra* note 141, at 43; Richard Stroup & John Baden, *Property Rights and Natural Resource Management*, 2 LITERATURE OF LIBERTY: A REVIEW OF LIBERAL THOUGHT 5–7 (1979), http://www.econlib.org/library/essays/LtrLbrty/strbdPR1.html (explaining that the right to use and the right to exert control over a resource is an important feature of a property right). The right of exclusion allows owners to decide who may enter a resource, which means they can capture for themselves (and for their offspring) the benefits from investments they undertake in a resource. Richard Posner, *Economic Analysis of Law*, *in* ECONOMIC FOUNDATIONS OF PROPERTY LAW 12, 12–13 (Bruce A. Ackerman ed., 1975).

150 Hardin, *supra* note 80, at 1247.

151 DANIEL W. BROMLEY, ENVIRONMENT AND ECONOMY: PROPERTY RIGHTS AND PUBLIC POLICY 171 (1991); THOMAS MICHAEL POWER, LOST LANDSCAPES AND FAILED ECONOMICS: THE SEARCH FOR A VALUE OF PLACE 138 (1996).

152 RICHARD R. POWELL, POWELL ON REAL PROPERTY, vol. 1, § 11.01 (Michael Allen Wolf ed. 2007); Eric T. Freyfogle, *Context and Accommodation in Modern Property Law*, 41 STAN. L. REV. 1529, 1530 (1989).

their properties up to the point of resource extinguishment and exhaustion when the discount rate sufficiently exceeds the maximum reproductive potential of the resource, and an immediate profit can be made from harvesting the last remaining resource.[153] Third, owners often have a relatively high discount rate, encouraging them to discount future costs and benefits quite heavily. High discount rates lead to exploitation and eventual loss of natural resources, particularly when the science behind resource renewal rates is not known or readily available.[154] The slow but steady depletion of the resource use component during Era III, while not socially optimal, was consistent with the wishes of the private property owners—to maximize private but not social benefits.

The law of private property was developed and then adopted in large part to permit the owner of a potentially valuable property to have exclusive use rights, free from other competing use interests.[155] While owners could, in theory, not use the resource they owned, that option was rarely exercised, either because there was no perceived value in an unused resource, or because it was flatly discouraged by applicable legal doctrine.[156] As a matter of economic reality, a high Era III demand for raw materials rewarded decisions that maximized short-term profits for private entrepreneurs.[157] With some renewable resources, such as fish, it even seemed rational for users to extinguish rather than conserve the resource.[158]

The Era III resource use path, coupled with a failure to protect nonuse values, led to three environmental consequences. First, the world began to deplete its stock natural resources, especially energy

153 Colin W. Clark, *The Economics of Overexploitation*, 181 SCIENCE 630, 630 (1973); Schlager & Ostrom, *supra* note 133, at 256.

154 Colin W. Clark, *Profit Maximization and the Extinction of Animal Species*, 81 J. OF POL. ECON. 950, 951 (1973); Bruce A. Larson & Daniel W. Bromley, *Property Rights, Externalities, and Resource Degradation: Locating the Tragedy*, 33 J. DEV. ECON. 235 (1990).

155 *See generally* Robert C. Ellickson, *Property in Land*, 102 YALE L.J. 1315, 1356 (1993).

156 For example, western water law was and is characterized by a use-it-or-lose-it mentality that encouraged needless use in order to maintain rights, and punished conservation and nonuse, since saved water was often forfeited. *See, e.g.*, Colorado Water Conservancy Dist. v. Shelton Farms, Inc., 529 P.2d 1321 (Colo. 1974); Stephen F. Williams, *The Requirement of Beneficial Use as a Cause of Waste in Water Resource Development*, 23 NAT. RESOURCES J. 7 (1983).

157 Zobler, *supra* note 22, at 190, 192.

158 Gordon, *supra* note 118; Clark, *supra* note 154, at 950–51.

fuels and industrial minerals.[159] The main driver of this resource demand was the need of rapidly industrializing European economies, as well as the burgeoning economy of the United States,[160] to exploit the seemingly plentiful natural resources of the New World.[161] The strength of the international market meant that natural resources that were not being used within the parent country could be transformed into other forms of capital by being traded to countries that needed them for economic growth.[162]

Second, renewable biological resources such as fisheries, forests, and pasturelands became exploited. As a result of intensifying fishing efforts, one marine fishery after another collapsed in Era III.[163] Forests and woodlands shrank, accounting for perhaps half of the net deforestation in world history.[164] Massive forest clearance reduced biodiversity, added carbon to the atmosphere, and exposed millions of square miles of soil to erosion. Rangelands and pasturelands become over-grazed, degrading or destroying naturally occurring grasslands, along with the considerable ecological values provided when these resources are not used as a commodity.[165]

159 McNeill, *supra* note 4, at 51, 53–55.

160 The United States, spurred on by the nation's dreams of Manifest Destiny, also consumed its own land and natural resources on an unprecedented scale during Era III. Sandra Zellmer, *Sustaining Geographies of Hope: Cultural Resources on Public Lands*, 73 U. COLO. L. REV. 413, 425 (2002).

161 Era III is often referred to as the "Golden Age of Resource-Based Development." EDWARD B. BARBIER, NATURAL RESOURCES AND ECONOMIC DEVELOPMENT 81–83 (2005); Alan Green & M.C. Urquhart, *Factor and Commodity Flows in the International Economy of 1870–1914: A Multi-Country View*, 36 J. ECON. HIST. 217, 247 (1976); Zobler, *supra* note 22, at 190.

162 Ronald Findlay & Mats Lundahl, *Natural Resources, "Vent-For-Surplus," and the Staples Theory*, *in* FROM CLASSICAL ECONOMICS TO DEVELOPMENT ECONOMICS 68 (G. Meier ed. 1994).

163 *See* Jeremy B.C. Jackson et al., *Historical Overfishing and the Recent Collapse of Coastal Ecosystems*, 293 SCIENCE 629 (2001). *See also* McNeill, *supra* note 4, at 58 ("Since the late 1980s, all marine fisheries have been exploited at or above sustainable levels.").

164 SING C. CHEW, WORLD ECOLOGICAL DEGRADATION: ACCUMULATION, URBANIZATION AND DEFORESTATION, 3000 B.C.–A.D. 2000, at 3 (2001); J.R. MCNEILL, SOMETHING NEW UNDER THE SUN: AN ENVIRONMENTAL HISTORY OF THE TWENTIETH CENTURY WORLD 229–37 (2000); DAVID EVANS, A HISTORY OF NATURE CONSERVATION IN BRITAIN 57 (Routledge, 2d ed. 1992).

165 COLE, *supra* note 140, at 97 (explaining that in the early twentieth century, Great Britain "had the smallest percentage of forested land—just 3 percent—of any country in Europe"); *see generally* Joseph M. Feller & David E. Brown, *From Old-Growth Forests to Old-Growth Grasslands: Managing Rangelands for Structure and Function*, 42 ARIZ. L. REV. 319 (2000); LAITOS ET AL., NATURAL RESOURCE LAW 464–65 (2006).

Third, raw population growth, worldwide industrialization, and increasing combustion of fossil fuels for energy use required that the inevitable waste products of this resource use and consumption be deposited somewhere. The atmosphere, the hydrosphere, and the earth's underground soils accepted the wastes and pollution of Era III. Because in most situations these naturally occurring resources were not owned (and in the case of air and many waters, not capable of ownership), the market's pricing mechanism did not provide useful signals to those seeking a free depository for the growing amount of pollution that was being produced.[166] As a result, pollutants accumulated faster than they could be absorbed, recycled, or dissipated. As Era III closed out in middle of the twentieth century, environmental goods with enormous nonuse value—such as the atmosphere, hydrosphere, and even the earth itself—were receiving overloads of pollutants, with increasingly disturbing consequences for both ecosystems and humans.[167]

Resource owners and users in Era III were predictably acting in their own self-interest. Unfortunately, in overconsuming or overusing their resources, or exploiting public environmental goods such as the atmosphere, they imposed externalities upon a larger group that also had some stake in the resource. An externality occurs when some market activity, such as resource use, affects third parties who are not participants in that market activity, and there is an imposed cost on an outside party. In other words, an externality is more formally defined as an "unintended spillover effect," where the costs or benefits of the activity are not adequately reflected in the price of the good. When numerous parties experience the spillover effect but are not responsible for the harm-producing activity, the result is a large group negative externality.[168]

In Era III, the large group externality affected nonowners. They were either nonowners who wanted to use the resource in a way different than the owner's use (or at another point in time), or who would have preferred that the resource not be used at all. For the first of these classes, the externality generated by the owner's use negatively impacted the interests, or presumed profits, of the nonowner, the would-be user of the resource. An example of this kind

166 COLE, *supra* note 140, at 2 ("In the absence of property rights to protect them, environmental goods have been abused, sometimes to the point of destruction.").

167 McNeill, *supra* note 4, at 55–56.

168 COLE & GROSSMAN, *supra* note 128, at 14; Hsu, *supra* note 80, at 78.

of externality is evident when an owner of subsurface minerals extracts them and negatively affects the surface use of the land for agriculture. For nonowners who benefitted from the resource in its natural state, the externality generated by the owner's use was the resulting degradation of nonuse values and benefits from indirect use.

There was a large group temporal externality as well, because a suboptimal rate of resource use also imposed negative costs on future resource users, who lost future access to resources such as virgin forests. While commentators have pointed out that domestication of nature took place over thousands of years,[169] the rate by which the human footprint affected natural settings intensified greatly during Era III. Such unprecedented human use forces future generations to engage in resource protective practices in order to maintain ecosystem service benefits. Heightened resource management, particularly in agricultural areas, perpetuated a profound long-term cycle of necessary management of human-altered ecosystems, by means of controlling fire, pests, and invasive species. The human imprint shifted the balance of the ecosystem, creating a new burden of future generations to continue these land management strategies.[170]

The two most immediate large group externalities to arise in Era III involved the exploitation of renewable biological resources, and the pollution of public goods such as the atmosphere and hydrosphere. Deforestation, overfishing, drained wetlands, and grasslands removal had short-term effects on nonowners who otherwise would have benefitted from the indirect services and existence value provided by healthy forests,[171] sustainable fisheries,[172] functioning wetlands,[173] and natural rangelands.[174] Air and water pollution, as well as the toxic contamination of land, had very real health effects on individuals who did not own, and therefore had no control over, the enterprises

169 *See* Peter Kareiva et al., *Domesticated Nature: Shaping Landscapes and Ecosystems for Human Welfare*, 316 SCIENCE 1866, 1866–67 (2007); *see also* Eric W. Sanderson et al., *The Human Footprint and the Last of the Wild*, 52 BIOSCIENCE 891, 892 (2002).

170 *See generally* Fred P. Miller, *After 10,000 Years of Agriculture, Whither Agronomy?,* 100 AGRONOMY J. 22 (2008).

171 JOHN COPELAND NAGLE & J.B. RUHL, THE LAW OF BIODIVERSITY AND ECOSYSTEM MANAGEMENT 435–41 (2d ed. 2006).

172 McNeill, *supra* note 4, at 58.

173 James Boyd & Lisa Wainger, *Measuring Ecosystem Service Benefits for Wetland Mitigation*, 24 NAT'L WETLANDS NEWSL. 11, 11–15 (2002).

174 *See generally* DEBRA L. DONAHUE, THE WESTERN RANGE REVISITED: REMOVING LIVESTOCK FROM PUBLIC LANDS TO CONSERVE NATIVE BIODIVERSITY (1999).

responsible for the waste disposal practices.[175] The consequences of stock resource depletion were not as immediately experienced, because new sources seemed to be constantly discovered.[176] However, the relentless removal of fossil fuels and valuable minerals would eventually adversely affect nonowners in Era IV, because by then newly discovered sources were far less plentiful, which meant that diminished supply and higher prices would become the norm.

C. Resource Popularity Conflicts and Noncooperative Games

The ubiquitous nature of private property law gradually divided the universe of parties interested in land and natural resources into two classes—owners and nonowners. Nonowners, in turn, consisted of those who also wished to use the owner's resource but could not do so, and those who held nonuse values for a resource. During Era III, owners typically were authorized, even encouraged, to use their property for their own short-term self-interest.[177] When an owner's use of a resource created conflict with nonowners who also wished to use that resource, these conflicts were usually sorted out by private property law.[178] The owner who held a property right to land or some natural resource had the legal right to use that resource and exclude nonowner, would-be users from it. Owners could also erect boundaries to keep this class of nonowners away, and to protect the owner's interests in a wide range of uses.[179]

If a nonowner wished to use an owner's property, in theory, the nonowner could engage in a cooperative game in order to produce a socially optimal result,[180] where, by contract and agreement, the nonowner would be able to purchase and acquire some ownership or

175 The most serious resource exploitation involved the use of the atmosphere, hydrosphere, and soils as sinks for all manner of pollutants, because there are no substitutes for human uses of air, water, and earth. McNeill, *supra* note 4, at 51.

176 KENNETH S. DEFFEYES, HUBBERT'S PEAK: THE IMPENDING WORLD OIL SHORTAGE 1–13 (2001); VACLAV SMIL, ENERGIES: AN ILLUSTRATED GUIDE TO THE BIOSPHERE AND CIVILIZATION 136–37 (1999).

177 JAMES WILLARD HURST, LAW AND ECONOMIC GROWTH: THE LEGAL HISTORY OF THE LUMBER INDUSTRY IN WISCONSIN, 1836–1915, at 105, 127 (1984).

178 Livestock grazing is a prominent resource use example where a nonowner of land, such as a livestock owner, might desire to use the property of another, such as the land owner, to feed his cattle.

179 Henry E. Smith, *Exclusion Versus Governance: Two Strategies for Delineating Property Rights*, 31 J. LEGAL STUD. S453, 454–56 (2002).

180 *Id.*

use interest from the owner.[181] However, the size of the group of nonowners affected by owners' resource use could potentially have been so large and diffuse that coordinating strategies between owners and nonowners would have been practically impossible. Since owners had a legally protected right to use their own resources, and since Era III positive law did not penalize use of environmental public goods as pollution sinks, owners likely were unwilling to engage in a strategy of mutual cooperation with nonowners that would have reduced the rate of resource use. [182] As a result, nonowners were often affected by an owner's resource use strategy, but they had no legal recourse to influence or deter the owner. Nonowners and nonusers were not players in the Era III resource use game.

Owners could safely ignore the plight of these nonowners, because those who were affected by resource overuse were powerless to halt, slow, or influence an owner's choices regarding resources. Unfortunately, nonowners either harmed by or benefitting from the owner's resource use were unable to engage in even noncooperative games in Era III. Although there were large group negative externalities experienced by these nonowners,[183] applicable law did not provide them with any effective legal recourse to halt an owner's exploitation of either an owned natural resource or an unowned environmental public good.[184] It was not until laws and legal institutions in Era IV gave legal stature to the nonuse interests of nonowners that they could become players in the resource game.

The suboptimal rate of resource use that dominated Era III was the result of information failures about stock depletion in the case of nonrenewable resources, the carrying capacity of the land, and the rate of regeneration for renewable resources. The rush of private landowners to produce commodities and short-term profits (along with considerable externalities) can be illustrated by a simplistic, noncooperative game theory model.[185] If the participants in a resource

181 *See supra* notes 85–90 and accompanying text.

182 McNeill, *supra* note 4, at 51.

183 *See supra* notes 159–70 and accompanying text.

184 Era III laws available to those adversely affected by an owner's overuse of a resource usually consisted of either common law nuisance doctrine or primitive anti-pollution regulations. These were rarely effective in curbing an owner's use preferences. *See generally* Jan G. Laitos, *Legal Institutions and Pollution: Some Intersections Between Law and History*, 15 NAT. RESOURCES J. 423 (1975).

185 Of course, specific local or state laws could facilitate different noncooperative game scenarios. For the purpose of illustration, we have selected a simple model with the most basic economic assumptions of a game theory model. Variations of different

game are either unable or unwilling to coordinate their behavior (in this case, resource conservation), and if they instead choose their strategies regarding the resource independently, then the resulting game becomes a noncooperative game.[186] In a noncooperative game, like a cooperative game, every player is assumed to be rational; a rational player will choose an action that leads to the outcome that player prefers, given what that player expects the other players to do.[187] Unlike a cooperative game, a noncooperative game does not require coordination among the players, and there are no cooperative enforceable agreements made between players that will allow them to maximize their gains collectively.[188]

Players engaged in a noncooperative game are not necessarily doomed to experience chaos.[189] In 1950, Nobel Prize laureate Dr. John Nash proved that even noncooperative games can yield a equilibrium between the players.[190] This is now called a Nash equilibrium. When players find themselves in a noncooperative game, there is either a unique solution or a set of available solutions that will produce maximum payoffs for each player in the game, given the likely strategies of the other players.[191] In a Nash equilibrium, each player is informed of the others' strategies, and each player makes the optimal choice given what the other players might choose. There is no further benefit for a player to change strategies if the strategies of the other players remain unchanged.[192] In other words, a Nash equilibrium does not necessarily coincide with Pareto optimality; a Nash equilibrium is defined as the best strategy for that player, when all other players in the noncooperative game are playing their best

noncooperative game models can be adapted to reflect nuances in property law. Furthermore, assigning probabilities to different strategies and relaxing assumptions may yield different equilibriums. These variations are voluminous and beyond the scope of this Article.

186 LARRY SAMUELSON, EVOLUTIONARY GAMES AND EQUILIBRIUM SELECTION 1, 10 (1998).

187 *See generally* TIM HARFORD, THE LOGIC OF LIFE: THE RATIONAL ECONOMICS OF AN IRRATIONAL WORLD (2008).

188 Scott Borg, *Finding Sanity With Game Theory*, STRATEGY & BUSINESS at 2, *available at* http://www.strategy-business.com/article/8527?gko=e6930.

189 *See generally* James W. Friedman, *A Noncooperative Equilibrium for Super Games*, 38 REV. OF ECON. STUD. 1 (1971).

190 Nash, Jr., *supra* note 27, at 155; John F. Nash, Jr., *Equilibrium Points in n-Person Games*, 36 PROC. NAT'L ACAD. OF SCI. 48 (1950).

191 *Id.*

192 DIXIT & NALEBUFF, *supra* note 31, at 77.

strategy. There is not necessarily a unique Nash equilibrium and it is not uncommon for multiple Nash equilibria to exist.

Resource owners in Era III engaged in a high rate of resource consumption that can be explained by a classic game of "chicken." Like the game of chicken, each resource player recognizes that their continued course of action may have detrimental consequences. However, the short-term gain of winning is so high that players are deterred from their hazardous, high-consequence course of action. The game has been heavily studied and adapted in several contexts to explain brinkmanship that pushes noncooperative behavior to the point of near disaster.[193] In the game of chicken, the Nash equilibrium is that of suboptimal use.[194] Consider a situation where the players drive toward each other on a single track at a high speed until one "chickens out," and swerves off the track to avoid colliding. The player who swerves gains nothing, and the player who stays on track gains everything. Neither player wants to yield to the other. Given the strategies of the other player in the game and the fact that players cannot communicate their intentions, the best strategy for each player is to select the course opposite of their opponent. Since both players assume that their opponent is rational and would prefer not to have a head-on collision, the Nash equilibrium strategy is to select the opposite of an opponent's course. The opponents are "deadlocked" because both assume that the other will back down.

The game played between owner-users in Era III is analogous to the chicken game. Two resource user-owners—suppose they are foresters—have incentive to clear-cut and supply as much wood to the market as possible to gain financial rewards. While it would be socially optimal to conserve the wood production in order to sustain the forest, each producer has incentive to clear-cut and gain market share if the opponent chooses conservation. The nonuser, who may have an interest in the existence value of the forest for its beauty, or who would benefit from forest nonuse because then it would supply oxygen, is not even a player in this game. But the nonuser would experience the negative externality of clear-cutting.

The payoffs and Nash equilibrium are illustrated in Figure E. Forester 2 may either conserve (upper left box), or clear-cut (upper right box). If Forester 2 conserves, Forester 1 experiences a high

193 AVINASH K. DIXIT & SUSAN SKEATH, GAMES OF STRATEGY 457 (1999).

194 Evolutionary biology has been likened to a game of chicken. *See* J. Maynard Smith & G.R. Price, *The Logic of Animal Conflict*, 246 NATURE 15 (1973).

payoff (5) from clear-cutting the forest, while Forester 2 experiences a much lower pay-out (1) due to Forester 1's market domination. Likewise, if Forester 1 conserves, Forester 2 experiences a high payoff (5) from clear-cutting the forest, while Forester 1 experiences a much lower payout (1) due to Forester 2's market domination. If both clear-cut, there will be a negative payout to both. But because this is a noncooperative game, both foresters will clear-cut the forest, even though this strategy produces the least desirable result for the two players and for society.

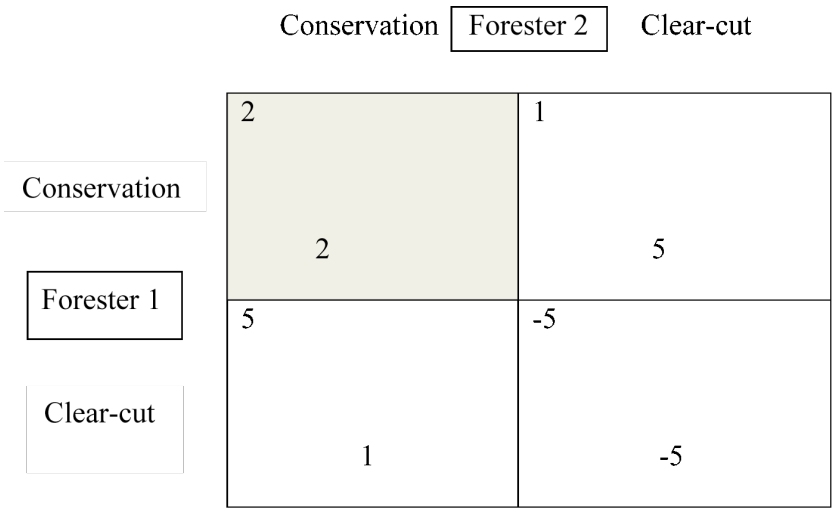

Figure E. Game of chicken.

Note that the number in each box on the left is the Forester 1's payoff; the number on the right is Forester 2's payoff. The Nash equilibrium solution is highlighted.

The owner-user foresters are deadlocked in trying to anticipate their opponent's strategy. As a result, there is an endless bout of suboptimal resource use. The foresters, nonusers, and ecosystem suffer as a result.

V
ERA IV—THE ANTHROCENE AGE

By the middle of the twentieth century, a new era had swept much of the planet, and its legal institutions. Era IV may be called the Anthrocene Age because of the prominent role played by human

anthropogenic decisions.[195] Era IV, which continues to the present, has three prominent anthropocentric characteristics: (1) continued suboptimal use of some resources, (2) laws requiring individuals and entities to comply with regulations in order to protect indirect resource values that provide human benefit, and (3) new laws that for the first time recognize and uphold human preferences for nonuse values. Throughout Era IV, the resource economy increasingly came under political and governmental control; however, these twentieth century laws were anthropocentric and designed to protect resource indirect use and nonuse values primarily for the benefit of humans.[196]

During Era IV, scientific knowledge emerged to document the human benefits gained from indirect resource benefits such as clean air and clean water. Most western countries, particularly the United States, enacted environmental protection laws that undermined absolutist notions of property rights prevalent in Era III. In Era IV, unlike Era III, ownership of natural resources no longer conferred unchecked authority over their extraction and development. The creation of scientifically grounded Best Management Practices (BMPs) and other science-based environmental standards resulted in regulations aimed to limit the external costs and deleterious effects on indirect uses imposed by an individual's private resource use.[197] Furthermore, the Era III preservation movement, ignited by prominent writings and activism of naturalists from this time period, gained momentum and popularity in Era IV, particularly in the last decade of the twentieth century.[198] Human preferences for resource existence

195 *See* Daniel H. Cole, *Climate Change, Adaption, and Development*, 26 J. ENVTL. L. 1 (2008); ANDREW REVKIN, GLOBAL WARMING: UNDERSTANDING THE FORECAST 55 (1992); *see generally* Michael Williams, *Forests*, *in* THE EARTH AS TRANSFORMED BY HUMAN ACTION: GLOBAL AND REGIONAL CHANGE OVER THE PAST 300 YEARS 179 (B.L. Turner II et al. eds., 1990).

196 *See, e.g.*, Friends of the Earth v. Laidlaw Environmental Services, 528 U.S. 167, 181 (2000) ("The relevant showing for purposes of Article III standing, however, is not injury to the environment but injury to the plaintiff."); The National Environmental Policy Act, 42 U.S.C. § 4331(a) (2006) ("[T]he continuing policy of the Federal Government [is] . . . to use all practicable means and measures . . . in a manner calculated to . . . maintain conditions under which man and nature can exist in productive harmony, and fulfill the . . . requirements of future generations of Americans."); *see also* Gunther Handle, *Human Rights and Protection of the Environment*, *in* ECONOMIC, SOCIAL, AND CULTURAL RIGHTS 304–05 (Asbjørn Eide, Catarina Krause & Allan Rosas eds., 2001).

197 ROBERT GOTTLEIB, FORCING THE SPRING: THE TRANSFORMATION OF THE AMERICAN ENVIRONMENT MOVEMENT 113 (1993); Wash. State Dep't of Natural Res. v. Browning, 199 P.3d 430 (Wash. Ct. App. 2008) (upholding state agency stop work orders prohibiting timber owner from harvesting trees).

198 *See* Meyer, *supra* note 24.

values were validated in Era IV by the passage of several laws to protect resource nonuse values. For example, the U.S. Forest Service, which manages multiple use lands, is mandated to consider ecosystem integrity and use and nonuse values (such as forestry, grazing, recreation, and wilderness).[199]

Increased government presence yielded two principal results: first, legislation and government enforcement that aimed to reduce negative externalities imposed by direct uses, and second, increased government ownership of public lands. Governments also gained momentum in acquiring public ownership interests in valuable resources, including land, in order to reduce exploitation of unowned public goods.[200] Increased scientific knowledge and changing public preferences led to an affirmative duty imposed on Era IV public land managers to protect indirect and nonuse values threatened by use demands,[201] and to impose nonuse values on certain lands that might otherwise have seemed important only for use potential.[202] These new Era IV laws restricted or prevented direct resource use. They also advanced the anthropocentric goals of protecting indirect uses, e.g., public goods healthy for humans, and nonuse values, e.g., option and existence values.

Era IV laws have created, and given legal power to, an important new interest to be reckoned with when considering our relationship to natural resources—resource indirect use and nonuse, for the benefit of humans. These laws give individuals, organizations, and even governments that value indirect use and nonuse of resources the legal ability to directly challenge both private and public resource use decisions that compromise the human interest in nonuse values.[203] Those asserting anthropocentric indirect use and nonuse interests have

199 JOHN B. LOOMIS, INTEGRATED PUBLIC LANDS MANAGEMENT (Columbia Univ. Press, 2d ed. 2002).

200 *See, e.g.*, Massachusetts v. Envtl. Prot. Agency, 127 S. Ct. 1438 (2007) (emission of greenhouse gases released into the atmosphere contribute to global warming, which is experienced by those who emit these gases, and those who do not).

201 *See* 16 U.S.C. § 1132 (2006) (future protection of roadless areas within national forests); 43 U.S.C. § 1782(a) (2006) (protection of wilderness study areas within U.S. Bureau of Land Management lands); Endangered Species Act of 1973, 16 U.S.C. § 1531 (2006).

202 *See, e.g.*, Antiquities Act of 1906, 16 U.S.C. § 431 (2006); 1968 Wild and Scenic Rivers Act, 16 U.S.C. §§ 1271–1287; Wilderness Act of 1964, 16 U.S.C. §§ 1131–1136.

203 RICHARD J. LAZARUS, THE MAKING OF ENVIRONMENTAL LAW 80–83 (2004). Era IV laws also permit those interested in the nonuse component of land to create an ownership interest in that component. *See also* ELIZABETH BYERS & KARIN MARCHETTI PONTE, THE CONSERVATION EASEMENT HANDBOOK (2d ed. 2005).

taken on resource use interest in three settings: private resource owners who use, or wish to use, resources under their control;[204] public resource owners who use, or authorize private use of, resources owned by some government entity;[205] and users who exploit an unowned resource.[206]

Despite the ubiquity of laws authorizing resource nonusers to challenge resource use decisions for anthropocentric ends, the harsh reality is that the world's resource base continues to diminish below suboptimal levels,[207] and natural systems continue to degrade and disappear.[208] There are, of course, many asserted and demonstrated reasons for the world's persistent pursuit of the use values associated with resources.[209] These range from exponentially increasing populations, to ever-increasing demand for raw materials from developing countries and certain sectors of the American economy that see their survival linked to resource use, to the human tendency to discount the value of future benefits associated with present conservation.

Market failures, such as unowned public goods, and government failures stemming from the management of these public goods also yield a suboptimal level of natural systems and natural resources in Era IV, much like they did in Era III. Ironically, increased government intervention itself has yielded government failures, an overcorrection stemming from attempts to address market imperfections. Government command and control policies mandating compliance with air and water quality standards do not provide

204 *See, e.g.*, Davis v. Agua Sierra Res., L.L.C., 174 P.3d 298 (Ariz. Ct. App. 2008) (challenging the withdrawal of percolating groundwater by the overlying landowner).

205 *See* Sue Major Holmes, *Judge Backs BLM Plan on Gas Drilling in N.M.*, DENV. POST, Oct. 10, 2008, at B2 (describing an environmental challenge to a Bureau of Land Management plan contemplating 10,000 new gas wells in northern New Mexico).

206 *See* El Comite Para El Bienestar v. Warmerdam, 539 F.3d 1062 (9th Cir. 2008) (citizen group challenge to emissions of volatile organic compounds into California's atmosphere).

207 DON HINRICHSEN ET AL., CONSEQUENCES OF OVERUSE AND POLLUTION, XXVI POPULATION REPORTS, ch. 4 (Population Info. Program ed., 1998); Elisabeth Rosenthal & Andrew C. Revkin, *Science Panel Calls Global Warming "Unequivocal,"* N.Y. TIMES, Feb. 3, 2007, at A1; WILLIAM MCKIBBEN, THE END OF NATURE 51 (2006).

208 *See* Thomas L. Friedman, *In the Age of Noah*, N.Y. TIMES, Dec. 23, 2007, *available at* http://www.nytimes.com/2007/12/23/opinion/23friedman.html; MICHAEL SHELLENBERGER & TED NORDHAUS, THE DEATH OF ENVIRONMENTALISM: GLOBAL WARMING POLITICS IN A POST-ENVIRONMENTAL WORLD (2004), *available at* http://www.thebreakthrough.org/images/Death_of _Environmentalism.pdf.

209 *See* SHELLENBERGER & NORDHAUS, *supra* note 208.

incentives to jointly improve productivity, and typically lead to further inefficiencies and mislaid incentives to protect use, indirect use, and nonuse interests.[210] Furthermore, government intervention explicitly developed to conserve resource use has also crowded out the private provisioning of public goods, such as open space.[211] Ultimately, this public action can yield a suboptimal production of environmental goods.[212]

Put in terms of game theory, Era IV laws legitimized a new player in natural resources games. This player had preferences for indirect uses and nonuses, and was legally empowered to resist user interests. Instead of simple user versus user games so prevalent in Eras II and III, in Era IV the games increasingly involved humans who believed their indirect use and nonuse interests would be harmed by resource use. Resource users were private resource owners, public resource owners who either used resources directly, or who authorized private use, or users of unowned public good resources. The new player, a resource nonuser, was a protector of natural systems for human-centric reasons. Not to be confused with nonuse values, which are essentially existence values, resource nonusers included individuals with preferences for (1) indirect use benefits that followed from a clean, unpolluted environment; (2) option values for possible future nonconsumptive use, such as low-impact recreation; and (3) nonuse interests, such as existence values realized when humans left a resource alone. Resource nonusers were individuals, resource-protective organizations, and government entities empowered to enforce new Era IV laws.

While motivations differed, the commonality is that nonusers demonstrated anthropocentric ambitions. Even nonusers with existence values presented anthropocentric preferences that furthered the rights of humans. While nonusers and users may have approached the resource differently, the anthropocentric focus resulted in suboptimal, unsustainable resource use, regardless of whether the game was cooperative or noncooperative. Achieving cooperation requires considerable coordination, often times imposing high transaction costs and requiring agency-based collaborative

210 Eric W. Orts, *Reflexive Environmental Law*, 89 Nw. U. L. REV. 1227, 1236 (1995).

211 *See* Theodore Bergstrom et al., *On the Private Provision of Public Goods*, 29 J. PUB. ECON. 25, 25–49 (1986).

212 *See generally* Richard Cornes & Todd Sandler, *Easy Riders, Joint Production, and Public Goods*, 94 ECON. J. 580, 580–98 (1984).

facilitation.[213] As noted in Part IV C, noncooperative games do not yield agreements between players that will allow them to maximize their gains collectively.[214] Such games, because they are refereed by proscriptive laws between two opposing interests, usually lead to a win-lose outcome. Such an outcome is neither a collectively optimal result nor an efficient result for the players.[215]

A. Resource Use and Anthropogenic Harm

Throughout Eras I and II, humans viewed nature, and natural resources, as either a source of cheap or free exploitable wealth, or a virtually costless dumping ground for wastes. Common law doctrine and resource-use friendly government agencies and courts validated human enterprises using resources for economic gain.[216] Nonuse interests were largely silent, in large part due to an absence of legal legitimacy for nonuse values.[217]

By Era IV, this unchecked use had been spurred on by an accelerated demand for raw materials. The earth's population was increasing almost exponentially. Economic growth among western countries was the norm, developing nations such as China and India put new demands on natural resource products, and resources were both the fuel for this growth and a free waste receptacle for growth's discarded byproducts.[218] Human resource use patterns fundamentally reshaped the earth; the planet was human-dominated and permanently altered.[219] Much of this mid-twentieth century transformation had serious negative effects on resource availability and viability.

213 *See generally* Holly Wise Bender & Wade E. Martin, *Modelling Conflict Using Spatial Voting Games: An Application to USDA Forest Service Lands*, 12 INT'L J. ENV'T & POLLUTION 217 (1999).

214 *See supra* note 186 and accompanying text.

215 *See supra* notes 185–88 and accompanying text.

216 *See, e.g.*, Ebbetts Pass Forest Watch v. Cal. Dept. of Forestry and Fire Prot., 183 P.3d 1210, 1226 (Cal. 2008) (approving timber harvesting plans despite concerns about environmental impacts); Adaven Mgmt., Inc. v. Mountain Falls Acquisition, Corp., 191 P.3d 1189, 1192–96 (Nev. 2008) (discussing "anti-speculation" doctrine in western water law, which ensures that property right in water is put to "beneficial use"); Karl Vick, *Secret Deal May Speed Development of Forest Land*, DENV. POST, July 6, 2008, at 7A (timber company approved by the U.S. Forest Service to build homes on forest land).

217 *See supra* notes 183–84 and accompanying text.

218 *See* ZOBLER, *supra* note 22, at 190.

219 Peter M. Vitousek, et al., *Human Domination of Earth's Ecosystem*, 277 SCIENCE 494, 498 (1997). *See also* Peter Kareiva et al., *Domesticated Nature: Shaping Landscapes and Ecosystems for Human Welfare*, 316 SCIENCE 1866 (2007) (we have converted roughly "50% of the world's surface . . . to grazed land or cultivated crops").

Era IV laws did have some effect on some dimensions of resource pollution and depletion. However, by the twenty-first century other indicators of environmental quality had declined.[220] Notably, carbon dioxide and other greenhouse gases had increased.[221] This change resulted in what many scientists believed to be anthropocentrically induced global climate change.[222] These deleterious impacts on resources eventually alarmed humans, who began not only to take note of a diminished resource base, but also feared human health threats from environmental pollution.[223] Eventually, fears about environmental degradation raised doubts about humankind's very survival. These anthropocentric fears caused us to turn to laws and legal institutions to address the growing exploitation of open access resources and the onslaught of negative environmental externalities.[224]

Apart from concerns about how resource overuse might adversely affect humans, evidence was also mounting that natural resources played an important ecological and biological role when they were not being exploited by humans. Just as exploitation of resources produced large group negative externalities, it was becoming equally clear that, when left alone and not used, certain natural resources

220 According to the theory of the environmental Kuznets curve, based on the work of Simon Kuznets, environmental quality is expected to increase as per capita income increases. *See generally* Simon Kuznets, *Quantitative Aspects of the Economic Growth of Nations, VIII: The Distribution of Income by Size*, ECON. DEV. & CULTURAL CHANGE, Jan. 1963, at 1.

221 Elaborations and laboratory experiments have since documented that improvements in environmental quality with increases in average income may not be the case in practice. Specifically, greenhouse gases do not actually decline when worldwide per capita income increases, implying that wealthier nations may reduce pollution in some areas, but greenhouse gas emissions may increase. *See generally* David I. Stern et al., *Economic Growth and Environmental Degradation: The Environmental Kuznets Curve and Sustainable Development*, 24 WORLD DEV. 1151–60 (1996).

222 RICHARD N.L. ANDREWS, MANAGING THE ENVIRONMENT, MANAGING OURSELVES: A HISTORY OF AMERICAN ENVIRONMENTAL POLICY 353 (1999); ANDREW GOUDIE, THE HUMAN IMPACT ON THE NATURAL ENVIRONMENT 167 (4th ed. 1994).

223 HERMAN E. DALY & JOSHUA FARLEY, ECOLOGICAL ECONOMICS PRINCIPLES AND APPLICATIONS (2004); Schlager & Ostrom, *supra* note 133, at 279; *see also Developing Nations Balk at Climate Plan*, DENV. POST, July 10, 2008, at 7A (the five main developing nations—China, India, Brazil, Mexico, and South Africa—rejected a goal for reducing global emissions of greenhouse gases, "since it is wealthier countries that have [already] created most of the environmental damage").

224 San Antonio Conservation Soc'y v. Tex. Highway Dep't, 400 U.S. 968, 969–71 (1970) (Black, J., dissenting). *See also* Pannaro Energy, Inc. v. Mont. Bd. of Envtl. Review, 199 P.3d 191, 194 (Mont. 2008) (agency concerned that water produced from privately-owned coal bed methane gas had a harmful effect on soils and stream life).

generated positive externalities.[225] For example, naturally occurring wetlands, whether unowned or privately owned, perform and provide several valuable ecosystem services, such as flood control and pollution filtration.[226] Since the market normally does not take into account such nonuse benefits when decisions are being made about resource use,[227] methodologies were developed in Era IV to attempt to measure such values, such as contingent valuation.[228]

B. Anthropocentric Laws Protecting Resource Human Indirect Use and Nonuse Values

As resource exploitation posed growing threats to both humans and ecosystems, new Era IV laws began to legitimate and empower resource nonusers. This player had been largely powerless in Era III,[229] but now it had a battery of statutory weapons to resist harmful resource use when the use adversely affected human nonuse values.[230] Era III laws had embraced largely absolutist notions of private property rights, which assumed that ownership conferred upon owners plenary authority to engage in maximum resource appropriation and exploitation.[231] By contrast, the core premise of many Era IV laws was that the sovereign's police power could regulate private activities, including the natural environment that adversely affected human health and welfare.

Governments in two ways asserted public rights protecting anthropocentric values threatened by excessive resource use. First, they claimed resources—often open access resources—as publicly

225 Ironically, once domesticated and managed, many natural resources require active management by humans to maintain positive benefits. Prominent examples are the infiltration of invasive plant species in former pasturelands and years of wildfire mitigation that have led to wildfires in the urban-rural interface. Human disturbance often yields a necessary cycle of land management, making the return to a truly natural system very difficult to achieve.

226 *See* RUHL ET AL., *supra* note 7, at 64–65.

227 Andrew Balmford et al., *Economic Reasons for Conserving Wild Nature*, 297 SCIENCE 950, 952–53 (2002).

228 Marino Gatto & Giulio A. De Leo, *Pricing Biodiversity and Ecosystem Services: The Never-Ending Story*, 50 BIOSCIENCE 347 (2000) (Revealed preference or hedonic pricing are other methods that try to capture the worth of resource's nonuse values. These impute some of the value of one good or service traded in the market to the presence of another attribute that is not traded.).

229 *See supra* Figure E in Part IV.C.

230 *See* LAZARUS, *supra* note 203, at 47–113.

231 ROBERT GOTTLIEB, FORCING THE SPRING: THE TRANSFORMATION OF THE AMERICAN ENVIRONMENTAL MOVEMENT 7–8 (1992).

owned property. Most western countries did this by establishing national forests, national parks, national rangelands, and other public lands.[232] Second, governments imposed public rights through the regulation of private resource use. Governments did this by regulating both private use of open access[233] and privately owned resources.[234]

Although perceived threats to human health were primary drivers for the adoption of these laws, another motive for this unparalleled government intervention lay in our gradual realization that natural systems generate positive spillovers, indirect uses, and nonuse values for the benefit of humans. This recognition of unused nature justified restrictions on private use decisions regarding resources. Humans also discovered that they cared deeply about preserving, from development and alteration, certain locations characterized as wildlands,[235] wildlife, and endangered species and their habitats.[236] Part of this benefit involved personal, sometimes mystical feelings people had toward nature.[237] Some of the benefit was due to a realization that humans and their natural environment are closely linked and mutually interdependent.[238] Ecologists and economists have tried to estimate the quantitative value to the world's economic well-being that was provided by productive natural systems—a 1997 publication in *Nature* concluded that the total annual global value of ecosystem services was between 16 and 54 trillion dollars.[239]

Such psychological, ecological, and economic factors influenced lawmakers, who in Era IV found themselves under pressure to

232 COLE & GROSSMAN, *supra* note 128, at 325–26.

233 *See, e.g.*, Clean Air Act of 1970, 42 U.S.C. § 7401 (2006) (imposing a system of public rights and private duties regarding the atmosphere); State ex rel. State Eng'r v. Comm'r of Public Lands, 200 P.3d 86, 99 (N.M. Ct. App. 2008) (under federal reserved rights doctrine, federal government may impliedly reserve water and exempt it from appropriation under state law).

234 *See, e.g.*, Home Builders Ass'n of Cent. Ariz. v. Kard, 199 P.3d 629 (Ariz. Ct. App. 2008) (home builders challenging state air quality permits required for earth-moving operations on privately owned lands).

235 *See, e.g.*, Wilderness Act of 1964, 16 U.S.C. §§ 1131–1136 (2006).

236 *See, e.g.*, Endangered Species Act of 1973, 16 U.S.C. § 1531 (2006); Tenn. Valley Auth. v. Hill, 437 U.S. 153 (1978); Nat'l Wildlife Refuge Improvement Act of 1997, 16 U.S.C. §§ 668dd–668ee (2006).

237 *See, e.g.*, Wallace Stegner, *Why We Need Wilderness*, MOTHER EARTH NEWS, Aug./Sept. 2004, at 64, 65.

238 Dan Tarlock, *The Nonequilibrium Paradigm in Ecology and the Partial Unraveling of Environmental Law*, 27 LOY. L.A. L. REV. 1121, 1126–27 (1994).

239 Robert Constanza et al., *The Value of the World's Ecosystem Services and Natural Capital*, 387 NATURE 253, 259 (1997).

acknowledge values of the natural world. However, throughout Era IV, the laws and legal doctrine that sought to protect the indirect use and nonuse components of resources did so for largely anthropocentric ends. It was the public's right to the benefits of resource nonuse that became legally protected; it usually was not the resource's right to remain in a natural state.[240] The new statutes and regulations focused on the harmful impacts that resource use decisions had on individual humans, rather than on the natural environment itself.[241] American environmental laws enacted in the latter half of the twentieth century seemed little concerned about the injuries to natural resources caused by overuse. Instead, these laws were more intent on the threats to personal health and welfare that followed from environmental degradation.[242] This anthropocentric emphasis is particularly evident with laws addressing overuse of open access resources.[243] Even under the National Environmental Policy Act (NEPA), when federal resource use actions are proposed, an impact statement must be prepared only if the action might affect "the quality of the *human* environment . . . ."[244] Many federal natural resources laws enacted in Era IV also emphasized the need for

240 There were some exceptions to the law's inclination to acknowledge and protect nonuse values so as to primarily advance strictly human ends. *See* Just v. Marinette Cnt'y, 201 N.W.2d 761, 768 (Wis. 1972); 42 U.S.C. § 9607(f) (2006) (for certain hazardous waste disposal sites subject to cleanup under CERCLA, a federal or state "trustee" may be designated to assess damages to natural resources); Katrina M. Wyman, *The Property Challenges in Marine Fisheries*, 50 ARIZ. L. REV. 511, 513–15, 528–29 (2008) (discussing "no take areas" for certain marine fisheries, where extractive uses are prohibited and nonuse values are preserved).

241 Gunther Handl, *Human Rights and Protection of the Environment: A Mildly "Revisionist" View*, *in* HUMAN RIGHTS, SUSTAINABLE DEVELOPMENT AND THE ENVIRONMENT 117 (Antonio Trindade ed., 1992).

242 LAZARUS, *supra* note 203, at 59.

243 The 1970 Clean Air Act, 42 U.S.C. § 7409(b) (2006), requires that national ambient air quality standards be established for the protection of public health. The 1972 Clean Water Act, 33 U.S.C. § 1251(a)(2) (2006), requires that the waters of the United States be fishable and swimmable. Amendments to the Resource Conservation and Recovery Act, 42 U.S.C. § 6924(a) (2006), call for disposal regulations for hazardous waste "as may be necessary to protect human health." The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), 42 U.S.C. §§ 9601 et seq. (2006), requires the cleanup of abandoned and inactive hazardous waste sites containing substances that could be toxic or harmful to humans.

244 42 U.S.C. § 4332(2)(c) (emphasis added).

publicly owned lands to be conserved and preserved because of "the anthropocentric virtues of wild lands."[245]

The law of standing similarly evolved to ensure that courts will not hear from plaintiffs raising the interests of natural resources; rather, it is only through the transformation of such interests into harms to persons that violations of environmentally protective laws can be remedied by courts.[246] Under Article III of the U.S. Constitution, if some resource nonuse attribute is threatened or harmed by a resource use decision, those wishing to challenge that action in court must claim that they have somehow been injured.[247] To satisfy standing requirements the injury must be to the human plaintiff,[248] and it is irrelevant that the underlying harm is to some otherwise protected natural resource.[249] Even in environmental lawsuits brought under the generous review provisions of the Administrative Procedure Act, it is the human plaintiff's interests in protecting and preserving resource nonuse from use that is the focus of a court's initial inquiry.[250] Yet the overuse of a resource that impairs that resource's nonuse component itself rarely attaches to identifiable humans, even when human plaintiffs allege "concrete and particularized" harm sufficient to satisfy standing requirements in court.[251]

An anthropocentric focus also affects cost-benefit analysis undertaken as a condition of environmentally protective legal action. If the cost of excessive resource use is only measured in human lives lost or human health impaired, the staggering nonuse values that are lost to the planet may be overlooked.[252] If one seeks to measure the benefits of nonuse, the accounting scope required to monetize the

245 Sandra Zellmer, *A Preservation Paradox: Political Prestidigitation and an Enduring Resource of Wildness*, 34 ENVTL. L. 1015, 1040 (2004); Wilderness Act of 1964, 16 U.S.C. § 1131(b), (c) (2006); LAZARUS, *supra* note 203, at 93.

246 *See* Friends of the Earth, Inc. v. Laidlaw Envtl. Servs. (TOC), Inc., 528 U.S. 167, 181 (2000).

247 Sierra Club v. Morton, 405 U.S. 727, 734–35 (1972).

248 *See* Weaver's Cove Energy v. R.I. Dep't of Envtl. Mgmt., 524 F.3d 1330, 1333 (D.C. Cir. 2008).

249 Lujan v. Defenders of Wildlife, 504 U.S. 555, 563 (1992) ("But the 'injury in fact' test requires more than an injury to a cognizable interest. It requires that the party seeking review be . . . injured." (quoting *Sierra Club*, 405 U.S. at 734–35).

250 Bennett v. Spear, 520 U.S. 154, 167–68 (1997); Salmon Spawning & Recovery Alliance v. United States, 532 F.3d 1338, 1347 n.7 (Fed. Cir. 2008).

251 Shi-Ling Hsu, *The Identifiability Bias in Environmental Law*, 35 FLA. ST. U. L. REV. 433, 467 (2008).

252 *See, e.g.*, James Salzman, Barton H. Thompson, Jr. & Gretchen C. Daily, *Protecting Ecosystem Services: Science, Economics, and Law*, 20 STAN. ENVTL. L.J. 309 (2001).

value to the earth for leaving a resource alone is monumental and will likely present much controversy.[253]

C. The Rise of a New Player in the Resource Game

In Era II, disputes over resources were typically between users who may have wished to use the same resource. With the emergence of contract law, these Era II users could sometimes engage in cooperative games, presented earlier in Figure B. At times, such agreements resulted in cooperation and win-win solutions to the conflict. In Era III, with the arrival of private property law, the two competing users were often user-owners and nonowners who wanted to use the resource. Since user-owners had the weight of property ownership justifying their use, few cooperative games were played with nonowner, would-be users. Also, during Era III another player arose—the nonowner who was harmed by resource use by experiencing negative externalities and by losing the positive nonuse values that were degraded by excessive resource use. But throughout most of Era III, this third player had no legal stature and therefore could largely be ignored by resource users.

All this changed in Era IV.[254] Users either had ownership rights permitting use, e.g., when the user was either a private or public owner, or in the case of an unowned resource, confronted no market barriers to resource exploitation. By contrast, nonusers had the ability to deploy Era IV laws, which gave them the legal power to curb or halt harmful use of both owned and unowned resources.[255] Users and nonusers with opposing interests often went toe to toe with equally viable legal support, and the frequent and often anticipated conflict made it difficult to predict whether the resulting game would be cooperative or noncooperative.

253 Sidney A. Shapiro & Christopher H. Schroeder, *Beyond Cost-Benefit Analysis: A Pragmatic Reorientation*, 32 HARV. ENVTL. L. REV. 433, 456 (2008); *see, e.g.*, Entergy Corp. v. Riverkeeper, Inc., 129 S. Ct. 1498, 1509 (2009) (discussing how the "non-use benefits" of national air quality performance standards would be of "indeterminate value").

254 Sometimes Era IV laws were activated by agencies, such as the U.S. Environmental Protection Agency, that relied on such laws to protect nonusers from the effects of resource use.

255 *See, e.g.*, Babbitt v. Sweet Home Chapter, 515 U.S. 687, 708 (1995) (finding that the Endangered Species Act prohibition against "taking" a species encompasses destruction or modification of the habitat of the red-cockaded woodpecker and northern spotted owl).

This uncertainty was particularly the case for collaborative decision-making sessions when stakeholders (either users or nonusers) had incentives to engage in a sophisticated game to disguise their preferences, and form a voting block to misrepresent their interests and to further their objectives.[256] Studies have shown that a number of variables can complicate a process in which users and nonusers, whose interests may support either indirect or nonuse values, met to vote on policy options. Examples of these complexities include ordering of status quo alternatives on the agenda during a voting process; the degree of required majority for a win to secure an alternative—i.e., simple majority or super majority; and transferable utility, which means that a nonuser would be willing to sacrifice the nonuse of a particular parcel of land if the nonuse is transferred to another parcel.[257]

Such complex strategies during Era IV made it difficult to predict whether a cooperative or noncooperative game would actually take place. Noncooperative situations arise when self-interested players either are unwilling or unable to communicate, or cannot or do not trust each other, and so cannot make credible commitments to cooperative strategies. Throughout Era IV, users and nonusers found themselves in exactly this situation. Involvement from a governmental agency tasked with supporting multiple uses within the constraints of ecosystem service carrying capacities often yields options that trump the preferences of the other players. In other words, agency multiple-use policies such as U.S. Forest Service lands policies that permit multiple activities often yield a compromise that allocates some use to each party. However, this result does not necessarily mean that the players are pleased—the outcome may lead to malcontent. Regardless of whether the game is cooperative or noncooperative, when government agencies are involved the end result is still usually an overall suboptimal allocation of

256 Bender, *supra* note 213 ("Although mandated to include the public in its decisions, the USDA Forest Service (USFS) can choose to undertake different types of public involvement. More recently, the USFS has embraced a collaborative (i.e., cooperative) decision-making process, which focuses on bringing stakeholders together for intensive education, communication and mediation to come to a consensus decision. In contrast, the purpose of the more traditional noncooperative National Environmental Policy Act (NEPA) process is solely to educate interested parties about USFS activities and solicit information about the public's desires. These models focus on comparing the results of non-cooperative public involvement models with the cooperative or collaborative models.").

257 *Id*.

environmental goods with respect to indirect use value or nonuse values. Government provisioning of environmental goods crowds out the private provisioning of these same goods.[258]

Figure F demonstrates how a noncooperative solution between two players defaults to a suboptimal multiple use plan that encourages both extraction and wilderness use. Imagine in this particular scenario that the U.S. Forest Service is evaluating a proposal to permit timber extraction in a national forest within an area well known for its scenic vistas and wildlife viewing.

The extraction proposal has triggered the need for an analysis of the environmental impacts under NEPA, which initiated considerable public involvement. For purposes of simplicity, we can break the groups into users who prefer the extraction option because it offers the potential to increase regional job availability and economic development, and nonusers—ardent environmentalists who truly prioritize existence values. In other words, environmentalists prioritize the nonuse values of these U.S. Forest Service lands, and these nonusers would prefer to see the area return to a natural state, to the point of closing visitor use even for hiking. The U.S. Forest Service, which is tasked with managing multiple uses, must consider all of these uses within the constraints of the ecosystem.[259] In this noncooperative game, the Nash equilibrium of the U.S. Forest Service multiple use mandate facilitates both use and nonuse, but to a degree that does not fully satisfy either group.[260]

258 Bergstrom et al., *supra* note 211.

259 *See, e.g.*, Multiple Use Sustained Yield Act of 1960, 16 U.S.C. §§ 528–531 (2006).

260 For the sake of simplicity, we model this game using pure strategies, where players do not assign probabilities to the outcome of the play.

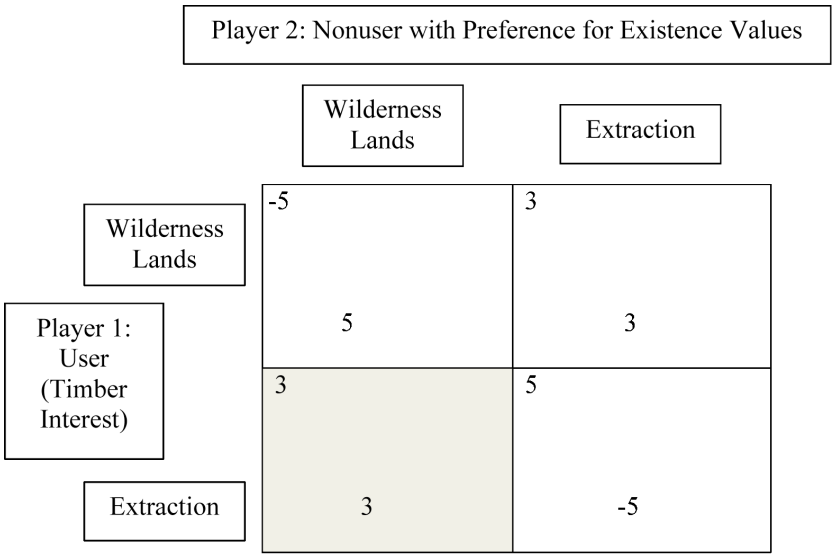

Figure F. Multiple use for Forest Service lands.

Note that the number in each box reflects Player 1's (timber interest) payoff on the left; the number on the right reflects Player 2's payoff. The box containing the noncooperative solution for agency multiple use is highlighted.

In Figure F, payoffs are based upon the number of acres of U.S. Forest Service lands that are allocated for each purpose, extraction and nonuse. Player 2 demonstrates considerable nonuse values for large wilderness areas (5). The wilderness area is compromised if extraction takes place, but Player 2 would prefer to see some wilderness maintained (3), even if less wilderness acreage is ultimately available. Player 1, with a timber interest, would prefer to see the lands converted to extraction (5). Maintaining the lands as wilderness areas would result in considerable profit losses to Player 1 (-5); however, Player 1 receives some benefit (3) from multiple use.

The Nash equilibrium occurs when Player 1 extracts and Player 2 enjoys some wilderness, reflected in the lower left box. This set of strategies also demonstrates multiple use and a Pareto optimal solution, in terms of acreage allocated towards each use. Those who value wilderness benefit from the nonuse designation, and the timber harvester benefits by the ability to cut some timber. However, due to the nature of the use and nonuse activities, there is still room for externalities and conflict between users and nonusers, as well as within these groups. For example, clear-cutting produces spillover effects such as excessive runoff on the adjacent wilderness lands.

Conversely, the timber harvesters are frustrated by the wilderness designation, because they are unable to maximize profits from the available resource next door. Government ownership of a resource does not necessarily yield a socially optimal result.[261]

D. Private Provisioning of Nonuse Environmental Goods

While a public ownership solution to the conflict between use and nonuse seemed elusive regarding lands and resources, so too did market-based solutions for the provisioning of environmental goods, common in the latter part of the twentieth century and early twenty-first century. Cap and trade programs were implemented in the mid-1990s to cap the total output of smog-inducing air emissions such as nitrogen oxides (NOx) and sulfur oxides (SOx). These cap-and-trade programs allowed firms to either buy or sell the right to emit pollution as appropriate for their manufacturing practices, while the industry as a whole was required to reduce total emissions. Firms were able to provide an environmental good, clean air, while deciding on the appropriate manufacturing processes to manage emissions and maximize profits.[262] While imperfect in implementation, economists and other professionals applauded cap-and-trade practices as market-based solutions, and the SOx cap-and-trade guidelines seemed to reduce this pollutant.[263] The trading of greenhouse gases such as carbon dioxide also emerged in the twenty-first century. While such carbon markets were mandated in the European Union,[264] the creation of the Chicago Climate Exchange—the first voluntary market for the trading of greenhouse gases—showed promise for trade in the United States.[265]

261 COLE, *supra* note 105, at 39–40 (discussing public mismanagement of publicly owned "multiple use" resources); Thomas Borcherding, *Natural Resources and Transgenerational Equity*, *in* ECONOMICS AND THE ENVIRONMENT: A RECONCILIATION 95–115 (Walter Block ed., 1990) (public ownership of resources sometimes merely converts the tragedy of open access into the "tragedy of the political commons").

262 LESSER ET AL., *supra* note 2, at 156–59.

263 COLE, *supra* note 140; Byron Swift, *The Acid Rain Test*, 14 ENVTL. FORUM 17 (1997); Barry Wallerstein, Letter to the Editor, *Our Cap and Trade NOx the SOx Off*, WALL ST. J., April 25, 2009, at A10.

264 *See* Emissions Trading System—Policies, EUROPEAN COMMISSION CLIMATE ACTION, http://ec.europa.eu/environment/climat/emission/index_en.htm (last updated Nov. 15, 2010) (summarizing cap and trade requirements in the European Union).

265 CHICAGO CLIMATE EXCHANGE, http://www.chicagoclimatex.com (last visited Nov. 26, 2010).

In Era IV, other laws sought to provide private firms and landowners financial incentives to reduce externalities and to create public goods on their private property. Most notably, conservation easements evolved into one of the most common tools for protecting private lands that provide public goods possessing nonuse value, such as wildlife habitat, aesthetic views, or historical significance.[266] With a conservation easement, land remains in private ownership, but the landowner enters into a contractual agreement to place restrictions on development or use of the land in return for benefits, which may include tax benefits and other forms of remuneration.[267] In order to implement a conservation easement, a landowner must work with a conservation organization, usually a land trust, which enforces the agreement and agrees to ensure protection of the nonuse conservation values of the land. In the case of a donated conservation easement, the land trust facilitates the conservation easement contract, but does not directly pay the landowner. Not to be confused with transferable development rights, the conservation easement contract effectively extinguishes the land's development use rights in perpetuity, regardless of whether the property is transferred at a future point in time to another owner.[268]

Like emissions trading practices, conservation easements represented a market-based solution to a market failure. While emissions trading reduced the negative externality—i.e., air pollution—imposed upon the public from private industry, conservation easements sought to correct a positive externality. Without the corresponding tax breaks, the landowners with such easements are uncompensated for keeping land undeveloped and providing public goods such as wildlife habitat and scenic views.[269] Conservation easements and emissions trading were considered two rather successful market-based programs to provide landowners with

266 John C. Bergstrom, B.L. Dillman & J.R. Stoll, *Public Environmental Amenity Benefits of Private Land: The Case of Prime Agricultural Land*, 17 S. J. AGRIC. ECON. 139, 139–49 (1985); J. Wyerman, *Private Land Conservation in U.S. Soars*, LAND TRUST ALLIANCE (2006), http://www.landtrustalliance.org/events-news/alliance-news/private-land-conservation-in-u.s.-soars (last visited Nov. 16, 2010).

267 Parkinson v. Bd. of Assessors, 495 N.E.2d 294 (Mass. 1986) (tax abatements permitted for valid conservation easements on taxpayer's property).

268 J.A. GUSTANSKI, PROTECTING THE LAND: CONSERVATION EASEMENTS PAST, PRESENT, AND FUTURE 1–14 (2000).

269 *See generally* CATHERINE M. KESKE, RENTS, EFFICIENCY, AND INCOMPLETE MARKETS: THE EMERGING MARKET FOR PRIVATE LAND PRESERVATION AND CONSERVATION EASEMENTS (2008).

a financial incentive to internalize the externalities, and to supply a more optimal quantity of environmental goods and nonuse benefits. Although other similar trading programs, such as water markets, proved to be less successful and did not gain momentum due to information failures and high transactions costs,[270] emissions trading and conservation easements showed that the market could in some cases act as an incentive for industry and private landowners to protect nonuse values from resource use.

By the twenty-first century, however, concerns about the irreversibility of environmental damage and the rate of change in environmental quality in emerging economies such as India and China called into question whether the market could react quickly enough to provide nonuse benefits and environmental goods in the United States and worldwide.[271] If the market had the potential to protect the environment and nonuse values in some cases, such as emissions trading programs and conservation easements, then why was there still a suboptimal level of environmental goods? A number of factors have contributed to this outcome: different discount rates between developed and developing nations;[272] variability in the preferences for environmental goods within a nation;[273] and differences of opinion between scientists about the level of existing environmental degradation.[274] Publicly owned resources have also produced suboptimal levels of nonuse benefits. As shown by Figure F above, while government may allocate use and nonuse values on

270 Janis M. Carey, David L. Sunding & David Zilberman, *Transaction Costs and Trading Behavior in an Immature Water Market*, 7 ENV'T & DEV. ECON. 733, 733–750 (2002); J.M. Carey & D.L. Sunding, *Emerging Markets in Water: A Comparative Analysis of the Central Valley and Colorado-Big Thompson Projects*, 14 NAT. RESOURCES J. 283, 283–328 (2001).

271 TYLER VOLK, CO_2 RISING: THE WORLD'S GREATEST ENVIRONMENTAL CHALLENGE (2009); KERRY EMANUEL, WHAT WE KNOW ABOUT CLIMATE CHANGE (2009); JAMES GUSTAVE SPETH, THE BRIDGE AT THE END OF THE WORLD: CAPITALISM, THE ENVIRONMENT, AND CROSSING FROM CRISIS TO SUSTAINABILITY, 17–45 (2008).

272 *See* Sebastian Edwards, *Country Risk, Foreign Borrowing, and the Social Discount Rate in an Open Developing Economy*, NAT'L BUREAU OF ECON. RESEARCH, INC., Working Paper Number 1651 (1986).

273 LYNNE KOONTZ & DANA L. HOAG, U.S. GEOLOGICAL SURVEY, FORT COLLINS SCIENCE CENTER, ANALYZING STAKEHOLDER PREFERENCES FOR MANAGING ELK AND BISON AT THE NATIONAL ELK REFUGE AND GRAND TETON NATIONAL PARK: AN EXAMPLE OF THE DISPARATE STAKEHOLDER MANAGEMENT APPROACH OPEN-FILE REPORT 1224 (2005).

274 Yuko Heath & Robert Gifford, *Free Market Ideology and Environmental Degradation* 38 ENV'T & BEHAVIOR 48, 48–71 (2006).

public lands, there is still not enough land and resources to meet everyone's desires.[275]

Failures of the market, limitations associated with government empowerment of individuals raising nonuse interests, and suboptimal results yielded by government ownership of public goods all lead to this conclusion: The only way to achieve an optimal amount of resource use is for humans to actually privatize the resource itself and bestow upon the resource legal rights so that the resource becomes its own player in a game of strategy. What seems to be needed is the legal formalization of the private provisioning of a public good, in order to prevent free-riding behaviors. This can be done by collective action or formation of small groups.[276] Instead of relying on Era IV laws that create rights in people and institutions to raise nonuse values in resources for human-oriented ends, laws should give legal stature and protection to the resource itself, so that its nonanthropocentric, ecocentric interests may be advanced in a resource game.[277] Through a series of elegant mathematical and economic models, several authors have shown that reliance on government alone to protect and assert nonuse values simply crowds out private solutions to relentless use activities threatening resource nonuse values.[278]

VI
ERA V—AN AGE OF ECOCENTRISM

Despite the ubiquitousness of Era IV laws, which gave individuals, organizations, and governments the ability to raise their interest in resource nonuse, the Anthrocene Age still experienced escalating human demands on resource nonuse services.[279] The questions that

275 John B. Loomis & Catherine M. Keske, *Mountain Substitutability and Peak Load Pricing of High Alpine Peaks as a Management Tool to Reduce Environmental Damage: A Contingent Evaluation Study*, 90 J. ENVTL. MGMT. 1751, 1751–1760 (2009).

276 *See generally* MANCUR OLSON, THE LOGIC OF COLLECTIVE ACTION: PUBLIC GOODS AND THE THEORY OF GROUPS (1965).

277 Peter G. Warr, *Pareto Optimal Redistribution and Private Charity*, 19 J. PUB. ECON. 131, 131–38 (1982); Peter G. Warr, *The Private Provision of a Public Good Is Independent of the Distribution of Income*, 13 ECON. LETTERS 207, 207–11 (1983).

278 Bergstrom et al., *supra* note 211; Steven J. Eagle, *Reflections on Private Property, Planning, and State Power*, 61 PLAN. & ENVTL. L. 3 (2009); Harold Demsetz, *Information and Efficiency: Another Viewpoint*, 12 J.L. & ECON. 1 (1969).

279 *See, e.g.*, CLIMATE CHANGE: WHAT IT MEANS FOR US, OUR CHILDREN, AND OUR GRANDCHILDREN (Joseph F.C. DiMento & Pamela M. Doughman eds., 2007); HARVEY BLATT, AMERICA'S ENVIRONMENTAL REPORT CARD: ARE WE MAKING THE GRADE? (2005); *see also supra* notes 267–71 and accompanying text.

arise from this failure are: Why are these laws and legal institutions unable to protect resource nonuse values? And what must be done to secure effective protection of the endangered nonuse component of resources?

The answer to the first question in large part lies in the fact that Era IV laws, while purporting to protect resource nonuse values, in reality gave humans and their institutions the right to assert their own anthropocentric interests in resource nonuse.[280] This human-centered focus has in turn been based on the standard economic assumption that environmental and resource policies should be assessed exclusively in terms of their effects on the well-being and preferences of individuals.[281] The answer to the second question follows from the answer to the first: If laws that permit humans to raise their interests in resource nonuse cannot adequately deter human assaults on the planet's natural resource base, then perhaps laws should give legal status to the resource itself, so that its nonanthropocentric, ecocentric interests may be protected.

The establishment of a right of nonuse held by natural resources would permit resources to assert a legally acknowledged right to be left alone when threatened by human use desires. Such a right would also empower a third player in the natural resources game—the resource itself and its nonuse component. When the resource's own nonuse interest must be reckoned with by the other two legally recognized resource players—users and nonusers raising human interests—the resulting resources game may finally yield a cooperative solution and an equilibrium that is a collectively optimal result.

A. Resource Endangerment Despite Era IV Laws

Most of the resource nonuse laws put in place during Era IV rested on two pillars of standard microeconomic theory. First, based on the groundbreaking work of welfare economist A.C. Pigou, policy makers realized that pollution was an externality or social cost of production that required some non-market response to an otherwise intractable market failure.[282] Era IV pollution control laws were in turn designed to constrain the health risks that one person may impose on another. These laws were also meant to internalize externalities

280 *See supra* Part V.B.

281 LESSER ET AL., *supra* note 2, at 40–43.

282 *See generally* A.C. PIGOU, THE ECONOMICS OF WELFARE 172–203 (4th ed. 1932).

when resources such as air, water, and land are used as free dumping grounds for waste, thereby impairing the indirect use value that humans enjoy from unpolluted public environmental goods.[283] Second, based on the insight of John Krutilla and others that people value natural objects simply because they are natural when unused, policy makers also recognized that markets fail to respond to the nonuse value of natural objects that people want to preserve, but may not ever use, consume, or experience.[284] As a consequence of this realization, statutes were enacted that preserved natural landscapes, landmarks, and living things such as endangered wildlife.[285]

All these pollution prevention and resource preservation laws no doubt have helped to reduce the rate of pollution of public environmental goods and the degradation and destruction of natural objects. However, by the first decade of the twenty-first century it was becoming apparent that they had not been able to prevent four potentially catastrophic environmental threats. These drivers of planetary collapse include climate crisis,[286] natural systems destruction,[287] diminution of biomass productivity,[288] and species extinction.[289] Unlike pollution and impairment of natural objects,

283 *E.g.*, Clean Air Act, 42 U.S.C. §§ 7401–7671q (2006); Noaki Schwartz, *60% in Nation Live in Dirty Air*, DENV. POST, April 29, 2009, at 6A, *available at* http://www.denverpost.com/search/c:_12249820.

284 *See generally* John V. Krutilla, *Conservation Reconsidered*, 57 AM. ECON. REV. 777 (1967).

285 *See e.g.*, Wilderness Act, 16 U.S.C. §§ 1131-1136 (2006); Endangered Species Act, 7 U.S.C. § 136, 16 U.S.C. §§ 1531–1544 ; Antiquities Act, 16 U.S.C. §§ 431–433 (1906).

286 *See generally* VOLK, *supra* note 271; MARK LYNAS, SIX DEGREES: OUR FUTURE ON A HOTTER PLANET (2007); EMANUEL, *supra* note 270; Dan Vergano & Doyle Rice, "*Game Changer": Report on Climate Change Urges Action*, USA TODAY, June 17, 2009, at 6D, *available at* http://www.usatoday.com/weather/climate/globalwarming/2009-06-16-Climate_change_damage_n.htm; Mark Jaffe, *Developing World's Impact Rises in Ozone*, DENV. POST, Feb. 19, 2009, at 12A, *available at* http://www.denverpost.com/headlines/ci_11738042.

287 *See generally* JAMES LOVELOCK, THE REVENGE OF GAIA: EARTH'S CLIMATE CRISIS AND THE FATE OF HUMANITY (2006); TYLER VOLK, GAIA'S BODY: TOWARD A PHYSIOLOGY OF EARTH (2003); RUHL ET AL., *supra* note 7; REED F. NOSS ET AL., ENDANGERED ECOSYSTEMS OF THE UNITED STATES: A PRELIMINARY ASSESSMENT OF LOSS AND DEGRADATION, app. A (1995), *available at* http://biology.usgs.gov/pubs/ecosys.

288 VACLAV SMIL, THE EARTH'S BIOSPHERE: EVOLUTION, DYNAMICS AND CHANGE (2002); *see* THE WORLDWATCH INSTITUTE, VITAL SIGNS 2002, at 106 (2002).

289 STEPHEN M. MEYER, THE END OF THE WILD (2006); Boris Worm et al., *Impacts of Biodiversity Loss on Ocean Ecosystem Services*, 314 SCIENCE 787 (2006); Council on Environmental Quality, *Environmental Quality, 21st Ann. Rep*. 137 (1990); Corneia Dean,

these four particular perils do not just threaten human welfare, they jeopardize the earth's entire biosphere, irrespective of human preferences or needs.[290] Passage of more Era IV–like pollution prevention and resource preservation laws seems doomed to fail.[291] After all, the four threats to planetary survival arose despite the existence of such laws. What is called for is something new—some response that does what existing law does not.

B. From Human Harm to Eco-Harm

The distinguishing characteristic of Era IV laws was that they acknowledged a human preference that certain resources not be used, because the converse—resource use—was interfering with various human nonuse values. For example, use of public environmental goods as pollution sinks was thought to impair human health values, while use and development of wild lands and species habitat as economic commodities was thought to impair the existence value of natural objects people wanted to preserve. The laws that responded to these resource nonuse preferences were thereby either explicitly or implicitly anthropocentric.[292] They assumed that the harms sought to be redressed were harms to humans, but not necessarily to the natural resource being overused by humans.[293]

This human-centered view reflected in Era IV laws was, and is, consistent with one of the central tenets of welfare economics: Nature is valuable only as a means to the end of individual well-being, defined as the satisfaction of preferences. The goal of social policy, as reflected in laws, has therefore been to raise the level of human

One-Third of U.S. Bird Species Endangered, Survey Finds, N.Y. TIMES, Mar. 20, 2009, at A15, *available at* http://www.nytimes.com/2009/03/20/science/earth/20bird.html.

290 SPETH, *supra* note 271; FRED PEARCE, WITH SPEED AND VIOLENCE: WHY SCIENTISTS FEAR TIPPING POINTS IN CLIMATE CHANGE (2007); Geoffrey Lean, *A World Dying, But Can We Unite to Save It?*, INDEPENDENT U.K., Nov. 18, 2007, *available at* http://www.independent.co.uk/environment/climate_change/a-world-dying-but-can-we-unite-to-save-it-400847.html.

291 SHELLENBERGER & NORDHAUS, *supra* note 208.

292 *See supra* Part V.B.

293 *See, e.g.*, Summers v. Earth Island Inst., 129 S. Ct. 1142, 1148–49 (2009) ("Anglo-American courts . . . [are restricted] to redress or prevent actual or imminently threatened injury to persons . . . ."); Friends of the Earth, Inc. v. Laidlaw Envtl. Servs., Inc., 528 U.S. 167, 181 (2000) ("[It] is not injury to the environment but injury to the plaintiff [that matters]."). *See also* Heather Elliott, *The Functions of Standing*, 61 STAN. L. REV. 459, 485–86 n.126 (2008) (it is difficult "to sue to vindicate environmental interests . . . [because the relevant] harm . . . [is not] to the environment . . . [but] harm to the plaintiff").

welfare—or to maximize the social aggregate of utility—as much as natural resources allow.[294] Legal resource policies are to be assessed exclusively in terms of their effects on individuals; conversely, a law or policy that is unrelated to individual well-being is largely irrelevant.[295] Moreover, welfare economists argue that the satisfaction of individual preferences—and its collective product, social welfare—is best tested by willingness to pay for environmental benefits such as nonuse values.[296] For example, the reduction of pollution from public environmental goods is a preference reflected in environmental quality policies because humans are willing to pay for the enforcement of laws that protect the nonuse benefits of uncontaminated air, water, and soil.[297] And the existence value of unused wild lands is a preference incorporated in laws authorizing conservation easements, because humans are willing to pay to have some lands go undeveloped.[298]

These human-based laws are meant to legitimize resource nonusers so that nonusers can act as a countervailing force to user interests. But there is another stakeholder in natural resources conflicts that is usually not legally legitimated by Era IV laws—the resource itself. User-versus-nonuser conflicts are typically clashes between two classes of humans who are driven by individual self-interest where the central question for each class is: What is the outcome that is good for me? A question that is rarely asked during conflicts between users and nonusers is: What is the outcome that is good for the resource itself?

Gradually, commentators are beginning to take recognition of the anthropocentrism inherent in traditional responses to environmental calamities, and the tensions that may arise when nonuse protections

294 MARK SAGOFF, PRICE, PRINCIPLE, AND THE ENVIRONMENT 8–9 (2004).

295 *See* LOUIS KAPLOW & STEVEN SHAVELL, FAIRNESS VERSUS WELFARE 16 (2002); EDITH STOKEY & RICHARD ZECKHAUSER, A PRIMER FOR POLICY ANALYSIS 275 (1978) ("individual welfare is all that counts in making policy choices"); Kenneth Arrow et al., *Is There a Rule for Benefit-Cost Analysis in Environmental, Health, and Safety Regulation?*, 272 SCIENCE 221, 221–22 (1996) ("[V]alues to be assigned to program effects . . . should be those of the affected individuals . . . .").

296 JAMES R. KAHN, THE ECONOMIC APPROACH TO ENVIRONMENTAL AND NATURAL RESOURCES (1998).

297 *See, e.g.*, Anne R. Carey & Karl Gelles, *Environmental Concerns*, USA TODAY, Apr. 28, 2009, at 1A (most adults worry a "great deal" about pollution of drinking water, river and lake pollution, and soil contamination by toxic waste).

298 Margaret Jackson, *Ruling Puts Value on Land Contribution*, DENV. POST, May 12, 2009, at 7B (U.S. Tax Court upholds conservation easement program allowing landowners to get tax deductions in exchange for restricting use development on their land).

are framed in human, but not necessarily environmental terms.[299] These commentators challenge human-centered value systems, and instead embrace the intrinsic worth of plants, animals, habitat, ecosystem, and natural resources irrespective of instrumental or economic worth.[300] They also realize that protection of nonuse benefits primarily for human ends will likely fall short of meeting global environmental goals.[301] Acknowledgement of ecocentric values suggests that legal norms should not be defined in purely anthropocentric terms, but must also acknowledge the ecocentric worth and benefit of natural resources when they are left alone by humans.

Unfortunately, antipollution and preservation legislation continues to be framed in light of human benefits that derive from nonuse benefits,[302] and environmental protection measures found in international law are also typically couched in human rights terms.[303] Although several state constitutions provide a legal right to a healthful environment, reviewing courts have ruled that these provisions refer only to human health, and not to non-human elements of the environment.[304] These decisions are consistent with the prevailing view that conceives the natural environment and its resources as a mere good that serves to satisfy human needs, while possessing no intrinsic value.

This anthropocentric perspective has not been able to halt the four harbingers of planetary collapse noted above in Part VI.A.[305] What

299 *See, e.g.*, Günther Handl, *Human Rights and Protection of the Environment*, *in* ECONOMIC, SOCIAL AND CULTURAL RIGHTS 303–05 (Asbjørn Eide, Catarina Krause & Allan Rosas eds., 2001); DINAH SHELTON, ENVIRONMENTAL RIGHTS, PEOPLE'S RIGHTS (Philip Alsten ed., 2001).

300 *See, e.g.*, CHRISTOPHER J. PRESTON, SAVING CREATION: NATURE AND FAITH IN THE LIFE OF HOLMES ROLSTON III (2009); DAVID TAKACS, THE IDEA OF BIODIVERSITY 249–54 (1996). In one survey, eighty-seven percent of the public agreed with the statement "Our obligation to preserve nature is not just a responsibility to other people but the environment itself." WILLETT KEMPTON, JAMES S. BOSTEN & JENNIFER A. HARTLEY, ENVIRONMENTAL VALUES IN AMERICAN CULTURE 113 (1997).

301 Michael R. Anderson, *Human Rights Approaches to Environmental Protection: An Overview*, *in* HUMAN RIGHTS APPROACHES TO ENVIRONMENTAL PROTECTION (Alan E. Boyle & Michael R. Anderson eds., 1996).

302 *See supra* Part V.B.

303 Luis E. Rodriguez-Rivera, *Is the Human Right to Environment Recognized Under International Law? It Depends on the Source*, 12 COLO. J. INT'L ENVTL. L. & POL'Y 1, 4 (2001).

304 Glisson v. City of Marion, 720 N.E. 2d 1034, 1044 (Ill. 1999); *see also* Sunburst School Dist. No. Two v. Texaco, Inc., 2007 MT 183, 165 P.3d 1079, 1088 (Mont. 2007).

305 *See supra* notes 286–89.

seems needed is an ecocentric view that begins with the assumption that the nonuse component of resources is a condition to all life on the planet, including but not limited to human health. It would follow then that legal institutions should do more than impose limitations on individual human freedom to exploit the use component of resources and allow individuals to assert the human benefits that arise from resource nonuse. Laws and legal norms should also recognize that natural resources are a good in their own right. Such laws would not have the protection of humans as the central focus, but instead would acknowledge the right to have the natural environment itself protected.

C. A Right of Nonuse and the Rise of a Third Player in the Resource Game

The idea of affording legal rights to natural resources has not escaped the attention of courts or commentators. In *Georgia v. Tennessee Copper Co.*,[306] the U.S. Supreme Court in 1907 expanded the scope of quasi-sovereign interests protected by state *parens patriae* suits from protecting not only the health of their citizens from public nuisances, but also to safeguarding land, air, and natural resources.[307] In 1972, Professor Christopher Stone argued that states should not be the only advocates for natural resources. Stone proposed that natural objects should have the ability to raise their own unique interest in nonuse values and environmental quality.[308] A landmark federal energy bill, the Clean Energy Act of 2009, designed to reduce greenhouse gases contributing to climate change, would encourage resource nonuse actions that have reverse global-warming effects by absorbing carbon dioxide.[309] This bill would permit such resource nonuse decisions—e.g., a forest company not cutting trees it would otherwise harvest—to be marketed to resource users and polluters as offsets.[310] Another ecocentric approach is reflected in Ecuador's new Constitution, which gives "[n]atural communities and ecosystems . . . the unalienable right to exist, flourish[,] and evolve

306 206 U.S. 230, 238–39 (1907).

307 *Id.* at 237 ("[T]he state has an interest independent of . . . its citizens, in all the earth and air within its domain."); *see also* Massachusetts v. EPA, 549 U.S. 497, 499 (2007).

308 Christopher D. Stone, *Should Trees Have Standing? Toward Legal Rights For Natural Objects*, 45 S. CAL. L. REV. 450, 456 (1972).

309 H.R. 2454, 111th Cong. (2010).

310 Michael Riley, *Windfall For, or Waste of, Energy*?, DENV. POST, June 27, 2009, at 20A, *available at* http://www.denverpost.com/politics/ci_12701102?source=pkg.

. . . ."[311] The Ecuadorian law explicitly measures environmental injury not to a person or people, but to the ecosystem; it creates a non-anthropocentric right of nonuse in natural resources.

These ecocentric measures are slowly moving us towards a paradigm that sees a natural resource as a good in its own right, not only as an instrument of human preference. Such a paradigm would value resources for the worth and benefit they provide the biosphere when they are left alone. But in order to resist human desires to use resources, one cannot rely only on humans raising their own interest in nonuse values by asserting an array of Era IV species chauvinistic laws. These laws have resulted in noncooperative resource games between users and nonusers, and they have not deterred climate change, natural systems destruction, biomass depletion, or species extinction. Instead, one should also create a legal right in the resource itself—a right of nonuse that acknowledges and empowers a third player in the natural resources game, the natural resource.

A natural resource empowered by a legally cognizable "right of nonuse" would be able to affect and perhaps prevent human development, exploitation, and use of that resource when such use would substantially interfere with the nonuse qualities that are essential to natural ecocentric processes. These processes include the creation and perpetuation of clean air, water, and land capable of sustaining the biosphere. Natural processes also encompass the indirect uses that follow from human nonuse of resources listed in Table 1 above, such as carbon sequestration, uncontaminated fertile soils, contiguous parcels of undeveloped land for natural ecosystems, and moderated climate, weather, temperature, and precipitation. The planet itself benefits from these resource nonuse qualities, not just the one species on this planet that has been so intent on either aggressively using resources for purely anthropocentric ends, or conversely, preventing such uses for human health and existence values. A right of nonuse would permit the nonuse qualities for resources to be asserted for ecocentric purposes.

A right of nonuse would establish an Era V game that now has three players: the user who relies on Era III laws permitting resource use; the nonuser who relies on Era IV laws protecting anthropocentric anti-pollution and resource preservation values; and the resource that can raise its Era V right of nonuse to sustain long-term ecocentric

311 Clare Kendall, *A New Law of Nature*, GUARDIAN, Sept. 24, 2008, *available at* http://www.guardian.co.uk/environment/2008/sep/24/equador.conservation.

benefits that are of worth to the entire biosphere. Because the resource has become a credible player, the dynamics of the Era IV two-player game between users and nonusers have changed. These two players have traditionally been locked in a noncooperative game where the best that can be expected is an uneasy Nash equilibrium, where neither can improve their condition without ending up in a less desirable situation. But as noted above in Figure E, when competing resource users clashed, or Figure F, when competing users and nonusers conflicted, this eventual Nash equilibrium outcome has not yielded a satisfactory, socially optimal result. The introduction of a third player—the resource—now able to raise its own interests, provides a critical incentive for coordination between users and nonusers. Coordination can bring about cooperation between these two human players that results in a Pareto optimal solution where everyone, and everything, is made better off.[312]

The three players each have two choices. First, they may contribute to nonuse values, and this contribution in turn both benefits the viability of the biosphere and provides indirect uses consistent with human survival. Second, they may not contribute to nonuse values, which occurs when their choices either interfere with or are neutral towards the nonuse component of resources. The choice to contribute or not refers to whether the choice will provide or deny a payoff to the resource's nonuse potential. In the case of a user or nonuser, the motive behind the choice may be anthropocentric, but the effect of this human choice is experienced by the resource. For example, a user may choose to not contribute by polluting, removing, or otherwise using the resource in a way that prevents the resource's nonuse qualities from being realized. A nonuser may choose to contribute, either by financially supporting nonuse values—e.g., for option value, in order to recreate there in the future—or for existence value, knowing that a landscape will be preserved, or simply by the act of leaving the resource alone.

The third player in this game, the resource, obviously has no opinions or volitional choices. The resource simply exists in one of two states. It can exist where humans leave it alone, so it can produce its nonuse benefits, or where humans use it, exploit it, and degrade it, in which case it cannot yield nonuse value. In Eras II and III, the resource was used in different ways by the user. In Era IV, nonusers

312 *See generally* Richard H. McAdams, *Beyond the Prisoners' Dilemma: Coordination, Game Theory, and Laws*, 82 S. CAL. L. REV. 209 (2009).

became players and were able to slow, deter, or halt resource use by asserting their human-centric interests in resource nonuse. In Era V, where the resource has been conferred a right of nonuse, the resource is no longer a passive reflection of user and nonuser interests; the resource now has the legal ability to protect its ecocentric nonuse capabilities. The choice for the Era V resource is to contribute towards the furtherance of nonuse values by affirmatively asserting its right of nonuse, or to not contribute by existing without imposing the nonuse right.

The exercise of this choice to either assert or not assert the right of nonuse hinges on whether the user and nonuser, in a two-player game, decide to contribute to maintaining the resource and its nonuse benefits. Without the resource's ability to raise its own right of nonuse, users and nonusers typically engaged in two-player noncooperative games of brinkmanship, previously diagrammed in Figures E and F. These games produced equlibria that were typically neither optimal for the parties nor optimal from the perspective of the larger society. When a third player is introduced into such a game, and where this third player has a legal voice in the outcome, the dynamics of the normal two-player game change. The fact that the resource can play its right of nonuse card alters the behavior of the users and nonusers when they play their two-player game.

The right of nonuse does not necessarily need to be asserted by the resource in a three-player game; if the user and nonuser can coordinate their choices in light of an incipient future resource nonuse right, those two human players may engage in a cooperative game that yields a Pareto optimal solution. The role of a right of nonuse help by the resource, then, is not to bludgeon users and nonusers into accepting ecocentric nonuse values. It is to provide a mechanism that promotes the alteration of a noncooperative two-player, user-nonuser game into a cooperative game.[313]

The three-player game is in fact a two-stage game.[314] During the first stage, the users and nonusers simultaneously decide whether to contribute to maintaining the resource's nonuse values and its concomitant indirect use benefits that humans thereby enjoy. During this first stage, both players know that the third player, the resource, holds a right of nonuse. Both players also know that the resource

313 Robert Sugden, *A Theory of Focal Points*, 105 ECON. J. 533 (1995); McAdams, *supra* note 313, at 231.

314 *See* Appendix for a more detailed description of this three-player game.

would prefer that each player contribute to nonuse values and indirect use benefits. Furthermore, both players know during the first stage that the resource would rather not engage in an expensive legal action raising and defending the resource's right of nonuse; the resource would prefer to be left alone, without imposing its legal nonuse right. This knowledge, along with the knowledge of the resource's latent potential to assert its own nonuse interests, should serve as a catalyst during stage one to change what would have been noncooperative strategies into a cooperative solution between users and nonusers.

If nonuse values remain threatened and if stage one has not produced a cooperative game, then the resource may step in and effectively act as a third player in the second stage of the game. By affirmatively asserting its Era V right of nonuse, the resource is now able to contribute to its continued existence. But it will formally trigger the right of nonuse only when the other two human players, the user and nonuser, are not willing to contribute. The resource will sequentially join in the game to maintain its self-interest only if the other two human players do not cooperatively protect ecocentric nonuse values and resulting anthropocentric indirect use values. It is the ability of the resource to effectively trump during stage two the noncooperating human players' actions during stage one that makes this a three-player, two-stage game. And it is the acknowledgement of the resource as an independent player with intrinsic qualities—providing planet-wide nonuse benefits that are not just defined by human utility—that permits this particular game to result in a socially optimal result.

APPENDIX

ECONOMIC MODEL OF THE ERA V "RIGHT OF NONUSE" GAME

In this game, it is known to all players that Player 3, the resource, now has the right to exist. Nonusers and users understand that the resource will prevail if one of the other players does not contribute to supporting the indirect use values. However, the sub-game requiring a different sequence of decisions between Player 1 and Player 2 is imperfect because it is not known whether either of these two players will take the strategy of contributing to indirect uses. This results in a simultaneous sub-game between users and nonusers, followed by a sequential game where the resource will contribute if the nonusers will not contribute.

Figures G and H reflect a two-stage, three-by-three game, presented in a two-by-four matrix rather than a three-dimensional matrix. There are three payoffs that reflect indirect use values to each player based upon each player's choices. The left-most payoff is that of Player 1, the user. The middle payoff reflects Player 2, the nonuser. The payoff furthest to the right is that of Player 3, the resource. The best payoff for each player, given the actions of the other players, is italicized. The payoff values can be explained as follows:

- The resource receives the most benefit when both of the other players contribute (4) because indirect use benefits are least threatened.
- The resource receives the second highest level of benefit (3) when one other player contributes and the resource does not need to contribute.
- Players receive a benefit of 2 when one other player contributes to the resource and they do not, because these players are able to receive benefits from free riding on that player's contribution. Users and nonusers also receive a benefit of 2 when both contribute, to reflect the cooperation and shared costs and benefits of maintaining indirect use benefits.
- Players receive a benefit of 1 when they must contribute to the resource and other players do not do so.
- Players receive a payoff of -1 when no one contributes, because the indirect use benefits of the parcel are destroyed.

In the first stage, a sub-game between Player 1 (user) and Player 2 (nonuser), should the user decide to contribute, the payoff to the nonuser is equal to 2, as the nonuser is able to free-ride to some extent. Should Player 1 (user) not contribute, the best that the nonuser

can do is a payoff of 1, because the nonuser is forced to contribute. This yields a payoff of 2 to the user, who is able to free-ride when the nonuser is forced to contribute.

If Player 2 (the nonuser) decides to contribute, the best that Player 1 (the user) can do is contribute, resulting in a payoff of 2. However, if the nonuser decides to not contribute, then the best that the user can do is to contribute, which results in a payoff of "1" to the user. In this case, the nonuser becomes the free-rider and receives a payoff of 2.

		Player 3: The Resource	**Contribute**			**Not Contribute**	
	Player 2: Nonuser		**Contribute**	**Not Contribute**		**Contribute**	**Not Contribute**
	Contribute		(**2**, **2**, 4)	(**1**, **2**, 2)		(**2**, **2**, 4)	(**1**, **2**, 3)
Player 1: User							
	Not Contribute		(**2**, **1**, 2)	(**1**, **1**, 1)		(**2**, **1**, 3)	(-1,-1,-1)

Figure G. Stage 1 in the three-player game of chicken.

Note that the best payoff for each player, given the actions of the other players, is in bold. The payoffs are expressed in this order: Player 1 (user), Player 2 (nonuser), Player 3 (resource).

After the first stage of this game, there are some interesting results. One result is that there are seven potential Nash equilibria. This will be resolved once the resource plays during the second stage. The second interesting result is that this game of chicken forces at least one player (either the user or the nonuser) to contribute to providing indirect use values. The box at lower right (-1,-1,-1) is not in consideration for the Nash equilibrium.

The results of the second stage, the resource's play, are presented in Figure H. The resource knows the results of the first stage, the sub-game between the users and nonusers. Since the resource knows that others are willing to contribute and the resource prefers not to contribute, it will simply not play its first column (which encompasses the nonusers' first two columns). This leaves the second column, Not Contribute, encompassing the nonusers second two columns for its actions. Therefore, the resource will choose the path

that provides it the highest payoff, given the actions of the other players.

The resource will receive the highest payoff (4) if both Players 1 and 2 contribute, and the resource itself does not contribute. This is also a Pareto optimal solution, and transaction costs may be minimized. While there are two other Nash equilibria, as Player 3 plays a sub-game with each of the players, its payoff of 4 each selected twice (hence, the value is in shaded). The effect of giving the resource a right of nonuse means that the best action for both users and nonusers to take is to contribute to the indirect uses maintained by the resource. The right of nonuse has effectively created a quasi-cooperative game.

		Player 3: The Resource	**Contribute**			**Not Contribute**	
	Player 2: Nonuser		**Contribute**	**Not Contribute**		**Contribute**	**Not Contribute**
	Contribute		(**2**, **2**, 4)	(**1**, **2**, 2)		(**2, 2, 4**)	(**1**, **2**, **3**)
Player 1: User							
	Not Contribute		(**2**, **1**, 2)	(**1**, **1**, 1)		(**2**, **1**, **3**)	(-1,-1,-1)

Figure H. Stage 2 in the three-player game of chicken.

Note that the best payoff for each player, given the actions of the other players, is in bold. The payoffs are expressed in this order: Player 1 (user), Player 2 (nonuser), Player 3 (resource). Player 3, the resource, knows the outcome of the first stage game and only chooses to play its last column, i.e., not contribute. The Pareto optimal solution is for users and nonusers to contribute, which provides the Resource a payoff of 4. If the resource plays the sub-game, the payoff of 4 is selected twice, and the solution is shaded.

The three-player chicken game demonstrates that by giving a right of nonuse to the resource, other players have incentive to contribute to upholding indirect uses provisioned by the resource, and the resource itself can simply exist. In a sense, the resource has induced cooperation. While this game shows that this option is feasible, there are challenges in the implementation of such laws. Chiefly, there becomes a principal-agent problem, where a human must infer and represent nature and what nature wants despite the fact that nature

cannot articulate what it desires and scientists may disagree about what it wants. Furthermore, environmental philosophers have debated the rights of the species versus the rights of the individual members of the species, coming down on both sides of the issue. In other words, should the set of species as a whole be optimized, or should the welfare of each individual species members be optimized? Federal agencies such as the U.S. Fish and Wildlife Service have already implemented a similar perspective, such as the goal of no net loss of wetlands, although the individual wetlands are somewhat put at risk.

There is also the matter of defining when nature has veto power over human interests and can impose policies arbitrarily on humans, such as a tax on clean air for the use of human respiration. However, based upon the three-player game shown in Figures G and H, we can see that the right of nonuse can provide the proper incentives for users and nonusers to contribute to the well-being of the resource and the indirect use values that result.