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# Replacing Sustainability

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## REPLACING SUSTAINABILITY

*Robin Kundis Craig\* and Melinda Harm Benson\**

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### I. INTRODUCTION

The Rio+ 20 United Nations (“U.N.”) Conference on Sustainable Development held in June 2012 resulted in a forty-four page, nonbinding “Declaration” that many consider a failed document.<sup>1</sup> While not surprising, given the recent trend of international environmental

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1. Colin Sullivan, *RIO+20: Side agreements pitched as the real meat behind Earth Summit*, ENV’T & ENERGY NEWS, June 22, 2012, at 1-2.

negotiations,<sup>2</sup> this failure to establish binding requirements toward global sustainability is, of course, disappointing. Its failure, however, provides an opportunity to collectively reexamine—and, we argue, ultimately move past—the concept of sustainability for anything other than the broadest of global ecological goals: leaving a living planet to future generations.

From almost the beginning, the pursuit of sustainability and sustainable development has occurred in an emerging climate change era. Indeed, the 1992 United Nations Conference on Environment and Development in Rio de Janeiro reflected a shared sense of urgency regarding the need to change how we think about development,<sup>3</sup> an urgency generated at least in part by increasing awareness of climate change as a global phenomenon. Just two years prior, the Intergovernmental Panel on Climate Change (“IPCC”) had issued its First Assessment Report, which concluded that human activities were responsible for substantially increasing the atmospheric concentrations of the greenhouse gases.<sup>4</sup>

The co-emergence of sustainable development goals and climate change awareness, however, did not result in effective mitigation of climate change. Greenhouse gas emissions have continued to increase.<sup>5</sup> As a result, the socio-ecological systems (“SEs”) of which we are all a part must now adapt to the impacts of climate change.<sup>6</sup> Resource consumption patterns have also proceeded since 1992 on similar trends in terms of pace and scale,<sup>7</sup> requiring concurrent adaptation to the short- and long-term impacts of contemporary consumption, including pervasive toxic contamination and other forms of pollution.

In anticipation of Rio+20, the U.N. Environment Programme released a report that Executive Director Achim Steiner summarized by

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2. STEPHEN M. GARDINER, *A PERFECT MORAL STORM: THE ETHICAL TRAGEDY OF CLIMATE CHANGE* (2011).

3. Annie Rochette, *Stop the Rape of the World: An Ecofeminist Critique of Sustainable Development*, 51 U. NEW BRUNSWICK L.J. 145, 145-46 (2002).

4. See generally J.T. HOUGHTON, *THE 1990 REPORT OF THE IPCC SCIENTIFIC ASSESSMENT WORKING GROUP* (1990) (reporting that climate change was occurring and that human emissions contributed to it); K. Hasselmann, *Are We Seeing Global Warming?*, 276 SCI. 865, 914-15 (May 9, 1997).

5. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *CLIMATE CHANGE 2007: SYNTHESIS REPORT 2* (2007) [hereinafter 2007 IPCC SYNTHESIS REPORT].

6. Robin Kundis Craig, *“Stationarity Is Dead”—Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 HARV. ENVTL. L. REV. 9, 10-16, 23-27 (2010).

7. W. V. REID ET AL., *MILLENNIUM ECOSYSTEM ASSESSMENT SYNTHESIS REPORT 17* (2005); N. Myers, *Consumption: Challenge to Sustainable Development*, 276 SCI. 1, 53-54 (Apr. 4, 1997).

stating, “if current patterns of production and consumption of natural resources prevail and cannot be reversed and ‘decoupled,’ then governments will preside over unprecedented levels of damage and degradation.”<sup>8</sup> The report emphasized the increasingly likely possibility of large-scale irreversible change, concluding that as human pressures on the Earth system accelerate, critical global, regional, and local thresholds are quickly being approached or, in some cases, have already been exceeded.<sup>9</sup> These conclusions are echoed by a growing consensus of scientists calling for increased attention to “tipping points” that could cause sudden, irreversible changes in relatively stable (and humanly beneficial) ecological conditions.<sup>10</sup>

Despite this alarming and unpredictable situation, policy discussions remain framed by the goal of sustainability.<sup>11</sup> This adherence to sustainability ignores the fact that the concept has failed to meaningfully change the human behavior that created the Anthropocene.<sup>12</sup> It also ignores the fact that, as climate change attests, we have lost for the foreseeable future the struggle to sustainably govern the global commons.<sup>13</sup> In particular, the continued invocation of sustainability in international talks, development goals, and other policy discussions ignores the emerging scientific realities of the Anthropocene—unprecedented and irreversible rates of human-induced biodiversity loss,<sup>14</sup> exponential increases in per-capita resource

8. Press Release, United Nations Environment Programme, “World Remains on Unsustainable Track Despite Hundreds of Internationally Agreed Goals and Objectives,” (June 6, 2012), available at <http://www.unep.org/geo/>.

9. UNITED NATIONS ENVIRONMENT PROGRAMME, GLOBAL ENVIRONMENT OUTLOOK 21-22 (5th ed. 2012), available at <http://www.unep.org/geo/geo5.asp>.

10. Anthony D. Barnosky et al., *Approaching a state shift in Earth’s Biosphere*, 486 NATURE 52, 55-56 (June 7, 2012).

11. See, e.g., Richard Grosso, *Regulating for Sustainability: The Legality of Carrying Capacity-Based Environmental and Land Use Permitting Decisions*, 35 NOVA L. REV. 711 (2011); Keith H. Hirokawa, *Sustainability and the Urban Forest: An Ecosystem Services Perspective*, 51 NAT. RESOURCES J. 233 (2011); Heather Hughes, *Enabling Investment in Environmental Sustainability*, 41 ENVTL. L. REP. NEWS & ANALYSIS 10745 (Aug. 2011); Chelsea M. Keeton, *Sharing Sustainability: Preventing International Environmental Injustice in an Age of Regulation*, 48 HOUS. L. REV. 1167 (2012); Joseph P. Mitikish, *Achieving Sustainability Through Existing Environmental Regulations*, 43 ARIZ. ST. L.J. 835 (2011); L. Kinvin Wroth, *Achieving Sustainability in the Face of Climate Change: A Joint Cross-Border Conference on Sustainability*, 13 VT. J. ENVTL. L. 417 (2012) (all assuming the sustainability paradigm for environmental, natural resources, and land use law and policy).

12. Frank Biermann et al., *Navigating the Anthropocene: Improving Earth System Governance*, 335 SCI. 1271, 1306 (Mar. 16, 2012).

13. See T. Dietz, Eleanor Ostrom, & P. C. Stern, *The Struggle to Govern the Commons*, 302 SCI. 1847, 1907 (Dec. 12, 2003).

14. Howard Wolinsky, *Will we wake up to biodiversity?*, 12 EMBIO REP. 1226, 1226 (2011);

consumption,<sup>15</sup> and global climate change.<sup>16</sup> Combined, these and other factors are increasing the likelihood of rapid, non-linear, social and ecological regime changes.<sup>17</sup> They create an urgent need to move past our current state of paralyzing denial and acknowledge that we cannot nostalgically cling to prior states of existence as we head into the “no-analog future.”<sup>18</sup>

This Article argues that, from a policy perspective, we must face the impossibility of even defining—let alone pursuing—a goal of “sustainability” in a world characterized by such extreme complexity, radical uncertainty, and discomfiting loss of stationarity.<sup>19</sup> Instead, we need new policy directions and orientations that provide the necessary capacity to deal with these “wicked problems” in a meaningful and equitable way.<sup>20</sup> The realities of current and emerging SES dynamics warrant a new set of tools and approaches to governance of those systems.<sup>21</sup>

Part II of this Article provides a brief history of sustainability and sustainable development, including corollary emphases on preservation and restoration in contemporary U.S. natural resources and environmental law and policy. Part III examines in detail how climate change problematizes sustainability as a goal for natural resources management at anything but the most general of scales, warranting a search for a replacement paradigm. Part IV offers up resilience thinking as a candidate for that new paradigm. In particular, this Article argues, resilience thinking—unlike the stationarity-based sustainability—emphasizes that environmental regulation and natural resource management require a continuing effort to identify, manage, and adapt to continual change, making it a more useful paradigm for the climate

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Oswaldo E. Sala *et al.*, *Global Biodiversity Scenarios for the Year 2100*, 287 *SCI.* 1701, 1770-74 (Mar. 10, 2000).

15. Myers, *supra* note 7, at 53-54.

16. See generally 2007 IPCC SYNTHESIS REPORT, *supra* note 5 (describing the latest scientific consensus findings regarding the pace of climate change and its impacts).

17. Barnosky *et al.*, *supra* note 10, at 57.

18. Douglas Fox, *Back to the No-Analog Future?*, 316 *SCI.* 781, 823, 825 (May 11, 2007); Diana Stralberg *et al.*, *Re-Shuffling of Species with Climate Disruption: A No-Analog Future for California Birds?*, 4:9 *PLoS ONE* e6825, (2009), available at <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0006825>.

19. P.C.D. Milly *et al.*, *Stationarity Is Dead: Whither Water Management?*, 319 *SCI.* 533, 573 (Feb. 1, 2008).

20. BRYAN G. NORTON, *WICKED PROBLEMS: SUSTAINABILITY: A PHILOSOPHY OF ADAPTIVE ECOSYSTEM MANAGEMENT* 132-38 (2005).

21. Jianguo Liu *et al.*, *Complexity of Coupled Human and Natural Systems*, 317 *SCI.* 1453, 1516 (Sept. 14, 2007).

change era. In addition, properly implemented, resilience thinking could demand even more from humans in terms of precautionary uses of resources than sustainability has yet managed, productively shattering the illusion that we can still “have it all.”

## II. SUSTAINABILITY, PRESERVATION, AND RESTORATION IN ENVIRONMENTAL AND NATURAL RESOURCES LAW

### A. *A Brief History of Sustainability in the United States*

As the National Research Council (“NRC”) of the National Academy of Sciences articulated in 2011, “[s]ustainability is based on a simple and long-recognized factual premise: Everything that humans require for their survival and well-being depends, directly or indirectly, on the natural environment.”<sup>22</sup> Acknowledgements of this dependency have been articulated since at least the nineteenth century.<sup>23</sup> In contrast, ignoring this dependency leads to unsustainable consumption of natural resources, which in turn often leads to ecosystem disruption and depletion of natural resources in ways that inevitably harm humans. Examples include the Dust Bowl of the 1930s, groundwater aquifer depletion throughout the U.S., and the extinction of species such as bison and carrier pigeons.<sup>24</sup>

By pursuing goals of “sustainability,” policy makers acknowledge humans’ basic dependency on the natural environment and the vulnerability of the environment to over-exploitation. As a policy development, acknowledging this dependency was an important step forward for environmental and natural resources law and policy, eroding some of the technological hubris that followed World War II<sup>25</sup> and the

22. COMMITTEE ON INCORPORATING SUSTAINABILITY IN THE U.S. ENVIRONMENTAL PROTECTION AGENCY, NATIONAL RESEARCH COUNCIL, NATIONAL ACADEMY OF SCIENCES, SUSTAINABILITY AND THE U.S. EPA 15 (2011) [hereinafter 2011 NRC SUSTAINABILITY REPORT].

23. *E.g.*, GEORGE PERKINS MARSH, MAN AND NATURE, OR, PHYSICAL GEOGRAPHY AS MODIFIED BY HUMAN ACTION (1864).

24. 2011 NRC SUSTAINABILITY REPORT, *supra* note 22, at 15. Notably, people’s denial of the growing Dust Bowl in the 1930s bears remarkable similarities to their denial of climate change. For a description of the Dust Bowl denials, see DONALD WORSTER, DUST BOWL: THE SOUTHERN PLAINS IN THE 1930S, at 10-25 (2004).

25. *See, e.g.*, Daniel Solomon, *ERAS*, 29 *FORDHAM URBAN L.J.* 1439, 1441 (2002) (“The whole evolution of the American townscape can be divided into eras—one that begins with the earliest colonial settlements and ends at World War II, one that extends from then almost to the present, and now a new era with the work of a current generation reacting to what was built on such a vast scale with such hubris, blind optimism and historiophobia in the fifty years after the war.”); Alyson C. Fluormoy, *Restoration Rx: An Evaluation and Prescription*, 42 *ARIZ. L. REV.* 187, 201 (2000) (“Human population and the power and speed of our technology for altering the environment

related sense of pervasive human control over the destiny of SESs.<sup>26</sup>

More specifically, in the United States, the NRC has traced the rise of sustainability goals to four converging drivers. The first is the recognition that current approaches aimed at decreasing existing risks, however successful, are not capable of avoiding the complex problems in the United States and globally that threaten the planet's critical natural resources and that put current and future human generations at risk, including population growth, the widening gaps between the rich and the poor, depletion of finite natural resources, biodiversity loss, climate change, and disruption of nutrient cycles. Second, sophisticated tools are increasingly available to address the complex and challenging issues that go beyond current risk management of major threats. Third, sustainability is being used as a common approach to address broader social, environmental, and economic issues by international bodies in which the United States is an active participant. Finally, the potential economic value of sustainability to the United States is recognized to not merely decrease environmental risks but also to optimize the social and economic benefits of environmental protection.<sup>27</sup>

As a governance measure, at least in theory, sustainability leads to laws and policies that limit human activity in and consumption of the natural environment to levels that can be continued on a long-term basis with minimal harm to either side of the equation. It is this sense of "sustainability" that the U.S. invoked in the 1996 amendments<sup>28</sup> to the federal Magnuson-Stevens Fishery Conservation and Management Act,<sup>29</sup> which, for fisheries management purposes, limits the "optimum yield" of a fishery to the "maximum sustainable yield."<sup>30</sup> Timber in National Forests is similarly managed for "maximum sustainable yield."<sup>31</sup>

Nevertheless, linguistically and politically, sustainability goals

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have changed dramatically since the end of World War II, and the consequences of these changes have only begun to unfold over the past thirty years."); BARRY COMMONER, *THE CLOSING CIRCLE* 128-29 (1971) (indicating that because "technologies rapidly transformed the nature of industrial and agricultural production" there were significant changes after World War II in the "pace of environmental deterioration").

26. See, e.g., Senator Bill Bradley, *Water and the West*, 6 WYO. L. REV. 339, 342 (2006) (acknowledging "that man's attempt to control nature in the West meant damming, storing, and distributing the water of the great river basins; the Colorado, the Columbia, the Missouri and a few others").

27. 2011 NRC SUSTAINABILITY REPORT, *supra* note 22, at 7.

28. Sustainable Fisheries Act of 1996, Pub. L. No. 104-297, §§ 103, 116(a), 202-207, 404(c), 110 Stat. 3559 (1996).

29. 16 U.S.C. §§ 1801-1884 (2006).

30. *Id.* § 1802(33).

31. *Id.* §§ 529, 1604.

depend on a conservative assumption of ecological stationarity. As a matter of language, “to sustain” means “to keep in existence or effect; maintain.”<sup>32</sup> A subject is “sustainable” if it is “capable of being sustained” or “of, relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged.”<sup>33</sup> Thus, as a matter of basic linguistic definition, sustainability is about human efforts to maintain continuity and to keep things—natural resources—in the same state of being as when management started or with reference to this baseline. Both popular and regulatory visions confirm this emphasis. For example, Wikipedia, that repository of collective both popular and specialized wisdom, defines sustainability as endurance achieved through effort: “Sustainability is the capacity to endure through renewal, maintenance, and sustenance, or nourishment, in contrast to durability, the capacity to endure through unchanging resistance to change.”<sup>34</sup> Similarly, the U.S. Environmental Protection Agency (“EPA”) emphasizes that “[s]ustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic and other requirements of present and future generations. Sustainability is important to making sure that we have and will continue to have, the water, materials, and resources to protect human health and our environment.”<sup>35</sup>

Similar assumptions that human effort can keep SESs in desirable states of productivity inhere in almost all sustainability goals. More specifically, first, sustainability assumes that humans can figure out how much human use of an ecosystem or natural resource can be maintained indefinitely without untoward consequences<sup>36</sup>—despite complex and multiscalar ecological system dynamics and despite natural variability in temperature, precipitation, species population levels, species migrations, and other variables that affect any given ecosystem on a seasonal, yearly, or longer basis.<sup>37</sup> Federally managed fisheries in the U.S., for

32. THE AMERICAN HERITAGE DICTIONARY 685 (Dell Paperback ed. 1983).

33. *Sustainable*, MERRIAM WEBSTER UNABRIDGED DICTIONARY ON-LINE, <http://www.merriam-webster.com/dictionary/sustainable> (last visited Aug. 8, 2013).

34. *Sustainability*, WIKIPEDIA, <http://en.wikipedia.org/wiki/Sustainability> (last visited Oct. 7, 2012).

35. *Sustainability: What is Sustainability*, U.S. ENVTL. PROT. AGENCY, <http://www.epa.gov/sustainability/basicinfo.htm> (last visited Oct. 7, 2012).

36. For example, as the NRC noted, “conservation laws and programs require or encourage greater efficiency in the use of natural resources, and still others impose limits on harvesting natural resources so that those resources will be able to regenerate or reproduce for use in the future . . .” 2011 NRC SUSTAINABILITY REPORT, *supra* note 22, at 17.

37. BRIAN WALKER & DAVID SALT, RESILIENCE PRACTICE: BUILDING CAPACITY TO

example, set seasonal catch limits based on estimates of stock size<sup>38</sup>—but, at least traditionally, with little consideration for the targeted stock’s role in the immediate ecosystem or larger food webs.<sup>39</sup>

Second, sustainability assumes that baseline environmental conditions—temperature, precipitation, soil moisture, species mix, and so forth—will remain more or less the same, within natural variability envelopes, over long periods of time. This principle of stationarity, for example, provides the basis for much of the water supply management throughout the U.S., as managers assume that conditions over the next decades will be roughly the same as conditions over the past decades.<sup>40</sup>

Sustainability, therefore, is a conservative concept that assumes a lack of baseline environmental change and minimal ecological complexity. As the NRC’s four factors suggest, proponents of sustainability focus not on change in nature itself but instead posit, as a basic presumption, that the problems that require environmental law and natural resource management arise from human causes—population growth, consumption, and uses (including pollution) of the environment.<sup>41</sup> Notably, the NRC traced the development of sustainable governance principles in the U.S. in part to the conservation and preservation movements in the late nineteenth and early twentieth centuries<sup>42</sup> and the environmental movement of the mid- to late twentieth century.<sup>43</sup> These assumptions imply that management of human uses of the environment lies largely within human control: Nature will be as it always has been, so we can simply adjust human action to achieve the ecological benefits that we want. While this is, of course, an overly simplistic *ecological* description—as ecologists and biologists have known for years<sup>44</sup>—it remains a fairly accurate

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ABSORB DISTURBANCE AND MAINTAIN FUNCTION 3-24 (2012).

38. *Fish Stock Assessment 101 Series: Part 1—Data Required for Assessing U.S. Fish Stocks*, NAT’L OCEANIC & ATMOSPHERIC ADMIN. (May 23, 2012), [http://www.nmfs.noaa.gov/stories/2012/05/05\\_23\\_12stock\\_assessment\\_101\\_part1.html](http://www.nmfs.noaa.gov/stories/2012/05/05_23_12stock_assessment_101_part1.html).

39. *What is Ecosystem-based Management?*, NOAA CELEBRATES 200 YEARS OF SCI., SERV., & STEWARDSHIP, [http://celebrating200years.noaa.gov/magazine/chesapeake\\_fish\\_mgmt/side1.html](http://celebrating200years.noaa.gov/magazine/chesapeake_fish_mgmt/side1.html) (last visited Oct. 26, 2012).

40. Milly et al., *supra* note 19, at 573.

41. 2011 NRC SUSTAINABILITY REPORT, *supra* note 22, at 7, 16-19.

42. *Id.* at 16-17. See also JOHN C. DERNBACH, ED., *STUMBLING TOWARD SUSTAINABILITY* xxxi (2002) [hereinafter DERNBACH, *SUSTAINABILITY*] (noting that “sustainable development can be understood as an outgrowth of environmental and conservation law, which have had a powerful and positive influence on American society”).

43. 2011 NRC SUSTAINABILITY REPORT, *supra* note 22, at 17-19.

44. See, e.g., Liam Heneghan, *Out of kilter: Old ideas of balance and harmony need to be put aside if we are to save a natural world in constant flux*, AEON MAGAZINE (Oct. 9, 2012), available at <http://www.aeonmagazine.com/nature-and-cosmos/liam-heneghan-balance-of-nature/> (describing

description of how the *laws and policies* governing natural resources management have operated.<sup>45</sup> Are fishers overfishing a commercially or recreationally important fish stock? Then adjust how and when they can fish. Are landowners pumping groundwater faster than the aquifer can recharge? Adjust pumping rates through permits, or purposely decide to “mine” an aquifer for a predetermined period of time. Are loggers clear-cutting forests faster than they can regrow? Allow less logging or impose more conditions for selective cutting and replanting. The concept of discontinuous regime change, and the idea that there might not be a way back to “optimality,” however defined, are not part of current legal regimes.

Although tangential to this Article’s discussion, it is also worth noting that, outside of “pure” natural resources management, sustainability has become almost inextricably enmeshed in sustainable development. “Sustainable development” reflects a broader societal goal of how economic and social development should proceed—namely, with sufficient consideration of the environment and natural resources to assure the continuing availability of natural capital and other ecological amenities for further development.<sup>46</sup> The 1987 Brundtland Commission of the United Nations put forth the first widely accepted definition of sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”<sup>47</sup>

The international community embraced sustainable development at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, incorporating it into both the Rio Declaration and Agenda 21.<sup>48</sup> Ten years later, however, “the United States [was] far from being a sustainable society, and in many respects [was] farther away than it was in 1992.”<sup>49</sup> Another decade did little to improve the picture.<sup>50</sup> Thus, it is important to remember that sustainability is itself a

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the criticism that began in the early 20th century of ecological theories that described “how organisms and their environments interact to produce orderly and predictable results”). As Heneghan notes, “The trouble was, an attachment to ideas of balance and stability didn’t seem to match the messy dynamic reality of nature.” *Id.*

45. *See id.* (noting that the “balance of nature” idea “is alive and kicking in popular ideas of ‘ecology’ and conservation”).

46. DERNBACH, SUSTAINABILITY, *supra* note 42, at 1, 5.

47. UNITED NATIONS, REPORT OF THE WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT: OUR COMMON FUTURE (General Assembly Resolution 42/187), at ¶ 27 (Dec. 11, 1987), available at <http://www.un-documents.net/our-common-future.pdf>.

48. DERNBACH, SUSTAINABILITY, *supra* note 42, at 1, 6.

49. *Id.* at 1.

50. JOHN C. DERNBACH, PRINCIPAL AUTHOR, ACTING AS IF TOMORROW MATTERS:

difficult and largely unachieved goal; we argue that it is increasingly becoming a futile goal, as well.

Sustainability goals presume both stationarity within ecological process and a human ability to keep SESs more or less the same as they always have always been and/or to restore them to prior and “better” states of being. Current environmental and natural resource laws reflect these assumptions of sustainability. As Robin Craig has argued previously, “existing environmental and natural resources laws are preservationist, grounded in a stationarity framework . . . .”<sup>51</sup> More specifically, “one of the assumptions that pervades these laws is that anthropogenic change is unnatural and degrading, but also non-transformative and hence (generally) reversible. This assumption sets up the most basic paradigms of environmental and natural resource regulation and management: preservation and restoration.”<sup>52</sup> The next two subsections explore the law’s thorough incorporation of preservation and restoration—aspirations that serve sustainability goals but that are often poor fits for climate change adaptation.

#### B. *Preservation in Environmental and Natural Resources Law*

The paradigm of preservation pervades existing natural resources laws, generally through a focus on minimizing or mitigating destructive human change to ecosystems. For example, the National Environmental Policy Act (“NEPA”) forces federal agencies to thoroughly consider the specific and cumulative impacts of any federal activity that might significantly affect the environment and to consider alternatives to environmentally damaging proposals.<sup>53</sup> Section 404 permitting under the Clean Water Act<sup>54</sup> is now supposed to effectuate a national policy of “no net loss” of wetlands<sup>55</sup> and to mitigate adverse effects on any

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ACCELERATING THE TRANSITION TO SUSTAINABILITY 1 (2012) (“Over the past several decades, we have made some progress toward sustainability but have also encountered major obstacles.”); *id.* at 2 (“Our actions as a species and as a nation are not sustainable.”).

51. Craig, *supra* note 6, at 17 (citing JONATHAN M. VERSCHUUREN, ADAPTATION TO CLIMATE CHANGE: OPPORTUNITIES AND BARRIERS 9 (Proceedings of the International Colloquium on Global Warming, Rio de Janeiro, May 21, 2007) (*available at* [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1291183](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1291183))) (“[N]ature conservation law is aimed at conserving a certain habitat type, or certain species.”).

52. *Id.* at 32.

53. 42 U.S.C. § 4332(2)(C) (2006).

54. 33 U.S.C. § 1344 (2006).

55. Memorandum of Agreement Between The Department of the Army and The Environmental Protection Agency: The Determination of Mitigation Under the Clean Water Act Section 404(b)(1) Guidelines (Feb. 6, 1990) (*available at* <http://water.epa.gov/lawsregs/guidance/wetlands/mitigate.cfm>).

remaining wetlands.<sup>56</sup> The overall goals of the Endangered Species Act are to prevent imperiled species from going extinct and then to recover them to levels necessary for the ecosystem state that humans deem most desirable, based on an historical baseline of “naturalness.”<sup>57</sup>

Multiple-use management of the public lands presents a more complex management paradigm precisely because it promotes continued human use of public natural resources and hence is less completely preservationist. Completely in line with sustainability and sustainable development goals, however, the statutes governing federal public lands management emphasize a goal to minimize human “destruction” of these resources and to preserve key ecosystem attributes despite human use.<sup>58</sup> Moreover, as Robert Fischman has noted, public lands managers have been moving toward an ecosystem management approach, with the goal of preserving ecosystem functions and services.<sup>59</sup>

### C. *Restoration in Environmental and Natural Resources Law*

If public lands and natural resources management laws are grounded in a paradigm of preservation, Craig has noted, “[t]he restoration paradigm is perhaps clearest in pollution regulation, where the largely internalized baseline or assumed ‘pristine’ condition is an area’s preindustrial status, even though the relevant laws generally allow

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56. *Id.*

57. 16 U.S.C. § 1531(b), 1532(3) (West 2013). *See also* J.B. Ruhl, *Thinking of Environmental Law as a Complex Adaptive System: How to Clean Up the Environment by Making a Mess of Environmental Law*, 34 HOUSTON L. REV. 933, 968-75 (1997) (discussing the “uniformitarianism” of the Endangered Species Act).

58. *See, e.g.*, 43 U.S.C. § 1701(a)(8) (West 2013) (declaring a national policy that “the public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife and domestic animals; and that will provide for outdoor recreation and human occupancy and use”); *id.* at § 1702(a) (defining “areas of critical environmental concern” to be “areas within public lands where special management attention is required (when such areas are developed or used or where no development is required) to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources or other natural systems or processes, or to protect life and safety from natural hazards”); *id.* at § 1702(c) (defining “multiple use” to be in part the “harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or the greatest unit output”).

59. Robert Fischman, *The Significance of National Wildlife Refuges in the Development of U.S. Conservation Policy*, 22 J. LAND USE & ENVTL. L. 1, 14-22 (2005) (describing the 1997 conversion of National Wildlife Refuge Management to an ecosystem-based approach).

for some postindustrial compromise in the actual regulatory goal.”<sup>60</sup> Statutes as diverse as the Clean Water Act;<sup>61</sup> the Comprehensive Environmental Response, Compensation, and Liability Act (“CERCLA”);<sup>62</sup> the Resource Conservation and Recovery Act (“RCRA”);<sup>63</sup> the Oil Pollution Act;<sup>64</sup> the Clean Air Act;<sup>65</sup> and the Surface Mining Control and Reclamation Act<sup>66</sup> all formalize requirements to restore land, air, and water to states that “undo” the primary harms caused by industrialization.<sup>67</sup>

As one example, the federal Clean Water Act declares a “national goal that the discharge of pollutants into the navigable waters be eliminated by 1985.”<sup>68</sup> Moreover, the ultimate goal of the Act is “to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters.”<sup>69</sup>

Similarly, both CERCLA and the Oil Pollution Act<sup>70</sup> allow governments and Tribes to collect natural resources damages for ecosystems impaired by releases of hazardous substances and oil spills, respectively, and the basic measurement of those damages is the costs of restoring the area to pre-spill or pre-release conditions.<sup>71</sup> Treatment, storage, and disposal facilities regulated under the Resource Conservation and Recovery Act (“RCRA”) must undertake corrective actions if their activities contaminate land and/or groundwater,<sup>72</sup> restoring those sites to pre-contamination status; the Surface Mining Control and Reclamation Act seeks to ensure that mining operations restore the disturbed landscape to something approaching its pre-mining condition.<sup>73</sup> Finally, while the Clean Air Act less explicitly indulges in

60. Craig, *supra* note 6, at 17.

61. 33 U.S.C. §§ 1251-1387 (2006).

62. 42 U.S.C. §§ 9601-9628 (2006).

63. 42 U.S.C. §§ 6901-6992k (2006).

64. 33 U.S.C. §§ 2701-2762 (2006).

65. 42 U.S.C. §§ 7401-7671q (2006).

66. 30 U.S.C. §§ 1201-1328 (2006).

67. Craig, *supra* note 6, at 32-33.

68. 33 U.S.C. § 1251(a)(1) (2006).

69. *Id.* § 1251(a).

70. 33 U.S.C. §§ 2701-2762 (2006).

71. Comprehensive Environmental Response, Compensation, and Liability Act (“CERCLA”), 42 U.S.C. § 9607(a)(4)(C) (West 2013); Oil Pollution Act, 33 U.S.C. §§ 2702(2)(A), 2706; 33 C.F.R. § 136.211(a) (noting that natural resources damages for the Oil Pollution Act include “the cost of restoring, rehabilitating, replacing, or acquiring the equivalent of the damaged natural resources”); 43 C.F.R. § 11.10(e)(3) (using the same language for natural resources damages under CERCLA).

72. 42 U.S.C. § 6924(u), (v) (2006).

73. 30 U.S.C. § 1265(a), (b)(2) (2006) (requiring mining permittees to “restore the land

restoration rhetoric, it nevertheless seeks “to protect and enhance the quality of the Nation’s air resources so as to promote the public health and welfare and the productive capacity of the population.”<sup>74</sup> The act fairly explicitly recognizes that industrialization can turn clean air into something unhealthy.

#### D. *Criticisms of Sustainability*

Preservation and restoration of SESs make sense as sustainability goals because they attempt to ensure that such systems persist in highly functional or valuable (as defined by humans) states over time. Nevertheless, it is important to recognize that sustainability has had its critics even before climate change, from both ecological and legal/political perspectives.

Sustainability and sustainable development have been criticized from a number of perspectives. For example, one group of critics, generally with a property-rights focus, have criticized sustainability for its failure to embrace free market mechanisms and continued human progress.<sup>75</sup> Others view “sustainability” and “sustainable development” as being too broadly defined to become meaningful policy measures<sup>76</sup> or, relatedly, argue that progress toward sustainability cannot be “properly” measured.

Of more value to this article, however, are the many scholars and policymakers who critique sustainability goals and sustainable development as either fundamentally unattainable or as fundamentally incomplete. Perhaps the most popular critique of sustainability and its actual implementation in society—essentially, a critique that sustainability goals have been incompletely implemented or even co-opted—are the increasingly common charges that sustainability claims are often a form of “greenwashing.”<sup>77</sup> The *Oxford English Dictionary*

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affected to a condition capable of supporting the uses which it was capable of supporting prior to any mining”).

74. 42 U.S.C. § 7401(b)(1) (2006).

75. *E.g.*, AUSTIN WILLIAMS, *THE ENEMIES OF PROGRESS: THE DANGERS OF SUSTAINABILITY* 145-51 (2008).

76. *E.g.*, *Towards a Critique of Sustainability*, PROGRESSIVE REACTIONARY (Jan. 3, 2009), <http://progressivereactionary.blogspot.com/2009/01/towards-critique-of-sustainability.html>.

77. *E.g.*, Peter Benson & Stuart Kirsch, *Corporate Oxymorons*, 34:1 DIALECTICAL ANTHROPOLOGY 45, 45-48 (2010); Charles Francis, Roger Elmore, John Ikerd & Mike Duffy, *Greening of Agriculture: Is It All a Greenwash of the Globalized Economy?*, 19 J. CROP IMPROVEMENT 193, 193-220 (2007); Debashish Munshi & Priya Kurian, *Imperializing Spin Cycles: A Postcolonial Look at Public Relations, Greenwashing, and the Separation of Publics*, 31:4 PUB. RELATIONS REV. 513, 513-20 (2005); Katharine Ainger, *GREENWASH: A Guide to Corporate Eco-*

first recognized the terms “greenwash” and “greenwashing” in 1999 and defines them as “disinformation disseminated by an organization so as to present an environmentally responsible public image . . . .”<sup>78</sup> As sustainability and sustainable development have become increasingly important components of corporate social responsibility,<sup>79</sup> the linking of “sustainability speak” and greenwashing has become more pronounced.<sup>80</sup>

Other critics, however, argue that, even if implemented as intended, sustainability still falls short as a paradigm for humans’ interaction with the environment. As early as 1998, for example, Peter Marcuse pointed out that socially *unjust* programs can be just as sustainable as socially just ones:<sup>81</sup> there is nothing inherently normative or good, in other words, about the capacity to endure. Moreover, while Marcuse acknowledged that sustainability has had a positive effect on environmental policy, he also cautioned that “even in the environmental arena, sustainability cannot be the sole criterion by which programmes are judged except in the, not useful, very long term because environmental policies must also take into account considerations of, for example, social justice . . . .”<sup>82</sup>

More recently, Annie Rochette has argued that sustainability and especially sustainable development are not enough of a paradigm shift from prior views of humanity’s relationship to nature. Employing a perhaps controversial ecofeminist framework, Rochette argues that:

[S]ustainable development, as it is presently conceptualized, is so fun-

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*Speak*, 347 NEW INTERNATIONALIST 22 (July 2002), available at <http://www.newint.org/features/2002/07/01/earth-summit-for-sale/>.

78. *Greenwash*, OXFORD ENGLISH DICTIONARY ONLINE, <http://oxforddictionaries.com/definition/english/greenwash?q=greenwash> (last visited Oct. 16, 2012); see also generally ADRIAN PARR, HIJACKING SUSTAINABILITY (2012).

79. See, e.g., BANDLOGIC & CRD ANALYTICS, 2012 SUSTAINABILITY LEADERSHIP REPORT: MEASURING PERCEPTION VS. REALITY FOR 100 PROMINENT GLOBAL BRANDS 1 (Sept. 2012), available at [http://www.sustainabilityleadershipreport.com/downloads/2012Sustainability\\_leadership\\_report.pdf](http://www.sustainabilityleadershipreport.com/downloads/2012Sustainability_leadership_report.pdf) (“This past year we have witnessed dramatically rising interest in and commitment to corporate sustainability around the world. Corporate investment is increasing and more third parties are monitoring and analyzing environmental, social and governance (ESG) performance. . . . In this environment of increasing focus, we believe that managing the linkage between sustainability practices and corporate brands is more relevant than ever.”).

80. One study, for example, examined about 12,000 “green” marketing claims and found that 95% were vague or unsupported. David J. Gilles & Matthew T. Kemp, *Greenwash: Overselling a Product’s “Greenness,”* 85 WIS. LAWYER 4, 4 (2012).

81. Peter Marcuse, *Sustainability is not enough*, 10:2 ENV’T. & URBANIZATION 103, 103 (1998).

82. *Id.* at 104.

damentally flawed that it will not likely be achieved, even if the international community focuses all its efforts on the implementation of *Agenda 21*. The main flaw of sustainable development lies in its failure to challenge the fundamental assumptions of the dominant development model that it seeks to replace, as well as its dependence on the global market economy. Furthermore, the concept of sustainable development does not sufficiently address the marginalization of the poor and especially women in developing countries, where women continue to be disproportionately affected by environmental degradation, yet are largely excluded from the process of sustainable development. Finally, we argue that sustainable development is based on the androcentric view of humans as separate and above Nature, a view that has led to the overexploitation of Nature. Unless this core concept of sustainable development is challenged, a sustainable future for the planet is impossible.<sup>83</sup>

In her critique, sustainable development depends on “permanent economic growth,”<sup>84</sup> raising the significant concern “that sustainable development has come to signify ‘sustained economic growth,’ thus jeopardizing environmental protection.”<sup>85</sup> As a result, “sustainable development thus fails to question the assumption that continuous economic growth will eventually lead to the destruction of the planet.”<sup>86</sup>

The point here is not to endorse all or even any of these critiques but rather instead simply to note that neither sustainability or sustainable development has been universally embraced as a complete solution to the issue of how humans should interact with and manage the ecosystems that they depend upon. For the purposes of this Article, even assuming that sustainability goals have served useful purposes, and even conceding that some governments have managed to pursue sustainability goals and sustainable development seriously and appropriately, climate change significantly undermines sustainability as a governance paradigm.

Nor does this Article argue that the pollution control and remediation laws that take a “restorative” approach do not have important continuing roles to play in environmental protection; indeed, cleaning up, reducing, and eliminating the stresses caused by pollution will be critical to resilience-based efforts moving forward.<sup>87</sup> Instead,

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83. Annie Rochette, *Stop the Rape of the World: An Ecofeminist Critique of Sustainable Development*, 51 U. NEW BRUNSWICK L.J. 145, 149-50 (2002).

84. *Id.* at 161.

85. *Id.* at 162.

86. *Id.*

87. Craig, *supra* note 6, at 43-46.

this Article uses the laws to highlight that the goal of “restoration,” as currently conceived, envisions the removal of human influence on the environment, a vision of human interaction with the environment that is both unhelpful and unrealistic and will become even more so when climate change is taken into account.

Thus, climate change undermines even the most productive visions of sustainability and human separateness from nature. To emphasize both of these points, this Article now turns to a brief discussion of climate change impacts and their implications for sustainability.

### III. THE PROBLEM OF CLIMATE CHANGE

Climate change<sup>88</sup> is already altering the base conditions of ecosystems in the United States and is beginning to impact the human economies that depend on those ecosystem’s services.<sup>89</sup> Because of “committed” warming, climate change will occur regardless of the world’s success in implementing mitigation measures, a result of the already accumulated greenhouse gases in the atmosphere.<sup>90</sup> What happens to SESs over the next decades, and most likely over the next few centuries, will largely be beyond human control. The nature of these changes and humans’ limited abilities to predict or control them call the continued viability of sustainability goals severely into doubt.

The already occurring and projected impacts of climate change have been summarized in a number of places,<sup>91</sup> so this Article’s discussion will be brief. Most importantly, continuing climate change

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88. As the Intergovernmental Panel on Climate Change (“IPCC”) explained in 2007, “climate change” means:

any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the Framework Convention on Climate Change, where *climate change* refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION, AND VULNERABILITY 6 (2007) [hereinafter 2007 IPCC ADAPTATION REPORT].

89. Craig, *supra* note 6, at 10-16.

90. Maximillian Martin & Andreas Ernst, *Climate Change: Enlarging the Toolbox*, VIEWPOINTS 35, 39 (2008), available at <http://ssrn.com/abstract=1322306> (“Existing CO<sub>2</sub> levels will persist for at least a century, with average global temperatures predicted to rise by up to 2°C regardless of steps taken to reduce GHG [greenhouse gas] emissions.”).

91. Craig, *supra* note 6, at 10-16, 24-27; see also U.S. GLOBAL CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS IN THE UNITED STATES 9 (2009), available at <http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf> (summarizing the observed and projected impacts of climate change in the United States) [hereinafter 2009 USGCRP US IMPACTS REPORT]; 2007 IPCC SYNTHESIS REPORT, *supra* note 5 (summarizing the observed and projected impacts of climate change throughout the world).

impacts are inevitable because carbon dioxide persists in the atmosphere for a significant period of time—centuries to forever.<sup>92</sup> As a result, such impacts will continue to increase through at least the 21st century<sup>93</sup> and probably much longer.<sup>94</sup> Even if the world immediately implements comprehensive efforts to significantly reduce emissions of carbon dioxide and other greenhouse gases, there will be a substantial time lag between implementation of those efforts and either actual stabilization of greenhouse gas concentrations in the atmosphere or cessation of climate change impacts.<sup>95</sup>

Moreover, climate change is creating not only long-term alterations in SESs but also a complex human adaptation and governance problem.<sup>96</sup> For example, climate change is affecting atmospheric, land, freshwater, and ocean temperatures<sup>97</sup>—but not uniformly. Temperatures toward the poles are increasing faster than temperatures nearer the equator, and temperatures of the land are rising faster than temperatures in the ocean.<sup>98</sup> As a result, climate change impacts will vary from location to location, creating needs for both geographically specific and multiscale responses.<sup>99</sup> These changes are likely to become both worse and more complex in the coming decades,<sup>100</sup> and climate change impacts affect all sectors of SESs.<sup>101</sup>

Finally, these SESs are themselves complex systems,<sup>102</sup> and hence climate change impacts set in motion feedback loops (positive and negative) and non-linear changes, neither of which are entirely (or even

92. Mason Inman, *Carbon is forever*, NATURE REPORTS CLIMATE CHANGE (Nov. 20, 2008), <http://www.nature.com/climate/2008/0812/full/climate.2008.122.html> (quoting oceanographer David Archer).

93. *Id.*; Cornelia Dean, *Emissions Cut Won't Bring Quick Relief, Scientists Say*, N.Y. TIMES, Jan. 27, 2009, at A21.

94. Inman, *supra* note 92 (quoting oceanographer David Archer); *see also* Dean, *supra* note 93, at A21 (noting that “the effects of carbon dioxide persist”).

95. Inman, *supra* note 92 (quoting oceanographer David Archer); Dean, *supra* note 93, at A21.

96. J.B. Ruhl & James Salzman, *Massive Problems in the Administrative State: Strategies for Whittling Away*, 98 CAL. L. REV. 59, 61-62 (2010).

97. 2007 IPCC SYNTHESIS REPORT, *supra* note 5, at 2.

98. *Id.*

99. *See, e.g.*, 2009 USGCRP US IMPACTS REPORT, *supra* note 91, at 107-52 (describing the differing regional changes in the United States).

100. 2007 IPCC SYNTHESIS REPORT, *supra* note 5, at 7. *See also* 2007 IPCC ADAPTATION REPORT, *supra* note 88, at 19 (“Past emissions are estimated to involve some unavoidable warming (about a further 0.6°C by the end of the century relative to 1980-1999) even if atmospheric greenhouse gas concentrations remain at 2000 levels . . .”).

101. 2007 IPCC SYNTHESIS REPORT, *supra* note 5, at 3, 9, 13 tbl. SPM.3.

102. U.S. CLIMATE CHANGE RESEARCH PROGRAM, THRESHOLDS OF CLIMATE CHANGE IN ECOSYSTEMS 2 (2009) [hereinafter 2009 USCCRP THRESHOLDS REPORT].

mostly) predictable. For example, as ice melts in the Arctic Ocean and as permafrost melts in the Arctic tundra, the exposed surface changes from white to dark. As a consequence, that surface absorbs more heat, creating a positive feedback loop that accelerates regional warming, leading scientists to predict an ice-free summer Arctic Ocean by as early as 2013<sup>103</sup> and the conversion of the Arctic tundra to the Arctic shrubland.<sup>104</sup>

The latter alteration is an example of an ecosystem crossing a threshold into a new state of being,<sup>105</sup> a source of real concern for the future for SESs of many types. As the IPCC rather cautiously acknowledged in its 2007 reports, “[a]nthropogenic warming could lead to some impacts that are abrupt or irreversible, depending upon the rate and magnitude of the climate change.”<sup>106</sup> Two years later, the U.S. Climate Change Science Program noted that:

[A]n ecological threshold is the point at which there is an abrupt change in an ecosystem quality, property, or phenomenon, or where small changes in one or more external conditions produce large and persistent responses in an ecosystem. Ecological thresholds occur when external factors, positive feedbacks, or nonlinear instabilities in a system cause changes to propagate in a domino-like fashion that are potentially irreversible. Once an ecological threshold is crossed, the ecosystem in question is not likely to return to its previous state.<sup>107</sup>

Thus, climate change is creating a world of non-stationarity—a world where baseline conditions in the natural world can no longer be assumed. These baseline conditions include air, water, and land temperatures; hydrological conditions, including the form, timing, quality, and amount of precipitation, runoff, and groundwater flow; soil conditions; and air quality. Alterations in these basic ecological elements, in turn, are prompting shifts and rearrangements of species, food webs, ecosystem function, and ecosystem services, increasing the likelihood that the ecosystems upon which human societies depend will cross ecosystem thresholds into new states of being.<sup>108</sup>

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103. Jonathan Amos, *Arctic summers ice-free 'by 2013,'* BBC News, Dec. 12, 2007, <http://news.bbc.co.uk/2/hi/7139797.stm>.

104. Matthew Sturm et al., *Winter Biological Processes Could Help Convert Arctic Tundra to Shrubland*, 55:1 *BIOSCIENCE* 17, 17 (2005).

105. 2009 USCCRP THRESHOLDS REPORT, *supra* note 102, at 1-2.

106. 2007 IPCC SYNTHESIS REPORT, *supra* note 5.

107. 2009 USCCRP THRESHOLDS REPORT, *supra* note 102, at 1.

108. *See id.* (comparing gradual ecosystem alterations from climate change to the “major, abrupt responses in ecosystems when a threshold is crossed”).

Thus, climate change is creating an increasingly uncomfortable world of unpredictability. Nevertheless, this is our new reality, and it poses non-hypothetical challenges for our reigning sustainability paradigm for law, ecosystem governance, and environmental policy. The U.S. Climate Change Research Program, for example, has noted that “[t]he potential for sudden, unanticipated shifts in ecosystem dynamics make resource planning, preparation, and management intensely difficult. These sudden changes to ecosystems and the goods and services they provide are not well understood, but they are extremely important if natural resource managers are to succeed in developing adaptation strategies in a changing world.”<sup>109</sup> More specifically, in February 2008, a group of researchers noted in *Science* that current water resource management in the developed world is grounded in the concept of stationarity—“the idea that natural systems fluctuate within an unchanging envelope of variability.”<sup>110</sup> They concluded that, because of climate change, “stationarity is dead.”<sup>111</sup> These researchers emphasized that impacts to water supplies from climate change are now projected to occur “during the multidecade lifetime of major water infrastructure projects” and are likely to be wide-ranging and pervasive, affecting every aspect of water supply.<sup>112</sup> As a result, the researchers argue that stationarity “should no longer serve as a central, default assumption in water-resource risk assessment and planning. Instead, finding a suitable successor is crucial for human adaptation to changing climate.”<sup>113</sup> The implications for natural resources law and policy are clear: natural resources law and policy in a climate change era can no longer be preservationist or restorationist. The point should not be—and in many areas and sectors, *cannot* be—to preserve as much of the current *status quo* as possible, to restore an ecosystem to an historical baseline or state of being, or even to make a shift to a new and stable *status quo*.<sup>114</sup>

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109. *Id.*

110. Milly et al., *supra* note 19, at 573.

111. *Id.*

112. *Id.* Specifically, they noted that climate change impacts will include “the means and extremes of precipitation, evapotranspiration, and rates of discharge of rivers,” “atmospheric humidity and water transport,” “flood risk,” “contamination of coastal freshwater supplies” from sea-level rise, and “natural seasonal and interannual storage.” *Id.*

113. *Id.* See also Martin & Ernst, *supra* note 90, at 40 (“The management of water, air, and other resources will become essential as the long-term impacts of warming become evident.”); 2009 USGCRP US IMPACTS REPORT, *supra* note 91, at 49 (“Because climate change will significantly modify many aspects of the water cycle, the assumption of an unchanging climate is no longer appropriate for many aspects of water planning.”).

114. See, e.g., Daniel A. Farber, *Rethinking the Role of Cost-Benefit Analysis*, 76 CHI. L. REV.

As a consequence, governance models for the climate change era must treat with considerable skepticism—and be willing in many places to outright reject—all traditional paradigms that are based on assumptions of stationarity. These paradigms include not only preservation and restoration but also sustainability. Finding a successor to the sustainability paradigm is critical.

The rejection of sustainability will likely be met with considerable resistance. This resistance is understandable because sustainability goals certainly can and have fostered less destructive relationships than unbridled consumerism between particular groups of humans and the ecosystems upon which they depend. Sustainability goals have also enhanced some first (although often limited) measures that are climate change-adaptive, such as energy and water conservation efforts, increased creation of green spaces in urban areas, and increased recycling of consumer materials. In addition, sustainability goals added a much-needed temporal perspective to environmental law and natural resources management. Specifically, “sustainable development,” as defined by the Bruntland Commission, Agenda 21, and other national and international reports, treaties, and instruments, explicitly takes the needs of future generations into account in the current use of natural resources.

This Article is not arguing that sustainability is a *bad* idea, it is arguing that it is just an increasingly futile one at anything but the largest and most general of scales. For purposes of day-to-day environmental

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1355, 1401 (2009) (noting that in climate change adaptation, “the whole point is that the status quo will become unsustainable due to climate change”). See also J.B. Ruhl, *Climate Change and the Endangered Species Act: Building Bridges to the No-Analog Future*, 88 B.U. L. REV. 1, 18-23 (2008) (describing how climate change is leading us to a “no-analog” future); Ruhl, *Thinking of Environmental Law*, *supra* note 57, at 940, 968-75 (arguing that environmental law inappropriately engages in uniformitarianism).

Nevertheless, while “[p]ublic opinion has largely accepted that climate change is occurring,” “climate change is not yet considered irreversible and its long-term implications have not been accepted.” Martin & Ernst, *supra* note 90, at 41. This lack of acceptance is obvious in the thrust of many of the few climate change adaptation articles that have been written, most of which adopt, consciously or unconsciously, a preservationist approach. See, e.g., David Takacs, *Carbon Into Gold: Forest Carbon Offsets, Climate Change Adaptation, and International Law*, 15 HASTINGS W.-N.W. J. ENVTL. L. & POL’Y 39, 43-44 (2009) (defining “ecological resiliency” to be “*protecting and preserving* the natural ecosystems that help human communities survive through buffering from floods, filtering drinking water, stabilizing soil; providing sustainable forest products, and *preserving* a host of other ecosystem services necessary for human survival”); William S. Eubanks II, *The Life-Altering Impacts of Climate Change: The Precipitous Decline of the Northeastern Sugar Maple and the Regional Greenhouse Gas Initiative’s Potential Solution*, 17 PENN STATE ENVTL. L. REV. 81, 81 (2008) (arguing that “the public must first realize the scientific and economic necessity of *preserving* the sugar maple in the northeastern United States”).

regulation and natural resources management, climate change requires both that we replace goals of sustainability with something else and that expand our awareness of multi-scalar interactions and consequences.

At a purely verbal level, sustainability is by definition the ability to sustain *something*: the verb needs an object, and the goal of sustainability needs a particular focus or foci—an ecosystem, an SES, extant biological diversity, economic growth, development, human health—but *something*. To talk about sustainability in the abstract is to philosophize, not to pursue meaningful policies and laws. Climate change, however, is a game-changer. There will be very few, if any, of the ecological *somethings* that humans would seek to sustain and maintain in their current states of being that will be able to be sustained in exactly those states. Consequently, because human survival and well-being will remain dependent on the environment—that basic fact will not change in the climate change era—climate change also undermines humans' ability to sustain SESs in their current forms. Whether other aspects of human society—culture and religion, for example—remain sustainable in a climate change era remains an open question, the answers to which are likely to vary among societies.<sup>115</sup>

For other reasons, as well, climate change requires a more sophisticated scalar awareness than sustainability generally needs. Because sustainability is grounded in assumptions of ecological stationarity, governance systems pursuing sustainability goals effectively presume that they can ignore interactions among various scales of natural and human processes, from microscalar to global: so long as everything operates within unchanging envelopes of variation, how the various scales of processes produce those envelopes is largely irrelevant. However, ecological theorists such as Lance Gunderson and C.S. Holling have recognized that ecosystems (and hence SESs) do change in complex ways and that those changes both reflect and drive multi-scalar

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115. Indeed, evaluation of these questions underscores how climate change will make considerations of scale increasingly important in evaluating how both human societies and ecosystems are responding to climate change impacts. To focus for a moment on religion, for example, from a macroscale perspective, Christianity has been sustained for over 2000 years despite radical cultural and socio-ecological changes over that period. A more fined-grained examination, however, would surely note that the once-monolithic control of the Catholic Church over Christianity has fragmented badly and that several different versions of the basic faith now exist, immediately underscoring the necessity of defining *what exactly* has been sustained. With a similarly sliding scalar awareness, we can continue to pursue sustainability at a very general scale: Maintaining a living and functional planet for future generations, even if it is a different planet than the one we grew up with. At more specific scales, however, identifying the *what* we are sustaining will become increasingly impossible.

interactions that can have unexpected effects.<sup>116</sup> The continual alterations that climate change impacts are causing and will continue to cause make these complex multi-scalar interactions critical components of modeling and scenario building for the “no analog” future, although human understanding of this scalar complexity remains rudimentary. Nevertheless, ignoring multiscale interactions and scalar complexity is no longer an option.

#### IV. A NEW PARADIGM: RESILIENCE THINKING

In 2008, in proclaiming “stationarity is dead,” the *Science* researchers discussed above also emphasized that the critical question is what a successor regime to stationarity should look like.<sup>117</sup> As noted, the replacement of stationarity requires the replacement of sustainability goals, as well. While it is always important to remember that there will be no panacea—“one size fits all” solution to environmental problems<sup>118</sup>—particularly in the realm of natural resources management, we must begin to formulate ecological governance goals by some metric other than sustainability.

The concept of resilience, and the theory of resilience thinking, offers a new and potentially more productive orientation than sustainability to the environmental challenges ahead. This Part first defines resilience and resilience thinking as used in this Article, then describe an ongoing attempt by the U.S. Bureau of Reclamation to incorporate resilience thinking into water resources management. It ends by explaining how resilience thinking can produce more productive responses to climate change impacts in environmental law and natural resources management, and the challenges associated with making this paradigm shift.

##### A. *Defining Resilience and Resilience Thinking for a Climate Change Era*

As defined by its founder and ecological resilience scholar C.S. “Buzz” Holling, “resilience determines the persistence of relationships

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116. See generally, e.g., LANCE GUNDERSON & C.S. HOLLING, PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS (2002) (posing the theory of panarchy to integrate ecological, economic, and social dynamics at multiple scales through cycles of change).

117. Milly et al., *supra* note 19, at 573-74.

118. Elinor Ostrom, Marco A. Janssen & John M. Anderies, *Going Beyond Panaceas*, 104 PROC. NAT'L ACAD. SCI. 15176 (2007) (“A core aspect of panaceas is the action or tendency to apply a single solution to many problems.”).

within a system and is a measure of the ability of these systems to absorb change of state variables, driving variables, and parameters, and still persist.”<sup>119</sup> Resilience can be characterized by: (1) the amount of change the system can undergo and still retain the same controls on function and structure; (2) the degree to which the system is capable of self-organization; and (3) the ability to build and increase the capacity for learning and adaptation. Taking each of these aspects of resilience in turn provides a basic overview of resilience theory.

First, as noted, one aspect of resilience emphasizes a system’s capacity to absorb change without shifting into a qualitatively different state that is controlled by a different set of processes<sup>120</sup>—the resistance end of the resilience thinking continuum. However, resilience thinking also recognizes that when events or system processes are altered in ways that go beyond the systems’ capacity to absorb changes to the system, it “flips” into a new system state.<sup>121</sup> This result is often referred as *regime change*, the transformative end of the resilience thinking continuum. For example, a freshwater lake can undergo an ecological regime change from a system that supports fish and other aquatic species to an algae-dominated eutrophic lake if, as a result nutrient-loading from nonpoint source pollution and other sources, the system crosses an ecological threshold.<sup>122</sup> The new, algae-dominated system then has its own state of resilience. Similarly, a social system dominated by a dictatorial political regime reaches “tipping point” when levels of education and economic opportunity in a society prompt democratic regime changes.<sup>123</sup> These examples illustrate another important aspect of resilience thinking: “system resilience” is not inherently good or bad. Values dictate decisions regarding which system states we want to foster, maintain and protect.

The second element of system resilience, the capacity for self-organization, relates to the system’s development of stabilizing feedbacks among system components that maintain the system.<sup>124</sup>

119. C.S. HOLLING, RESILIENCE AND STABILITY OF ECOLOGICAL SYSTEMS 17 (1973).

120. Stephen B. Carpenter et al., *From metaphor to measurement: Resilience of what to what?*, 4 ECOSYSTEMS 765, 766 (2001).

121. C. S. Holling, *Engineering resilience versus ecological resilience*, in ENGINEERING WITHIN ECOLOGICAL CONSTRAINTS 36 (P. Schulze ed., 1996).

122. Motomi Genkai-Kato & Stephen R. Carpenter, *Eutrophication Due to Phosphorous Recycling in Relation to Lake Morphology, Temperature and Macrophytes*, 86 ECOLOGY 210, 210 (2005).

123. Recent political events in Egypt and Tunisia provide possible examples. See Robert L. Tignor, *Can a New Generation Bring about Regime Change?*, 43 INT’L J. OF MIDDLE EAST STUDIES 384, 384 (2011).

124. Carl Folke, F. Stuart Chapin & Per Olsson, *Transformations in Ecosystem Stewardship*,

Systems that must continually rely on external process or support to maintain themselves are less resilient than systems that can remain functional and productive through their own capacities. A farm (itself a complex SES) that requires government subsidies in order to keep going from year-to-year is less resilient than one that can operate with outside assistance. Similarly, ecosystems that need constant management interventions are less resilient than those that require little in terms of external controls.<sup>125</sup>

The relative dependency on management intervention is closely related to the third element of resilience, a system's adaptive capacity. Adaptive capacity describes the "capacity of actors, both individuals and groups, to respond to, create and shape variability and change in the state of the system."<sup>126</sup> Adaptive capacity reflects a system's flexibility and ability to effectively respond to change and is often reflective of both functional diversity and redundancies within a system.<sup>127</sup> The greater the system's ability to formulate effective and deliberate responses to change, the more resilient it is.

Unfortunately, "resilience" already resonates through a number of both common and specialized meanings, some of which promote stationarity almost as thoroughly as sustainability. Thus, for example, one can conceptualize resilience as the capacity to remain the same—to endure—despite external shocks. From this perspective, even Holling's basic definition of "resilience" quoted above could seem to promote just another form of the stationarity paradigm. As a result, and critically for our argument, it is important to contextualize "resilience" itself into a particular formulation of resilience theory or resilience thinking (which we use largely interchangeably).

There are two schools of resilience theory advancing differing definitions of resilience. One school, often referred to as "engineering resilience," refers to the ability of a system to return to "balance" in the face of perturbations.<sup>128</sup> In contrast, our characterization of resilience follows Holling's school of "ecological resilience."<sup>129</sup> Ecological

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in PRINCIPLES OF ECOSYSTEM STEWARDSHIP 14, 14 (Stuart Chapin, Gary P. Kofinas & Carl Folke eds. 2009).

125. *Id.* at 14-15.

126. F. Stuart Chapin, Carl Folke & Gary P. Kofinas, *A Framework for Understanding Change*, PRINCIPLES OF ECOSYSTEM STEWARDSHIP 3, 23 (Stuart Chapin, Gary P. Kofinas & Carl Folke eds., 2009).

127. *Id.* at 26-37.

128. *See generally* STUART L. PIMM, *THE BALANCE OF NATURE?* (1991).

129. For more information regarding the distinction, see Holling, *supra* note 121, at 36-38. For more on the distinction from a legal perspective, *see generally* J.B. Ruhl, *General Design*

resilience theory reflects a complex systems approach to understanding SES dynamics. Overall, resilience thinking emphasizes understanding and responding to change rather than identifying and maintaining stationarity. As environmental science professor Liam Heneghan notes:

Resilience thinking assumes that change and disturbance are an integral part of every system, but that some systems are more resilient to destructive change than others. This might seem a subtle point, but if we understand the processes that promote or restore resilience, we have a much better chance both of mopping up after ecological catastrophes—or of avoiding them altogether.<sup>130</sup>

In putting an awareness of continual change at its core, resilience thinking contrasts sharply with the restoration-, preservation-, and optimization-based paradigms that currently dominate environmental law and natural resource management. To put it another way: Sustainability and other stationarity-based paradigms, as discussed above, *assume* the system's ability to endure, provided that humans behave rationally, whereas (to quote Heneghan again) “[r]esilience thinking ultimately theorises about the limits of a system's capacity to endure. Financial markets collapse, crops fail, love blanches, ecosystems unravel, and death, alas, is a part of every life.”<sup>131</sup>

The difference in emphasis may at times be subtle, but it is enough of a difference that true adoption of resilience thinking would force several changes in natural resource management. For example, resilience thinking should force managers to act in terms of entire systems, not specific and favored ecosystem goods and services: “Natural resource management for optimization of ecosystem services with immediate commodity value, such as energy, timber, or large game, does not lead to resilience or sustainability of an ecosystem.”<sup>132</sup> Thus, resilience theory recognizes that a management focus that seeks to stabilize a selected set of ecosystem services tends instead to actually increase system vulnerability to shocks and perturbations.<sup>133</sup>

In addition, because resilience theory embraces the dynamics and complexities of SESs, it promotes a more flexible and responsive approach to natural resource management, including but not limited to

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*Principles for Resilience and Adaptive Capacity in Legal Systems: Applications to Climate Change Adaptation Law*, 89 N.C. L. REV. 1373, 1375-77 (2011).

130. Heneghan, *supra* note 44.

131. *Id.*

132. See Barbara Cosens, *Resilience and Law as a Theoretical Backdrop for Natural Resource Management: Flood Management in the Columbia River Basin*, 42 ENVTL L. 241, 245-246 (2012).

133. *Id.*

adaptive management.<sup>134</sup> Certainty in human management is not required.<sup>135</sup> Indeed, the complexity of forces acting on SESs removes many aspects of these SESs from the illusion of complete human managerial control.<sup>136</sup> As a result, resilience thinking allows environmental law and policy to forge a new, more realistic relationship with science as a method for providing information—one that is capable of designing interesting and informative questions rather than expecting definitive answers.

More specifically, resilience thinking assumes that systems are continually responding and adapting to continual change, with the ever-present possibility that the changes will cross a threshold and induce an abrupt regime shift in the system. As such, resilience thinking acknowledges a continuum of possible system responses to change, ranging from fairly complete resistance to a particular perturbation, to complete transformation into a different state or regime.<sup>137</sup>

Even at the resistance end of this continuum, the focus, emphasis, and assumptions of resilience thinking are again different from those of sustainability. Sustainability, as discussed, incorporates the underlying assumption that we know what can be sustained and have the capacity to hold onto some sort of stationarity. In contrast, resilience thinking not only acknowledges continual change in a variety of variables that affect the system of interest, but also actively incorporates disequilibrium and nonlinear change into management theory.<sup>138</sup> This is an important distinction from the stationarity assumptions of sustainability, because even at the resistance end of the resilience continuum, SESs are continually adapting to a variety of perturbations rather than passively persisting in naturally stable states.

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134. See, e.g., WALKER & SALT, *supra* note 37, at 127-30 (noting that “[t]he ideas of adaptive management arose in conjunction with the ideas behind resilience thinking, and they are an integral part of a resilience approach” and providing an extended definition of adaptive management and description of its use); NAT’L RESEARCH COUNCIL, ADAPTIVE MANAGEMENT FOR WATER RESOURCES PROJECT PLANNING 1-2 (2004) (defining adaptive management and discussing its relationship to system resilience).

135. Carpenter et al., *supra* note 120, at 778. See also Heneghan, *supra* note 44 (noting that “[o]ne of the striking findings [of resilience thinking] is that diversity is crucial to success. When an ecological system is managed for just one factor (say, a single crop) or where a nation’s wealth is dominated by a single economic sector (say, the housing market before the 2008 global financial crisis), the result is a loss of resilience.”).

136. Heneghan, *supra* note 44.

137. Rob Fischman, “Public Lands Management,” Northwestern University School of Law Climate Change Roundtable, Chicago, Illinois (Oct. 5, 2012) (conference presentation).

138. Robert L. Glicksman, *Ecosystem Resilience to Disruptions Linked to Global Climate Change: An Adaptive Approach to Federal Land Management*, 87 NEB. L. REV. 833, 836-37, 852-56 (2009) (describing the paradigm shift in ecology away from the equilibrium model).

Resilience thinking, in short, is always about coping with change. Most dramatically, at the transformation end of the continuum, resilience thinking acknowledges the possibility—and perhaps inevitability—that an SES’s adaptation to a particular perturbation or constellation of changes will be to transform—to move from one relatively stable state of being or regime to another, such as the Arctic tundra becoming the Arctic shrubland.

Thus, even though resilience thinking emerged independently of climate change, it provides a better paradigm than sustainability for designing environmental and natural resources law and policy in a climate change era. The U.S. Climate Change Research Program’s 2009 report on ecosystem thresholds provides one illustration of how incorporating resilience thinking, with its acknowledgement of a continuum of system response from resistance to transformation, could overhaul how governance systems manage SESs. The Program acknowledges that “climate change is pushing more ecosystems toward thresholds” and recognizes the “threat of transformative change”<sup>139</sup> with the (common, but notable) assumption that these changes will be “bad” from a human perspective. The Program advocates both additional research to identify these thresholds and increased attention to system resilience:

Given that threshold changes are increasingly likely to occur, it is important to prepare for them by increasing societal and ecological resilience. Managers that understand ecological diversity and the other factors that influence the resilience of the systems they manage are in a better position to implement changes that reduce the likelihood that thresholds will be crossed.<sup>140</sup>

Nevertheless, managers must also prepare for system transformations: “If a threshold seems likely to occur but the uncertainties remain high as to when it will occur, contingency plans should be created. These can be implemented when the threshold shift begins to occur or can be carried out in advance if the approaching threshold is clear.”<sup>141</sup> In addition, modeling should include ecosystem thresholds,<sup>142</sup> and managers need to increase their awareness of multi-scalar complexity: “It is also apparent that many changes are causing secondary, or cascading, domino-like changes in other parts of ecosystems. Management policies that were

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139. 2009 USCCRP THRESHOLDS REPORT, *supra* note 102, at 5-6.

140. *Id.* at 6.

141. *Id.* at 7.

142. *Id.* at 7-8.

developed during relatively stable climate conditions may be inadequate for a variable world with more surprises.”<sup>143</sup>

*B. The Bureau of Reclamation’s Efforts to Incorporate Resilience Thinking into Water Management*

While some federal agencies remain mired in a pursuit of sustainability,<sup>144</sup> the concept of resilience is gaining influence within natural resource policy.<sup>145</sup> Examples include the U.S. Fish and Wildlife Service’s Strategic Plan for Responding to Accelerating Climate Change for the National Wildlife Refuge System,<sup>146</sup> management of National Forest System Lands,<sup>147</sup> and the National Oceanic and Atmospheric

143. *Id.* at 8.

144. See 2011 NRC SUSTAINABILITY REPORT, *supra* note 22, at 1 (“The U.S. Environmental Protection Agency (EPA) has been working to create programs and examining applications in a variety of areas to better incorporate sustainability into decision making at the agency. To further strengthen the analytic and scientific basis for sustainability as it applies to human health and environmental protection, EPA asked the National Research Council (NRC) to convene a committee under the Science and Technology for Sustainability Program to provide an operational framework for integrating sustainability as one of the key drivers within the regulatory responsibilities of EPA.”).

145. Adaptive management is based on and is considered a primary vehicle for putting resilience theory into practice. Melinda Harm Benson, *Intelligent Tinkering: The Endangered Species Act and Resilience*, 17:4 *ECOLOGY & SOC’Y* 28, available at [www.ecologyandsociety.org/vol17/iss4/art28/ES-2012-5116.pdf](http://www.ecologyandsociety.org/vol17/iss4/art28/ES-2012-5116.pdf). For further information regarding the integration of adaptive management into legal and institutional frameworks, see J.B. Ruhl & Robert L. Fischman, *Adaptive Management in the Courts*, 95 *MINN. L. REV.* 424, 431-36 (2010).

146. U.S. FISH AND WILDLIFE SERVICE, *CONSERVING THE FUTURE: WILDLIFE REFUGES AND THE NEXT GENERATION* 36 (Oct. 2011), available at <http://americaswildlife.org/wp-content/uploads/2012/01/Final-Documents-Conserving-the-Future.pdf>. As the USFWS explains:

Our mandate to conserve and manage Refuge System lands and waters to maintain biological integrity, diversity and ecosystem health requires us to support ecological resilience and provide fish, wildlife and plants with opportunities to adapt to climate-changed landscapes. Wilderness will be a key part of our understanding of climate-mitigated changes. Large, unfragmented wilderness areas will support ecosystem resiliency and species adaptation, and be a source of valuable baseline data as the climate changes.

*Id.* at 36-37.

Perhaps because of the Refuge System’s relatively recent and overarching consolidation of federal wildlife refuge management, it has been more innovative than the federal land management agencies with respect to integration of adaptive management, resilience and other next generation environmental concepts. See Robert L. Fischman, *From Words to Action: The Impact and Legal Status of the 2006 National Refuge System Management Policies*, 26 *STAN. ENVTL. L.J.* 77 (2007).

147. The U.S. Forest Service recently incorporated in agency manual a directive containing “foundational policy for using ecological restoration to manage National Forest System lands in a sustainable manner.” U.S. FOREST SERVICE, *FOREST SERVICE MANUAL* (updated continually), [https://fs.usda.gov/FSI\\_Directives/wo\\_id\\_2020-2011-1.doc](https://fs.usda.gov/FSI_Directives/wo_id_2020-2011-1.doc). Within the policy on “ecological restoration,” the Service emphasizes resilience as a key element:

The aim is to reestablish and retain ecological resilience of National Forest System lands

Administration's Next Generation Strategic Plan.<sup>148</sup> This section, however, focuses on the U.S. Bureau of Reclamation's ("BOR's") efforts to integrate resilience thinking into its water management responsibilities in response to the 2009 Secure Water Act.

### 1. The BOR and the Secure Water Act: An Overview

The BOR's approach to integrating resilience thinking provides an illustration of how agencies are incorporating resilience thinking into natural resources management—but also of how additional reforms are necessary. The BOR is responsible for the management and operation of hundreds of dams and reservoirs in the United States, providing irrigation water to over 140,000 farmers operating over 10 million acres.<sup>149</sup> In recent years, the BOR has placed increased attention on the impact of climate change and drought in its operations, a result in large part of the Secure Water Act of 2009.<sup>150</sup>

The Secure Water Act authorized the Reclamation Climate and Water Program and directed the BOR to assess risks to the water resources of the American West, analyze the extent to which those risks will impact water deliveries, and develop strategies to mitigate those risks.<sup>151</sup> Among the required elements of this work, the Secure Water Act invokes the concept of resilience by directing the agency to:

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and associated resources to achieve sustainable management and provide a broad range of ecosystem services. Healthy, resilient landscapes will have greater capacity to survive natural disturbances and large scale threats to sustainability, especially under changing and uncertain future environmental conditions, such as those driven by climate change and increasing human uses.

*Id.* at 2020.2.

148. NATIONAL MARINE FISHERIES SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEP'T OF COMMERCE, NOAA'S NEXT GENERATION STRATEGIC PLAN V (Dec. 2010), available at [http://www.ppi.noaa.gov/wp-content/uploads/NOAA\\_NGSP.pdf](http://www.ppi.noaa.gov/wp-content/uploads/NOAA_NGSP.pdf):

Resilient ecosystems, communities, and economies can maintain and improve their health and vitality over time by anticipating, absorbing and diffusing change. This vision of resilience will guide NOAA and its partners in a collective effort to reduce vulnerability of communities and ecological systems in the short-term, while helping society avoid or adapt to longer-term environmental, social and economic changes.”).

Note that NMFS is somewhat unique among natural resource management agencies in the sense that it explicitly states an intention to address social as well as ecological resilience.

149. *Bureau of Reclamation Quickfacts*, BUREAU OF RECLAMATION (as updated May 3, 2012), <http://www.usbr.gov/facts.html>.

150. BUREAU OF RECLAMATION, SECURE WATER ACT SECTION 9503(C)—RECLAMATION CLIMATE CHANGE AND WATER 2011, at 2-3 (2011) [*hereinafter* BOR SECURE WATER ACT REPORT]. The Secure Water Act was incorporated into and passed as part of the Omnibus Public Land Management Act of 2009, 123 Stat. 991 (2009), *codified as* 16 U.S.C. §§ 9501-9510.

151. BOR SECURE WATER ACT REPORT, *supra* note 150, at 2-3.

[a]nalyze the extent that the risks to water supply will impact water deliveries to the contractors of the Secretary of the Interior, hydroelectric power generation facilities, recreation at Reclamation facilities, fish and wildlife habitat, applicable species listed as an endangered, threatened, or candidate species, water quality issues, flow and *water dependent ecological resiliency*, and flood control management.<sup>152</sup>

In March 2011, the BOR provided its first report to Congress, which primarily addressed and quantified changes in water supply resulting from climate change.<sup>153</sup> In the next report, due in March 2016, the BOR will provide a West-wide approach to addressing the challenges associated with its findings.<sup>154</sup>

## 2. Current BOR Initiatives

The BOR is currently pursuing three major initiatives associated with this task. First, it is conducting a West-Wide Climate Risk Assessment (“WWCRA”).<sup>155</sup> The WWCRA will assess the potential changes in water supply and demand resulting from climate change, establishing baseline conditions and developing adaptation strategies that reflect a resilience-based perspective.<sup>156</sup> This information will then be used in two concurrent efforts taking place as part of the WaterSMART Initiative: Landscape Conservation Cooperatives and Basin Studies.<sup>157</sup>

The Landscape Conservation Cooperatives are collaborative,

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152. *See id.* at 3 (emphasis added).

153. *See id.* at vi-ix. Key findings from the report include: is projected further warming during the 21st century varying from roughly 5–7°F, depending on location; precipitation increases over the northwestern and north-central portions of the western United States and a decrease over the southwestern and south-central areas; a decrease for almost all of the April 1st snowpack, a standard benchmark measurement used to project river basin runoff; and an 8 to 20 percent decrease in average annual stream flow in several river basins, including the Colorado, the Rio Grande, and the San Joaquin. *Id.*

154. Interview with Dagmar K. Llewellyn, BOR hydrologist and member of the West-wide Climate Risk Assessment Implementation Team (Aug. 13, 2012). Impacts to changing supply are being analyzed in eight categories: (1) delivery of water, (2) hydroelectric generation, (3) recreation, (4) fish and wildlife, (5) ESA listed species, (6) water quality, (7) flow and water dependent ecological resiliency and (7) flood control. Categories 4, 5, 6 and 7 are considered “ecological resources” and are considered together as a group.

155. Secretarial Order No. 3285, issued on March 11, 2009, *available at* <http://www.usbr.gov/WaterSMART/docs/so3289A1.pdf> [hereinafter WWCRA].

156. *See* Llewellyn, *supra* note 154.

157. The WaterSmart program actually predates the Secure Water Act; it expanded the “Water 2025” initiative that began in 2003. For a general overview of WaterSmart, see Reed D. Benson, *New Adventures of the Old Bureau: Modern-day Reclamation Statutes and Congress’s Unfinished Business*, 48 HARV. J. ON LEG. 137, 169-72 (2011).

intergovernmental programs coordinated by both the BOR and the U.S. Fish & Wildlife Service. They include participation from local and state governments and nongovernmental organizations and are designed to combine scientific information and resource management in order to develop climate adaptation strategies within a specific landscape.<sup>158</sup>

In turn, the Basin Studies are associated with WaterSMART's grant program.<sup>159</sup> The program applies in locations where: (1) there are BOR projects; and (2) there are existing or projected imbalances between water supply and demand.<sup>160</sup> For each grant project, the BOR partners with a local or state agency and works with it to develop a comprehensive water study and subsequent strategy for meeting future water demands.<sup>161</sup>

As one example, the BOR is partnering with the City of Santa Fe, New Mexico, to assess climate vulnerabilities in its watershed.<sup>162</sup> The two entities released a preliminary report in July 2012 as part of a Basin Study, which will assess the impact of climate change on the watershed, quantify the corresponding impact to water supply, assess the vulnerabilities of current water supply strategies, and evaluate mitigation and adaptation strategies that can be integrated into the region's water supply plan.<sup>163</sup> Throughout the document, the preliminary report emphasizes the importance of building resilience:

Deep crushing cycles of drought are part of the natural history of the Southwest and, for all practical purposes, they always have been. *Building resilience against drought into the region's water systems and cultural practices would be a wise course, irrespective of the cause or timing of the next emergency.* Perhaps the dangers now arising from anthropogenic climate change will goad us into doing things we should have been doing all along . . . to strive for resilience, . . . the

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158. *Landscape Conservation Cooperatives: Frequently Asked Questions*, LANDSCAPE CONSERVATION COOPERATIVE: CONSERVATION IN ACTION (U.S. Fish & Wildlife Services) Feb. 2012, at 1, available at [http://www.fws.gov/landscape-conservation/pdf/LCC\\_FAQs\\_2012.pdf](http://www.fws.gov/landscape-conservation/pdf/LCC_FAQs_2012.pdf).

159. According to the BOR website, "Each study includes four key segments: [1] State-of-the-art projections of future supply and demand by river basin. [2] An analysis of how the basin's existing water and power operations and infrastructure will perform in the face of changing water realities. [3] Development of options to improve operations and infrastructure to supply adequate water in the future. And [4] Recommendations on how to optimize operations and infrastructure in a basin to supply adequate water in the future." *Basin Studies*, BUREAU OF RECLAMATION, <http://www.usbr.gov/WaterSMART/bsp/index.html> (last visited Aug. 31, 2012).

160. *Id.*

161. *Id.*

162. BUREAU OF RECLAMATION, PRELIMINARY ASSESSMENT REPORT: CLIMATE CHANGE AND THE SANTA FE WATERSHED 3 (July 13, 2012) (on file with Melinda Harm Benson).

163. *Id.* at 2-3.

capacity of an ecosystem to experience disturbance without losing its essential character and becoming something else.<sup>164</sup>

Thus, water management in the West is at least beginning to “talk the talk” of resilience thinking.

### 3. Walking the Walk? Has the Paradigm Truly Shifted to Resilience Thinking?

What all this emphasis on resilience within the BOR will actually mean, however, is yet to be seen. The Secure Water Act does not define the term, and the WWCRA team is currently in the process of developing a working definition for their efforts.

In this respect, the BOR’s approach to integrating resilience thinking and managing for climate change is indicative of what is occurring in most federal agencies. There is recognition of the pressing need to shift the management paradigm; however, rather than actually changing course with new mandates and authorities, agencies instead attempt simply to add a resilience-based approach to the agency’s existing set of priorities and statutory requirements.<sup>165</sup>

In this sense, it is perhaps less important to note what the Secure Water Act and similar efforts authorize than it is to note what they *fail* to do from a resilience perspective. These failures fall into three categories. First, current efforts to incorporate resilience thinking do not challenge the dominant paradigm based in assumptions of stationarity. Indeed, the very name of the BOR’s mission, Secure Water, speaks to the disconnect between the underlying realities that ground resilience thinking and current natural resource policy orientations, because there is no such thing as “secure water” in a climate change era.<sup>166</sup> Thus, while many of the operational mechanisms for the WaterSMART program come close to recognizing this fact, the overarching policy is still trapped in outdated ways of thinking. This failure to reject stationarity and fully embrace dynamism is important because it reflects

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164. *Id.* at 2 (quoting WILLIAM DEBUYS, A GREAT ARIDNESS: CLIMATE CHANGE AND THE FUTURE OF THE AMERICAN (2011)) (emphasis added). The Assessment Report notes there are three primary elements of climate change that will impact the City of Santa Fe’s watershed: rising temperatures, changes in precipitation patterns and increases in climate variability. *Id.* at 8. Current models project that the basin could see a temperature increase in the range of 5.5 to 6.5 degrees Fahrenheit by 2100. *Id.* at 7-8.

165. Melinda Harm Benson & Ahjond Garmestani, *Can We Manage for Resilience? The Integration of Resilience Thinking into Natural Resource Management in the United States*, 48 ENVTL. MGMT. 392, 399 (2011).

166. See Milly et al., *supra* note 19, at 573-74.

a larger problem, a collective and cultural refusal to face the emerging realities of the Anthropocene<sup>167</sup> and the extent to which climate change will require fundamentally different choices in the face of unprecedented challenges to “the settled expectations of humans.”<sup>168</sup>

Second, current efforts do not create binding and enforceable new policy directions that integrate resilience thinking. The Secure Water Act, for example, is basically a grant program. It authorizes further studies and activities and funding,<sup>169</sup> but it does not substantively reorient the BOR’s operations, which is what is required.<sup>170</sup> In the absence of some actual authority to manage its water projects differently, existing allocations and requirements will continue to orient the agency to meeting existing demands rather than building resilience—or adequately preparing for potentially cataclysmic disaster. This failure reflects an unwillingness to acknowledge the trade-offs that will be required by climate change and associated challenges. A resilience-based perspective cannot simply be pasted on top of an existing management scheme based on a rigid resource allocation regime; instead, fundamental and radical restructuring of resource management is required.

The lack of reorientation is perhaps magnified in the BOR’s case because the agency already suffers from the lack of a unified set of management priorities: Congress has not created an organic act for the agency and legislative mandates and authorizations are project-by-project. Perhaps predictably, Congress has taken a piecemeal approach to revising the BOR’s management responsibilities. Even at the project-specific level, however, Congress has never fundamentally altered the main purpose of the various projects—damming rivers and then diverting water for irrigation purposes.

Moreover, for the BOR, competing statutory mandates further challenge the integration of resilience as an environmental goal or approach. Even if Congress enacted new legislation for the BOR and created an organic act that provided the agency with general authority to use a more diversified suite of management directives,<sup>171</sup> other

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167. See Biermann et al., *supra* note 12, at 1306.

168. Ruhl, *General Design Principles*, *supra* note 129, at 1374.

169. Benson, *New Adventures of the Old Bureau*, *supra* note 157, at 169-72.

170. *Id.* at 167-75.

171. Professor Benson calls for an organic act for the BOR that provides programmatic authorization to manage for biodiversity “Congress has left a gaping hole in that statutory quilt by failing to provide the Bureau with general authority to take actions for the benefit of fish and wildlife affected by reclamation projects.” Benson, *New Adventures of the Old Bureau*, *supra* note 157, at 167.

environmental requirements built on old and outdated assumptions apply to BOR projects and would continue to challenge the agency. The federal Endangered Species Act (“ESA”),<sup>172</sup> for example, makes recovery a goal for imperiled species,<sup>173</sup> but this 1973 Act has no recognition of how climate change is changing and will continue to change habitat availability and other constraints on species protection.<sup>174</sup> Similarly, the federal National Environmental Policy Act (“NEPA”)<sup>175</sup> assumes that we can accurately anticipate the environmental impact of federal agency actions.<sup>176</sup>

The third failure associated with current attempts to integrate resilience thinking into natural resource management is the continued bifurcation of social and ecological systems into separate management categories. The BOR’s approach again provides a relevant example. Created by Congress in 1902 through the Reclamation Act<sup>177</sup> to facilitate settlement of the American West by Europeans, the BOR peppered the landscape with water projects in places where people needed irrigation in order to pursue the Jeffersonian pastoral ideal.<sup>178</sup> The BOR focused on one narrow aspect of the social system, the development of irrigated agriculture.<sup>179</sup> Environmental impacts were not a consideration—obviously, the environmental movement was several decades away—but even today the BOR lacks the necessary authority to address many ecological concerns.<sup>180</sup> Congress also ignored important social system elements regarding the BOR’s many water projects. For example, when the BOR enters into contracts with farmers to provide water, the agency has little capacity to influence important land use decisions made by communities supported by the projects.<sup>181</sup>

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172. 16 U.S.C. §§ 1531-1544 (2006).

173. *Id.* at § 1533(f)(1).

174. Ruhl, *Climate Change and the Endangered Species Act*, *supra* note 114, at 23-24.

175. 42 U.S.C. §§ 4321-4370h (2006).

176. Melinda Harm Benson & Ahjond Garmestani, *Embracing panarchy, building resilience and integrating adaptive management through a rebirth of the National Environmental Policy Act*, 92 J. ENVTL. MANAGEMENT 1420, 1422-23 (2011). *See also* Sam Kalen, *Ecology Comes of Age: NEPA’s Lost Mandate*, 21 DUKE ENVTL. L. & POL. FORUM 113, 156-62 (2010) (providing historical context on NEPA and its substantive provision).

177. Benson, *New Adventures of the Old Bureau*, *supra* note 157, at 137-38.

178. *See generally* MARK REISNER, *CADILLAC DESERT: THE AMERICAN WEST AND ITS DISAPPEARING WATER* (rev’d ed. 1993) (thoroughly describing the role of the BOR in the development of the West).

179. *See* Reed D. Benson, *Whose Water Is It? Private Rights and Public Authority Over Reclamation Project Water*, 16 VA. ENVTL. L.J. 363, 365-366 (1997) (outlining the basic history and purpose of reclamation projects).

180. *See* Benson, *New Adventures of the Old Bureau*, *supra* note 157, at 171.

181. *See* Benson, *Whose Water Is It?*, *supra* note 179, at 146 n.145.

As a more extended example, in New Mexico's Middle Rio Grande Basin, the growing cities of Santa Fe and Albuquerque are placing increased pressure on a water allocation system already struggling to meet the demands of irrigated agriculture and in-stream flow for endangered species.<sup>182</sup> Federal, state, and local governments all have management authority over, and obligations related to, various elements of the social system. Moreover, while there are an increasing number of interagency and multi-stakeholder collaborative programs, these programs tend to focus on one element of the system at a time. Thus, the Middle Rio Grande Endangered Species Collaborative Program is an effort led by the BOR to coordinate ESA compliance among various water users.<sup>183</sup> However, the program focuses on just one aspect of this complex SES, the need to protect endangered species. It does not address important and related issues, such as urban growth and land use planning and irrigation efficiency methods.

In order to truly integrate resilience thinking to governance approaches, agencies cannot simply layer resilience as a new theoretical blanket on top of existing mandates and authorities. The BOR and other governance entities will need to participate in a reconfiguration of priorities and approaches, leaving behind outdated mandates such as "secure water" that, realistically, cannot be met in the no-analog future. To date, recognition of this uncertain future is found almost exclusively in funded studies and scenario planning.<sup>184</sup> While such efforts are of course necessary, much more is needed, including revisiting how current allocation regimes for water and other aspects of the ecological system build in assumptions of stationarity.

#### 4. Designing Governance Systems for Resilience Thinking

The challenge becomes how to design a new governance structure that thoroughly incorporates resilience thinking. The design must address the need for adaptive capacity and administrative flexibility while also providing the necessary strong and enforceable frameworks that will be sufficiently supportive of the SES system states that we seek to foster and protect.

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182. Kevin J Flanagan & Amy I. Haas, *The impact of full beneficial use of San Juan-Chama Project water by the City of Albuquerque on New Mexico's Rio Grande Compact obligations*, 48 NAT. RES. J. 371, 372 (2008).

183. Lara Katz, *History of the Minnow Litigation and Its Implications for the Future of Reservoir Operations on the Rio Grande*, 47 NAT. RES. J. 675, 689 (2007).

184. See Benson, *New Adventures of the Old Bureau*, *supra* note 157, at 163-164 (outlining the provisions of the SECURE Water Act).

The tension between enforceability and flexibility and the challenge of accommodating both within current environmental management challenges has become the focus of legal scholars paying close attention to the interrelationship of conservation science and law.<sup>185</sup> For example, in his recent article *General Design Principles for Resilience and Adaptive Capacity in Legal Systems: Applications to Climate Change Adaptation Law*,<sup>186</sup> J.B. Ruhl provides some suggestions for designing legal systems that are themselves resilient and therefore more responsive to climate change and other challenges. Noting the extent to which this design effort will require a significant departure from the status quo, Ruhl emphasizes how the current legal system is preoccupied with certainty and finality and the difficulty many federal agencies are having in incorporating adaptive management as a primary vehicle for resilience theory:

The problem is that natural resource management agencies are locked in an administrative law system that . . . shows no sign of being flexible in that regard. The system's fixation on pre-decisional environmental assessment, cost-benefit analysis, records of decisions, and judicial review litigation has only pushed the system toward a "front-end" focus on reliability and efficiency that has made adaptive management exceptionally difficult to implement.<sup>187</sup>

Ruhl focuses on strategies for building adaptive capacity within the legal system. He identifies the needs to: (1) move away from the current level of investment in land use planning, NEPA, and other processes that are inherently built on assumptions of stationarity and predictability;<sup>188</sup> (2) embrace strategies that are emerging from new governance theory, which include less emphasis on command-and-control and more encouragement of collaborative, poly-centric and

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185. See generally, e.g., Cosens, *supra* note 132 (assessing resilience theory's application to transboundary water governance in the Columbia River system); Sandra Zellmer & Lance Gunderson, *Why Resilience May Not Always Be a Good Thing: Lessons in Ecosystem Restoration from Glen Canyon and the Everglades*, 87 NEB. L. REV. 893 (2009) (discussing restoration efforts in the Florida Everglades). See also Sandra Zellmer, *Wilderness, Water, and Climate Change*, 42 ENVTL. LAW 313 (2012) (applying resilience theory to wilderness management); Bradley C. Karkkainen, *Panarchy and Adaptive Change: Around the Loop and Back Again*, 7 MINN. J. L. SCI. & TECH. 59 (2005) (examining the implications of resilience theory for environmental governance).

186. Ruhl, *General Design Principles*, *supra* note 129, at 1391.

187. *Id.* at 1392-93. Ruhl refers to many of the current natural resource management strategies as reflective of "engineering resilience," which, in contrast to ecological resilience, devotes all system resources to staying near equilibrium. *Id.* at 1377; see also Holling, *supra* note 121, at 36-38 (providing a comparison of ecological and engineering resilience theories).

188. Ruhl, *General Design Principles*, *supra* note 129, at 1394.

adaptive models of governance;<sup>189</sup> (3) invoke dynamic federalism as an approach for addressing the multi-scalar dimension of climate change and other challenges;<sup>190</sup> and (4) encourage formation of maintenance of trans-governmental networks as informal but critical linkages across scale of governance that promote information sharing and social learning.<sup>191</sup>

Bringing these suggestions back to the BOR's efforts to incorporate resilience thinking, Ruhl would likely view the agency's emphasis on climate risk assessments and information gathering as a front-end, "business as usual" effort to gain certainty. He would also likely argue that the BOR's main statutory mandates are still too narrow and optimization oriented, providing the agency with only limited capacity to address the multi-dimensional nature of current and emerging challenges to water resource management.<sup>192</sup> On the other hand, he would applaud the agency's efforts to work across traditional jurisdictional boundaries and to build networks at local and regional scales.

Flexibility and adaptive capacity will be important moving forward, but so will changes in our use of the rule of law. Beyond redesigning administrative law to accommodate adaptive management and other flexible management procedures,<sup>193</sup> the law needs to incorporate new designs that allow for flexibility without turning natural resources management into an unreviewable agency free-for-all. As one step in this direction, Robin Craig has referred elsewhere to this balancing act as *principled flexibility*—*i.e.*, designing and implementing environmental policies that promote and build adaptive capacity to respond to changing environmental conditions while also providing stronger, more legally enforceable and institutionally supported goals to reduce existing and preventable stressors on SESs, increasing their resilience to climate change impacts.<sup>194</sup>

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189. *Id.* at 1395.

190. *Id.* at 1396. Dynamic federalism is an emerging challenge to traditional notions that the division of responsibilities across scales of governance promotes optimization and efficiency. *Id.* at 1398-1399 (citing Benjamin K. Sokacool, *The Best of Both Worlds: Environmental Federalism and the Need for Federal Action on Renewable Energy and Climate Change*, 27 STAN. ENVTL. L.J. 397, 448 (2008)).

191. *Id.* at 1399-1400.

192. See Benson, *New Adventures of the Old Bureau*, *supra* note 157, at 167-175 (providing a detailed account of the BOR's need for new authorities, including his examination of the U.S. Army Corps of Engineer's broader statutory authorization for ecological restoration).

193. See generally Robin Kundis Craig & J.B. Ruhl, *Redesigning Administrative Law for Adaptive Management*, 67 VAND. L. REV. (forthcoming Jan. 2014), *draft available at* [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2222009](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2222009).

194. See Craig, *supra* note 6, at 63-66 (outlining ways to promote principled flexibility in

In its current stage of integration and development, resilience is in danger of becoming—like sustainability—a rhetorical device with little influence on actual decision-making. We are at a critical point with regard to the challenge of integrating resilience thinking into environmental policies and approaches. Increased use of real adaptive management offers promise in terms of putting resilience thinking into practice. However, to date, these ideas have not yet been integrated into legal and regulatory frameworks in enforceable ways.<sup>195</sup> Key elements currently lacking in many resilience-based approaches are the mechanisms needed to provide the necessary accountability to ensure that adaptive approaches will actually work.

## V. CONCLUSION

Even in the lucky places and for the lucky people destined to be climate change winners,<sup>196</sup> changing conditions will be a continuous reality. We are at a point in history where the ability to respond productively to continuing change *matters*. As Charles Darwin is purported to have said, “It’s not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change.”<sup>197</sup>

Sustainability is not, *per se*, a bad idea. However, the pursuit of sustainability goals is not an appropriate response to the continual change of the climate change era, particularly with respect to natural resources law and policy and ecosystem management. By definition, sustainability assumes that there are desirable states of being for SESs that humans can maintain (within a defined and expected range of variability) indefinitely.

In practice, sustainability proved difficult to achieve in many SESs even before climate change impacts became noticeable. For example,

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regulatory goals and natural resource management); *see also* Marleen van Rijswijk & Willem Salet, *Enabling the Contextualization of Legal Rules in Responsive Strategies to Climate Change*, 17:2 *ECOLOGY & SOCIETY* 18, available at <http://dx.doi.org/10.5751/ES-04895-170218> (emphasizing the importance of legal rules).

195. *See* Ruhl & Fischman, *supra* note 145, at 431-36 (providing a comprehensive overview of the integration of adaptive management by federal agencies).

196. *See generally* J.B. Ruhl, *The Political Economy of Climate Change Winners*, 97 *MINN. L. REV.* 206 (arguing that policymakers need to recognize that certain people and groups will benefit from climate change and to adjust climate change policy accordingly).

197. This quotation is widely attributed to Charles Darwin but may be apocryphal, akin to Mark Twain’s supposed statement that “whiskey is for drinkin’, and water is for fighting over.” *See* John van Wyhe, *It ain’t necessarily so . . .*, *THE GUARDIAN*, Feb. 8, 2008, <http://www.guardian.co.uk/science/2008/feb/09/darwin.myths>.

fisheries management has long been challenged by the difficulties of obtaining accurate estimates of fish stocks, unacknowledged yearly or longer variability in fish stocks, and often intense political pressure to allow fishers to fish. The result has been collapsed, collapsing, and overfished stocks the world over, even in countries like the United States that purport to enforce sustainable fishing requirements.<sup>198</sup> Imagine how much more difficult it will be to define, let alone achieve, “sustainable fishing” when important fish stocks are changing their ranges, migratory patterns, and population numbers in response to rising global average sea temperatures, ocean acidification, sea-level rise, changing ocean currents, and attendant changes in marine food webs.<sup>199</sup>

Future management of other natural resources faces similar challenges. What constitutes sustainable use of water in a given region when we no longer can trust historical rainfall, snowfall, and snowmelt patterns?<sup>200</sup> How much water pollution is “too much” when the historic flows and other ecological conditions (*e.g.*, temperature, chemical activity) of rivers, even major rivers, are changing?<sup>201</sup>

We face a future that requires us to admit that we have no idea what we can “sustain”—or what “sustainability” even means—when the world is continually in flux. Sustainability presumes stationarity in environmental conditions, a presumption that climate change vitiates. Moreover, sustainability goals at anything other than the most general levels promote conservatism, embodied in the popular conception that we can “have it all” if we are simply careful enough,<sup>202</sup> undermining the drive to adapt to our new reality of constant changes in SESs.

Shifting governance focus from sustainability goals to resilience thinking is not admitting defeat. Instead, a resilience approach would reorient current research and policy efforts toward coping with change instead of focusing on increasingly futile efforts to maintain existing states of being. It would, for example, place increased emphasis on developing climate adaptation strategies. Similarly, research to develop baseline data retains importance moving forward—but not as a guide

198. R.A. Myers et al., *Population Dynamics of Exploited Fish Stocks at Low Population Levels*, 269 *SCI.* 1106, 1106 (1995).

199. *How Does Climate Change Affect Fish Populations?*, CLIMATE CHANGE & FISH POPULATIONS (N.H. Sea Grant/Univ. of N.H./NOAA, Durham, N.H.) 2009, at 2, available at <http://nsgl.gso.uri.edu/nhu/nhug10001.pdf>.

200. See 2009 USGCRP US IMPACTS REPORT, *supra* note 91, at 41-52 (describing the impacts of climate change on water resources).

201. See *id.* at 46-47 (describing projected changes in water quality), *id.* at 95-96 (describing some projected water-related health effects).

202. See *supra* Part II.D and sources cited therein.

toward what we can “sustain.” Instead, such research would seek to locate historical tipping points that might provide insight into future regime change and help to identify critical ecological thresholds. Finally, a resilience orientation allows for a more realistic approach to management—especially in the Anthropocene—because it acknowledges nonlinear change and provides a way of thinking about how to foster SES components and dynamics we value and want to protect.

In the end, resilience thinking may prove to be a more demanding regime than sustainability, even as sustainability was originally envisioned. As climate change progresses, avoiding ecosystem and SES thresholds will likely demand more and more from the human members of those systems: stringent water and energy conservation measures, reduced fossil fuel consumption, changes in eating patterns, and revised public health and land use requirements designed to minimize the foothold that old diseases (malaria), new diseases (dengue fever), and new and revitalized pests can gain in newly attractive habitat are just four of the most predictable adaptation measures that will likely be needed in many parts of the United States. The inevitable regime shifts, moreover, will challenge—perhaps to the point of breaking—not only ecological but also social and cultural coping mechanisms.

Changing paradigms is never easy. However, it is, on occasion, necessary.<sup>203</sup> As climate change begins posing what may eventually become the ultimate series of “adapt or die” scenarios, we can only conclude that this is one of those times.

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203. See, e.g., THOMAS S. KUHN, *THE STRUCTURE OF SCIENTIFIC REVOLUTIONS* (1962) (describing the complex and often disruptive process by which scientific paradigms displace each other).