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THE WILDERNESS ACT AND CLIMATE CHANGE ADAPTATION

BY

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Resource managers, scientists, and legal scholars have struggled with the question of how to adapt natural resources law and policy to the future of climate change. A common proposal has been that rigid legal restrictions may need to be made more flexible to allow for dynamic, active management that responds to climate change. But how rigid is natural resources law, and is flexibility really needed?

We explore these questions by looking at the Wilderness Act, by reputation one of the most rigid natural resource laws on the books. Climate change effects will not stop at federal wilderness area boundary signs, and in response there have been specific calls to make the Act more flexible to allow for climate change adaptation. The fiftieth anniversary of the Act, which established a strong presumption that hands-off management is the best choice for wilderness areas, provides us with a timely opportunity to consider the question of how well existing environmental and natural resources law can provide for climate change adaptation.

We survey the range of proposals developed by scientists and managers to respond to climate change in forested wilderness ecosystems—including both active and passive management. We then compare that list of proposals with the range of management choices that might plausibly be allowed under the Act, as determined by the statutory text, agency policies and regulations, and relevant case law.

Our conclusions may surprise some readers. Despite the Wilderness Act's reputation as an inflexible law, it is not an absolute prohibition on active management for climate change adaptation. Rather, the vast majority of management options are available to agencies that manage wilderness areas, though the agency must jump through a variety of procedural and substantive hoops to justify active management for climate change adaptation.

To be sure, these procedural and substantive hurdles place a thumb on the scale in favor of restraint and passive management. While

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advocates for more aggressive active management might believe that these costs and constraints are not worth it, we disagree. The thumb on the scale in favor of restraint may be particularly important given the uncertainty about what kinds of active management techniques might be effective, the possible negative effects of active management on other resources, and the political and bureaucratic pressures that might otherwise lead to the overuse of active management in response to climate change. At the same time, our analysis shows that the Act allows for responses in situations where we are more certain that actions will be effective and the benefits of active management are worth the costs.

I. INTRODUCTION

Policymakers, resource managers, lawyers, and legal scholars are all struggling with the implications of climate change for environmental and natural resources law. Substance, procedure, goals: All of the elements of environmental and natural resources law are up for debate in light of the effects that climate change will have. A common theme in those discussions is the need for more legal and political flexibility to allow for adaptation to climate change. But what kind of flexibility? How much? And at what cost? These are difficult questions that the environmental law community is just starting to get a handle on.

The Wilderness Act[1] is an excellent place to start answering these questions. The passage of the Act in 1964 was, in many ways, a precursor to the wave of federal environmental and natural resource laws enacted in the 1970s.[2] It was one of the first examples of the modern environmental movement flexing its political muscles and forcing legislative changes.[3] It marked a major paradigm shift in federal natural resources law and policy away from discretionary decision making by resource management agencies—decision making that was primarily intended to allow for significant amounts of human management, development, and exploitation

1 Wilderness Act, 16 U.S.C. §§ 1131–1136 (2006 & Supp. II 2008), *amended by* Pub. L. No. 111-11 (2006).

2 *See* Robert L. Glicksman & George Cameron Coggins, *Wilderness in Context*, 76 DENV. U. L. REV. 383, 383, 387 (1999) (stating that the Wilderness Act was "the beginning of a new era in federal land and natural resource policy," and was "the true onset of what has been called the Age of Preservation in America").

3 *Id.* at 385–87.

of natural resources for human use and enjoyment.[4] The Wilderness Act removed some discretion from management agencies, providing Congress with primary decision making authority: It retained sole authority to create, eliminate, expand, or contract wilderness areas.[5] The Wilderness Act established a strong presumption that hands-off management was the best choice for wilderness areas and would allow for the maintenance and restoration of a natural balance; exploitation and development were not the primary goals for wilderness areas.[6] It was one of the first examples in federal environmental law and policy establishing that passive, recreational use was to be one of the dominant uses of federal public lands.[7]

All of these presumptions are in question today. Active management may be required to respond and adapt to climate change, as hands-off management is no longer a guarantee that natural processes will dominate in wilderness areas.[8] For instance, there have been frequent proposals to aggressively use timber harvests to respond to climate change-induced pine beetle infestations.[9]

Thus, the Wilderness Act, at age fifty, provides us with an excellent case study to consider the question of how well existing environmental and natural resources law can provide for climate change adaptation.

We begin in Part I with an overview of the Wilderness Act and why it can be seen as an exemplar of an inflexible law at a time when flexibility might be required to adapt to climate change. We also discuss the current and future effects of climate change on the resources in wilderness areas, how wilderness areas will be a critical component of adaptation to climate change in the United States, and the very tentative steps that management agencies have taken so far to respond to climate change in wilderness areas. In Part II, we discuss the wide range of possible adaptation steps that might be taken to respond to climate change in wilderness areas, all the way from passive management—what we categorize as restraint—to short-term steps to resist climate change or provide resilience for wilderness resources, to long-term efforts to actively facilitate changes in wilderness areas—what we categorize as realignment. In Part III, we examine how many of these

4 *See id.* at 384–87 (discussing the transformation of a land use paradigm from a focus on disposition of lands for economic development to preservation of wilderness values).

5 16 U.S.C. § 1131(a) (2006) ("[N]o Federal lands shall be designated as 'wilderness areas' except as provided for in this chapter or by a subsequent Act.").

6 *See id.* § 1133(a) (requiring that "wilderness areas" be "administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness"); Glicksman & Coggins, *supra* note 2, at 387 (noting that the Wilderness Act marked the first time "Congress acted to preserve lands in a pristine state for their own sake," not simply as a mechanism for the realization of human goals).

7 *See* Glicksman & Coggins, *supra* note 2, at 387.

8 *See* David N. Cole & Laurie Yung, *Park and Wilderness Stewardship: The Dilemma of Management Intervention*, *in* BEYOND NATURALNESS: RETHINKING PARK AND WILDERNESS STEWARDSHIP IN AN ERA OF RAPID CHANGE 1 (David N. Cole & Laurie Yung eds., 2010) (arguing for intervention and stewardship to protect the beauty, heritage, and biodiversity of wilderness areas in the face of threats such as climate change and invasive species).

9 *See* Diana L. Six et al., *Management for Mountain Pine Beetle Outbreak Suppression: Does Relevant Science Support Current Policy?*, 5 FORESTS 103, 104 (2014).

management options are foreclosed or limited by the Wilderness Act. We start with an examination of agency policies to see if the agencies have limited themselves with respect to available options. We then proceed with a close review of the relevant statutory text and case law—supplemented by agency practice and regulations—to identify the constraints the Act itself imposes on management agencies.

Our conclusions may surprise some readers. It turns out that the vast majority of management options are available to management agencies in wilderness areas, though the agencies may have to jump through some procedural and substantive hoops. Of course, these hoops might still be too much of a constraint to allow for effective adaptation to climate change. But we do not think so. There are substantial benefits to restraint and passive management for climate change adaptation—at least in the particular context of wilderness areas—and the procedural and substantive requirements for active management under the Wilderness Act put a thumb on the scale in favor of agencies focusing primarily on restraint and passive management. That thumb on the scale may be particularly important given the uncertainty about what kinds of active management techniques might be effective, the possible negative effects of active management on other resources, and the political and bureaucratic pressures that might otherwise lead to the overuse of active management in response to climate change.

II. HOW THE WILDERNESS ACT CAN HELP US UNDERSTAND THE ROLE OF LEGAL FLEXIBILITY FOR CLIMATE CHANGE ADAPTATION

Not long after the creation of the U.S. Forest Service, the idea of wilderness was born. Early in the agency's history, leaders recognized the need to preserve areas of national forests in a natural state.[10] In 1919, officials in Colorado's White River National Forest decided to forgo road construction into the Trappers Lake basin, concluding that "the mood" of the area would be better preserved by preventing motorized access.[11] Then in 1924, the Forest Service designated the Gila Wilderness in New Mexico's Gila National Forest at employee Aldo Leopold's behest.[12] In the following decades, the agency added more acres to its young system of wilderness, wild, and primitive areas.[13] However, increasing recreational use and timber harvests in national forests led to public concerns about the administrative system for designating and preserving wilderness.[14] In response, Congress enacted the Wilderness Act of 1964.[15] The Act established the National

10 *See* Margaret Shulenberger, Annotation, *Construction and Application of Wilderness Act (16 USCS §§ 1131 et seq.) Providing for National Wilderness Preservation System*, 14 A.L.R. FED. 508, 510 (1973) (noting that the Wilderness Act gave recognition to objectives that "had been recognized to a certain extent in the management of the national forests for some 40 years").

11 *Id.*

12 ROSS W. GORTE, CONG. RESEARCH SERV., WILDERNESS: OVERVIEW AND STATISTICS 1 (2010).

13 *See* Shulenberger, *supra* note 10, at 511.

14 *See* GORTE, *supra* note 12, at 1; Shulenberger, *supra* note 10, at 511.

15 *See* 16 U.S.C. § 1131 (2006) (declaring a national policy of securing "an enduring resource of wilderness").

Wilderness Preservation System (NWPS), consisting of fifty-four federally owned and congressionally designated "wilderness areas," and created a process by which Congress could designate additional wilderness areas.[16]

Today, wilderness areas are managed by four federal agencies in two departments: the U.S. Forest Service in the Department of Agriculture, and the Bureau of Land Management (BLM), National Park Service (Park Service), and Fish and Wildlife Service (FWS) in the Department of Interior.[17] This Article focuses on wilderness areas managed by the Park Service and Forest Service because these two agencies manage the greatest wilderness acreage and have the most developed climate change policies.[18]

A. The Wilderness Act: An Inflexible Law That Could Obstruct Climate Change Adaptation

The Wilderness Act is often characterized as one of the most restrictive and inflexible environmental laws.[19] Under the Act, mechanized transport and roads are generally prohibited in wilderness areas.[20] Construction of buildings and other man-made structures is also generally prohibited, as is the use of mechanized tools, such as chainsaws.[21] The general purpose of the Act is to preserve certain federal lands in "such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness."[22]

On the other hand, the Act has significant exemptions: The Act's restrictions can be waived for "the control of fire, insects and diseases."[23] Also, temporary roads and motorized and mechanized equipment are permissible "as necessary to meet minimum requirements for the administration of the area for the purpose of this chapter (including

16 *See id.* § 1132; Peter A. Appel, *Wilderness and the Courts*, 29 STAN. ENVTL. L.J. 62, 82–83 (2010).

17 *See* Frequently Asked Questions About Wilderness Stewardship, http://www.wilderness.net/NWPS/manageIssuesOverview (last visited Apr. 12, 2014)*;* GORTE, *supra* note 12, at 6–8.

18 These two agencies manage over 73% of all wilderness areas. GORTE, *supra* note 12, at 11.

19 Sandra Zellmer, *A Preservation Paradox: Political Prestidigitation and an Enduring Resource of Wildness*, 34 ENVTL. L. 1015, 1043 (2004) (noting that "wilderness designation leads to the most restrictive management prescriptions for any category of federal public lands"); Sandra Zellmer & John M. Anderies, *Wilderness Preserves: Still Relevant and Resilient After All These Years*, RESILIENCE & LAW 2, 3 (2011) (noting that "wilderness designations impose the most restrictive management directives in federal law")*; see also* Jamison E. Colburn, *Habitat and Humanity: Public Lands Law in the Age of Ecology*, 39 ARIZ. ST. L.J. 145, 176 n.129 (2007) ("Very generally, this kind of active management (with its attendant restoration techniques) is routinely troublesome in wilderness areas given the very concept of 'wilderness' animating the whole system.").

20 16 U.S.C. § 1133(c) (2006).

21 *Id.*; Sandra Zellmer, *Wilderness, Water and Climate Change*, 42 ENVTL. L. 313, 345 (2012).

22 16 U.S.C. § 1133(c) (2006).

23 *Id.* § 1133(d)(1).

measures required in emergencies involving the health and safety of persons within the area).”[24] Pursuant to these exemptions, agencies have undertaken major active management projects in wilderness areas using tools such as prescribed fire,[25] pesticides to control insects[26] or nonnative fish,[27] timber harvest to prevent beetle infestations,[28] helicopters,[29] and mechanized transport and chainsaws.[30] A number of commentators have concluded that the Wilderness Act is not as rigid as it is sometimes portrayed,[31] and that there is significant uncertainty about how stringent the restrictions in the Act actually are in practice.[32] Some have even argued that land management agencies may have a mandate to take active management steps to restore wilderness characteristics that have been damaged by human intervention.[33]

Nonetheless, despite the exemptions and the implementation of active management in wilderness areas by various federal land management agencies, it is accurate to say that of all the federal land management statutes, the Wilderness Act is the most restrictive.[34] It is far more restrictive

24 *Id.* § 1133(c). These exemptions are discussed in more detail in Part III.

25 Zellmer, *supra* note 21, at 339.

26 *Id.*

27 *Id.* at 340.

28 *See* Sierra Club v. Lyng, 663 F. Supp. 556, 557–58 (D.D.C. 1987); Zellmer, *supra* note 21, at 338.

29 The helicopters allowed for monitoring of wolf populations that had been reintroduced into wilderness areas. Zellmer, *supra* note 21, at 351 (citing Wolf Recovery Found. v. U.S. Forest Serv., 692 F. Supp. 2d 1264, 1266–68 (D. Idaho 2010)).

30 *See* Cole & Yung, *supra* note 8, at 2–4 (describing management in Bandelier National Monument wilderness to reduce fire hazards, restore soil and reduce erosion that, in part, required the use of chainsaws and mechanized vehicle access).

31 Gordon Steinhoff, *Naturalness and Biodiversity: Why Natural Conditions Should be Maintained Within Protected Areas*, 37 WM. & MARY ENVTL. L. & POL’Y REV. 77, 84–85, 87–88, 90–91, 100–01 (2012) [hereinafter *Naturalness & Biodiversity*] (identifying water development, mineral exploitation, grazing, and forest management as examples of exemptions to the Wilderness Act, and citing agency wilderness policies that allow for ecological restoration); J.B. Ruhl & James Salzman, *Gaming the Past: The Theory and Practice of Historic Baselines in the Administrative State*, 64 VAND. L. REV. 1, 44 (2011) (noting the presence of significant exemptions in the Wilderness Act).

32 *See* Alejandro E. Camacho, *Assisted Migration: Redefining Nature and Natural Resource Law Under Climate Change*, 27 YALE J. ON REG. 171, 198–99 (2010) [hereinafter *Assisted Migration*] (“[N]either the statute nor case law provides clear guidance on how much human interference or active management is permissible or required in wilderness areas. The statute could be construed to prohibit substantial active management; alternatively, it could be understood to require active management to ensure outside human activities do not interfere with statutory goals—preserving wilderness character and natural conditions.”); Cole & Yung, *supra* note 8, at 78–79 (arguing that current agency wilderness policies are very vague).

33 Daniel Rohlf & Douglas L. Honnold, *Managing the Balances of Nature: The Legal Framework of Wilderness Management*, 15 ECOLOGY L.Q. 249, 259 (1988).

34 Katherine Daniels Ryan, *Preservation Prevails over Commercial Interests in the Wilderness Act: Wilderness Society v. U.S. Fish & Wildlife Service*, 32 ECOLOGY L.Q. 539, 546 (2005) (“The definition of Wilderness . . . emphasizes that human influence is to be kept to a minimum. Land managers therefore place the most restrictive use requirements on the NWPS.”); Zellmer, *supra* note 21, at 346 (“To preserve the natural conditions and wild, untrammeled characteristics of designated wilderness areas, the Wilderness Act imposes some of the most restrictive management constraints found in federal law.”).

than the multiple-use standards that apply to BLM and Forest Service lands, standards that give broad discretion to those agencies in making management decisions.[35] Even the Park Service and the FWS have significant discretion under their organic acts. While the Park Service is tasked with both providing recreational opportunities and protecting natural resources on its lands, it is given broad discretion as to how to balance those goals.[36] While FWS is tasked with an overarching goal of protecting biodiversity on its lands, it is given significant discretion to determine whether other goals, such as recreational uses, are compatible with conservation and therefore can be permitted.[37] The breadth and specificity of the restrictions on

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35 Broad powers of the U.S. Forest Service to manage its lands are contained in the Multiple-Use Sustained Yield Act of 1960 (MUSYA). *See, e.g.*, Multiple-Use Sustained Yield Act of 1960, 16 U.S.C. § 528 (2006) (authorizing management of National Forest System lands for "outdoor recreation, range, timber, watershed, and wildlife and fish purposes"); *see also id.* § 529 (requiring management of National Forest System lands for "multiple use and sustained yield"); *id.* § 531(a) (broadly defining multiple use to include the "management of all the various renewable surface resources of the national forests so that they are utilized in the combination that will best meet the needs of the American people."). The substantive constraints imposed on Forest Service decision making in the National Forest Management Act of 1976 are generally considered to be relatively limited. *See* Federico Cheever, *Four Failed Forest Standards: What We Can Learn From the History of the National Forest Management Act's Substantive Timber Management Provisions*, 77 OR. L. REV. 601, 648–49 (1998).

BLM has similarly broad powers under its governing statute, the Federal Land Policy and Management Act of 1976 (FLPMA), 43 U.S.C. §§ 1701–1787 (2006). *See, e.g.*, 43 U.S.C. § 1702(c) (defining multiple use in similar language as under MUSYA); *id.* § 1712 (c)(1) (requiring agency to comply with multiple use mandate in developing land use plans). The only substantive constraint on BLM decision making under FLPMA is a requirement that the agency "prevent unnecessary or undue degradation of the lands" under its control. *Id.* § 1732(b). One court has characterized the discretion granted to agencies such as BLM and the Forest Service under the multiple-use mandate as so broad that it "breathe[s] discretion at every pore." Perkins v. Bergland, 608 F.2d 803, 806 (9th Cir. 1979) (quoting Strickland v. Morton, 519 F.2d. 467, 469 (9th Cir. 1975)).

36 *See* National Park Service Organic Act, 16 U.S.C. § 1 (2006) (mandating that the Park Service manage its lands to "provide for the enjoyment of [those lands] in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."). For case law deferring to the Park Service's balancing of conservation and recreation pursuant to the Organic Act, *see e.g.*, *Int'l Snowmobile Mfrs. Ass'n. v. Norton*, 340 F. Supp. 2d 1249, 1266 (D. Wyo. 2004) (rejecting claim that restrictions on snowmobiles in Yellowstone National Park violated the Park Service Organic Act); *Sierra Club v. Babbitt*, 69 F. Supp. 2d 1202, 1247 (E.D. Cal. 1999) (rejecting Organic Act challenge to Park Service road reconstruction project); *Nat'l Wildlife Fed'n v. Nat'l Park Serv.*, 669 F. Supp. 384, 392 (D. Wyo. 1987) (rejecting challenge to campground operation based on Organic Act). *See also* DALE D. GOBLE & ERIC T. FREYFOGLE, WILDLIFE LAW: CASES AND MATERIALS 1002 (2d ed. 2010) ("The courts have rarely found the balance struck by the agency between promotion and regulation to be illegal.").

37 *Compare* 16 U.S.C. § 668dd(a)(4)(A) (2006) (setting the overall mission for wildlife refuges to "provide for the conservation of fish, wildlife, and plants, and their habitat within the System"), *with id.* § 668dd(a)(4)(H) (requiring "compatible wildlife-dependent recreational uses" on refuges), *and id.* § 668dd(d)(1)(A) (permitting "the use of any area within the System for any purpose, including but not limited to hunting, fishing, public recreation and accommodations, and access whenever he determines that such uses are compatible with" the purposes of a wildlife refuge).

management choices under the Wilderness Act are much greater than any of the other federal land management standards.[38]

Moreover, courts have been quite willing to enforce the Wilderness Act's restrictions against federal land management agencies.[39] Courts have prevented agencies from conducting timber projects, fish hatchery projects, motorized transport of tourists, and maintenance of dams in wilderness areas.[40] As one scholar documented, courts are far more likely to intervene to restrict agency decision making pursuant to the Wilderness Act than under other federal land management or environmental statutes.[41]

Thus, while it is certainly fair to say that the Wilderness Act does not absolutely prevent all active management and does have some flexibility given its exemptions, it is also one of the most—if not the most—restrictive environmental laws in the United States.

It is therefore not surprising that the Wilderness Act has also been identified as one of the statutes that might pose particular challenges to, and be particularly challenged by, the need to adapt to climate change.[42] Commentators have asserted that the Wilderness Act is based on a premise of a stationary, balanced, natural world that can be kept pristine from human intervention.[43] That premise is false, according to these

38 William G. Myers III & Jennifer D. Hill, *Along the Trammeled Road to Wilderness Policy on Federal Lands*, 56 ROCKY MT. MIN. L. INST., 15-1, 15-3 (2010).

39 *See* Peter A. Appel, *Wilderness and the Courts*, 29 STAN. ENVTL. L.J. 62, 96 (2010).

40 *See e.g.*, Wilderness Soc'y v. Lyng (Lyng I), 662 F. Supp. 40, 41–42 (D.D.C. 1987) (enjoining proposed timber sale in wilderness area, even though the timber project was intended to control insects, because it would have assisted commercial timber operations); Wilderness Soc'y v. U.S. Fish & Wildlife Serv., 353 F.3d 1051, 1066–67 (9th Cir. 2003) (holding that substantial and essential portions of a salmon enhancement project using a commercial fish hatchery occurred within a wilderness area, violating the Wilderness Act's prohibition of commercial enterprise in wilderness.), *amended by* Wilderness Soc'y v. U.S. Fish & Wildlife Serv., 360 F.3d 1374 (9th Cir. 2004); Wilderness Watch v. Mainella, 375 F.3d 1085, 1094 (11th Cir. 2004) (finding that the Wilderness Act unambiguously prohibits "the Park Service from offering motorized transportation to park visitors through the wilderness area."); High Sierra Hikers Ass'n v. U.S. Forest Serv., 436 F. Supp. 2d 1117, 1137 (E.D. Cal. 2006) (rejecting agency efforts to maintain dams that allowed for recreational fishing in mountain lakes because recreational fishing was "not an integral part of the wilderness nature of the area" and therefore building small dams to enhance fishing was not necessary for maintaining the area as a wilderness).

41 *See* Appel, *supra* note 39, at 110–19 (providing statistical comparisons showing courts are more likely to reverse agency action challenged as insufficiently protective of wilderness under the Wilderness Act, and more likely to affirm agency action challenged as too protective of wilderness under the Wilderness Act relative to challenges to agency action generally and under NEPA).

42 Wilderness Ranger Academy, Wilderness and Climate Change *Redefining Untrammeled?*, 9, 28 (2012).

43 Alejandro E. Camacho, *Transforming the Means and Ends of Natural Resources Management*, 89 N.C. L. REV. 1405, 1407 (2011) [hereinafter *Transforming the Means*] (stating that the Wilderness Act is "the primary federal example of passive management"); *see id.* at 1426–27 (asserting that the Wilderness Act epitomizes the concept of "shielding nature from active human intervention"); Ruhl & Salzman, *supra* note 31, at 52 (stating that the Wilderness Act "depend[s] heavily on the strategy of setting aside habitat reserves to preserve the status quo . . . [and] depend[s] strongly on the stationarity premise and its appeal to 'natural' and 'native' models of ecosystem dynamics"). *But see Naturalness & Biodiversity*, *supra* note 31, at 95 ("Within the Wilderness Act there is no mandate to maintain climax communities; there is no reference

commentators, because the natural world is extremely dynamic, and because human intervention is pervasive across the planet, most obviously as a result of climate change.[44] Because of those pervasive human impacts on all wilderness areas—particularly climate change—active human intervention in wilderness areas will be necessary to retain desired natural features, protect biodiversity, and maintain functioning ecosystems.[45] At heart, climate change and other indirect human effects on wilderness areas create a tension between maintaining the historic natural state of the wilderness area and avoiding human intervention in the wilderness area.[46] Accordingly, a range of commentators have called for reconsideration of the goals and restrictions of the Wilderness Act to adapt to a new, human-dominated world.[47]

These specific critiques of the Wilderness Act are consistent with broader calls for changes in environmental law to allow for adaptation to climate change. The general argument is that climate change will make many of the goals under existing environmental law—particularly those based on a vision of a stable natural world that can be protected from human

to climax or to stable states. In short, it is highly problematic to assert . . . that protected area law and policy rests on the older and discredited view that ecosystems are largely predictable and static.").

44 *See* Cole & Yung, *supra* note 8, at 259 ("The laws that guide protected area management, though visionary, are also in many ways outdated."); J.B. Ruhl, *Climate Change Adaptation and the Structural Transformation of Environmental Law*, 40 ENVTL. L. 363, 393–94 (2010) (stating that the Wilderness Act is an example of preservationism in environmental law, which is "going to fall to pieces in the era of climate change"); Ruhl & Salzman, *supra* note 31, at 52 ("But the stationarity premise is on shaky ground in the era of climate change."); Lakshman Guruswamy, *Climate Change: The Next Dimension*, 15 J. LAND USE & ENVTL. L., J. TRANSNAT'L L. & POL'Y (JOINT ISSUE) 341, 380 (2000) (stating that the Wilderness Act is "based on the premise that nature should be preserved or left untouched" and that this is based on the "equilibrium paradigm" which is outdated); Colburn, *supra* note 19, at 178 ("[A]s climate change's effects become perceptible, the whole notion [of wilderness] is unraveling.").

45 *See* Cole & Yung, *supra* note 8, at 252–55, 258.

46 PETER B. LANDRES, ET AL., *Naturalness and Wildness: The Dilemma and Irony of Managing Wilderness,* BIODIVERSITY, Winter 2000–2001, at 77, 78; *see also* Gregory H. Aplet & David N. Cole, *The Trouble with Naturalness: Rethinking Park and Wilderness Goals*, *in* BEYOND NATURALNESS: RETHINKING PARK AND WILDERNESS STEWARDSHIP IN AN ERA OF RAPID CHANGE 12, 21–22 (David N. Cole & Laurie Yung eds., 2010) (noting that there are two components to "naturalness": freedom from human control and pristine ecological conditions, and the two may not align in many situations); *Transforming the Means*, *supra* note 43, at 1435 ("[C]limate change pits the historical preservation goal against the goal of avoiding human management of ecological systems.").

47 *See Assisted Migration*, *supra* note 32, at 245 ("Accordingly, statutes like the . . . Wilderness Act that primarily seek to preserve historical conditions will need to be reconceived away from a strict fidelity to the past toward a greater focus on promoting desirable future conditions in light of climatic changes."); *Transforming the Means*, *supra* note 43, at 1407 ("By exerting increased stress on already taxed ecosystems and causing or accelerating fundamental ecological changes from prior conditions, climate change makes the significant costs and ultimate unsuitability of the . . .Wilderness Act's passive management goals particularly evident."); Guruswamy, *supra* note 44, at 380 (contrasting the present understanding "that ecological systems do not possess fixed equilibria, or static stability, and are [instead] characterized by changes[,] not by constancy" with the Wilderness Act, which is "based on the premise that nature should be preserved or left untouched").

intervention—obsolete.[48] Likewise, rigid constraints in existing environmental law are incompatible with adaptation to climate change because they constrain the experimentation and novel active management tools needed to deal with unprecedented changes in natural systems.[49] Relatedly, some have argued that flexibility in environmental law is essential for the implementation of adaptive management, which in turn is required to reduce uncertainty in a world affected by climate change.[50]

Applying these broader arguments to the Wilderness Act raises the question: Can such a rigid, inflexible law like the Wilderness Act feasibly allow for adaptation to climate change?

B. Climate Change and Wilderness Areas

Wilderness areas are not just important as a case study for understanding the importance of legal flexibility for climate change adaptation; they will also be important in their own right for the process of climate change adaptation in the United States. There are 759 wilderness areas across forty-four states, totaling approximately 110 million acres.[51] They comprise nearly 5% of all land in the United States.[52] These areas will play an important role in climate change adaptation and mitigation because

48 Robin Kundis Craig, *"Stationarity Is Dead"—Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 HARV. ENVTL. L. REV. 9, 17 (2010) ("[E]xisting environmental and natural resource laws are preservationist, grounded in the old stationarity framework that no longer reflects ecological realities. In contrast, the new climate change adaptation law needs to incorporate a far more flexible view of the natural world."); *Transforming the Means*, *supra* note 43, at 1436 ("[N]atural resources management must be principally directed at anticipating future climatic conditions, developing mechanisms for assessing the value of potential ecological components and processes, weighing tradeoffs between such potential components and processes, and minimizing the detrimental and maximizing the beneficial consequences from management strategies and other human activities on natural systems.").

49 Ruhl, *supra* note 44, at 426 ("The role of environmental law, if it is to contribute to climate change adaptation, cannot be to impede and obstruct such measures through rigid command-and-control mechanisms . . . ."); *see also id.* at 395 ("[M]ost ecologists believe active management of some kind is needed to better serve the twin goals of adaptation—to minimize harm along the way and to position us to resume sustainability planning in the future."). From this perspective, litigation to enforce rigid environmental law standards might be an additional concern. *Id.* at 433 ("Fighting in court to hold on to preservationism defies the biological reality of climate change, whereas using environmental law to facilitate transitional strategies for species and ecosystems holds much promise."); *id.* at 416–23 (arguing for a shift away from front end decision making, including significant judicial review, because it interferes with the flexibility and experimentation that climate change adaptation requires); J.B. Ruhl, *General Design Principles for Resilience and Adaptive Capacity in Legal Systems—With Applications to Climate Change Adaptation*, 89 N.C. L. REV. 1373, 1392–93 (2011) (stating that litigation is part of what has pushed environmental law "toward a 'front-end' focus on reliability and efficiency that has made adaptive management exceptionally difficult to implement").

50 *See* Eric Biber, *Adaptive Management and the Future of Environmental Law*, 46 AKRON L. REV. 933, 934–39 (2013) (discussing the merits of adaptive management).

51 GORTE, *supra* note 12, at 2.

52 *Id.*

they contain undeveloped and relatively intact land, as discussed in more detail below.[53]

Climate change is already affecting wilderness areas, and will continue to do so.[54] It will amplify and compound existing stressors to wilderness ecosystems, including invasive species, fire, pathogens, disease, insects, pollution, and extreme weather events.[55] Other changes, including variations in the timing, amount, and type of precipitation (i.e., snow vs. rain), drought, and shifting species ranges will create a "kaleidoscope of new patterns and trends" and require new management strategies.[56] The changes described below lead scientists and managers to question whether maintaining existing conditions in wilderness areas will be feasible in the future, and whether resisting changes makes financial and ecological sense.[57]

1. Temperature and Precipitation

By 2100, average annual temperatures in the United States are projected to increase by 2 to 11.5 degrees Fahrenheit (°F).[58] While temperature changes across federal lands will not be uniform,[59] rising temperatures will create a "no analog" future in many ecosystems.[60] All climate models predict warmer temperatures overall and most models predict higher average winter temperatures by 2100 throughout the West, where wilderness areas are primarily located.[61] In Alaska, home to over half of wilderness acreage, air temperature has increased 0.4°C; permafrost has warmed by 0.5°C each decade since 1950; and temperatures are projected to continue warming between 0.4 and 0.7°C per decade over the next century.[62] Outside Alaska, the majority of wilderness is located in five ecoregions: California's Mojave

53 *See* discussion *infra* Parts III.C.1–III.C.2.

54 DAVID L. PETERSON ET AL., U.S. DEP'T OF AGRIC., PNW-GTR-855, RESPONDING TO CLIMATE CHANGE IN NATIONAL FORESTS: A GUIDEBOOK FOR DEVELOPING ADAPTATION OPTIONS 1 (2011).

55 *Id.*

56 *See id.*

57 *See* Zellmer, *supra* note 21, at 325.

58 U.S. GLOBAL CHANGE RESEARCH PROGRAM, GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES 9 (Thomas R. Karl et al., eds., 2009).

59 Robert L. Glicksman, *Ecosystem Resilience to Disruptions Linked to Global Climate Change: An Adaptive Approach to Federal Land Management*, 87 NEB. L. REV. 833, 839 n.18 (2009); *see also* Christa Marshall, *The Western U.S. Heats Up Faster: Report*, CLIMATEWIRE, Mar. 28, 2008, http://www.eenews.net/climatewire/2008/03/28/stories/62651 (last visited Apr. 12, 2014).

60 *See, e.g.*, John W. Williams & Stephen T. Jackson, *Novel Climates, No-Analog Communities, and Ecological Surprises*, 5 FRONTIERS IN ECOLOGY & ENV'T 475, 476, 480 (2007); J.B. Ruhl, *Climate Change and the Endangered Species Act: Building Bridges to the No-Analog Future*, 88 BOSTON U. L. REV. 1, 19–23 (2008).

61 JOHN T. KLIEJUNAS, U.S. FOREST SERV., PSW-GTR-236, A RISK ASSESSMENT OF CLIMATE CHANGE AND THE IMPACT OF FOREST DISEASES ON FOREST ECOSYSTEMS IN THE WESTERN UNITED STATES AND CANADA 6 (2011).

62 F.S. Chapin III et al., *Policy Strategies to Address Sustainability of Alaskan Boreal Forests in Response to a Directionally Changing Climate*, 103 PROCEEDINGS OF THE NAT'L ACAD. OF SCI. OF THE U.S. 16,637, 16,639 (2006). Since 1950, the growing season has also lengthened by 2.6 days. *Id.*

Desert, the southern and middle Rocky Mountains, California's Sierra Nevada, and the Pacific Northwest's Cascade Mountains. The latter four contain significant forest components.[63] Temperatures in each of these regions are projected to increase.[64] In the Pacific Northwest, temperatures may rise between 1.5 and 3.2°C by 2040.[65] By 2100, temperatures in the Sierra Nevada are projected to rise between 1.7 and 5.8°C[66] and temperatures in the Intermountain West are projected to rise between 2 and 5°C.[67]

In the last fifty years, climate change has already altered river flows and snowpack throughout the West.[68] Further changes in the amount, timing, and nature of precipitation are predicted to accompany increased temperatures.[69] Climate warming and moderate increases in precipitation in Alaska have affected the hydrologic cycle, soil resources, and disturbance regimes by lowering regional water tables, causing soil drying and reductions in tree growth.[70] Further, despite increases in overall precipitation, scientists are predicting less snowpack throughout the Sierra Nevada and the Cascades.[71] In the Intermountain West, future declines in snowpack will compound those that have occurred since the 1950s.[72] These changes are predicted to impair water quality and quantity.[73] Shifts in the timing of runoff may also overwhelm existing dams and reservoirs and cause flooding downstream.[74]

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63 Zellmer, *supra* note 21, at 316 (citing Wilderness Soc'y, *Frequently Asked Questions About Wilderness*, http://web.archive.org/web/20100312084852/wilderness.org/content/frequently-asked-questions-about-wilderness (last visited Apr. 12, 2014).

64 *Id.* at 326.

65 KLIEJUNAS, *supra* note 61, at 6 (citing Philip W. Mote et al., *Preparing for Climactic Change: the Water, Salmon, and Forests of the Pacific Northwest*, 61 CLIMATE CHANGE 45, 54 (2003)).

66 CAL. DEP'T OF FORESTRY & FIRE PROT., FIRE & RES. ASSESSMENT PROGRAM, CALIFORNIA'S FORESTS AND RANGELANDS: 2010 ASSESSMENT 253 (2010) [hereinafter FRAP].

67 KLIEJUNAS, *supra* note 61, at 7 (citing Jeanne C. Chambers & Mike Pellant, *Climate Change Impacts on Northwestern and Intermountain United States Rangelands,* RANGELANDS, Aug. 2008, at 29.

68 *See* Tim P. Barnett et al., *Human-Induced Changes in the Hydrology of the Western United States*, 319 SCI. 1080, 1080 (2008).

69 *See, e.g.*, Glicksman, *supra* note 59, at 839. However, changes in annual mean precipitation will vary by region. *Id.* Annual mean precipitation is likely to increase in the northeast but decrease in the southwest. *Id.* Additionally, models predict drier conditions in the southwest, but the Pacific Northwest will experience wetter winters. KLIEJUNAS, *supra* note 61, at 6.

70 Chapin III et al., *supra* note 62, at 16,639.

71 *See* Kathleen A. Miller, *Climate Change and Water in the West: Complexities, Uncertainties and Strategies for Adaptation*, 27 J. LAND RESOURCES & ENVTL. L. 87, 88–89 (2007).

72 KLIEJUNAS, *supra* note 61, at 7.

73 EPA, *Water Impacts of Climate Change*, http://water.epa.gov/scitech/climatechange/Water-Impacts-of-Climate-Change.cfm (last visited Apr. 12, 2014).

74 *See* Zellmer, *supra* note 21, at 327 (describing a record-breaking 2011 flood season linked to changes in the timing and velocity of snowmelt from the Rockies).

2. Synergistic Effects of Climate Change and Fire Suppression

Anthropogenic alteration of fire regimes[75] has significantly affected natural resource management and biodiversity conservation.[76] Decades of fire suppression have produced increased tree densities on many public lands, including in some wilderness areas.[77] Even with wilderness designations, approximately 85% of all natural fire ignitions in Forest Service wilderness areas are suppressed each year.[78] Collectively, fire suppression decisions have had a large effect. According to one study, over half of the area within wilderness areas in the eleven western states is moderately or highly departed from historical fire regimes.[79]

This legacy of fire suppression is problematic in a changing climate because ecosystems that are stressed from altered fire regimes are probably more vulnerable to climate-driven ecological change.[80] Regional changes in temperature and precipitation can add to existing stress and increase the severity and frequency of wildfires.[81] Warmer and drier conditions caused by climate change lead to increased moisture stress in trees and forest vegetation, which in turn result in earlier and longer fire seasons.[82] Fewer

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75 Cathy Whitlock et al., *Paleoecological Perspectives on Fire Ecology: Revisiting the Fire-Regime Concept*, 3 OPEN ECOLOGY J. 6, 6 (2010) ("A fire regime describes the characteristics of fire and its role in a particular ecosystem. A suite of climate, fuel, and landscape variables is required for fire to occur and spread, although their relative importance changes across scales.").

76 *See* Thomas A. Spies et al., *Challenges and a Checklist for Biodiversity Conservation in Fire-Prone Forests: Perspectives from the Pacific Northwest of USA and Southern Australia*, BIOLOGICAL CONSERVATION Jan. 2012, at 5.

77 *Id.* at 7.

78 Dustin Doane et al., *Barriers to Wildland Fire Use: a Preliminary Problem Analysis*, 12 INT'L J. WILDERNESS 36, 36 (2006). Most natural ignitions are suppressed even in large wilderness areas. For example, between 1988 and 2000, over 80% of lightning ignitions in Montana's Bob Marshall Wilderness Complex were suppressed, despite the wilderness area's large size and that the relevant planning documents allowed management of natural ignitions. David J. Parsons, *The Challenge of Restoring Natural Fire to Wilderness*, *in* 5 WILDERNESS SCIENCE IN A TIME OF CHANGE CONFERENCE 276, 278 (David N. Cole et al. eds., 2000).

79 Carol Miller et al., *Wilderness Fire Management in a Changing Environment*, *in* THE LANDSCAPE ECOLOGY OF FIRE 269, 270 (Donald McKenzie et al. eds., 2011) (citing U.S. DEP'T OF AGRIC., RMRS-GTR-175, THE LANDFIRE PROTOTYPE PROJECT: NATIONALLY CONSISTENT AND LOCALLY RELEVANT GEOSPATIAL DATA FOR WILDLAND FIRE MANAGEMENT 356 (Matthew G. Rollins & Christine K. Frame eds., 2006)). However, not all wilderness ecosystems would benefit from more fire. *Id.*

80 M.D. Hurteau, *Climate Change, Fire Management, and Ecological Services in the Southwestern US*, FOREST ECOLOGY & MGMT (forthcoming 2014).

81 *See* Sean P. Healey et al., *The Relative Impact of Harvest and Fire upon Landscape-Level Dynamics of Older Forests: Lessons from the Northwest Forest Plan*, 11 ECOSYSTEMS 1106, 1117 (2008) (describing correlations between increase in wildfire activity and changing climate).

82 *See* FRAP, *supra* note 66, at 254. California experienced its three largest fire years since 1950, between 2000 and 2010. *Id.* The increase is partially attributed to "warmer spring and summer temperatures, reduced snowpack and earlier spring snowmelt, as well as increased frequency of Santa Ana conditions." *Id.*

months of snow cover will allow more time for vegetation and forest fuels to dry during increasingly warm summers.[83]

Together, climate change and fire suppression have caused the acreage burned by fire and suppression costs to rise dramatically since 2000.[84] These patterns are expected to continue throughout the next century.[85] According to fire ecologists, the 2013 Rim Fire, which burned more than 402 square miles (257,314 acres) in the Stanislaus National Forest and Yosemite National Park, including some wilderness areas,[86] may be a sign of things to come.[87]

Moreover, increasingly large patches of high-severity fire in forest types not adapted to this fire type raise concerns that forests are becoming vulnerable to "type conversion from forest to a different vegetation type (e.g., shrubland or grassland) following some high-severity fires."[88] In addition, more frequent fires may cause an increase in greenhouse gas emissions and the number of "bad air days."[89]

Despite these challenges, wilderness areas offer hope in a changing future. The chances of restoring natural fire regimes—and therefore ending the need for continued human manipulations (e.g., thinning)—are best in large wilderness areas.[90] The Rim Fire suggests that programs that allow for management of natural ignitions in wilderness areas may be successful in preventing large-scale type conversions from forest to shrubland.[91] In total, an estimated 40% of the vegetation in the total area burned by the Rim Fire burned at high severity—typically defined as at least 95% canopy tree mortality—an occurrence that may be unprecedented in the Sierra Nevada.[92] By comparison, only 7% of the 77,000 acres of the vegetation in wilderness

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83 *See* JAMES BURCHFIELD & MARTIN NIE, UNIV. OF MONT., NATIONAL FORESTS POLICY ASSESSMENT REPORT TO MONTANA SENATOR JON TESTER 11 (2008).

84 *Id.* at 10 (declaring that large fires have become "so extensive that they forced the creation of a new size category of large fires exceeding 250,000 acres."). Federal cost for fire suppression in the 2007 calendar year was $1.8 billion. *Id.*

85 For example, a 2009 study estimates that the area burned by wildfire in Northern California will increase 100% by 2085. A.L. WESTERLING ET AL., CAL. CLIMATE CHANGE CTR., CLIMATE CHANGE, GROWTH, AND CALIFORNIA WILDFIRE 17–18 (2009).

86 InciWeb, *Rim Fire*, http://inciweb.nwcg.gov/ (last visited Apr. 12, 2014).

87 Barry Bergman, *In Rim Fire's Wake, Lessons for Saving our Forests*, UC BERKELEY NEWS CENTER, Oct. 15, 2013, http://newscenter.berkeley.edu/2013/10/15/scott-stephens-poi/ (last visited Apr. 12, 2014). According to Professor Scott Stephens, the Rim Fire "confirms the most urgent finding from decades of research," that "[f]ire policy that focuses on suppression only delays the inevitable, promising more dangerous and destructive future fires." *Id.*; *see also* Stephens et al., *Managing Forests and Fire in Changing Climates*, 342 SCI. 41, 41 (2013).

88 Matthew D. Hurteau & Matthew L. Brooks, *Short-and Long-term Effects of Fire on Carbon in US Dry Temperate Forest Systems*, 61 BIOSCIENCE 139, 141 (2011).

89 FRAP, *supra* note 66, at 254.

90 Miller et al., *supra* note 79, at 269.

91 *See* Hurteau & Brooks, *supra* note 88, at 142.

92 *See* Tracie Cone, *Rim Fire: Burned Areas See 'Unprecedented' Destruction*, HUFFINGTON POST, Sept. 18, 2013, http://www.huffingtonpost.com/2013/09/19/rim-fire-burned-areas_n_3951185.html (last visited Apr. 12, 2014). "'In other words, it's nuked,' said Jay Miller, senior wildland fire ecologist with the U.S. Forest Service. 'If you asked most of the fire ecologists working in the Sierra Nevada, they would call this unprecedented.'" *Id.*

areas burned by the Rim Fire experienced high-severity fire.[93] This severity pattern may be attributed to the long history of prescribed fire and managed natural fire in these wilderness areas.[94]

3. *Effects on Species Persistence and Distribution*

Climate change will also have dramatic effects on biodiversity.[95] There is evidence that drought conditions are already negatively affecting pinyon-juniper woodlands in Arizona, shrub communities in the Colorado Plateau, amphibian species in Yellowstone National Park, and aquatic habitat in the Chugach National Forest.[96] Certain public lands, including Bandelier National Monument and Mesa Verde National Park, are at risk of losing their forests altogether.[97]

Many species will likely respond to climate change by migrating northward and to higher altitudes; therefore, species that live at high elevation, where many wilderness areas are located, are especially vulnerable.[98] Increasing temperatures contributed to substantial upward changes in elevation limits for many small mammal species like the pika in Yosemite National Park from 1914 to the mid-2000s.[99] This changed community compositions at mid- and high-elevations because former low-elevation species expanded their ranges, while high-elevation species contracted their ranges.[100] These "trends do not bode well for several mid-to high-elevation species . . . ."[101]

Because rates of climate change are significantly faster than they were in the past, in situ genetic adaptation to new conditions is unlikely in most

93 *Id.*

94 For a description of the history of prescribed natural fire and wildland fire use in Yosemite and other areas, *see generally* Jan W. van Wagtendonk, *The History and Evolution of Wildland Fire Use*, FIRE ECOLOGY, Jan. 2007, at 3; Gregory H. Aplet, *Evolution of Wilderness Fire Policy*, INT'L J. WILDERNESS, Apr. 2006, at 9.

95 *See infra* notes 96–107 and accompanying text.

96 Glicksman, *supra* note 59, at 842 (citing Sarah K. McMenamin et al., *Climactic Change and Wetland Desiccation Cause Amphibian Decline in Yellowstone National Park*, 105 PROC. NAT'L ACAD. SCI. U.S. 16,988, 16,988 (2008); Phillip J. van Mantgem et al., *Widespread Increase of Tree Mortality Rates in the Western United States*, 323 SCI. 521, 523 (2009).

97 Glicksman, *supra* note 59, at 842–43; *see also* Stephen Saunders et al., *Losing Ground: Western National Parks Endangered by Climate Disruption*, 24 GEORGE WRIGHT F. 41, 48 (2007) ("Sudden, widespread, climate-driven loss of forests is now occurring in the American Southwest, where semiarid conditions make even the hardy trees that can survive there susceptible to drought.").

98 FRAP, *supra* note 66, at 255. Under a variety of modeled scenarios, alpine and subalpine vegetation cover declined with longer growing seasons and warmer temperatures, and grasslands encroached on woodlands and shrublands. *Id.*; *see also* Nicole E. Heller & Erika S. Zavaleta, *Biodiversity Management in the Face of Climate Change: A Review of 22 Years of Recommendations*, 142 BIOLOGICAL CONSERVATION 14, 15 (2009) (discussing similar effects on animal species).

99 Craig Moritz et al., *Impact of a Century of Climate Change on Small-Mammal Communities in Yosemite National Park, USA*, 322 SCI. 261, 261–62 (2008).

100 *Id.* at 264.

101 *Id.*

populations.[102] Additionally, many species may not migrate fast enough to keep pace with changes.[103] Climate-caused alterations in wildlife and plant community composition and "mismatches in life history events (e.g., migration and blooming)" will create many new species assemblages and additional species losses.[104] All of these responses will increase the risk of species extinctions, adding to the extinctions that studies suggest climate change has already caused.[105] Due to "rapid loss of habitable climate space," the first climate-caused species extinctions affected mountain-restricted species.[106] Climate change may even cause the disappearance of entire ecosystems, including alpine tundra and some oak woodlands.[107]

4. *Effects on Insects, Disease, and Invasive Species*

Climate change will alter the distribution, range, and severity of pathogens and diseases that affect plant and animal species.[108] "[O]verwintering survival" of plant and tree pathogens and diseases is projected to increase in a warming climate because low winter temperatures limit the survival of these pathogens and diseases.[109] Likewise, many vector-transmitted diseases that affect wildlife are climate-limited and their prevalence may increase in warmer temperatures.[110] As climate change

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102 *See* Alistair S. Jump & Josep Penuelas, *Running to Stand Still: Adaptation and the Response of Plants to Rapid Climate Change*, 8 ECOLOGY LETTERS 1010, 1012–14 (2005).

103 Margaret B. Davis & Ruth G. Shaw, *Range Shifts and Adaptive Responses to Quaternary Climate Change*, 292 SCI. 673, 677–78 (2001).

104 INTERAGENCY CLIMATE CHANGE ADAPTATION TASK FORCE, FEDERAL ACTIONS FOR A CLIMATE RESILIENT NATION 20 (2011) [hereinafter CLIMATE CHANGE TASK FORCE 2011 PROGRESS REPORT].

105 Heller & Zavaleta, *supra* note 98, at 15 (citing John F. McLaughlin et al., *Climate Change Hastens Population Extinctions*, 99 PROC. NAT'L ACAD. SCI. U.S. 6070, 6070 (2002); J. Alan Pounds et al., *Widespread Amphibian Extinctions from Epidemic Disease Driven by Global Warming*, 439 NATURE 161, 161 (2006)).

106 Camille Parmesan, *Ecological and Evolutionary Responses to Recent Climate Change*, 37 ECOLOGICAL EVOLUTIONARY SYS. 637, 652 (2003).

107 Glicksman, *supra* note 59, at 842–43 (citing U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-07-863, CLIMATE CHANGE: AGENCIES SHOULD DEVELOP GUIDANCE FOR ADDRESSING THE EFFECTS ON FEDERAL LAND AND WATER RESOURCES 26 (2007), *available at* http://www.gao.gov/products/GAO-07-863).

108 *See* C. Drew Harvell et al., *Climate Warming and Disease Risks for Terrestrial and Marine Biota*, 296 SCI. 2158, 2159–60 (2002); KLIEJUNAS, *supra* note 61, at 7 ("Climate influences the survival and spread of pathogens as well as the susceptibility of their hosts. Climate change could alter stages and rates of development of the pathogen, modify host resistance, and lead to changes in the physiology of host-pathogen interactions."). For example, the incidence of Armillaria Root Disease, which decays wood in the roots, lower boles, and stumps of dead or living trees, is projected to increase. This may reduce the available area that can support Douglas fir, an important ecosystem component, in the Pacific Northwest. *Id.* at 39–41. Like other species, pest species are "moving poleward and upward." Parmesan, *supra* note 106, at 650.

109 KLIEJUNAS, *supra* note 61, at 7; Harvell et al., *supra* note 108, at 2159 (explaining that for plant disease, "Winter is a major period of pathogen mortality, potentially killing more than 99% of the pathogen population annually. Greater overwintering success of pathogens will likely increase disease severity. Because temperatures are expected to increase more in winter than in other seasons, this population bottleneck may be removed for many pathogens.").

110 Harvell et al., *supra* note 108, at 2,160.

increases pathogen survival and spread, it will also increase host susceptibility.[111]

Climate change will affect the abundance of insects and their impact on forest ecosystems.[112] Shifts in temperature and precipitation directly affect insect reproduction, survival, and spread; alter host defenses and susceptibility to attack; and indirectly affect ecological relationships by causing changes in the abundance of competitors, parasites, and predators.[113] Climate change is already credited with increasing insect infestations, which further exacerbate the fuel loading problem created by fire suppression.[114] Scientists blame climate change for the mountain pine beetle outbreak that killed hundreds of thousands of acres of trees throughout the interior West.[115] Warmer winters associated with climate change are thought to have perpetuated the outbreak because warmer weather decreases generation time and winter mortality, resulting in "exponential population growth and major range extension."[116] Beetle attack and the introduced pathogen white pine blister rust have severely affected whitebark pine, which provides a critical food supply for species including the grizzly bear.[117] This epidemic has resulted in such extensive whitebark pine mortality that FWS has found that listing the species as threatened or endangered is warranted.[118] One study that has tracked tree stands in wilderness areas and other protected areas since 1955 found that approximately 87% have experienced increased tree mortality due, in part, to insects.[119]

Finally, climate change is likely to increase invasions by nonnative plant and animal species.[120] Many of the same traits that make species invasive, including their ability to survive in adverse conditions and rapid growth rates, allow invasive species to succeed in competing with native species in response to climate change.[121] Additionally, increased ecosystem

111 KLIEJUNAS, *supra* note 61, at 7.

112 *See infra* notes 113–22 and accompanying text.

113 FOOD & AGRIC. ORG. OF THE U.N., MANAGING FORESTS FOR CLIMATE CHANGE 13 (2010), *available at* www.fao.org/docrep/013/i1960e/i1960e00.pdf [hereinafter MANAGING FORESTS FOR CLIMATE CHANGE].

114 *See* W.A. Kurz et al., *Mountain Pine Beetle and Forest Carbon Feedback to Climate Change*, 452 NATURE 987, 987 (2008).

115 Six et al., *supra* note 9, at 111. Bark beetle outbreaks are also on the rise in Alaska. Chapin III et al., *supra* note 62, at 16,639.

116 MANAGING FORESTS FOR CLIMATE CHANGE, *supra* note 113, at 13.

117 BURCHFIELD & NIE, *supra* note 83, at 12.

118 Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to List Pinus albicaulis as Endangered or Threatened with Critical Habitat, 76 Fed. Reg. 42,631 (July 19, 2011).

119 STEPHEN SAUNDERS ET AL., GREAT LAKES NATIONAL PARKS IN PERIL: THE THREATS OF CLIMATE DISRUPTION 21 (2009), *available at* www.rockymountainclimate.org/images/GreatLakesParksInPeril.pdf.

120 Susan A. Mainka & Geoffrey W. Howard, *Climate Change and Invasive Species: Double Jeopardy*, 5 INTEGRATIVE ZOOLOGY 102, 104 (2010).

121 *Id.*

disturbances and stress on native species from climate change may allow for the establishment of more invasive species.[122]

5. Land Management Agencies' Responses to Climate Change Effects on Wilderness Areas

Until recently, federal agencies were slow to integrate climate change into project planning and implementation due to its uncertain effects, insufficient local information, budget and personnel constraints, and lack of a mandate to do so.[123] This began to change in the late 2000s. In 2008, the Forest Service formally adopted a strategic framework that identified climate change adaptation as a key agency goal and recommended integrating climate change considerations into agency-wide policies and program guidance.[124] In September 2009, the Department of Interior issued a series of policy documents asking the Park Service and other agencies to initiate actions for climate change adaptation and mitigation.[125] Then, in October 2009, President Obama signed Executive Order 13514, which tasked the Interagency Climate Change Adaptation Task Force with recommending federal efforts to prepare the country for climate change.[126] The Task Force's 2010 report called on agencies to "demonstrate leadership on climate change adaptation," and its 2011 report defined five "key areas of federal adaptation progress."[127]

Now, both the Forest Service and Park Service recognize that climate change challenges their ability to implement their missions.[128] Former Forest Service Chief Abigail R. Kimbell "characterized the Agency's response to the challenges as 'one of the most urgent tasks facing the Forest Service.'"[129]

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122 FOREST SERV. CLIMATE CHANGE RESOURCE CTR., CLIMATE CHANGE AND INVASIVE PLANTS IN FORESTS AND RANGELANDS (2012), *available at* http://www.fs.fed.us/ccrc/topics/invasive-plants/. Elevated CO_2 levels will also allow some invasive plants to be increasingly competitive. *Id.*

123 PETERSON ET AL., *supra* note 54, at 4.

124 U.S. FOREST SERV., FOREST SERVICE STRATEGIC FRAMEWORK FOR RESPONDING TO CLIMATE CHANGE 11 (2008).

125 Ken Salazar, Sec'y of the Interior, Secretarial Order 3289: Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources (Sep. 14, 2009).

126 Exec. Order No. 13,514, 74 Fed. Reg. 52,117 (Oct. 8, 2009). The goal of Executive Order Number 13,514 is "to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of greenhouse gas emissions a priority for Federal agencies." *Id.*

127 CLIMATE CHANGE TASK FORCE 2011 PROGRESS REPORT, *supra* note 104, at 1. The five key areas of federal adaptation progress referenced in the text include: 1) "Integrating Adaptation into Federal Government Planning and Activities"; 2) "Building Resilience to Climate Change in Communities"; 3) "Improving Accessibility and Coordination of Science for Decision Making"; 4) "Developing Strategies to Safeguard Natural Resources in a Changing Climate"; and 5) "Enhancing Efforts to Lead and Support International Adaptation." *Id.*

128 *See supra* notes 124–25 and accompanying text.

129 U.S. FOREST SERV., CLIMATE CHANGE CONSIDERATIONS IN PROJECT LEVEL NEPA ANALYSIS 1 (2009), *available at* http://www.fs.fed.us/emc/nepa/climate_change/includes/cc_nepa_guidance.pdf [hereinafter FOREST SERVICE PROJECT LEVEL CLIMATE CHANGE GUIDANCE] (citing Letter from Abigail R. Kimbell, Chief, U.S. Forest Serv., to Forest Serv. Nat'l Leadership Team (Feb. 15, 2008)).

Likewise, in a statement before the U.S. Senate Subcommittee on Public Lands and Forests, Forest Service Chief Tom Tidwell stated that:

> [C]limate change is already altering our Nation's forests in significant ways and those alterations are very likely to accelerate in the future, in some cases dramatically . . . . In the uncertain environment of climate change, risk management will become critical. This is managing ecosystems for resiliency to prepare uncertain future outcomes.[130]

The Forest Service now directs managers to consider climate change "in the delivery of [the Agency's] overall mission."[131] To implement this mandate, guidance documents direct that managers consider climate change in both land management plan revisions and in planning individual projects.[132] This guidance urges agency staff to demonstrate "[l]leadership in mitigating climate change and adaptive management for unavoidable climate change" effects in furtherance of "proper land stewardship for our national forests and grasslands."[133]

Similarly, in the 2010 Park Service Climate Change Response Strategy, the agency wrote: "The NPS is moving rapidly beyond the question of whether the Earth is warming and is focused on what to do about it."[134] In the 2010 Strategy, Park Service Director Jonathan B. Jarvis asserted that that "climate change is fundamentally the greatest threat to the integrity of our national parks that we have ever experienced."[135] To meet this threat, Director Jarvis created a Climate Change Coordinating Group in 2010 to "address tough questions of policy, such as impairment, arrival of new species, or facilitated migration."[136] According to Director Jarvis, the Park

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130 U.S. FOREST SERV., CLIMATE CHANGE CONSIDERATIONS IN LAND MANAGEMENT PLAN REVISIONS 1 (2010), *available at* http://www.fs.fed.us/emc/nepa/climate_change/includes/cc_land_mgmt_plan_rev_012010.pdf [hereinafter FOREST SERVICE CLIMATE CHANGE IN LRMP REVISIONS GUIDANCE] (citing *Climate Change on Fed. Forests: Hearing Before the Subcomm. on Pub. Lands & Forests of the S. Comm. on Energy & Natural Res.*, 111th Cong. 14 (2009) (statement of Tom Tidwell, U.S. Forest Serv. Chief)).

131 FOREST SERVICE CLIMATE CHANGE IN LRMP REVISIONS GUIDANCE, *supra* note 130.

132 *See id.*; *see also* FOREST SERVICE PROJECT LEVEL CLIMATE CHANGE GUIDANCE, *supra* note 129, at 2. Each unit (e.g., national forest or grassland) of the National Forest System is guided by a Land and Resource Management Plan ("LRMP" or "Forest Plan") that the agency developed pursuant to the National Forest Management Act (NFMA). Each LRMP designates allowable management actions in particular areas within the management unit.

133 FOREST SERVICE CLIMATE CHANGE IN LRMP REVISIONS GUIDANCE, *supra* note 130.

134 NAT'L PARK SERV., CLIMATE CHANGE RESPONSE STRATEGY 2 (2010) [hereinafter NPS CLIMATE CHANGE RESPONSE STRATEGY].

135 *Id.* at 1.

136 *Id.* The concept of "impairment" discussed by Director Jarvis comes from the National Park Service Organic Act, which defines the purpose of National Park management as: "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." 16 U.S.C. § 1 (2006). "Facilitated migration," also known as "assisted migration," is defined as the physical moving of species from native habitat to more suitable habitat. This management tool is discussed *infra* notes 255–66 and accompanying text.

Service "shall not sit idle" because the agency's organic act[137] directs it to "conserve" the resources in national parks "in such manner and by such means as will leave them unimpaired for future generations." Director Jarvis interprets the words "by such manner and by such means" as giving the agency "latitude to use whatever resources we have to protect parks in a future that has been characterized as 'hot, flat and crowded.'"[138]

Neither agency's guidance clearly explains whether and to what extent managers should use resources to actively manage wilderness areas for climate change adaptation. However, there are indications that federal managers envision wilderness areas as suitable for certain climate change adaptation projects.[139] In 2010, University of Washington researchers found that the majority of Park Service and Forest Service managers from six different units in Washington State did not view the Wilderness Act as a barrier to climate change adaptation projects,[140] though respondents noted that the Wilderness Act may preclude certain types of projects requiring infrastructure development or use of mechanized equipment.[141]

III. POSSIBLE CLIMATE CHANGE ADAPTATION ACTIONS IN WILDERNESS AREAS

The Intergovernmental Panel on Climate Change defines climate change adaptation as the "[a]djustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities."[142] Adaptation may be achieved through implementation of passive or active management strategies. Active management involves human manipulation of natural systems (e.g. restoration treatments including reforestation, weed or erosion control, prescribed fire, and fire suppression), while passive management is hands-off (e.g. allowing naturally ignited fires to burn or acquiring lands to serve as migration corridors and leaving those lands alone). Of course,

137 16 U.S.C. § 1 (2006).

138 NPS CLIMATE CHANGE RESPONSE STRATEGY, *supra* note 134, at 1.

139 Lesley C. Jantarasami, et al., *Institutional Barriers to Climate Change Adaptation in U.S. National Parks and Forests*, 15(4) ECOLOGY & SOC'Y 1, 9 2010, *available at* http://www.ecologyandsociety.org/vol15/iss4/art33/ES-2010-3715.pdf.

140 *Id.* Forty percent of respondents identified the Wilderness Act as a potential barrier to climate change adaptation projects. *Id.* Those respondents perceived the Wilderness Act as a potential barrier "to implementing certain proposed adaptation strategies that require extensive management intervention and manipulation to achieve adaptation goals." *Id.* at 12. Interestingly, a larger majority of respondents believed that the National Park Service Organic Act (50%) and the Endangered Species Act (81%) were potential barriers to adaptation. *Id.* at 9.

141 *Id.* "Examples discussed included situations where, without heavy moving equipment, stream channels destroyed by floods could not be properly restored, and where roads continually washed out by recurring floods could not be relocated because they are bordered on both sides by a wilderness area." *Id.* at 12.

142 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, WORKING GROUP II, FOURTH ASSESSMENT REPORT, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY § 18.1.2 (Martin Parry et al. eds., 2007), *available at* http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch18s18-1-2.html.

ecosystems will adapt to climate change absent human interaction.[143] However, active management strategies for climate change adaptation may be appropriate where inaction would allow changes to exceed socially acceptable levels.[144] For example, society may consider the cost of species extinctions, weed invasions, or habitat alteration to be too high to forgo active management.

There are various formulations of strategies to adapt to climate change. Many adaptation strategies have "roots in traditional conservation and ecosystem management principles."[145] These strategies include: reducing existing stressors like invasive species, pollution, and habitat fragmentation; "managing for ecosystem processes and function rather than for particular species or community types"; and establishing habitat buffers and wildlife corridors to connect habitat in existing protected areas with habitat that may be suitable in the future.[146] However, there are more controversial adaptation strategies, including translocation of threatened species to new areas where they did not previously exist, or implementing "triage" systems to concentrate conservation efforts on those species with the greatest chance for survival.[147] Many of these more controversial strategies are designed to address a specific climate change impact and will therefore have more uncertain outcomes that depend on the nature of future change.[148]

Ecologists Nathan Stephenson and Constance Millar divide these strategies into four broad classes of management actions for climate change adaptation in wilderness areas: "restraint (do nothing), resilience, resistance (near-term ways of buying time), and realignment (long-term adaptation)."[149] These four categories represent a "spectrum of possible management actions" for climate change adaptation in wilderness areas.[150] While an exhaustive review of proposed climate change adaptation strategies is beyond the scope of this article, Part III draws on scientific literature, agency proposals, and examples from wilderness case law to identify a

143 *See* Holly Doremus, *Adapting to Climate Change with Law That Bends Without Breaking*, 2 SAN DIEGO J. OF CLIMATE & ENERGY L. 45, 74–75 (2010) ("Even if its rhythms have been drastically changed by human impacts to the planet, nature which remains autonomous will develop its own strategies for responding to human encroachment.").

144 *See* David L. Spittlehouse & Robert B. Stewart, *Adaptation to Climate Change in Forest Management*, 4 B.C. J. ECOSYSTEMS & MGMT. 1,2 (2003).

145 Jantarasami et al., *supra* note 139, at 34. Many of these general strategies are "based on a relatively simple understanding of species biology and historic climate change effects on species distribution" rather than "less certain projected potential climate impacts. . . ." Joshua J. Lawler et al., *Resource Management in a Changing and Uncertain Climate* 8 FRONTIERS IN ECOLOGY 35, 38 (2010).

146 Jantarasami et al., *supra* note139, at 34; *see also* Lawler et al., *supra* note 145, at 38.

147 *See, e.g.*, Camacho, *supra* note 32, at 173 (discussing assisted migration); Ruhl, *supra* note 60, at 31 (discussing strategies aimed at "Dealing with the Doomed"); Jantarasami et al., *supra* note 139, at 34; Lawler et al., *supra* note 145, at 38 (giving certain species higher conservation priority based on their ecological or societal value or degree of impact).

148 Lawler et al., *supra* note 145, at 38.

149 Nathan L. Stephenson & Constance I. Millar, *Climate Change: Wilderness's Greatest Challenge*, 28 PARK SCI. 34, 34 (2012).

150 *Id.* at 35.

variety of adaptation actions that have been or may be proposed for application in wilderness areas, organized by Stephenson and Millar's four categories.

Our assessment focuses on how the Wilderness Act may help or hinder adaptation efforts related to forest health and biodiversity in forest ecosystems, rather than desert, grassland, or coastal ecosystems. Wilderness areas are not limited to forest ecosystems, but we limit our analysis to forest ecosystems for two reasons. First, the majority of acres in wilderness areas are forested.[151] Second, the scientific literature on climate change adaptation largely discusses actions that may be appropriate in various forest ecosystems.[152] However, we believe that our conclusions are relevant to a wide range of other ecosystems and management choices.

A. Where Inaction is Deemed Unacceptable, Management Strategies May be Employed to Enhance Ecosystem Resilience and Resist Changes to "Buy Time."

Resistance refers to "management actions designed to resist change,"[153] or the ability of an ecosystem to "resist forces of climate change and maintain values and ecosystem services in their present or desired states and conditions."[154] Similarly, resilience is defined as "an ecosystem's ability to absorb a stress without flipping into an entirely new state, such as from forest to eroded shrubland."[155] According to Forest Service research scientist David Peterson, the goal of managing for resilience is to enhance the ability of ecosystems to "withstand or absorb increasing effects without irreversible changes" to processes or functions.[156]

Management for climate change resistance and resilience may take various forms. For example, managers may construct fuel breaks around endangered or otherwise vulnerable plant species in order to lessen the likelihood of extinction from "climate-aggravated wildfire"; combat insect-caused tree mortality with prescribed burning or thinning treatments to

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151 *See Mont. Wilderness Ass'n, National Forests* http://wildmontana.org/discover-the-wild/montanas-public-lands/national-forests/ (last visited Apr. 12, 2014).

152 *See* Heller & Zavaleta, *supra* note 98, at 17.

153 Stephenson & Millar, *supra* note 149, at 36.

154 PETERSON ET AL., *supra* note 54, at ii.

155 Stephenson & Millar, *supra* note 149, at 35. Conservation biologist Reed Noss defines resilient systems as those that "recover quickly after a disturbance." Reed F. Noss, *Beyond Kyoto: Forest Management in a Time of Rapid Climate Change*, 15 CONSERVATION BIOLOGY 578, 580 (2001).

156 PETERSON ET AL., *supra* note 54, at ii. Resilience is the most recommended strategy for climate change adaptation. *Id.* at 71. Resilience has different meanings in various land management contexts. For example, in an ecological context, a resilient forest ecosystem might refer to one that "regenerates and restores its former vegetation structure, composition, and function after wildfire . . . ." *Id.* at 74. In the biodiversity context, resilient systems include wildlife populations that remain viable "despite climate-induced habitat degradation; and watersheds that retain erosion control, adequate water supply, and fish habitat despite floods, fires, insect epidemics, or spread of exotic plant species." *Id.*

reduce drought stress; or implement an aggressive invasive species monitoring and removal program.[157]

Treatments that promote resilience all seek to reduce "species or system vulnerability to acute or chronic stress" so that species and ecosystems can better respond to, and recover from, climate change effects.[158] Treatments to enhance resistance improve the ability of species and ecosystems to "maintain a relatively constant state," despite climate change disturbances and stressors.[159] As such, neither climate change resistance nor resilience is an end itself. Both strategies aim to keep ecosystems within the historic range of variability[160] despite climate change effects, and may be most appropriate where current societal values dictate that change is unacceptable. While these strategies might "seem counter to working with change," they may be especially important where resources of high social or ecological value, such as endangered species, are increasingly vulnerable to climate change's direct or indirect effects.[161]

These strategies are also means of buying time until wilderness managers, the public, and policymakers more carefully assess climate change implications and researchers develop and test long term adaptive responses.[162]

1. Fire and Fire Surrogates to Restore Natural Fire Regimes, Improve Forest Health, and Benefit Plants and Wildlife

In a warmer climate, studies show that lower stand densities may be necessary in some forest types "to achieve the same level of reduced intertree competition as was achieved in the past."[163] Existing stand density problems caused by decades of wildfire suppression may compound climate change effects within and outside wilderness areas.[164] Additionally, in areas where climate change has resulted in rain replacing snow, declining snowpack, and an upward migration of the freezing line,[165] tree regeneration at higher elevation has increased, leading to the filling of canopy gaps and

157 *Id.* at 71.

158 *Id.* at 75. This objective is met by treatments that "[f]ocus on maintaining, reconnecting, and reestablishing ecosystem processes and functions" and "[r]educe existing pressures on species from sources other than climate change." *Id.* at 69.

159 Noss, *supra* note 155, at 580.

160 Peter B. Landres et al., *Overview of the Use of Natural Variability Concepts in Managing Ecological Systems*, 9 ECOLOGY APPLICATIONS 1179, 1180 (1999) (defining the historical range of variability as "the ecological conditions, and the spatial and temporal variation in these conditions, that are relatively unaffected by people, within a period of time and geographical area appropriate to an expressed goal."). *Id.* at 1182.

161 *See* PETERSON ET AL., *supra* note 54, at 69.

162 *See* Stephenson & Millar, *supra* note 149, at 36–37.

163 PETERSON ET AL., *supra* note 54, at 76.

164 *See* AUTUMN BERNSTEIN, SIERRA NEVADA ALLIANCE, DANGEROUS DEVELOPMENT: WILDLIFE AND RURAL SPRAWL IN THE SIERRA NEVADA 4, 10 (2007).

165 *See, e.g.*, H.D. Safford et al., U.S. Forest Serv., *Climate Change and the Relevance of Historical Forest Conditions*, *in* U.S. FOREST SERVICE, MANAGING SIERRA NEVADA FORESTS 23, 24–25 (Malcolm P. North ed., 2012).

formerly perennial snow patches with small trees.[166] This is leading to higher fuel continuity, and could lead to more extreme fire behavior in high elevation forests, where many wilderness areas are located.[167] To address these problems, managers may prescribe stand density reduction to minimize water stress, fire hazard, and certain types of insect outbreaks by reducing competition for water and increasing tree vigor.[168] Prescribed fire, managed natural ignitions, and thinning are management strategies that may be proposed to reduce stand densities, as well as to reestablish historic fire regimes, benefit plants and wildlife, and increase resilience in wilderness areas.[169]

Where fires cannot be allowed to burn due to high fuel loads or resource protection concerns, mechanical thinning can be used to achieve lower stand densities.[170] In dense stands, managers may also recommend mechanical thinning prior to reintroducing wildfire to restore historic fire regimes.[171] To promote climate change resistance, managers may also conduct fuels reduction treatments around populations of sensitive plant species or ecologically valuable riparian areas in order to prevent high-intensity fire from causing habitat loss.[172] However, studies caution that thinning is only a partial solution as a surrogate for fire, because "silvicultural prescriptions that attempt to mimic natural forest-fire dynamics may never achieve the complexity that freely burning fire can."[173] Therefore, scientists recommend "[e]xpanding the domain for allowing more freely burning wildland fire" in order to increase patch heterogeneity and forest resiliency.[174]

166 Christopher R. Dolanc et al., *Widespread Shifts in the Demographic Structure of Subalpine Forests in the Sierra Nevada, California, 1934 to 2007*, 22 GLOBAL ECOLOGY & BIOGEOGRAPHY 264, 272 (2013).

167 *See* Safford et al., *supra* note 165, at 24.

168 PETERSON ET AL., *supra* note 54, at 75; *see also* Reed F. Noss et al., *Managing Fire-Prone Forests in the Western United States*, 4 FRONTIERS IN ECOLOGY & THE ENV'T 481, 483 (2006).

169 *See* Spies et al., *supra* note 76, at 10 (discussing "options for dealing with fire").

170 Dylan W. Schwilk et al., *The National Fire and Fire Surrogate Study: Effects of Fuel Reduction Methods on Forest Vegetation Structure and Fuels*, 19 ECOLOGICAL APPLICATIONS 285, 286 (2009).

171 For example, in dry coniferous forests, "[e]fforts to restore fire resiliency (the ability of forests to tolerate fire and recover quickly following wildfire) . . . have focused on reducing surface fire intensity and severity, reducing the probability of crown fire initiation, reducing the extent of crown fire spread, and creating defensible spaces for fire suppression activities. Mechanical thinning and prescribed fire are the tools commonly proposed for achieving these objectives. Mechanical thinning (with subsequent treatment of residual coarse woody debris) is typically recommended for altering stand structure and species composition, while prescribed fire is often recommended for reducing and maintaining acceptable levels of surface fuels." David W. Peterson et al., *Reintroducing Fire in Regenerated Dry Forests Following Stand-Replacing Wildfire*, *in* U.S. FOREST SERV., GEN. TECH. REP. PSW-GTR-203, 79, 80 (2007) (internal citations omitted).

172 PETERSON ET AL., *supra* note 54, at 69, 71.

173 Brandon M. Collins & Scott L. Stephens, *Stand-Replacing Patches within a 'Mixed Severity' Fire Regime: Quantitative Characterization Using Recent Fires in a Long-Established Natural Fire Area*, 25 LANDSCAPE ECOLOGY 927, 938 (2010).

174 *Id.* Collins and Stephens recommend this practice within upper elevation mixed-conifer forests. *Id.*

In some stands, managers may want to introduce prescribed fire before allowing natural ignitions to burn. For example, the Deschutes and Willamette National Forests have proposed to implement prescribed burns in areas of the Three Sisters and Mt. Washington Wilderness Areas in order to "create breaks in the continuous vegetation, resulting in conditions that could improve opportunities to allow lightning-caused fires to play their natural role in the wilderness."[175] Likewise, in Minnesota's Boundary Waters Canoe Area Wilderness (BWCAW), a prescribed fire program was implemented to respond to fire danger created after a major storm caused expansive wind-throw in 1999.[176]

However, prescribed fire or mechanical thinning is not always necessary before allowing natural fires to burn because "many unlogged, fire-excluded forests possess latent resilience to reintroduced fire."[177] Therefore, "a passive forest restoration approach of simply returning fire can be effective" in some stands without implementing active treatments.[178]

Beyond fuel reduction, other resiliency benefits flow from restoring fire to wilderness areas.[179] In some cases, allowing wildfires to burn freely may achieve desired objectives for wildlife habitat creation because fire is often "key to ecosystem integrity and biological diversity, particularly in unroaded areas."[180] For example, high severity wildfires create early seral habitats, which benefit species like the black-backed woodpecker, that are dependent on high-severity fire.[181] Prescribed and natural fires can also help decrease

175 U.S. Forest Serv., *Prescribed Fire in Wilderness*, http://www.fs.usda.gov/detail/willamette/landmanagement/resourcemanagement?cid=stelprdb5383417 (last visited Apr. 12, 2014).

176 Lee E. Frelich & Peter B. Reich, *Wilderness Conservation in an Era of Global Warming and Invasive Species: A Case Study from Minnesota's Boundary Waters Canoe Area Wilderness*, 29 NAT. AREAS J. 385, 390 (2009).

177 Andrew J. Larson et al., *Latent Resilience in Ponderosa Pine Forest: Effects of Resumed Frequent Fire*, 23 ECOLOGICAL APPLICATIONS 1243, 1248 (2013) (evaluating the effects of reintroduced fire in an unlogged, fire-excluded ponderosa pine forest in Montana's Bob Marshall Wilderness); Jamie Lydersen & Malcolm North, *Topographic Variation in Structure of Mixed-Conifer Forests Under an Active-Fire Regime*, 15 ECOSYSTEMS 1134 (2012) (evaluating resumed frequent fire in the Sierra Nevada); Zachary A. Holden et al., *Effects of Multiple Wildland Fires on Ponderosa Pine Stand Structure in Two Southwestern Wilderness Areas, USA*, 3 FIRE ECOLOGY, 18, 28 (2007) (evaluating effects of multiple wildland fires on ponderosa pine stand structure in two southwestern wilderness areas); Alan H. Taylor, *Fire Disturbance and Forest Structure in an Old-Growth* Pinus Ponderosa *Forest, Southern Cascades, USA*, 21 J. VEGETATION SCI. 561 (2010) (evaluating the effects of fire disturbance and forest structure in *Pinus ponderosa* forests in the southern Cascades).

178 Larson et al., *supra* note 177, at 1248.

179 *See* Dominick A. DellaSala & Evan Frost, *An Ecologically Based Strategy for Fire and Fuels Management in National Forest Roadless Areas*, FIRE MGMT. TODAY, Spring 2001, at 17 (citations omitted) (describing the various benefits of prescribed fire when "ecological integrity and biodiversity are important management objectives").

180 *Id.*

181 Richard L. Hutto, *The Ecological Importance of Severe Wildfires: Some Like It Hot*, 18 ECOLOGICAL APPLICATIONS 1827, 1832 (2008).

pest outbreaks,[182] enhance fire-dependent plant species populations,[183] and prevent conifer encroachment into ecologically diverse alpine meadows.[184]

Currently, the use of prescribed fire and the management of natural ignitions is allowed in some National Park and Forest Service wilderness areas, including some in the Rockies and Sierra Nevada.[185]

2. Actions to Control Insects and Disease Outbreaks

In response to the increase in insect and disease epidemics as a result of climate change, managers and scientists have proposed several treatments for direct control of mountain pine beetles, including sanitation cuts (e.g., single tree or small patch removal) that attempt to eliminate beetles in a particular area by removing infested trees before beetles develop and disperse, and prescribed burns or toxin applications that attempt to destroy beetles in infested trees onsite.[186] Other treatments, including insecticide application, and even acoustic technology, can be used to prevent beetle infestations.[187]

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182 DellaSala & Frost, *supra* note 179, at 17 (citations omitted). Collins and Stephens contend that restoring the process of fire has allowed forests in two Sierra Nevada wilderness areas to become more resistant to disturbances, such as insects, disease, and drought, which could be important in a changing climate. Brandon M. Collins & Scott L. Stephens, *Managing Natural Wildfires in Sierra Nevada Wilderness Areas*, 5 FRONTIERS IN ECOLOGY & ENV'T 523, 527 (2007).

183 However, where long term retention of old forest habitats for wildlife is an objective, fire suppression may sometimes be necessary. Jon E. Keeley & C.J. Fotheringham, *Role of Fire in Regeneration From Seed*, *in* SEEDS: THE ECOLOGY OF REGENERATION IN PLANT COMMUNITIES 311, 311 (Michael Fenner ed., 2d ed. 2000).

184 *See* Harold S.J. Zald et al., *Climatic, Landform, Microtopographic, and Overstory Canopy Controls of Tree Invasion in a Subalpine Meadow Landscape, Oregon Cascades, USA*, 27 LANDSCAPE ECOLOGY 1197, 1197 (2012) (finding that the "[p]roportion of meadow occupied by trees increased from 8% in 1950 to 35% in 2007" in Oregon's Cascade Range).

185 *See* van Wagtendonk, *supra* note 94, at 11–14 (discussing the use of prescribed and managed fire in the United States by land management agencies); Aplet, *supra* note 94, at 9–10; Carol Miller, *Wildland Fire Use: A Wilderness Perspective on Fuel Management*, *in* FIRE, FUEL TREATMENTS, AND ECOLOGICAL RESTORATION: CONFERENCE PROCEEDINGS 379, 380 (Philip Omi & Linda Joyce eds., 2003), *available at* http://www.fs.fed.us/rm/pubs/rmrs_p029.pdf. Forest Service policy is fairly restrictive as to the use of prescribed fire in wilderness areas; *see also infra* notes 371–76 and accompanying text.

186 *See* Six et al., *supra* note 9, at 112; University of California Statewide Integrated Pest Management Program, *Bark Beetles*, http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7421.html (last visited Apr. 12, 2014) (discussing control methods including tree selection, reducing tree stress, biological control, behavior control, and chemical control); SUSAN DONALDSON & STEVEN J. SEYBOLD, THINNING AND SANITATION: TOOLS FOR THE MANAGEMENT OF BARK BEETLES IN THE LAKE TAHOE BASIN, *available at* http://www.unce.unr.edu/publications/files/ho/other/fs9842.pdf (discussing thinning and sanitation); CHRISTOPH KRIEGER, AN OVERVIEW OF BARK BEETLE CONTROL METHODOLOGIES 3–7 (1998), *available at* www.gov.pe.ca/ffw/index.php3?number=72696&lang=E (discussing traps, trap trees, and baiting with pheromones).

187 Christopher J. Fettig et al., *Advances in Insecticide Tools and Tactics for Protecting Conifers From Bark Beetle Attack in the Western United States*, *in* INSECTICIDES–DEVELOPMENT OF SAFER AND MORE EFFECTIVE TECHNOLOGIES 473, 474–476 (Stanislav Trdan ed., 2013) (discussing preventive applications of insecticides); Richard W. Hoffstetter et al., *Using Acoustic Technology to Reduce Bark Beetle Reproduction*, 70 PEST MGMT. SCI. 24, 24–25 (2013) (describing a "bio-

A variety of projects to combat insect and disease epidemics have already been implemented or proposed in wilderness areas, though not for climate change adaptation.[188] For example, a series of lawsuits in the late 1980s challenged a Forest Service program to control southern pine beetle infestations in wilderness areas in Arkansas, Louisiana, and Mississippi using timber harvest and insecticides.[189] The Forest Service has also proposed actions in wilderness areas to address the aftermath of beetle infestations for safety purposes.[190] In 2009, the Forest Service proposed to use chainsaws to fell dead hazard trees along trails for public safety in New Mexico's Sandia Mountain Wilderness.[191]

Similar actions may be proposed if climate change brings new or increasingly severe insect and disease epidemics to wilderness areas. Scholars suggest that sanitation, "removal of susceptible species to create breaks in transmission," chemical, and bio control treatments for exotic tree diseases and pests may be necessary for climate change resistance and resilience in BWCAW.[192] They predict that wilderness managers may want to chemically treat "exemplary stands" when a pandemic arrives in order to preserve those stands, and they cite an example in Shenandoah and Great Smoky National Parks where chemical treatments have been used to save a few stands of eastern hemlock from the hemlock wooly adelgid.[193]

acoustic approach to reducing bark beetle reproduction" using "[p]layback of modified biological sounds" in order to reduce reproduction and survival).

188 The Forest Service's policy is to not take actions to control insect or disease outbreaks "unless it is necessary to prevent unacceptable damage to resources on adjacent lands or an unnatural loss to the wilderness resource due to exotic pests." U.S. FOREST SERV., FOREST SERVICE MANUAL § 2324.12 (2007).

189 Sierra Club v. Lyng (*Sierra Club I*), 662 F. Supp. 40, 41, 43–44 (D.D.C. 1987) (temporarily enjoining proposal for insecticide and harvest of thousands of acres because the Forest Service failed to show that the program was necessary); Sierra Club v. Lyng (*Sierra Club II*), 663 F. Supp. 556, 557–58, 560 (D.D.C. 1987) (upholding Forest Service decision to use "spot control" harvest to combat insect infestation).

190 *See* U.S. FOREST SERV., WESTERN BARK BEETLE STRATEGY: HUMAN SAFETY, RECOVERY AND RESILIENCY 7 (2011) (discussing the dangers posed by beetle infested trees, and the Forest Service's strategy to mitigate public safety hazards).

191 Letter from George Nickas, Exec. Dir., Wilderness Watch, to Lisa L. Jones, Trails and Wilderness Program Manager, Sandia Ranger District, Cibola National Forest 1 (Feb. 16, 2009), *available at* www.wildernesswatch.org/pdf/Sandia_CommentLetter.pdf.

192 *See* Frelich & Reich, *supra* note 176, at 390–91.

193 *Id.* at 391. In the BWCAW, managers may want to use chemicals to preserve stands of black ash if future climate change facilitates invasion of the emerald ash borer. *Id.* Several factors may lead managers to treat and preserve exemplary ash stands, including "esthetic reasons, preservation of the germplasm, the scientific information contained in tree rings, the ecological relationships among tree species, and the relationship of the species to habitat factors." *Id.* Frelich and Reich fear that because it may be more difficult to implement traditional insect and disease management strategies in wilderness areas, these areas "may end up with fewer native species (i.e., be less natural) than the surrounding forest, an unintended consequence of wilderness laws implemented during times when we as a society believed that natural areas of sufficient size were capable of maintaining themselves." *Id.*

3. Actions to Control Nonnative Invasive Plant and Animal Species

Nonnative invasive species interact with other elements of climate change and can considerably damage managed and natural systems, imposing "huge costs [on] society."[194] In western forest ecosystems, large scale insect outbreaks, wildfire, and thinning treatments designed to ameliorate the effects of insects and fire can exacerbate climate change effects by further facilitating the spread of nonnative invasive species.[195] Active treatments to remove invasive species in order to preserve ecologically diverse landscapes may be especially important in wilderness areas, which generally contain intact habitat. With climate change, monitoring for invasives may become increasingly necessary to enable a rapid response to aggressively target and prevent spread into habitat for threatened, endangered, and sensitive species.[196]

Several methods have been developed and deployed to control a wide range of invasive plant and animal species.[197] Eradication, the "removal of every individual and propagule of an invasive species so that only reintroduction could allow its return," is the favored approach where possible.[198] Although eradication can be expensive and time consuming, successfully removing an invader provides the best opportunity to recover native biodiversity.[199] Where eradication is impossible, control—which reduces the presence of the invasive species—and containment—which limits further spread—are options.[200] Standard eradication and control tools include manual methods (e.g., hand pulling, burning, or "manual destruction or removal of nests, egg masses or other life stages"); chemical methods (e.g., pesticides, herbicides, and fungicides); biological methods ("the use of animals, fungi or diseases to control invasive populations"); cultural methods ("the manipulation of forest structure and composition to control invasive species or the alteration of the stand so that effects will be limited if invasion occurs"); and mechanical methods (e.g., hoeing, cutting, mowing, or constructing barriers).[201]

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194 Erica S. Zavaleta et al., *Viewing Invasive Species Removal in a Whole-Ecosystem Context*, 16 TRENDS IN ECOLOGY & EVOLUTION 454, 454 (2001).

195 Timothy R. Seastedt et al., *Management of Novel Ecosystems: Are Novel Approaches Required?*, 6 FRONT. ECOL. ENVIRON. 547, 549 (2008).

196 PETERSON ET AL., *supra* note 54, at 72.

197 Zavaleta et al., *supra* note 194, at 454.

198 *Id.* at 459. When new nonnative species move into an area, time is of the essence because "[t]he best way to reduce the probability that an introduced species will become invasive is to eliminate it before it has time to become abundant and widespread and to evolve adaptations that may allow it to out-compete native species." F.W. Allendorf & Laura L. Lundquist, *Introduction: Population Biology, Evolution, and Control of Invasive Species*, 17 CONSERVATION BIOLOGY 24, 28 (2003).

199 Zavaleta et al., *supra* note 194, at 454.

200 *Id.*

201 WIS. DEP'T OF NAT'L RES., *INVASIVE SPECIES CONTROL METHODS*, *available at* dnr.wi.gov/topic/ invasives/control.html (last visited Apr. 12, 2014); Zavaleta et al., *supra* note 194, at 454. Studies warn that in isolation, invasive species removal can result in unexpected

Examples of various nonnative and invasive species control projects exist in wilderness areas.[202] In several Sierra Nevada wilderness areas, projects have been proposed to eliminate nonnative fish, which have negative effects on endangered frogs and native fish species.[203] Many wilderness lakes in California's Sierra Nevada were historically fishless until state fish stocking programs brought nonnative species like rainbow, brook, and golden trout to these lakes.[204] These nonnative fish prey upon native species, like the federally endangered mountain yellow-legged frog, and have pushed the frogs out of deep mountain lakes where they previously lived.[205] The endangered frogs are now relegated to smaller ponds, which are more vulnerable to drying associated with climate change.[206] Nonnative trout also affect native fish species.[207] In a 2011 district court case, plaintiffs challenged a nonnative trout eradication project in the Carson-Iceberg Wilderness that proposed to use rotenone to kill nonnative fish before restoring the native and federally threatened Paiute Cutthroat Trout.[208]

Invasive plant species removal projects are ongoing in wilderness areas.[209] In 2013, the Superior National Forest approved a project to remove a total of 14.3 acres of invasive species in the BWCAW, 10.8 acres using herbicide, and 3.5 acres using manual treatment.[210] The project also approved treatment of an additional forty to sixty acres over the next ten years.[211] In the future, similar projects may be implemented in the BWCAW and elsewhere.[212]

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changes to ecosystems. Therefore, managers should consider effects of eradication and control measures on native ecosystems. *Id.*

202 *See infra* notes 203–12 and accompanying text.

203 *See* Roland A. Knapp et al., *The Introduction of Nonnative Fish into Wilderness Lakes: Good Intentions, Conflicting Mandates, and Unintended Consequences*, 4 ECOSYSTEMS 275 (2001) (discussing the effects of nonnative trout in the Sierra Nevada); *see also* ROLAND A. KNAPP, NON-NATIVE TROUT IN NATURAL LAKES OF THE SIERRA NEVADA: AN ANALYSIS OF THEIR DISTRIBUTION AND IMPACTS ON NATIVE AQUATIC BIOTA (1996).

204 The Mountain Yellow-Legged Frog Site, *Threats: Introduced Fish*, http://www.mylfrog.info/threats/introducedfish.html (last visited Apr. 12, 2014) ("Early fish stocking efforts were conducted using horses and mules, but in the 1950s the California Department of Fish and Game began using airplanes to stock even the most remote backcountry lakes.").

205 *Id.*

206 *Id.*

207 *See* Knapp, *supra* note 203 (concluding that the introduction of non-native trout has substantially altered the native fish fauna of the Sierra Nevada).

208 Californians for Alts. to Toxics v. U.S. Fish & Wildlife Serv., 814 F. Supp. 2d 992, 995–96 (E.D. Cal. 2011).

209 *See generally* U.S. FOREST SERV., RECORD OF DECISION, BWCAW NON-NATIVE INVASIVE PLANT MANAGEMENT PROJECT (2013) (listing information about projects that manage the resources and uses in the Superior National Forest).

210 *Id.* at 2–3.

211 *Id.*

212 Frelich & Reich, *supra* note 176, at 390 (suggesting that climate change will require substantial improvements in efforts to remove invasive species in the Boundary Waters and this effort "would be greatly facilitated by an invasive species buffer zone implemented outside the wilderness").

4. *Intensive Measures to Keep Endangered Plant and Animal Species Healthy in Their Current Range*

Conservation of biological diversity is connected to climate change resilience because genetic diversity "allows species to adapt continuously to evolving environmental conditions."[213] While simply leaving wilderness areas alone would benefit some wildlife species because untreated habitats offer heterogeneity,[214] intensive measures may be necessary to ensure the persistence of endangered, threatened, or sensitive species.[215] Several studies suggest that conservation resources should be focused on species that might become extinct due to climate change effects.[216]

One method for allowing wildlife species to persist in a warmer and drier climate is the installation of artificial water sources, also known as wildlife guzzlers.[217] Guzzlers have been proposed in several wilderness areas to support wildlife populations, particularly in dry areas like Southern California mountain ranges, where there is evidence that water scarcity has significantly affected the success of bighorn sheep populations.[218] Guzzler installation in wilderness areas has been quite controversial.[219] In 2010, an environmental group successfully challenged FWS's decision to construct a 13,000-gallon guzzler in Arizona's Kofa Wilderness.[220]

Water may be important for plant conservation as well. Stephenson and Millar provide the example of "keeping an endangered plant population healthy by drip irrigation,"[221] as a climate change adaptation strategy that can help reduce environmental stress and facilitate restoration.[222] This strategy may be recommended in wilderness areas as climate change impacts worsen. For example, managers have begun to discuss the possibility of

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213 MANAGING FORESTS FOR CLIMATE CHANGE, *supra* note 113, at 14.

214 DAVID S. PILLIOD ET AL., U.S. FOREST SERV., RMRS-GTR-173, WILDLIFE AND INVERTEBRATE RESPONSE TO FUEL REDUCTION TREATMENTS IN DRY CONIFEROUS FORESTS OF THE WESTERN UNITED STATES: A SYNTHESIS 13, 23 (2006).

215 *Id.* at 1, 15, 24.

216 *See* Jonathan R. Mawdsley et al., *A Review of Climate-Change Adaptation Strategies for Wildlife Management and Biodiversity Conservation*, 23 CONSERVATION BIOLOGY 1080, 1084 (2009).

217 Guzzler construction can be quite intensive. *See* Craig Deutsche, *Artificial Water: When is it Justified in Desert Wilderness?*, J. WILDERNESS, April 2009, at 15–16 (2009) ("Typically, a check dam is built across a small wash that carries water after a rain. The water is then stored in a large, underground tank—10,000 gallons is typical. A 'drinker' for the animals is built a short distance away slightly below the level of the tank; this is essentially a trough from which animals get the water. The drinker is provided with an escape ramp so that small animals would not be trapped. All water movement is gravity fed so that there are no moving parts subject to failure. Following construction, the ground is returned to its natural contours and native vegetation restored to the extent possible.").

218 *Id.* at 15.

219 *Id.* at 17.

220 Wilderness Watch, Inc. v. U.S. Fish & Wildlife Serv. *(Wilderness Watch v. FWS)*, 629 F. 3d 1024, 1036–37 (9th Cir. 2010).

221 Stephenson & Millar, *supra* note 149, at 36.

222 V.H. Dale et al., *Climate Change and Forest Disturbances*, 51 BIOSCIENCE 723, 730 (2001).

watering giant sequoias in California's southern Sierra Nevada.[223] This action may be necessary because scientists predict that the optimal temperature zone for these trees will rise hundreds of feet in elevation, leaving the trees at risk of dying from drought and heat.[224] However, these strategies may be extremely expensive and cannot be directed at every climate-imperiled species absent significant new funding sources.[225]

Because climate change is projected to negatively impact water quality and quantity in some areas, agencies may also choose to manage for resistance in wilderness areas by restoring eroded areas after disturbances, especially where flooding is expected to increase.[226]

5. *Reintroductions of Native Plant and Animal Species After Disturbances and Extirpations Caused by Direct or Indirect Human Action*

As discussed earlier, climate change will increase disturbances such as fire, insects, and disease.[227] Active management may assist recovery of species and ecosystems from those disturbances. Post-disturbance forest recovery efforts can focus on: 1) "managing the state of the system immediately after the disturbance (e.g., salvage logging)" or 2) "managing the ongoing process of recovery (e.g., planting and reseeding)."[228] Actions like salvage logging may be unlikely to be proposed in wilderness areas due to prohibitions on mechanized equipment and road construction and because "stands can recover naturally" without removing dead and damaged trees.[229] However, other actions may be important for enhancing recovery in wilderness areas. An important strategy to resist climate change is revegetation with native plant and tree species after disturbances affect a

223 Tracie Cone, *Should Giant Sequoias be Watered? Scientists Ponder Impacts of Climate Change Across Sierra*, ASSOCIATED PRESS, July 1, 2013, http://news.yahoo.com/giant-sequoias-watered-scientists-ponder-impacts-climate-change-152854760.html (last visited Apr. 12, 2014). Already, researchers have found that giant sequoias in Sequoia National Forest are dying at twice their historic rate. *Id.*; *see also* Molly Samuel, *Can Giant Sequoias Survive the Future?*, KQED, Dec. 2, 2011, http://blogs.kqed.org/climatewatch/2011/12/02/can-giant-sequoias-survive-the-future/ (last visited Apr. 12, 2014).

224 Cone, *supra* note 223.

225 Mawdsley et al., *supra* note 216, at 1084.

226 *See* Spittlehouse & Stewart, *supra* note 144, at 10; PETERSON ET AL., *supra* note 54, at 69. A high profile example of active management in a wilderness area to protect biodiversity was not a response to climate change, but instead to acid rain. In Virginia's Saint Mary's Wilderness, atmospheric pollution has lowered pH and harmed native invertebrate and fish populations. David N. Cole et al., *Naturalness and Beyond: Protected Area Stewardship in an Era of Global Environmental Change*, 25 GEORGE WRIGHT F. 36, 41 (2008). In response, the Forest Service approved use of a helicopter to dump limestone sand into creeks. *Id.* This treatment so far has successfully "raised pH levels as well as taxa richness and the population of native invertebrates and fishes." *Id.* It has been repeated three times since 1999. Va. Wilderness Comm., *St. Mary's Wilderness Limited by Helicopter*, http://www.vawilderness.org/1/post/2013/03/st-marys-wilderness-limed-by-helicopter.html (last visited Apr. 12, 2014).

227 *See* PETERSON ET AL., *supra* note 54.

228 Dale et al., *supra* note 222, at 730.

229 *Id.*

landscape in order to speed succession.[230] For example, in 2013, the Forest Service proposed to replant native whitebark pine in Washington State's Pasayten Wilderness where the species existed before the 2002 Quartz Mountain Fire.[231]

Climate change will increase species extinctions and cause extirpations of local plant and animal populations.[232] Captive breeding or propagation and reintroduction of animal and plant species may be suggested for climate change resistance.[233] While these strategies may not be viable over the long term for more than a few species, reintroductions of native wildlife species may be proposed in some wilderness areas.[234] Frelich and Reich suggest that reintroductions of native species extirpated by direct or indirect human action may be desirable in the BWCAW.[235] With all reintroduction strategies, monitoring is essential to inform managers about the outcomes of their actions.[236]

One existing example is wolf reintroduction efforts, which have a long history in wilderness areas.[237] In March 1998, reintroduction of Mexican gray wolves began with eleven wolves in New Mexico's Blue Range Wilderness Area.[238] Thirty-six gray wolves were also reintroduced to Idaho's Frank Church-River of No Return Wilderness in 1995 and 1996.[239] Wolf management currently occurs in some wilderness areas.[240] In 2010, an Idaho district court upheld the use of helicopters to dart and collar gray wolves in wilderness areas.[241] Some scientists have asked whether wolves should be reintroduced in Isle Royale National Park, a federally designated wilderness area in Lake Superior, Michigan.[242]

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230 V.H. Dale et al., *Climate Change and Forest Disturbances*, 51 BIOSCIENCE 723, 730–31 (2001).

231 U.S. Forest Serv., *Planting Whitebark Pine Proposed in Pasayten Wilderness*, http://www.fs.usda.gov/detail/okawen/news-events/?cid=STELPRDB5427086 (last visited Apr. 12, 2014).

232 Mawdsley et al., *supra* note 216, at 1084; N. S. SODHI ET AL., CAUSES AND CONSEQUENCES OF SPECIES EXTINCTIONS, THE PRINCETON GUIDE TO ECOLOGY 514–520 (S. A. Levin ed., 2009).

233 Mawdsley et al., *supra* note 216, at 1084–85.

234 *Id.* at 1085.

235 Frelich & Reich, *supra* note 176, at 390.

236 *See* Dale et al., *supra* note 222, at 731.

237 *See* U.S. Fish & Wildlife Serv., *The Mexican Gray Wolf Recovery Program History*, http://www.fws.gov/southwest/es/mexicanwolf/RP_history.cfm (last visited Apr. 12, 2014).

238 *Id.*

239 Friends of the Clearwater, *Frank Church-River of No Return Wilderness*, http://www.friendsoftheclearwater.org/frank-church-river-of-no-return-wilderness/ (last visited Apr. 12, 2014).

240 Declaration of Jeff Gould, Maughan v. Tom Vilsack, No. 14-35043, D.C. No. 4:14-cv-00007-EJL (Dist. Of Idaho) http://www.eenews.net/assets/2014/01/28/document_gw_03.pdf.

241 Wolf Recovery Found. v. U.S. Forest Serv., 692 F. Supp. 2d 1264, 1270 (D. Idaho 2010).

242 *See* John A. Vucetich et al., *Should Isle Royale Wolves be Reintroduced? A Case Study on Wilderness Management in a Changing World*, 29 GEORGE WRIGHT F. 126, 130 (2012), *available at* http://www.georgewright.org/291vucetich.pdf (analyzing the possible effects and values of wolf reintroduction in Isle Royale National Park).

B. Management for Realignment May Successfully Facilitate Changes

Resistance and resilience are not always long term solutions.[243] Both will become more difficult as climate pressures increase and management priorities change.[244] Long term climate change impacts will likely be so great that many resistance and resilience strategies "will fail, perhaps catastrophically."[245] Because changes may "exceed physical and biological thresholds" and result in undesirable outcomes—including species mortality or extinctions—it is important for managers to have approaches that accommodate, rather than resist, change.[246]

Climate change may therefore require responsive management strategies that work "directly with climate-induced changes to assist transitions to future states."[247] Long term biodiversity maintenance and preservation of key ecosystem functions may be most successful if wilderness managers "actively facilitate change."[248] These strategies may be necessary where the ecosystems that existed under the historic "baseline" are no longer adapted to the climatic patterns anticipated in the next century.[249] For example, where species are unable to migrate fast enough to keep up with shifts in suitable habitat, assisted migration—the physical moving of species from native habitat to more suitable habitat—may be desirable, especially where extinction is the alternative.[250] Likewise, for plant species, some authors believe that it may be appropriate to plant novel species mixes better adapted to future conditions post disturbance, or purposefully mix genotypes more adapted to projected future conditions.[251]

Assisted migration, also known as translocation, has received recent attention in both scientific and legal literature.[252] Techniques for

243 Stephenson & Millar, *supra* note 149, at 36.

244 *See id.*

245 *Id.*

246 *See* PETERSON ET AL., *supra* note 54, at 71; Constance I. Millar et al., *Climate Change and Forests of the Future: Managing in the Face of Uncertainty*, 17 ECOLOGICAL APPLICATIONS 2145, 2147 (2007).

247 Peterson et al. term these strategies "response" and "realignment." These techniques "enable ecosystem processes and functions (including conditions that may or may not have existed in the past) to persist through a changing climate." PETERSON ET AL., *supra* note 54, at ii.

248 Stephenson & Millar, *supra* note 149, at 36.

249 *See* STEPHEN T. JACKSON, *Conservation and Resource Management in a Changing World: Extending Historical Range of Variation Beyond the Baseline*, *in* HISTORICAL ENVIRONMENTAL VARIATION IN CONSERVATION AND NATURAL RESOURCE MANAGEMENT 92, 93 (John A. Wiens et al. eds., 2012).

250 Stephenson & Millar, *supra* note 149, at 36.

251 *See id.*; *see also* PETERSON ET AL., *supra* note 54, at 75.

252 Assisted migration is defined as the "intentional movement of an organism to an area in which its species has never existed" for the purpose of avoiding extinctions and other harms to ecological health associated with escalating climate change. *Assisted Migration*, *supra* note 32, at 171; *see also, e.g.*, Jason S. McLachlan et al., *A Framework for Debate of Assisted Migration in an Era of Climate Change*, 21 CONSERVATION BIOLOGY 297 (2007) (describing assisted migration efforts to save the Florida torreya (*Torreya taxifolia*) from extinction). Other "[p]otential climate refugees include the American pika (*Ochotona princeps*), bighorn sheep, red wolves (*Canis lupus rufus*), San Bernardino flying squirrels (*Glaucomys sabrinus californicus*), Quino

translocation have been developed for numerous plant and animal species,[253] and some studies have begun to consider translocation for climate change adaptation purposes in wilderness areas.[254] For example, one study suggests that assisted migration within and around the BWCAW may be desirable for climate change adaptation.[255]

There is at least one example of a wilderness area assisted migration project, though the purpose was not climate change adaptation. In 2006, the Forest Service approved a project in Montana's Bob Marshall Wilderness that would assist the migration of "genetically pure westslope cutthroat trout" to twenty formerly fishless lakes.[256] The fish would otherwise be unable to migrate to these lakes, which "offer a refuge from other fish that hybridize with westslope cutthroat and pollute them genetically."[257] This example illustrates the potential to use techniques like assisted migration in wilderness areas for climate change adaptation, "despite the degree to which they seem like 'playing God.'"[258]

The outcomes of assisted migration are especially uncertain.[259] As compared to strategies designed to increase connectivity or remove ecosystem stressors (e.g., dam removal and restoration of riparian vegetation), translocations are far more unpredictable.[260] This is due to challenges associated with forecasting optimal future habitat and "significant gaps" in our knowledge about the biology of many rare species.[261] While resilience and restoration strategies are likely to be "more robust to the uncertainties of climate change," strategies like translocation are more dependent on the particular nature of climate change and will not be beneficial to species throughout the full range of future scenarios.[262] "Strategies with highly uncertain outcomes" necessarily "depend on the specific nature of future climatic changes [and] will be most successful if they include monitoring and prescriptions for alternative actions."[263]

Managers may also intentionally plant species with genotypes adapted to expected new conditions after disturbances like wildfire.[264] For example,

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checkerspot butterflies (*Euphydryas editha quino*), and white bark pine (*Pinus albicaulis*)." Zellmer, *supra* note 21, at 341.

253 Mawdsley et al., *supra* note 216, at 1084.

254 *See* Zellmer, *supra* note 21, at 341.

255 Frelich & Reich, *supra* note 176, at 391.

256 Cole et al., *supra* note 226, at 42. The project would remove all nonnative trout from these wilderness lakes that were previously stocked. *Id.* For a more detailed description of the project, see U.S. FOREST SERV., FLATHEAD NATIONAL FOREST, SPOTTED BEAR AND HUNGRY HORSE RANGER DISTRICTS, RECORD OF DECISION, SOUTH FORK FLATHEAD WATERSHED WESTSLOPE CUTTHROAT TROUT CONSERVATION PROGRAM (2006).

257 Cole et al., *supra* note 226, at 42.

258 *Id.*

259 Lawler et al., *supra* note 145, at 41.

260 *Id.*

261 Mawdsley et al., *supra* note 216, at 1084.

262 Lawler et al., *supra* note 145, at 41.

263 *Id.* at 38.

264 MANAGING FORESTS FOR CLIMATE CHANGE, *supra* note 113, at 11. For a discussion of seed sourcing strategies in a changing climate, see Martin F. Breed et al., *Which Provenance and*

based on climate conditions, managers might plant trees that come from a lower elevation seed zone at a higher elevation. The BLM and Forest Service have pursued this strategy in Southwestern Colorado.[265] To respond to regional climate change,[266] these agencies developed a drought vulnerability model, an alpine monitoring program, and created projections of future temperatures and precipitation patterns for the management unit.[267] The agencies will use this new information to help land managers respond to climate change by planting different tree species that are better adapted to fire, drought, and pests.[268] This type of information may also assist wilderness managers in planning for higher elevation insect or disease outbreaks and anticipate species loss and forest mortality events.[269] However, as one study warns, expanding seed zone sizes or relaxing genetic transfer rules "is experimental by design [and] should be undertaken cautiously."[270]

In grassland ecosystems, there are also examples of realignment approaches used to exclude invasion by nonnative plants. In one grassland revegetation project at the base of Colorado's Front Range, managers revegetated a gravel pit with an "uncertain climate seed mix" of native grasses whose moisture demands spanned a 500 mm gradient.[271] The plant community that emerged, dominated by a mixed grass prairie species capable of surviving a three year drought, differed from the tallgrass species mix that might have otherwise emerged. It appears largely resistant to nonnative plant invasions.[272]

C. Restraint

Restraint means "selecting certain areas in which no interventions will occur," or more simply: "leav[ing] some places alone."[273] Many legal scholars have argued that the restrictive constraints of the Wilderness Act are beneficial because the most appropriate management choice for wilderness

Where? Seed Sourcing Strategies for Revegetation in a Changing Environment 14 CONSERVATION GENETICS 2 (2013).

265 *See, e.g.*, Gilbert H. Fechner, U.S. Forest Serv., *Blue Spruce*, http://www.na.fs.fed.us/pubs/silvics_manual/Volume_1/picea/pungens.htm (last visited Apr. 12, 2014).

266 The agencies manage a region where the temperature has increased approximately 1.5 degrees Fahrenheit since the 1970s; snowmelt is occurring earlier in the spring; and more severe spring floods and lower summer stream levels are projected. CLIMATE CHANGE TASK FORCE 2011 PROGRESS REPORT, *supra* note 104, at 6 (citing U.S. GLOBAL CHANGE RESEARCH PROGRAM, GLOBAL CLIMATE CHANGE IMPACTS IN THE U.S. 129 (2009)).

267 CLIMATE CHANGE TASK FORCE 2011 PROGRESS REPORT, *supra* note 104, at 6.

268 *Id.*

269 Millar et al., *supra* note 246, at 2147.

270 *Id.* at 2148. According to Millar et al., this type of adaptive management "requires careful documentation of treatments, seed sources, and outplanting locations to learn from both failures and successes." *Id.*

271 Seastedt et al., *supra* note 195, at 551–52.

272 *Id.* at 551.

273 Stephenson & Millar, *supra* note 149, at 35.

areas is a hands-off, passive management regime.[274] Likewise, some ecologists argue that in the "rare cases when managers might have the ability to affect every part of a wilderness landscape, strong consideration should be given to restraint."[275]

1. Passive Management in Wilderness Areas Allows for Adaptation.

One argument for restraint is that purely passive management in wilderness areas will assist with adaptation to climate change. For instance, roadless areas, including wilderness areas, benefit watershed health.[276] Road construction damages water quality by increasing sedimentation, and existing roads concentrate and reroute water flow during times of precipitation, thereby affecting subsurface water availability by decreasing the amount of porous land available for water absorption.[277] Improved watershed health, in turn, benefits fish species.[278] As climate change affects water temperature and dissolved oxygen levels, fish populations will increasingly depend on high-quality habitat in wilderness areas.[279] Indeed, Colorado's native cutthroat trout already heavily rely on intact habitat in roadless areas for survival.[280]

Passive management in wilderness areas may also be an important tool to protect biodiversity in a changing climate. Wilderness areas provide

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274 *See Naturalness & Biodiversity*, *supra* note 31, at 125 ("Considering climate change, the most effective strategy, as suggested by many studies, is to maintain natural conditions, or conditions as natural as possible, and allow native species to adjust and survive on their own."); *see, e.g.*, Zellmer, *supra* note 21, at 371.

275 Stephenson & Millar, *supra* note 149, at 35; *see also* Eric S. Higgs & Richard J. Hobbs, *Wild Design: Principles to Guide Interventions in Protected Areas, in* BEYOND NATURALNESS: RETHINKING PARK AND WILDERNESS STEWARDSHIP IN AN ERA OF RAPID CHANGE 234, 241 (David N. Cole & Laurie Yung eds., 2010) ("Less intervention is better than more."); Peter Landres, *Let It Be: A Hands-Off Approach to Preserving Wilderness in Protected Areas*, *in* BEYOND NATURALNESS: RETHINKING PARK AND WILDERNESS STEWARDSHIP IN AN ERA OF RAPID CHANGE 88, 88 (David N. Cole & Laurie Yung eds., 2010).

276 Zellmer, *supra* note 21, at 319.

277 HERMANN GUCINSKI ET AL., U.S. FOREST SERV., FOREST ROADS: A SYNTHESIS OF SCIENTIFIC INFORMATION 16–17 (2001), *available at* http://www.fs.fed.us/pnw/pubs/gtr509.pdf; *see also* Stephen C. Trombulak & Christopher A. Frissell, *Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities*, 14 CONSERVATION BIOLOGY 18, 21 (2000) (discussing how decreased absorption and water concentration leads to greater flooding and erosion).

278 *See, e.g.*, CHRIS FRISSELL & GARY CARNEFIX, THE GEOGRAPHY OF FRESHWATER HABITAT CONSERVATION: ROADLESS AREAS AND CRITICAL WATERSHEDS FOR NATIVE TROUT 1 (2007), *available at* http://pacificrivers.org/files/wopr/FRISSELL.pdf ("Scientists and fish and wildlife managers across the West recognize that native fish and high-quality waters are often positively associated with watersheds having low overall road density and large proportions of roadless area.").

279 *See* Ashley D. Ficke et al., *Potential Impacts of Global Change on Freshwater Fisheries*, 17 REVS. FISH BIOLOGY & FISHERIES 581, 600 (2007).

280 DOMINICK A. DELLASALA ET AL., HOPE IN AN ERA OF CLIMATE CHANGE: ROADLESS AREAS IN NATIONAL FORESTS 8 (2011), *available at* http://earthjustice.org/sites/default/files/hope_in_era_climate_change.pdf (citing KEITH CURLEY & DAVID PETERSEN, TROUT UNLIMITED, WHERE THE WILD LANDS ARE: COLORADO—THE IMPORTANCE OF ROADLESS AREAS TO COLORADO'S FISH, WILDLIFE, HUNTING & ANGLING 7 (2006), *available at* http://www.tu.org/sites/default/files/CO-Where-the-wildlands-are.pdf).

habitat for threatened and endangered plant and animal species.[281] They will become increasingly important as species migrations and extinctions associated with climate change increase.[282] A 2009 review of recommendations for biodiversity management in the face of climate change found that the most frequent recommendation for climate change adaptation of the surveyed scientific literature is to improve landscape connectivity to facilitate species migration.[283] This goal could be achieved by acquiring new protected lands adjacent to wilderness areas to serve as migration corridors that facilitate species movement spurred by climate change. Managers could also work across wilderness boundaries to designate migration corridors that cover a range of elevations and land designations and ownerships. One example of lands that may be suitable for management as migration corridors are Inventoried Roadless Areas (IRAs) on Forest Service lands, which are frequently located next to wilderness areas.[284] IRAs comprise more low- and mid-elevation habitat than wilderness areas and therefore may provide connected habitat over a wide elevation range.[285]

More generally, one of the best strategies to allow biodiversity to adapt to a changing climate is to simply protect more habitat from human intervention. Authors in the climate change adaptation literature encourage managers to increase the number of reserves across the landscape; improve interagency and regional coordination; protect larger areas and reserve size; create and manage buffer zones around reserves; and capture landscape and bioclimatic diversity in protected areas.[286] Likewise, researchers discuss the possibility of responding to climate change by identifying, acquiring, and protecting refugia, defined as environments that are "more buffered against climate change and short-term disturbances."[287] One study suggests that if refugia can be identified, "they could be considered sites for long-term retention of plants or for establishment of new forests."[288] Similarly, many studies recommend protecting areas projected to be future "hotspots for biodiversity" in order to provide habitat for species of high conservation

281 Zellmer, *supra* note 21, at 319–20.

282 *See Naturalness & Biodiversity*, *supra* note 31, at 124 ("Under agency policies, native species are allowed to adjust on their own to climate change within conditions that are natural or as close to natural as possible. This is the most effective strategy for preserving native biodiversity.").

283 Heller & Zavaleta, *supra* note 98, at 24; *see also* Millar et al., *supra* note 246, at 2148; Noss, *supra* note 155, at 583–84 (discussing the importance of connectivity).

284 Elisabeth Long, *Roadless Areas for Climate Change Mitigation and Adaptation*, 40 ECOLOGY L.Q. 329, 366 (2013).

285 James R. Strittholt & Dominick A. DellaSala, *Importance of Roadless Area in Biodiversity Conservation in Forested Ecosystems: Case Study of the Klamath-Siskiyou Ecoregion of the United States*, 15 CONSERVATION BIOLOGY 1742, 1749 (2001); *see also* Colby Loucks et al., *USDA Forest Service Roadless Areas: Potential Biodiversity Conservation Reserves*, CONSERVATION ECOLOGY, Aug. 2003, at 5 (2003).

286 Heller & Zavaleta, *supra* note 98, at 18–19, 26.

287 Millar et al., *supra* note 246, at 21, 49.

288 *Id.*

value.[289] Wilderness without active management already provides vital reserves from human intervention that help achieve these goals.[290]

Existing wilderness areas, many of which protect high elevation habitats, may become increasingly important for biodiversity protection, because as climate change creates conditions inhospitable to a particular species, species will generally migrate north and upward in elevation.[291] Likewise, wilderness areas without human intervention may be more resistant to the spread of invasive species.[292]

2. *Resources May be Better Spent on Active Management in More Altered Landscapes*

Because passive management of wilderness areas already provides climate change benefits, it might be best to forgo management in wilderness areas and spend what scarce resources are available on climate change adaptation efforts where they are already needed most.[293] At a basic level, active management is expensive.[294] The realities of limited funds, staffing, and access usually mean that human intervention can only occur in "relatively small, strategically chosen parts of a wilderness landscape, focused on resources of particularly high value and vulnerability (such as a popular grove of giant sequoias or an endangered species)."[295] Additionally, it may be more appropriate to spend limited funds on management in other areas, like unprotected lower elevation forests, where human intervention has already drastically altered ecosystem structure and function.[296] Likewise, the majority of areas at risk for insect outbreak are in roaded landscapes.[297] Because wilderness areas are less disturbed by roads and logging, these areas are a lower priority for active management to reduce harm caused by these human interventions.[298]

289 Heller & Zavaleta, *supra* note 98, at 22.

290 *See Naturalness & Biodiversity*, *supra* note 31, at 78.

291 *See* Gian-Reto Walther et al., *Ecological Responses to Recent Climate Change*, 416 NATURE 389, 390 (2002).

292 *See, e.g.*, M.L. Cadenasso & S.T.A. Pickett, *Effect of Edge Structure on the Flux of Species into Forest Interiors*, 15 CONSERVATION BIOLOGY 91, 91 (2001) (finding intact habitat helps prevent the spread of invasive species).

293 *See* DELLASALA ET AL., *supra* note 280, at 9 (arguing climate change management effort, such as prescribed burning and thinning, should be focused "where they are needed most—the already degraded, fire-prone roaded areas").

294 *See*, Stephenson & Millar, *supra* note 149, at 37.

295 *Id.* at 35.

296 *See* DellaSala & Frost, *supra* note 179, at 13 (explaining that management for climate change adaptation to reduce fire hazards in intensely managed forests may be more important for three reasons: 1) they have been harvested and timber harvest can "increase fuel loads and reduce a forest's resilience to fire"; 2) roadless areas "have been less influenced by fire suppression than intensively managed lands"; and 3) road access to forest lands increases "the risk of human-caused wildfire ignitions.").

297 DELLASALA ET AL., *supra* note 280, at 15.

298 *Id.* at 8.

3. *Uncertainties and Lack of Monitoring Caution Against Active Management*

There are significant uncertainties associated with projecting the potential impacts of climate change on species or systems.[299] Restricting active management in wilderness areas reduces the possibility that climate change uncertainties may lead managers to make wrong decisions.[300] Wilderness scholar Michael McCloskey cautions that active management to correct human-caused adverse impacts is "itself subject to the same hazardous consequences as the short-sighted actions it was intended to correct."[301] For example, skeptics of assisted migration draw on the checkered history of intentional species introductions and cite ecological concerns, including the possibility that assisted migration could "erode biodiversity, disrupt ecosystems, and contribute to extinctions at receiving sites."[302]

Many management strategies for climate change response and realignment are largely experimental; their use in wilderness areas may require substantial justification and built-in monitoring.[303] Because "it's hard to talk about making an ecosystem resilient if one doesn't know what it takes to kill it in the first place,"[304] monitoring the effects of climate change within and outside these areas is critical for effective and appropriate adaptation strategies.[305] A well designed, fully funded monitoring program

299 Lawler et al., *supra* note 145, at 37.

300 *See* Landres, *supra* note 275, at 94; Eric S. Higgs & Richard J. Hobbs, *Wild Design: Principles to Guide Interventions in Protected Areas*, *in* BEYOND NATURALNESS: RETHINKING PARK AND WILDERNESS STEWARDSHIP IN AN ERA OF RAPID CHANGE 234, 242 (David N. Cole & Laurie Yung eds., 2010).

301 Michael McCloskey, *Changing Views of What the Wilderness System Is All About*, 76 DENV. U. L. REV. 369, 379 (1999) (internal quotations omitted); *accord Transforming the Means*, *supra* note 43, at 1445 ("Perhaps the most important reasons for not managing reserve areas actively is the substantial uncertainty that exists regarding the efficacy and unintended effects of human interventions."); Colburn, *supra* note 19, at 164–65 (emphasizing the lack of knowledge about ecosystems and how our management needs far outstrip our knowledge); Doremus, *supra* note 143, at 75 (arguing that "[l]eaving some places where nature, rather than humanity, determines the details of the response to climate change is only sensible," given that our lack of knowledge "about how the biota will respond to climatic alterations" means that "[o]ur active management choices . . . might easily be wrong."); Zellmer, *supra* note 21, at 372–73 (stating that "our current record for 'ecosystem engineering' has been less than stellar. Even when decision makers have had the best of intentions and generous funding, their efforts to restore ecological features and functions that were degraded or destroyed by development have been spotty. . . . Dramatic changes in climate will make our predictive challenges even greater.").

302 *Assisted Migration*, *supra* note 32, at 185. For a broader discussion of the risks of assisted migration, *see generally* Jillian M. Mueller & Jessica J. Hellmann, *An Assessment of Invasion Risk from Assisted Migration*, 22 CONSERVATION BIOLOGY 562 (2008).

303 *See* Landres, *supra* note 275, at 94.

304 M. Martin Smith & Fiona Gow, *Unnatural Preservation*, HIGH COUNTRY NEWS, Feb. 4, 2008, http://www.hcn.org/issues/363/17481 (last visited Apr. 12, 2014).

305 *See, e.g.*, BURCHFIELD & NIE, *supra* note 83, at 14 ("Monitoring programs should be prioritized and adequately funded in the future. . . . Monitoring is a key component of any adaptive

would improve the science behind land management, "build trust in the agency[,] and reduce some types of science-based political conflict."[306] However, there is a "history of unfunded monitoring programs and monitoring-related line items are often the first cut by decision makers."[307] If we are skeptical that necessary monitoring will occur, then we might be even more skeptical of pursuing active management that requires that monitoring.

4. Political and Bureaucratic Pressures

A final concern is that the constraints of the Wilderness Act might be essential to resist political or bureaucratic pressures to develop wilderness areas. Some commentators argue that the "lack of clear, uniform standards" governing agency decision making leads the agency to "submit to the persistent pressures of local commodity interests."[308] Relaxed standards that would allow for active management might be susceptible to these pressures, and allow for development in the guise of active management for climate change adaptation.[309]

The political pressures for development and conservation are often asymmetric: The benefits of development often redound to a relatively small group of individuals or small interest groups, and therefore are concentrated and provide higher per capita rewards; the benefits of conservation often are public goods that are distributed across society as a whole, and the beneficiaries are often dispersed and rewards are lower per capita.[310] For instance, logging in a wilderness area might provide a small number of jobs and revenue for a few timber companies, which are benefits important to a particular community but relatively small from a societal perspective. Conservation of that same wild area would provide limited specific benefits to individuals (e.g., hikers who enjoy using the wilderness area) but would

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approach and there is widespread agreement that more of it should be done by the agency and multi-party teams.").

306 *Id.* at 14.

307 *Id.*; *see also* Biber, *supra* note 50, at 942–43 (noting difficulties associated with long-term effective environmental monitoring); Eric Biber, *The Problem of Environmental Monitoring*, 83 U. COLO. L. REV. 1, 22–34 (2011) (discussing challenges of effective ambient environmental monitoring).

308 Monica Voicu, *At a Dead End: The Need for Congressional Direction in the Roadless Area Management Debate*, 37 ECOLOGY L.Q. 487, 503 (2010); *see also* Michael C. Blumm, *Public Choice Theory and the Public Lands: Why Multiple Use Failed*, 18 HARV. ENVTL. L. REV. 405, 407 (1994) (arguing that "exposed to sustained pressure from local commodity interest groups, federal agencies frequently capitulate to those forces because of the lack of standards governing land and water decisionmaking.").

309 *See, e.g.*, *Transforming the Means*, *supra* note 43, at 1447 ("A key underlying challenge of relying on a goal that seeks to promote desired future conditions is that doing so makes natural resources management more vulnerable to the political pressures often wielded against natural resource conservation.").

310 *See, e.g.*, Eric Biber, *The Importance of Resource Allocation in Administrative Law*, 60 ADMIN. L. REV. 1, 43 (2008); Matthew D. Zinn, *Policing Environmental Regulatory Enforcement: Cooperation, Capture, and Citizen Suits*, 21 STAN. ENVTL. L. J. 81, 107–11 (2002).

also provide broader public benefits such as protection of habitat for endangered species.

Public choice theory would predict that in these circumstances, those who benefit from development would have substantial organizational advantages and have more success in using the political, administrative, and legal processes to achieve their goals compared to those who benefit from conservation.[311] This asymmetry can be overcome on occasion.[312] For instance, a major crisis or an active grassroots effort might succeed in mobilizing the public to push for enactment of a statute that provides substantial conservation benefits.[313] However, this is more likely to be successful on the high profile level of enacting legislation, for example, rather than in the mundane, day-to-day world of administrative determinations of whether a particular logging project should be implemented in a particular wilderness area.[314] Strict statutory standards enforced by courts might therefore be more effective in advancing conservation goals on average, and might also more accurately reflect public preferences and ensure the implementation of those preferences in on-the-ground management.[315] Vague standards that give substantial discretion to agency decision makers would, on the other hand, provide significant advantages to interest groups that benefit from development, even if they are a relatively small minority in society.[316]

In the context of natural resources decision making, vague standards may be particularly problematic because of the underlying, often inherent, uncertainty in the relevant science. Development projects can often be marketed as producing significant environmental improvements, but instead the projects can turn out to be ineffective, or worse counterproductive.[317] Even if evidence emerges that the development projects are ineffective or counterproductive, development interests might rely on scientific uncertainty to argue for continuing those development projects masquerading as "active management," because it has not been "proven" that the projects are ineffective or counter-productive.[318] Accordingly,

311 *See, e.g.*, Zinn, *supra* note 310, at 129–31 (arguing that "allocation of benefits and costs creates strong incentives for participation by regulated firms and weak incentives for pro-regulatory groups.").

312 Biber, *supra* note 310, at 40–41 (noting the function of courts in upholding "clear, specific congressional requirements for agencies to act.").

313 *See* Anthony Downs, *Up and Down with Ecology—The "Issue-Attention" Cycle*, 28 PUB. INTEREST. J. 38, 39 (1972); Daniel A. Farber, *Politics and Procedure in Environmental Law*, 8 J.L. ECON. & ORG. 59, 66–67 (1992); E. Donald Elliott et al., *Toward a Theory of Statutory Evolution: The Federalization of Environmental Law*, 1 J.L. ECON. & ORG. 313, 328 (1985).

314 *See* Biber, *supra* note 307, at 37; Daniel A. Farber, *Taking Slippage Seriously: Noncompliance and Creative Compliance in Environmental Law*, 23 HARV. ENVTL. L. REV. 297, 319 (1999).

315 *See* Biber *supra* note 310, at 49, n.163.

316 *See* Biber, *supra* note 307, at 48–49.

317 *Id.* at 72.

318 *See, e.g.*, Josh Eagle & Barton H. Thompson, Jr., *Answering Lord Perry's Question: Dissecting Regulatory Overfishing*, 46 OCEAN & COASTAL MGMT. 649, 651 (2003) (finding that fisheries managers consistently set fishing quotas to achieve the greatest level of fishing production within the range of uncertainty that fisheries scientists recommended).

development interests might have success in lobbying the agency or political actors to allow additional development projects despite the evidence of harm.[319]

Even riskier would be vague standards that expand or diversify the range of goals that can be pursued in wilderness areas. Then, development projects could be advanced not just based on claims about uncertainty, but also based on claims that they support alternative goals such as "community stability" or "sustainable development" as well as environmental protection or climate change adaptation. The most extreme example here is the multiple-use mandate of BLM and the Forest Service, a mandate that some scholars argue has allowed development interests to gain significant rewards from public lands at the expense of ecosystems and the broader public.[320] Again, political pressures might mean that those goals that are friendlier to development projects are systematically favored in the implementation process at the expense of ecological health, public preferences, and effective adaptation to climate change.

Bureaucratic pressures have somewhat different sources, but may produce similar outcomes. Agencies that have historically focused on development goals may resist placing greater weight on environmental protection as a result of institutional culture and inertia.[321] Agencies may pursue those development goals—relying on the uncertainty and conflicting goals discussed above—at the ongoing expense of environmental protection. Again, strict standards enforced by judicial review and citizen litigation or administrative participation might be necessary to change institutional cultures and reorient the agency around a new mission.[322]

IV. WHAT MANAGEMENT CHOICES ARE POSSIBLE UNDER THE WILDERNESS ACT?

Which of these management choices are open to management agencies under the Wilderness Act? Answering that question depends on both understanding the underlying legal question—what does the statute allow the agencies to do—and a separate practical question, what do the agencies believe they have the power to do? Even if the statute gives the agencies broad powers, if the agencies do not believe they have powers, or choose not to exercise their powers, management choices are effectively closed off.

We therefore begin with a brief overview of the Forest Service and Park Service wilderness policy guidelines. As it turns out, those policy guidelines

319 *See* Biber, *supra* note 307, at 36–37.

320 *See* Blumm, *supra* note 308, at 407, 411.

321 *See generally* Eric Biber, *Too Many Things To Do: How to Deal with the Dysfunctions of Multiple-Goal Agencies*, 33 HARV. ENVTL. L. REV. 1, 13–30 (2009) (exploring various options that policymakers may employ, such as breaking-up, reorganizing, or adding or removing authority, to better achieve an agency objective).

322 The litigation over logging of old-growth forest on public lands in the Pacific Northwest might have played an important role in reorienting the Forest Service from an historic orientation focused on timber production toward a new mission focused more on ecosystem protection and restoration. *See id.* at 55–57.

generally impose few constraints on agency management choices.[323] We then examine the legal constraints the Wilderness Act imposes on the agencies, as interpreted and applied by the courts that review agency decision making under the Act. Here, the constraints are more significant, though in the end the agencies are still provided with substantial discretion.[324]

A. *Management Agency Policy Handbooks Provide Broad Leeway Under the Wilderness Act*

While not legally binding on the agencies,[325] the Forest Service and Park Service wilderness management handbooks do provide insight into the types of climate change adaptation activities that the agencies believe are permissible in wilderness areas.[326] These policies, which provide guidance for individual projects in wilderness areas, describe a variety of management actions currently discussed in the climate change adaptation literature.[327]

We examine how agency policy handbooks construe agency authority under the Wilderness Act in our key areas of interest: biodiversity and forest health.

1. *Biodiversity*

The Forest Service addresses biodiversity in wilderness areas through its fish and wildlife wilderness management policies.[328] These policies provide that wildlife reintroductions are proper only in wilderness areas where a species once naturally occurred and was later extirpated by "human induced events."[329] Arguably, this would allow reintroduction of species extirpated by climate change, perhaps even in different locations than where they once occurred as long as the new locations were in the same wilderness area. However, this wildlife management policy would not allow assisted migration, which involves the introduction of a species to an area where it did not exist historically.[330] Additionally, predator control may be approved on a case-by-case basis where control is "necessary" to protect listed species, to protect human health and safety, or to prevent "serious" losses of

323 *See* U.S. FOREST SERV., FOREST SERVICE MANUAL, FSM 2324.34 (2007) [hereinafter FSM].

324 *See id.* at 2320.6.

325 *See* Wilderness Soc'y v. Norton, 434 F.3d 584, 596 (D.C. Cir. 2006) (holding that Park Service wilderness management policies are not binding on the agency); McGrail & Rowley v. Babbitt, 986 F. Supp. 1386, 1394 (S.D. Fla. 1997) (holding that the FWS Refuge Manual was not binding on FWS actions); W. Radio Servs. Co. v. Espy, 79 F.3d 896, 901 (9th Cir. 1996) (holding that Forest Service manual and handbook did not have independent force and effect of law so as to bind Forest Service).

326 *See* FSM, *supra* note 323, at 2323.12.

327 *See id.* at 2320.2; *see generally* NATIONAL PARK SERV., DIRECTOR'S ORDER # 41: WILDERNESS STEWARDSHIP 7 (2013) [hereinafter NPS DIRECTOR'S ORDER # 41].

328 FSM, *supra* note 323, at 2323.04(b).

329 *Id.* at 2323.33(a) "Reintroductions." To aid in reintroductions, motorized or mechanical transportation may be approved where reintroduction is otherwise impossible. *Id.* at 2326.

330 *See id.* at 2323.33(a).

livestock.[331] This policy may give managers flexibility to protect listed species that are threatened by both climate change and predation by nonnative invasive species.

The policies also state that fish stocking projects are permissible in wilderness areas.[332] Exotic fish species may not be stocked in wilderness areas and federally listed indigenous species, indigenous species, threatened or endangered native species, and native species are preferred, in that order.[333] Because native species are defined as any species that "naturally occurs in the United States," this policy could allow assisted migration of a wide variety of fish species.[334]

Forest Service wilderness managers may also consider stocking presently unstocked waters that formerly supported indigenous fish populations and "that could provide suitable habitat for an indigenous species with unusual wilderness appeal."[335] Chemical treatment may be used prior to reestablishment of desirable fish species "to correct undesirable conditions caused by human influence."[336] These provisions would give the Forest Service wide latitude for nonnative species control and native species reintroductions as part of climate change adaptation projects in aquatic systems.

The policies might also allow manipulation of fish and wildlife habitat for climate change resistance, resilience, and realignment. They direct that habitat manipulation is permissible "to perpetuate the wilderness resource," "sustain a primary value of a given wilderness," or to "perpetuate" a listed species.[337] However, active habitat management projects may only proceed where three conditions are met: 1) "The condition needing change is a result of abnormal human influence"; 2) "serious or lasting damage to wilderness values" will not result; and 3) it is reasonably certain that the project will achieve "desired objectives."[338] Climate change likely qualifies as "abnormal

331 *Id.* at 2323.33(c) "Predator Control." The agency must "[f]ocus control methods on offending individuals and under conditions that ensure minimum disturbance to the wilderness resource and visitors." Control projects may only be approved where "strong evidence exists that removing the offending individual(s) will not diminish the wilderness values of the area." *Id.*

332 *See id.* at 2323.34(a) "Stocking Programs." Stocking must normally be accomplished by "primitive means" rather than by aircraft. *Id.* at 2323.34(b).

333 *Id.* at 2323.34(c) "Stocking Policy." The agency policy defines indigenous species as one "that naturally occurs in a wilderness area and that was not introduced by man" where as a native species is one that "naturally occurs in the United States and that was not introduced by man." *Id.* at 2320.5(10)–(11).

334 *See id.* at 2320.5(11).

335 *Id.* at 2323.34(c)(3). Additionally, the agency may only stock barren waters after "determining that the scientific and research values of such barren waters will not be eliminated from a wilderness and documenting the desirability of such action in the forest plan." *Id.* at 2323.34(c)(2).

336 *Id.* at 2323.34(f) "Chemical Treatment" (citing *id.* at 2150).

337 *Id.* at 2323.35(a)–(b).

338 *Id.* at 2323.35(a)(1)–(3), (b). Additionally, major projects should be tested outside wilderness areas through a pilot study, where possible, and where wildlife spend only part of their time in wilderness, projects should be preferentially located outside of wilderness. *Id.* at 2323.35(a)–(b).

human influence," but where the impacts of climate change are uncertain, it could be difficult for managers to show that the project will achieve desired objectives. In any case, uncertainty might indicate that a project is inappropriate for implementation in a wilderness area.

The Park Service policy manual has a very short general section on climate change.[339] It directs wilderness managers and park superintendents to "collaborate across program areas to develop flexible, sustainable strategies that uphold wilderness values and integrate with park, regional, and national level responses."[340] Interestingly, the guidance specifies that climate change strategies must account for both the impacts on wilderness character from actions taken and those not taken.[341]

Otherwise, the Park Service only provides specific guidance as to nonnative invasive species.[342] The policy manual directs that "[p]arks should be managed with the goal of early detection and rapid response in areas adjacent to wilderness to prevent the spread [of nonnative species] into wilderness."[343] Parks must use Integrated Pest Management (IPM) techniques, including prevention, monitoring, prioritization, research, and education.[344] The objective of invasive species treatment within wilderness areas is eradication, or containment to prevent spread where eradication is impossible.[345] This policy appears to allow a wide range of invasive species management techniques for climate change resistance and resilience, including chemical, manual, and mechanical methods.[346]

2. Forest Health

As described above, logging or thinning to reduce fuel loads and restore forest ecosystems after major fire events have been suggested as possible management choices to improve forest health.[347] On National Forest System lands, after fires or other disturbances, managers must allow "natural" healing of disturbed communities with "structural or vegetative assistance only as a last resort."[348] Reforestation is only permissible "if a loss of the wilderness resource, due to human influence, has occurred and there is no

339 *See* NPS DIRECTOR'S ORDER # 41, *supra* note 327, at 10.

340 *Id.*

341 *Id.* Additionally, "[s]uperintendents and wilderness staff should fully participate and be leaders in efforts to increase landscape connectivity, improve ecosystem resilience through the reduction of the influence and negative impact of humans on the ecosystem, engage in inter-agency management collaboration, consider appropriate scientific research, and create relevant climate change communication products." *Id.*

342 *See id.* at 11–12.

343 *Id.* at 11.

344 *Id.* at 12.

345 *Id.*

346 While the policy does not define IPM, according to the EPA, IPM allows a variety of pest control methods, including targeting spraying of pesticides, and even "[b]roadcast spraying of non-specific pesticides" as a "last resort." EPA, *Integrated Pest Management (IPM) Principles*, http://www.epa.gov/opp00001/factsheets/ipm.htm (last visited Apr. 12, 2014).

347 *See supra* text accompanying notes 170–72.

348 FSM, *supra* note 323, at 2323.52.

reasonable expectation of natural reforestation."[349] In general, the agency may allow cutting and sale of vegetation only where "necessary for wilderness purposes or on valid mining claims[,]" or when emergency conditions like fire or insects require timber cutting.[350]

While these policies are restrictive, they do allow vegetation management to respond to forest health issues related to fire or insects.[351] Climate change will increase the impacts of both fire and insects,[352] and the majority of forest management activities for climate change adaptation will likely be proposed to respond to these forces. Likewise, reforestation for climate change adaptation might be acceptable if climate change, a human influence, causes forest loss and produces conditions that reduce the likelihood of natural reforestation, which are both plausible scenarios, as discussed above.[353] However, the policy does not explain whether the agency can reforest areas with different species or genotypes adapted to future conditions.[354]

Another reason for active management and restoration of forest ecosystems is to protect and restore water quality in watersheds on National Forest System lands.[355] The Forest Service allows active management for watershed improvements to restore "watersheds where deteriorated soil and hydrologic conditions caused by humans or their influences create a serious threat or loss of wilderness values" or where conditions "could cause serious depreciation of important environmental qualities outside the wilderness."[356] Climate change could certainly cause degradation of watersheds and qualifies as a human influence.[357]

However, managers must again promote "natural healing" where "natural vegetation would return in a reasonable time."[358] Where this is unlikely, managers should use "indigenous or appropriate naturalized species to reestablish vegetation."[359] After wildfire, burned area rehabilitation is permissible only "to protect life, property, and other resource values," or where an "unnatural loss of the wilderness resource" may occur.[360] This last phrase is not defined, but the agency could probably make a convincing

349 *Id.* at 2323.54.

350 *Id.* at 2323.52(4). Managers must also "[r]ecognize both climax and successional biotic communities as natural and desirable." *Id.* at 2323.52(2).

351 *See id.* at 2323.52(4).

352 PETERSON ET AL., *supra* note 54, at 1.

353 *See* FSM, *supra* note 323, at 2323.54.

354 *See id.* at 2323.52.

355 *See id.* at 2323.43(a).

356 *Id.*

357 *See* U.S. FOREST. SERV., PNW-GTR-812, WATER, CLIMATE CHANGE, AND FORESTS 12 (2010), *available at* http://www.fs.fed.us/pnw/pubs/pnw_gtr812.pdf.

358 FSM, *supra* note 323, at 2323.43(a).

359 *Id.* The agency defines "naturalized species" as a species "that is close genetically or resembles an indigenous species and that has become established in the ecosystem as if it were an indigenous species." *Id.* at 2320.5(12). Additionally, only "imminent" threats to downstream values justify the use of motorized equipment for restoration activities. *Id.* at 2323.43(a).

360 *Id.* at 2323.43(b). "Normally," only "hand tools and equipment" may be used to install watershed treatments. *Id.*

argument that climate change, along with fire effects, has created an unnatural loss.

While the Park Service wilderness stewardship policy does not contain guidance on insect and disease treatments, the Forest Service's manual directs that managers may not control outbreaks unless "necessary to prevent unacceptable damage to resources on adjacent lands or an unnatural loss to the wilderness resource due to exotic pests."[361] In determining whether controls are warranted, managers must perform a biological evaluation and weigh the effects of the epidemic on the wilderness, or on outside resource values, against the adverse effects of active control measures.[362] Where control is necessary, project actions must have the least adverse impact on wilderness values, other alternatives to chemical treatments must be considered, and managers must take "special care" in using chemicals within wilderness.[363]

These provisions allow managers to respond to increases in insect infestations and disease epidemics in wilderness areas that are exacerbated by climate change. While species like the mountain pine beetle would not qualify as an "exotic pest," beetle infestations certainly affect resources on lands outside wilderness.[364] Therefore, the policies may allow thinning, trapping, or chemical application to protect outside resources from climate-fueled infestations and disease outbreaks.[365] However, the actions must be shown to have the least adverse impact on wilderness values, and nonchemical treatments must be considered.[366]

Another management option is to rely on fire—whether prescribed or natural—to address management concerns, including high fuel loads, in wilderness areas.[367] Forest Service guidance directs managers to allow "lightning caused fires to play, as nearly as possible, their natural ecological role within wilderness" and allows two types of prescribed fires in wilderness areas: those ignited by agency managers and those naturally ignited by lightning and allowed to burn under prescribed conditions.[368] However, management-ignited prescribed fires are not allowed "to benefit wildlife, maintain vegetative types, improve forage production, or enhance other resource values."[369] The policy further provides that agency managers may only ignite prescribed fire in wilderness areas in order to "reduce unnatural buildups of fuels" if necessary to wilderness fire management

361 *Id.* at 2324.12. In considering whether to control insect or disease outbreaks, managers may "not consider the commercial value of trees in wilderness" areas. *Id.*

362 *Id.* at 2324.14.

363 *Id.* at 2324.15.

364 *See supra* Part II.B.4.

365 *See* FSM, *supra* note 323, at 2324.15.

366 *Id.* This analysis and standard is consistent with the relevant case law under the Wilderness Act. *See infra* Part IV.B.2.

367 FSM, *supra* note 323, at 2324.22(1), (6).

368 *Id.* at 2324.21, 2324.22(1).

369 *Id.* at 2324.22(7). The guidance does acknowledge that "these additional effects may result from a decision to use prescribed fire." *Id.*

objectives and several conditions are met.[370] These conditions include that prescribed fire and fuel treatment outside wilderness must be insufficient to achieve objectives within wilderness and that naturally ignited fires "cannot be allowed to burn because they will pose serious threats" inside or outside the wilderness.[371]

While the policy likely allows management of natural ignitions for climate change adaptation objectives, it is unclear whether managers could use prescribed fire to improve climate change resilience in order to maintain existing vegetative types, improve forage production, or benefit wildlife.[372] Where climate change impacts cause or might interact with "unnatural" fuel buildups, prescribed fire is likely appropriate as long as the agency demonstrates that alternatives are not available.

With respect to prescribed fire, Park Service guidance is less onerous. Where fire is not "adequately functioning as a natural change agent" due to "past fire management practices" and "the need to control wildfires" on neighboring lands,[373] managers may augment natural ignitions with "prescribed fire *or other fuel treatments*" that may be "necessary to restore or maintain ecological function if that is a goal identified in the park's Wilderness Stewardship Plan or [Fire Management Plan]."[374] The Park Service policy would likely allow a wide range of activities to maintain ecological function in the face of climate change, including prescribed fire, management of natural ignitions, and maybe even thinning.

Overall, agency policies provide wide latitude for climate change adaptation in wilderness areas as long as specified findings are made—findings that, as we will discuss, tend to track the statutory requirements of the Wilderness Act. The only major exceptions are the Forest Service's somewhat restrictive policies on assisted migration and prescribed fire.

B. Statutory Restrictions on Agency Wilderness Management

What constraints does the statute place on agency management discretion? We examine the statute, regulations, and existing Wilderness Act case law to outline the boundaries of those activities clearly prohibited or permitted in wilderness areas. Between the permissible and impermissible, there are a variety of actions that a court may uphold if the agency

370 *Id.* at 2324.22(6).

371 *Id.* at 2324.22(6)(a), (d). Likewise, management ignited fire is impermissible to achieve fire management objectives where these objectives can be achieved by lightning-caused fires. *Id.* at 2324.22(8). Additionally, an "interdisciplinary team of resource specialists" must evaluate the proposed use of fire and the public must be involved in the decisionmaking process. *Id.* at 2324.22(6)(b)–(c).

372 *See id.* at 2324.22(7).

373 NPS DIRECTOR'S ORDER # 41, *supra* note 327, at 10.

374 *Id.* (emphasis added). In Park Service wilderness areas, a Fire Management Plan (FMP) must be completed for each park with "burnable vegetation" that defines objectives and management considerations to meet land management and wilderness objectives. *Id.* Without an approved FMP, parks must suppress all wildfires. *Id.* at 11.

adequately explains the necessity of a particular action. As noted above, judicial review tends to be searching in the Wilderness Act context.[375]

Overall, agencies do have some discretion under the statute to pursue management actions that are inconsistent with the Act's restrictions, so long as they make a showing that a management action is: a) necessary to achieve the goals of the Wilderness Act; and, in most cases, b) that the action imposes the minimum possible intrusion on wilderness characteristics.[376] All passive management techniques ("restraint") are permissible under the Act's standards.[377] Many active management techniques to restore or protect existing native biodiversity and forests are likely permissible if the appropriate findings are made, and it is plausible that even active management to facilitate the shifting of native biodiversity and forests to new locations is permissible under the Act as well. In other words, the Act does not clearly foreclose the vast majority of active management for climate change adaptation.

1. Statutory Prohibitions and Exemptions

At the heart of the legal framework for the Wilderness Act are prohibitions on a range of active management techniques and exemptions to those prohibitions.[378] Section 4(c) of the Wilderness Act prohibits commercial enterprise and permanent roads, but section 4(d)(5) allows commercial services within wilderness areas "to the extent necessary for activities which are proper for realizing the recreational or other wilderness purposes of the areas."[379] Section 4(c) prohibits seven other actions, including: temporary road construction, use of motor vehicles, use of motorized equipment, motorboats, landing of aircraft, mechanical transport, and structures or installations.[380] However, an exception allows these seven prohibited uses where they are "necessary to meet minimum requirements for the administration of the area for the purpose of this chapter."[381] Section 4(b) states that management agencies "shall be responsible for preserving the wilderness character of the area," which, as discussed below, may impose a general mandate on management agencies to maintain or restore wilderness characteristics and may also prohibit activities that interfere with

375 Appel, *supra* note 39, at 96.

376 U.S. FISH & WILDLIFE SERV., WILDERNESS POLICY 3 (2008), *available at* http://www.fws.gov/refuges/whm/pdfs/wildernessPolicy_102808.pdf.

377 *See* Kevin Hood, *Scientific Study and Enduring Wilderness*, PARK SCI., Fall 2011, at 71–2, http://www.nature.nps.gov/parkscience/archive/PDF/Article_PDFs/ParkScience28(3)Winter2011-2012_71-74_Hood_2847.pdf (last visited Apr. 12, 2014).

378 *See* National Park Serv., *How is Wilderness Managed?*, http://www.nature.nps.gov/views/KCs/Wilderness/HTML/ET_05_How.htm (last visited Apr. 12, 2014).

379 16 U.S.C. § 1133(c), (d)(5) (2006).

380 *Id.* § 1133(c).

381 *Id.* (including "measures required in emergencies involving the health and safety of persons within the area").

wilderness character, even if not otherwise specifically prohibited under the Act.[382]

Section 4(d) of the Act contains other provisions that allow certain management activities in wilderness areas that might otherwise be prohibited.[383] For example, use of aircraft or motorboats is allowed in areas where these uses are already established.[384] Additionally, the Act allows the President to authorize water resources development in wilderness areas.[385] Most pertinent to climate change adaptation, section 4(d)(1) allows measures "necessary" to control fire, insects, and diseases.[386]

2. Demonstrating Necessity Under the Wilderness Act

What does it mean to establish that an action is "necessary" under either sections 4(c) or 4(d) and therefore is permissible under the Act?[387] Both case law and agency practice have effectively defined a two-step process.[388] First, the agency must demonstrate that the proposed action is essential to achieving some Wilderness Act goal, i.e., that it cannot be accomplished by non-prohibited activities.[389] This first step can be understood as an examination of whether the *type of action* proposed is the only feasible way of achieving the relevant goal.[390] Second, the agency must

382 *Id.* § 1133(b).

383 *Id.* § 1133(d).

384 *Id.*

385 *Id.* § 1133(d)(4). The Act also allows certain mineral activities. *Id.* § 1133(d)(2)–(3).

386 *Id.* § 1133(d)(1). While there are no Park Service regulations implementing the Act and the Forest Service regulations generally merely repeat the language in § 4(d)(1), 36 C.F.R. §§ 293.3, 293.6, the Fish and Wildlife Service wilderness regulations provide a bit more specificity with regards to § 4(d)(1). They provide that where "necessary," measures shall be prescribed "to prevent unacceptable loss of wilderness resources and values, loss of life, and damage to property." 50 C.F.R. § 35.7. The regulations do not define these terms. The FWS regulations also prohibit commercial timber harvest except "where necessary to control attacks of insects or disease." *Id.* § 35.8. The Forest Service regulations prohibit tree cutting "for nonwilderness purposes." *Id.* § 293.6. It is unclear whether a "nonwilderness purpose" is different from a commercial purpose.

387 Since "necessity" is used in both 4(c) and 4(d), courts have applied case law examining necessity under § 4(c) to conflicts under 4(d), and vice versa. "The term 'necessary' [under 4(d)] should be construed the same as it is for the 'as necessary to meet minimum requirements' exception described above [under 4(c)]." Zellmer, *supra* note 21, at 353. *See* High Sierra Hikers Ass'n v. Blackwell, 390 F.3d 630, 647 (9th Cir. 2004) (applying § 4(c) case law to a necessity determination under § 4(d)(5)).

388 See Rohlf & Honnold, *supra* note 33, at 262.

389 In § 4(d)(1) of the Act, which allows for management actions necessary to control fire, insects, and disease, it does not explicitly limit those actions to what is necessary to achieve the purposes of the Act. It only requires that the action be necessary to control fire, insects, and disease. *See* 16 U.S.C. § 1133(d)(1) (2006) ("such measures may be taken as may be necessary in the control of fire, insects, and diseases"). It therefore might support a broader range of active management choices to control fire, insects, and disease than the other exemptions under the Act. *But see Lyng I*, 662 F. Supp. 40, 41–42 (D.D.C. 1987) (enjoining proposed timber sale in wilderness area, even though timber project was intended to control insects, because it would have assisted commercial timber operations).

390 *See* ARTHUR CARHART NATIONAL WILDERNESS TRAINING CENTER, MINIMUM REQUIREMENT DECISION GUIDE, 9, U.S. FOREST SERVICE GUIDELINES (2008).

demonstrate that the proposed action would minimize impact on wilderness values or resources.[391] This can be understood as whether the *level of the action* proposed will minimize impacts on wilderness resources.[392]

An example of this two-step analysis comes from current Park Service management guidance.[393] Under this guidance, managers must complete a minimum requirements analysis (MRA) for each proposed action in a wilderness area that involves a prohibited use defined in section 4(c) of the Act, or for all other projects within wilderness areas that "could potentially affect wilderness character."[394] First, the agency determines whether a use is prohibited by the Act, and if it is, under the MRA documents whether the prohibited use is "necessary to meet minimum requirements for the

391 In some cases, it is unclear whether a court is analyzing the agency's management decision under the first or second step. *See, e.g.*, Wilderness Watch v. Iwamoto, 853 F. Supp. 2d 1063, 1074–76 (W.D. Wash. 2012) (enjoining agency proposal to reconstruct historic fire lookout in wilderness area on grounds that it was not "necessary," both because alternative options were available to preserve the historic feature and because the agency action "went too far"). The second requirement appears to be frequently applied in decision making under § 4(c), but some 4(d) cases have also required the agency to show that its approach is minimally intrusive. *See* Rohlf & Honnold, *supra* note 33, at 265 (discussing Minnesota Public Interest Research Group v. Butz (*Butz I*), 401 F. Supp. 1276 (D. Minn. 1975)). The two steps are explicit in § 4(d)(5)'s allowance for commercial activities to further recreational purposes. 16 U.S.C. § 1133(d)(5) (allowing commercial services "to the extent necessary for activities which are proper for realizing the recreational or other wilderness purposes"); High Sierra Hikers Ass'n v. Blackwell, 390 F.3d 630, 646–47 (9th Cir. 2004) (applying two step analysis). Rohlf and Honnold argue that the two steps should be applied to all necessity findings under the Wilderness Act. Rohlf & Honnold, *supra* note 33, at 279; *see also id.* at 270 ("[W]hen the Wilderness Act authorizes managers to take action within wilderness 'necessary' to accomplish the purposes of the Wilderness Act but inconsistent with the preservation of wilderness character, managers may employ only those methods that have the least adverse effect on wilderness character.").

392 *See* CARHART, *supra* note 390.

393 *Id.* at 10.

394 NPS DIRECTOR'S ORDER # 41, *supra* note 327, at 9. An MRA may never be used to allow permanent roads or commercial enterprise within a wilderness area. *Id.* Additionally, the policy states: "The use of motorized equipment and the establishment of management facilities are specifically prohibited when other reasonable alternatives are available." *Id.* The language in Order #41 requiring a necessity analysis for any action that "could potentially affect wilderness character" appears to implement § 4(b) of the Act, which requires agencies to preserve the wilderness character of wilderness areas. *See id.* Again, this makes § 4(b) a "fall-back" provision that prohibits management actions that degrade wilderness character, even if the management action is not otherwise prohibited under the Act. Order #41 requires a two-step analysis for actions that are not specifically prohibited but could "potentially affect wilderness character" even though § 4(b) nowhere uses the word "necessary." 16 U.S.C. § 1133(b) (2006). This is another example of the two-step necessity analysis being applied across the Wilderness Act, regardless of the specific text of the relevant provision. Application of the two-step necessity test nonetheless makes sense here. It seems implausible to read § 4(b) as prohibiting any and all management actions that "could potentially affect wilderness character" even if those management actions might (for instance) be necessary for ecological restoration or otherwise achieving the purposes of the Wilderness Act. That would nonsensically impose a higher standard on nonprohibited actions (e.g., use of hand tools) than applies to otherwise prohibited actions (e.g., use of motor vehicles). Instead, it makes sense to apply the same necessity test to all management actions under the Wilderness Act, and to conclude that if an otherwise non-prohibited action could "potentially affect wilderness character," the agency must ensure that any such impact is necessary to achieve some other purpose of the Wilderness Act.

administration of the area for the purpose of wilderness."[395] Second, the MRA must "determine the activity (method or tool) to accomplish the action (project) with the least negative impact to wilderness."[396]

The Forest Service recommends use of a Minimum Requirements Decision Guide (MRDG), or a similar process.[397] The MDRG was developed by the federal interagency training center for wilderness management.[398] While it also divides the analysis into a two-step process, the MDRG divides it slightly differently from the case law, placing more of the analysis in the second step.[399]

3. Identifying the Appropriate Goals of the Wilderness Act

A determination of whether an action is "necessary" to achieve the purposes or goals of the Wilderness Act implicitly requires a determination of what those purposes or goals are, and whether active management for climate change adaptation would be consistent with those purposes or goals.

The Wilderness Act defines wilderness areas as in contrast with areas "where man and his own works dominate the landscape."[400] Instead, wilderness is "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain."[401] More prescriptively, the Act states that wilderness is:

> an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may

395 NPS DIRECTOR'S ORDER # 41, *supra* note 327, at 9.
396 *Id.*
397 CARHART, *supra* note 390, at 1.
398 Arthur Carhart National Wilderness Training Center, *Who We Are* http://carhart.wilderness.net/index.cfm?fuse=who (last visited Apr. 12, 2014).
399 Specifically, the MDRG's first step requires a finding that action may be needed, that appropriate steps cannot be taken outside of the wilderness areas, and that the action is needed to satisfy one of the appropriate Wilderness Act goals. The second step requires an analysis of whether prohibited methods are needed to accomplish the action, and the extent to which otherwise prohibited methods must be used. *See* ARTHUR CARHART NATIONAL WILDERNESS TRAINING CENTER, MINIMUM REQUIREMENTS DECISION GUIDE, PROCESS OUTLINE (2012), *available at* http://www.wilderness.net/MRDG/documents/MRDG_process_outline.pdf; ARTHUR CARHART NATIONAL WILDERNESS TRAINING CENTER, MINIMUM REQUIREMENTS DECISION GUIDE, INSTRUCTIONS (2010), *available at* http://www.wilderness.net/MRDG/documents/MRDG_instructions.pdf.
400 16 U.S.C. § 1131(c) (2006).
401 *Id.*

also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.[402]

From this definition, it is not entirely clear whether adaptation to climate change is consistent with the goals of the Act. Commentators highlight different parts of the wilderness definition to support their conclusions about the propriety of active management in wilderness areas.[403] On one side, some emphasize the "untrammeled" and "natural conditions" parts of the wilderness definition in their conclusions that management intervention in wilderness areas should be limited.[404] On the other side, some emphasize the language "generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable," and flexibilities built into Act that allow managers discretion in manipulating wilderness areas.[405]

Other sections of the Act identify a diverse range of purposes for the law. Section 2 contains a policy statement that, like the Park Service Organic Act, balances between conserving or preserving natural resources and providing for recreational opportunities, with perhaps a primacy for conservation or preservation.[406] Additional language in section 2 appears to

402 *Id.*

403 *Compare* Zellmer, *supra* note 21, at 313, *and* Sean Kammer, *Coming to Terms with Wilderness: The Wilderness Act and the Problem of Wildlife Restoration*, 43 ENVTL. L. 83, 83 (2013), *with* Gordon Steinhoff, *Interpreting the Wilderness Act of 1964*, 17 MO. ENVTL. L. & POL'Y REV. 492, 501 (2010) (competing arguments about whether wildlife managers should or should not be allowed discretion in manipulating wilderness areas).

404 *See* Zellmer, *supra* note 21, at 313 (arguing that "managers and legislatures should not yield" to the pressure to "develop water resources within wilderness areas" and to exploit timber, wildlife, and "other virtually untapped components of wilderness" "[a]s the nation searches for climate change mitigation and adaptation strategies" and that "the need to preserve *untrammeled* wilderness characteristics is just as imperative today as it was in 1974 when the Wilderness Act passed") (emphasis added); Steinhoff, *supra* note 403, at 534–35 ("The act does not allow management interventions in wilderness that would hinder natural processes (trammeling) or otherwise diminish wilderness character, except in special circumstances and under tight constraints. . . . In accordance with the Wilderness Act, and values shared within our society concerning these lands, managers should attempt to preserve or restore natural wilderness conditions with unhindered natural processes."); Kammer, *supra* note 403 ("The Wilderness Act of 1964 calls for the preservation of certain areas in their natural, untrammeled conditions . . . . While it is commendable to strive to restore ecosystems that have been unduly degraded due to human behaviors, the Wilderness Act recognized the value of keeping some areas beyond humans' manipulative reach altogether—even if such interference is well-meaning.").

405 *See* Steinhoff, *supra* note 403, at 501 ("Hendee and Dawson, and other leaders in wilderness management, adopt interpretations of the Act that allow managers much discretion in manipulating these areas."). Hendee and Dawson emphasize the part of the Act's definition that describes wilderness as "general[ly] appear[ing] to have been primarily affected by the forces of nature, with the imprint of man's work substantially unnoticeable" as mandating preservation of the natural appearance of wilderness, not actual natural conditions. J.C. HENDEE & C.P. DAWSON, WILDERNESS MANAGEMENT: STEWARDSHIP AND PROTECTION OF RESOURCES AND VALUES 469–70 (3d ed. 2002).

406 16 U.S.C. § 1131(a) (2006) (stating that wilderness areas are to be "administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness"). These two purposes show that "[e]ven though Con-

provide further emphasis on the conservation and preservation goal, mandating that management agencies protect these areas from "expanding settlement and growing mechanization" so that there are lands left for "preservation and protection in their natural condition."[407]

Section 4(b) of the Act lists a wide range of goals that the protection of wilderness areas are intended to achieve, stating that wilderness areas are "devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use."[408]

Thus, it appears that Congress sought to attain multiple goals in enacting the Wilderness Act, including the "preservation of wildlands, protection and maintenance of natural areas for uses such as recreation and scientific research, and accommodation of local and commercial interests."[409] These goals can "obviously conflict."[410]

Scholarly commentary and agency regulations further interpret the Wilderness Act as imposing a mandatory duty on management agencies to restore wilderness areas where they have been harmed by human disturbance. Section 4(b) can be read as requiring managers to "preserve both the undisturbed, natural appearance and the ecological health of wilderness areas," suggesting that "managers may be obligated to take affirmative action to preserve or even restore wilderness character in addition to prohibiting or preventing activities that could harm wilderness character."[411] Any such duty to preserve wilderness character is still subject to the standards of the Act; section 4(b) qualifies the duty to preserve wilderness with the phrase "[e]xcept as otherwise provided in this chapter," implying that the management prohibitions and exemptions in sections 4(c) and (d) still apply.[412] Thus, prohibited uses are only allowed to preserve wilderness where they are "necessary to meet minimum requirements" for administration of wilderness areas.[413]

Likewise, the Forest Service regulations provide that "National Forest Wilderness resources shall be managed to promote, perpetuate, and, *where necessary, restore* the wilderness character of the land and its specific values of solitude, physical and mental challenge, scientific study, inspiration, and primitive recreation."[414] BLM regulations also provide that

gress recognized that humans and their technology pose threats to wild areas, Congress clearly did not intent to exclude people from wilderness." Rohlf & Honnold, *supra* note 33, at 256.

407 16 U.S.C. § 1131(a).

408 *Id.* § 1133(b).

409 Rohlf & Honnold, *supra* note 33, at 258. The authors cite the Act's provisions for mining, water and power development, grazing, and fire and pest control as showing "accommodation of local and commercial interests." *Id.* at 257–58.

410 *Id.* at 258.

411 Rohlf & Honnold, *supra* note 33, at 259. Rohlf and Honnold assert that the Act's "directive to preserve wilderness character requires managers to take affirmative actions *within* wilderness to mitigate these effects." *Id.* at 274. The relevant text of § 4(b) reads: "each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area." 16 U.S.C. § 1133(b) (2006).

412 16 U.S.C. § 1133(b) (2006).

413 Rohlf & Honnold, *supra* note 33, at 260.

414 36 C.F.R. § 293.2 (1995).

the agency will carry out management actions to restore wilderness character where necessary.[415]

One implication of this restoration mandate is that "efforts within wilderness to conserve threatened or endangered species seldom will conflict with the Wilderness Act as long as such efforts employ the minimum tools necessary to accomplish their purpose."[416] Another important implication might be that where climate change threatens wilderness character, this affirmative mandate may allow and even require a variety of adaptation efforts, including resistance and resilience, and where climate change has already affected wilderness areas, restoration may even be required. Of course, defining restoration is itself tricky. As discussed below, it is unclear if restoration can include adaptation of wilderness areas to new ecological conditions that were not historically present (realignment).[417]

C. Defining a Spectrum of Permissible to Impermissible Management Strategies for Climate Change Adaptation.

Given this structure, which of the management options identified in Part III would be legally permissible? There are a few clear examples on each end of the spectrum, but much gray area in between where the agency must adequately explain the necessity and minimal impact of a particular climate change adaptation action.

1. Prohibited

Section 4(c) prohibits permanent road construction and commercial enterprise in wilderness areas, subject to limited exemptions for commercial activities.[418] The impact of the absolute prohibition on permanent roads on climate change adaptation projects is mitigated because section 4(c) allows the construction of temporary roads and the use of mechanical transport in wilderness areas where the agency can show that these uses are "necessary to meet minimum requirements for the administration of the area."[419] In contrast, the prohibition on "commercial enterprise" has been expansively interpreted by the Ninth Circuit.[420] In *Wilderness Society v. U.S. Fish and Wildlife Service*, the Ninth Circuit interpreted the Act's prohibition on commercial enterprise to include management actions with a primary purpose and effect of enhancing a commercial enterprise.[421] The plaintiffs in

415 *See* 43 C.F.R. § 6303.1(d) (2009).

416 Rohlf & Honnold, *supra* note 33, at 275.

417 *See supra* text accompanying notes 477–482.

418 *See* 16 U.S.C. § 1133(d)(5) (2006) (allowing the performance of commercial services in wilderness areas "to the extent necessary for activities which are proper for realizing the recreational or other wilderness purposes of the areas").

419 *Id.* § 1133(c).

420 *See, e.g.*, Wilderness Soc'y v. U.S. Fish & Wildlife Serv., 353 F.3d 1051 (9th Cir. 2003); *Lyng I*, 662 F. Supp. 40, 41 (D.D.C. 1987).

421 *Wilderness Soc'y*, 353 F.3d at 1063–64 (9th Cir. 2003), *amended on rehearing en banc in part by* Wilderness Soc'y v. U.S. Fish & Wildlife Serv., 360 F.3d 1374 (9th Cir. 2003). For a de-

Wilderness Society challenged a decision by the U.S. Fish and Wildlife Service to grant a permit for a sockeye salmon enhancement project in Alaska's Kenai Wilderness, claiming that the permit sanctioned "an impermissible 'commercial enterprise'" within the wilderness area.[422]

Despite the fact that the enhancement project was administered by a non-profit organization, conducted using non-motorized means, and only benefitted commercial fishermen outside of the wilderness, the Ninth Circuit held that because the "purpose and effect" of the project was to aid the commercial fishing industry, the agency violated the terms of the Wilderness Act.[423] Despite the project's "benign" purposes, the court held that the primary purpose of the project was to advance the commercial interests of fishermen by increasing salmon runs.[424] Similarly, the primary effect of the project was to aid the commercial fishing industry because commercial fishermen caught more than eighty percent of the salmon produced by the project.[425]

The holding in *Wilderness Society* "creates a presumption that activities with commercial overtones will violate the Wilderness Act even if they are benign to wilderness areas."[426] Therefore, under *Wilderness Society*, a management action with a primary purpose and effect of aiding a commercial industry would be prohibited, even where those actions have ancillary climate change adaptation benefits. For example, if a court found that a forest thinning project's primary purpose and effect was to benefit the timber industry, it would be invalid, despite the fact that stand density reductions might create a more resilient forest in a warmer, dryer climate. Furthermore, under *Wilderness Society*, the court would not defer to the agency's characterization of the project.

However, this test is malleable. If the agency supports a claim that a project's primary purpose and effect is to protect an area's "wilderness character" through climate change resistance, resilience, or realignment

tailed description of this litigation, see generally Katherine Daniels Ryan, *Preservation Prevails over Commercial Interests in the Wilderness Act: Wilderness Society v. United States Fish & Wildlife Service*, 32 ECOLOGY L.Q. 539 (2005).

422 *Wilderness Soc'y*, 353 F.3d at 1055. The plaintiffs also claimed that the permit violated the Wilderness Act's mandate to preserve "natural conditions" that are part of the "wilderness character" of the area. Because the court held that the project was a commercial enterprise, it did not reach this claim. *Id.* at 1069 n.18.

423 *Id.* at 1064–65. According to the court, the "test looking to 'purpose and effect' is persuasive here because it gets to the heart of what has occurred in the wilderness." *Id.* at 1064. The court refused to defer to the agency's characterization of the project under *Chevron*. *Id.* at 1061; Chevron U.S.A., Inc. v. Natural Res. Def. Council, 467 U.S. 837, 842–43 (1984).

424 *Wilderness Soc'y*, 353 F.3d at 1064. The court acknowledged that this project had a "benign aim . . . with little visible detriment to the wilderness" and that the project was "nothing like building a McDonald's restaurant or a Wal-Mart store on the shores of Tustumena Lake." *Id.* at 1062.

425 *Id.* at 1065.

426 Ryan, *supra* note 421, at 539. It is also plausible that *Wilderness Society* appears to prohibit a management action that is otherwise consistent with the Act (i.e., does not violate any of the prohibitions in § 4(c)) so long as the action's purpose and effect was to advance commercial activities.

actions, this may be sufficient to survive judicial review even where a commercial operator benefits financially from a contract to implement the proposed activities. One commentator argues that an agency should be able to satisfy the "purpose and effect" test where the agency believes that "it makes sense to conduct an activity that has commercial overtones but which is nevertheless necessary for successful wilderness management."[427] For example, in the context of the *Wilderness Society* case, if the challenged project's purpose had been "to re-establish natural diversity among the salmon" and the project's effect had been "to improve the situation of salmon in the Kenai Wilderness, the USFWS might have successfully demonstrated that the Project was a management tool intended to rehabilitate salmon stocks and enhance recreational fishing—a legitimate wilderness purpose."[428] Or in the climate change context, where the preservation of the same salmon species in the face of climate change was the project's primary purpose, the project might be permissible, even if one effect of the project was to benefit the fishing industry.

2. Potentially Permissible: The Exceptions to Sections 4(c) and 4(d)

Section 4(c) prohibits temporary roads, use of motor vehicles, motorized equipment, motorboats, aircraft landings, mechanical transport, and structures or installations within wilderness areas.[429] These seven uses may be crucial to successful implementation of a variety of climate change adaptation projects. For example, a chainsaw might be needed to thin forests to promote climate change resilience; a mower or other motorized equipment might be needed to control nonnative invasive species; mechanical transport might be needed to carry a planting crew into a wilderness area to reforest with drought-adapted species where natural regeneration is unlikely after a large wildfire or to transport a fire crew to manage a natural ignition for resource benefit; a helicopter might be needed to track reintroduced species; or fences might be installed around climate-imperiled species to prevent predation or other stressors.

These prohibited uses all are allowed under section 4(c) if the agency can show that they are "necessary to meet minimum requirements for the administration of the area."[430] Section 4(d)(1) may allow similar actions to control fire, insects, and diseases for climate change adaptation if the agency can show that they are "necessary." Of course, an agency's determination that a particular management action is "necessary" may be challenged in court, and as noted above, courts have been very careful in scrutinizing agency compliance with the Wilderness Act.

Sometimes courts reject an agency effort to utilize a 4(c) or 4(d) exemption based on a conclusion that the agency action does not serve the

427 *Id.* at 570.
428 *Id.* at 571–72.
429 16 U.S.C. § 1133(c) (2006).
430 *Id.*

purposes of the Wilderness Act, but instead some other purposes.[431] A proposal for timber harvesting in a wilderness area to control beetle outbreaks pursuant to the exemption in 4(d), was enjoined by a district court because it concluded that the primary purpose and effect of the project would be to advance commercial timber production, rather than wilderness values.[432] Multiple courts have concluded that preservation of historic structures in wilderness areas is not a purpose compatible with the Wilderness Act.[433] Courts have at times been very narrow in their interpretation of the purposes permissible under the Wilderness Act.[434] Even though the Wilderness Act does identify recreation as one of the goals of the Act, a court rejected agency efforts to maintain dams that allowed for recreational fishing in mountain lakes because recreational fishing was "not an integral part of the wilderness nature of the area" and therefore building small dams to enhance fishing was not necessary for maintaining the area as a wilderness.[435]

However, in general, courts have recognized a wide range of goals that might be consistent with the Wilderness Act.[436] Helicopter training of search and rescue personnel in wilderness areas has been found to be consistent with the Act.[437] Most importantly for climate change adaptation, courts have repeatedly concluded that restoration of historic populations of native species or restoration of native ecosystems in wilderness areas is a permissible purpose under the Act that can support the 4(c) and 4(d) exemptions.[438] Even in concluding that supporting recreational fishing was not an appropriate purpose, a court noted that restoration of native trout populations might be an appropriate purpose that could, for instance, justify

431 *See*, *e.g.*, *Lyng I*, 662 F. Supp. at 41; Wilderness Soc'y v. U.S. Fish & Wildlife Serv., 353 F.3d 1051 (9th Cir. 2003).

432 *Lyng I*, 662 F. Supp. at 42. The court reached this conclusion even though § 4(d)(1) only limits management actions to those "necessary" to control fire, insects, and disease; necessity in § 4(d)(1) is not explicitly limited to advancing the purposes of the Wilderness Act. *See id.* at 41. However, commercial activities are explicitly prohibited under the Act, so the court's conclusion that 4(d)(1) could not justify advancing the goal of commercial activities seems reasonable. 16 U.S.C. § 1133(c) (2006). The reasoning in this case was later adopted by the court in *Wilderness Society*. *Wilderness Soc'y*, 353 F.3d at 1064. The court also appeared dubious about whether the proposed actions would be effective in controlling beetles. *Lyng I*, 662 F. Supp. at 42.

433 *See, e.g.*, Wilderness Watch v. Mainella, 375 F.3d 1085, 1091–92 (11th Cir. 2004); High Sierra Hikers Ass'n v. U.S. Forest Serv., 436 F. Supp. 2d 1117, 1135, 1138 (E.D. Cal. 2006). *But see* Wilderness Watch v. Iwamoto, 853 F. Supp. 2d 1063, 1072–74 (W.D. Wash. 2012) (deferring to agency conclusion that preservation of historic structures is a goal consistent with the Wilderness Act).

434 *See High Sierra Hikers Ass'n*, 436 F. Supp. 2d at 1132.

435 *Id.* at 1137.

436 *See infra* text accompanying notes 443–44.

437 Wilderness Watch v. Bureau of Land Mgmt. *(Wilderness Watch v. BLM)*, 799 F. Supp. 2d 1172, 1178 (D. Nev. 2011).

438 *See, e.g.*, *Lyng II*, 663 F. Supp. 556, 560 (D.D.C. 1987); Californians for Alts. to Toxics v. U.S. Fish & Wildlife Serv., 814 F. Supp. 2d 992, 996 (E.D. Cal. 2011); *Wilderness Watch v. FWS*, 629 F.3d 1024, 1035–36 (9th Cir. 2010); Wolf Recovery Found. v. U.S. Forest Serv., 692 F. Supp. 2d 1264, 1268 (D. Idaho 2010).

dam maintenance.[439] In upholding agency conclusions that conservation is an appropriate goal under the Wilderness Act, several courts have concluded that the Wilderness Act is ambiguous on this point and deferred to the agency's analysis.[440]

Where the purpose is appropriate, courts might still conclude that the agency management choice is not necessary to achieve that purpose.[441] For instance, in examining the construction of artificial water sources for wildlife populations in a wilderness area, a court concluded that while the purpose of restoring and protecting native wildlife was consistent with the Wilderness Act,[442] the agency had not demonstrated that construction of the water sources was the only feasible way to achieve that goal compared to other methods that would have been consistent with the Act.[443] Similarly, a proposal to harvest timber in a wilderness area in order to control a beetle infestation was enjoined in part because the agency had not provided an analysis of alternative control options.[444]

Courts have on occasion imposed a stricter "necessity" standard where the purpose being fulfilled is not wilderness protection per se, but an ancillary purpose consistent with the Act (e.g., historic preservation).[445] They have also imposed a requirement that the agency engage "in a formalized, side-by-side comparative analysis of the" need for the proposed action under a section 4(c) exemption compared to other possible, compliant actions.[446]

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439 High Sierra Hikers Ass'n, 436 F. Supp. 2d at 1133.

440 *See, e.g.*, *Wilderness Watch v. FWS*, 629 F.3d at 1033; Californians for Alts. to Toxics v. U.S. Fish & Wildlife Serv., 814 F. Supp. 2d 992, 1014–17 (E.D. Cal. 2011); *see also Wilderness Watch v. BLM*, 799 F. Supp. 2d at 1178 (deferring to agency conclusion that the goal of providing search and rescue support in a wilderness area is consonant with the Wilderness Act); Forest Guardians v. Animal & Plant Health Inspection Serv., 309 F.3d 1141, 1143 (9th Cir. 2002) (deferring to agency conclusion that predator control activities in a wilderness area were needed to achieve the goal of protecting lawful livestock grazing in the wilderness area).

Courts have reached different conclusions about whether restoration and conservation of native species is a goal that is separate from, and may be in tension with, wilderness protection (but nonetheless permissible under the Wilderness Act), or is in fact part of wilderness protection. *Compare Californians for Alts. to Toxics*, 814 F. Supp. 2d at 1022 n.32 (setting up a dichotomy between conservation and wilderness values), *with Wolf Recovery Found.*, 692 F. Supp. 2d at 1270 (finding restoration of wolf populations in a wilderness area to be equivalent to restoring wilderness).

441 *See infra* text accompanying notes 448–450.

442 *Wilderness Watch v. FWS*, 629 F.3d at 1035–36. The court's reasoning on this point relied to some extent on the fact that the wilderness area was located in a preexisting wildlife refuge.

443 *Id.* at 1037–38. Other methods the court suggested might be feasible alternatives included eliminating hunting, stopping translocations of endangered sheep, and ending predation by mountain lions. *Id.* at 1037–38.

444 *Lyng I*, 662 F. Supp. 40 at 41 (D.D.C. 1987).

445 *See* Wilderness Watch v. Iwamoto, 853 F. Supp. 2d 1063, 1075–77 (W.D. Wash. 2012) (concluding that helicopter use for the maintenance of a historic structure would be more closely scrutinized, and that the amount of use proposed by the agency was excessive) ("[H]ere, the Forest Service made frequent use of helicopters not to promote wilderness values but rather to further what the Service understands to be a separate purpose of the Wilderness Act, i.e. historic preservation.").

446 *Wilderness Watch v. FWS*, 629 F.3d at 1041.

Even where courts have found that the purpose of the management action is appropriate under the Wilderness Act, and the action is necessary to achieve that purpose, they have still found the particular manner in which the action was implemented was improper because it did not minimize impacts on wilderness resources.[447] A Forest Service proposal to use motorized equipment to eliminate non-native trout by using pesticides, and reintroduce native trout species, was consistent with the purposes of the Wilderness Act because it sought to conserve and restore native biodiversity.[448] Further, the use of motorized equipment was necessary to achieve that goal.[449] Even still, the court remanded back to the agency to consider in more detail possible impacts of the project on native invertebrate populations and whether those impacts required scaling back the extent of the project.[450] That analysis was required to ensure that the impact of the project on other wilderness resources was as minimal as possible.[451] Likewise, the Ninth Circuit rejected an agency management plan for commercial guided horse trips into a wilderness area because, while the commercial services fulfilled recreational goals that were consistent with the Act, the agency had not analyzed whether the number of trips authorized had an excessive impact on wilderness values.[452] The court required the agency to explicitly balance the impacts on wilderness values with the recreational goals being served in order to support its decision as to the extent of the use.[453]

The cases where courts have upheld proposed management actions provide useful guides as to what kinds of actions and justifications for those actions will pass muster with the courts. The kinds of actions that have been upheld have sometimes been quite substantial: In a sequel to the *Lyng* case discussed above, a court upheld limited timber harvesting in a wilderness area to control beetle infestations.[454] The court found that control of the beetle was necessary to protect habitat for an endangered bird species and prevent expansion of the beetle outbreak into properties outside the wilderness area, both of which were appropriate purposes under the Wilderness Act.[455] It also deferred to the agency's conclusion that timber

447 *See, e.g.*, Californians for Alts. to Toxics v. U.S. Fish & Wildlife Serv., 814 F. Supp. 2d 992, 1021–22 (E.D. Cal. 2011); High Sierra Hikers Ass'n v. Blackwell, 390 F.3d 630, 646–47 (9th Cir. 2004).

448 *Californians for Alts. to Toxics*, 814 F. Supp. 2d at 1015.

449 *Id.* at 1019. The court also deferred to the agency's conclusion that trout reintroduction was an appropriate restoration project. *Id.* at 1015.

450 *Id.* at 1019. The court required the agency to balance the impacts on native invertebrates with the benefits of trout reintroduction and justify its choice to weigh one factor over another. *Id.*

451 *Id.* (stating that the agency "violated the Wilderness Act by failing to consider the potential extinction of native invertebrate species as a factor relevant to the decision of whether the extent of the project was necessary.").

452 *High Sierra Hikers Ass'n*, 390 F.3d at 646–47.

453 *Id.* at 647.

454 *Lyng II*, 663 F. Supp. 556, 560 (D.D.C. 1987).

455 *Id.* at 558. Although the agency was careful to state it did not consider impacts on commercial timber on adjoining properties (to avoid running afoul of 4(c)'s prohibition on commer-

harvest would be at least "reasonably efficacious" in controlling the beetle,[456] and noted that site specific evaluation of the need for and impacts of each timber harvest project would minimize adverse impacts on wilderness resources.[457] Importantly, the court refused to require the Forest Service to prove the timber harvest project would be effective in controlling insects, and deferred to agency conclusions as to efficacy.[458]

Another case upheld the Forest Service's use of helicopters to aid in the monitoring and tracking of reintroduced wolves in Idaho wilderness areas.[459] Again, reintroduction of the native species was consistent with the purposes of the Wilderness Act; helicopters were necessary for the monitoring program to be feasible; and the impacts would be minimal.[460]

Courts have also upheld the use of predator control methods in wilderness areas to remove or kill mountain lions that threatened livestock.[461] While the purpose of these projects was to facilitate lawful grazing in wilderness areas,[462] the court indicated that other control methods against nonnative species would be upheld if they fulfill the purpose of protecting native biodiversity.[463]

There are therefore examples of courts upholding intrusive management actions—use of helicopters or timber harvesting—to restore or maintain native biodiversity and forest health in wilderness areas, that would otherwise be prohibited under the Wilderness Act.[464] Those intrusive

cial activity in wilderness areas), the goal of protecting nearby forests is fairly broad, and might justify a wide range of active management techniques to control insect or disease outbreaks as a result of climate change. *Id. Lyng II* demonstrates the potential breadth of the actions that might be justified under § 4(d)(1). Again, under § 4(d)(1) it is possible that any management action whose goal is simply to control fire, insects, or disease, without advancing a prohibited purpose under the Act (e.g., commercial activities) may be permissible. 663 F. Supp. 558. Rohlf and Honnold argue that the legislative history makes clear that the primary goal (besides advancing purposes of the Wilderness Act) that 4(d)(1) actions can advance is protecting neighboring forests from fire, insect, or disease threats originating within wilderness areas. *See* Rohlf & Honnold, *supra* note 33, at 269–70 n.124. Limiting § 4(d)(1) to only this additional goal seems reasonable, because otherwise it might justify wholesale exemptions from the Act given the widespread nature of fire, insect, and disease risks in forests. And again, the agency must also find that the impacts from any fire, insect, or disease control activity are the minimal necessary to accomplish the agency's goal. *See id.* at 269–70.

456 *Lyng II*, 663 F. Supp. at 559–560. The court did not require a showing that the project would be fully effective. *Id.*

457 *Id.* at 560.

458 *Id.* at 559. Other courts have deferred on technical findings by agencies in the context of wilderness management decision making. *See, e.g.*, *High Sierra Hikers Ass'n*, 436 F. Supp. 2d at 1132.

459 Wolf Recovery Found. v. U.S. Forest Serv., 692 F. Supp. 2d 1264, 1268 (D. Idaho 2010).

460 *Id.*

461 Forest Guardians v. Animal & Plant Health Inspection Serv., 309 F.3d 1141, 1142 (9th Cir. 2002).

462 *Id.* The case is an example of how one of the Wilderness Act goals can be to further limited; commercial exploitation of natural resources in wilderness areas.

463 *Id.* at 1143.

464 One commentator argues that these cases are wrongly decided or of limited relevance for the overall implementation of the Act. Kammer, *supra* note 403, at 121 (arguing that use of

management actions are the kinds of activities that might occur in order to provide resilience and resistance in the face of climate change. Courts have also upheld timber harvesting to control insect infestations in wilderness areas that threatened adjoining areas.[465] However, combining active management with commercial benefits does increase the risk that a court might conclude that the project is prohibited.[466]

Agencies, however, need to provide support for their claims that intervention is necessary and will have minimal impacts.[467] Agencies must explicitly consider alternative, non-prohibited activities; they must show that they have considered the impacts of the project on other wilderness values and concluded that the benefits of the project justify those impacts, including by explicitly balancing the benefits and costs of the proposed project and doing a site-specific analysis of the use of prohibited methods. Justification on these points need not rise to the level of conclusive proof and will be supported even in the face of contrary evidence.[468]

Overall, active management to respond to climate change is legally possible in wilderness areas. In particular, active management efforts to restore native species or ecosystems that fall into the categories of resilience or resistance should be possible if the agency makes the appropriate findings as to necessity and minimal impact. Motorized or mechanized uses (e.g., chainsaws, generators) would be possible, as would prescribed burns, construction of structures, or installation of equipment (such as wildlife guzzlers or irrigation systems for plants).[469] Obviously, the more intrusive and extensive (either in time or space) the prohibited activity, the heavier the agency's burden to show that the extent of the action is the minimum needed to accomplish the relevant goal.

Much trickier is active management to move species and ecosystems to a new status because of climate change, a status that has not been historically present in the wilderness area—what we call realignment.[470] Two

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active management techniques in wilderness areas should be prohibited even for wildlife restoration).

465 Sierra Club v. Block, 614 F. Supp. 488, 493–94 (D.D.C. 1985) (permitting the Forest Service to cut in order to control a beetle infestation and attempt to preserve other parts of the forest for the red-cockaded woodpecker).

466 As noted above, § 4(b) might serve as a general backstop prohibition on any actions that might degrade wilderness characteristics, even if the action is not otherwise specifically prohibited under the Act. *See supra* Part IV.B.3. However, also as noted above, the prohibitions under § 4(b) should not be more restrictive than the other prohibitions in §§ 4(c) and (d) of the Act. *Id.*

467 *See Block*, 614 F. Supp. 488 at 493 (analyzing the Forest Service's compliance with the National Environmental Policy Act in its decision to cut trees to prevent the spread of infestation, and looking in detail at the Forest Service's justification and decision-making).

468 *E.g.*, Wolf Recovery Found. v. U.S. Forest Serv., 692 F. Supp. 2d 1264, 1269 (upholding the use of helicopters to monitor reintroduced wolf populations in a wilderness area, even though there was evidence that wildlife managers were able to use less intrusive techniques).

469 Forest Service guidance would restrict use of prescribed burns on wilderness areas in National Forests. *See supra* text accompanying notes 372–75.

470 *But cf. supra* text accompanying notes 280–96 (discussing passive management, which allows species or ecosystems to transition to a new state under climate change and should usually be permissible under the Wilderness Act).

questions need to be answered to determine whether realignment actions are appropriate in a wilderness area. First, for any active managements steps that advance realignment (whether covered by the specific prohibitions in Section 4 or not), the agency will have to conclude that realignment is an appropriate goal under the Wilderness Act. This conclusion is required even for otherwise permissible management actions because the Wilderness Act contains general prohibitions against agency actions within wilderness that are contrary to the overall goals of wilderness protection and preservation.[471] Such actions cannot be seen as restoration of native habitat or ecosystems that were previously present in the wilderness area, such that they could be justified as necessary to achieve a goal consistent with the Wilderness Act. On the other hand, these actions are a response to human impacts on wilderness areas via climate change, and they are intended to manage change in order to reduce negative impacts on native species and ecosystem function.

Active management for conservation in wilderness areas in general highlights the tension in the general purposes of the Act between a) leaving wilderness areas "untrammeled" and, b) rendering the "imprint of man's work substantially unnoticeable" and protecting the "ecological" value of the wilderness area.[472] This conflict is particularly strong where realignment allows for wilderness areas to adapt to climate change in ways that are otherwise precluded because of other human impacts within or outside the wilderness area. For instance, climate change might cause a native species to migrate from one wilderness area to another; however, migration might now be blocked because the migration corridor has been eliminated or degraded by human impacts outside and between the two wilderness areas. In this situation, assisted migration to move a native species from one wilderness area to another can be seen as an effort to offset the impacts of human impacts that preclude natural adaptation to climate change.

As noted above, tension among goals in the Act has led a number of courts to conclude that the Wilderness Act is ambiguous with respect to whether conservation is an appropriate goal under the Act, and defer to agency conclusions on this question.[473] Given that a similar conflict exists for efforts to realign species and ecosystems so that they can adapt to climate change, it is plausible that a court would likewise defer to agency

471 *See* 16 U.S.C. § 1131(a) (2006) (stating that wilderness areas "shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness."); *id.* § 1133(b) ("[E]ach agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area. . . ."). Again, it is possible that to the extent active management for realignment is focused on fire, insect, or disease control, a wider range of actions may be permissible because under § 4(d)(1) the agency would only have to demonstrate that the action was "necessary" to control risks from fire, insects, or disease to neighboring forests. *See supra* notes 390, 438.

472 16 U.S.C. § 1131(c) (2006).

473 *See supra* text accompanying notes 445–46.

conclusions that realignment is consistent with the purposes of the Act.[474] Agencies would be more likely to receive deference to the extent that they conduct a thoughtful, public process to develop formal rules or policies articulating this position—ensuring that the agency conclusions receive *Chevron* deference.[475]

If the agency concludes that realignment is generally permissible in a particular context, then the second question would be whether the standard "necessity" analysis allows the use of otherwise prohibited methods (e.g., motorized vehicles or construction of structures). Again, assuming that the goal of realignment is appropriate under the Act, this should be no more difficult than for other active management efforts in wilderness areas.

In Table 1, we provide an overview of the wide range of activities discussed in Part II that would normally be prohibited under sections 4(c) and 4(d) but might be permissible if the agency finds they are necessary and have minimal impacts. Table 2 provides similar information, organized by the categories in Part II.

3. Permitted

It is clear that the passive management activities that fall into the restraint category and do not physically affect wilderness character are permissible under the Act.[476] For example, recommendations to expand habitat connectivity and networks of protected areas are allowed and are not controlled by the Act.[477] Additionally, active climate change adaptation actions that do not involve a prohibited use and seek to restore or protect native species or ecosystems are generally allowed.[478] For example, hand

474 Forest Service policy would limit the use of assisted migration in wilderness areas, U.S. FOREST SERV., FOREST SERVICE MANUAL 29–30 (2007) (providing that the Forest Service should seek to "[p]rovide an environment where the forces of natural selection and survival rather than human actions determine which and what numbers of wildlife species will exist" and precluding seeding of non-indigenous species). Moreover, other agency guidance that is more broadly applicable might limit the use of assisted migration. *See Assisted Migration*, *supra* note 32, at 191–96 (concluding that Forest Service and BLM policy guidance provide wide latitude for assisted migration, and that FWS and Park Service policy guidance are more restrictive, but still might allow some assisted migration in some circumstances).

475 *See generally* Chevron U.S.A., Inc. v. Natural Res. Def. Council, 467 U.S. 837, 842–43 (1984) (deferring to agency's reasonable interpretation of its enabling statute).

476 *See supra* text accompanying notes 280–96.

477 *See supra* text accompanying notes 280–96.

478 As discussed above, it is possible that § 4(b) might prohibit even management actions using nonprohibited methods if they would damage wilderness character. For instance, a large clearcut using hand tools might be prohibited by § 4(b). However, we believe that any such limitations in the context of climate change adaptation are minimal. The same "necessity" test applied under §§ 4(c) and (d) should equally apply to any prohibition under § 4(b), allowing management actions using nonprohibited tools if they are necessary to achieve the Act's purposes. Moreover, it seems unlikely that in the vast majority of cases the use of nonprohibited tools would even cause a possibility of significantly altering wilderness character and therefore triggering § 4(b).

The use of chemical treatments (such as pesticides or herbicides to control or eliminate nonnative species is one example where § 4(b) might impose some limits. Chemical treatments pulling a recently arrived nonnative invasive species does not require using prohibited tools and would advance wilderness goals by protecting native biodiversity. Similarly, limited management of a natural fire ignition using hand tools would not use prohibited tools and can be justified as helping to maintain natural disturbance patterns.

Likewise, it is probably permissible for managers to exercise restraint and decline to manage wilderness areas for climate change adaptation even where the result might degrade some components of native ecosystems or native species. As noted above, there is an argument that the Wilderness Act requires certain active management steps by agencies in order to restore wilderness areas; this would plausibly include impacts from climate change (since it is a human-caused impact on natural systems), mandating intervention and restoration at least where feasible.[479]

It is doubtful, however, that any mandate under the Wilderness Act for agencies to restore wilderness areas, if any mandate exists, would significantly constrain the ability of agencies to use passive management or restraint to adapt to climate change. First, courts are generally skeptical of relying on broad mandates to order agencies to take action, likely precluding judicial intervention to enforce any such broad mandate for restoration in the Wilderness Act.[480] Second, the impacts of climate change on native species and ecosystems will, in most cases, be a mix of beneficial, neutral, and harmful.[481] Of course, overall the net impacts may well be harmful when considered across all wilderness areas and all native species and ecosystems.[482] But in many situations the agencies will have a plausible argument that in this particular wilderness area, or for this particular native

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are not specifically prohibited under the Act. Even where management actions involving chemical treatments have been the subject of litigation, the plaintiffs and the court have focused their analysis on motorized equipment used to support the chemical treatments. *See* Californians for Alts. to Toxics v. U.S. Fish & Wildlife Serv., 814 F. Supp. 2d 992, 1016 (E.D. Cal. 2011). However, it is plausible that extensive use of chemical treatments might trigger § 4(b) (if that section does limit management choices) and might require a necessity analysis by the agency.

479 Relatedly, a recently revised Park Service wilderness management policy requires managers to account for the climate change effects on wilderness character from actions taken *and* those not taken. *See generally* NPS DIRECTOR'S ORDER # 41, *supra* note 327, at 10 (requiring wilderness managers to develop sustainable management strategies that "integrate with park, regional, and national level responses" to climate change and "account for any effects on wilderness character from actions taken or not taken").

480 *See, e.g.*, Norton v. S. Utah Wilderness Alliance, 542 U.S. 55, 66–67 (2004) (holding that only a specific, mandatory statutory duty can be enforced by a court against an agency with a judicial order compelling agency action). The statutory obligation must specify the particular action the agency is required to take, e.g., issuance of a regulation. *Id.* In *Norton*, the Court concluded that a statutory duty for an agency to prevent impairment of the wilderness qualities of potential wilderness areas was not judicially enforceable because the statute did not specify the particular action the agency was to take to prevent impairment. *Id.* at 69–72. Such an objection seems to be equally applicable to any agency mandate to take steps to restore or preserve wilderness harmed by human activities, since the statute does not specify precisely how restoration or preservation is to occur.

481 *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, WORKING GROUP II, *supra* note 142.

482 *See* Lawler et al., *supra* note 145, at 38, 41 (noting the uncertainty of the efficacy of climate adaptation methods for species).

species or ecosystem, the impacts might be neutral or even beneficial, such that intervention is unnecessary. Third, as noted above, there is significant uncertainty about whether and how human intervention can even successfully offset harmful effects of climate change. Thus, courts will likely defer to agencies on the highly technical questions as to whether a particular management technique is certain to be effective enough that its use is mandatory.[483] Finally, active management techniques to prevent or offset climate change impacts will necessarily involve tradeoffs among various wilderness values or impacts on various wilderness values. As noted above, courts have often deferred to agencies in making those tradeoffs, and where courts have not deferred, it has been in the context of ordering agencies *not* to take active management steps.[484] Overall then, it seems highly unlikely that courts would order agencies to take active management steps in wilderness areas to offset the impacts of climate change.[485]

V. CONCLUSION

Despite the Wilderness Act's reputation as an inflexible law, this analysis indicates that the vast majority of potential management actions for climate change adaptation, both active and passive, are possible under the Wilderness Act, provided that the right procedural steps are followed and the right substantive analyses are produced. Active management, even management that uses tools that are generally prohibited under the Act, is permissible if it can be shown to be necessary to achieve conservation purposes and if its impacts on other wilderness values are minimized. Even active management to move species and ecosystems to new locations or configurations in response to climate change may be permissible under the Act, though that question is closer.

The caveat mentioned above—that the right procedural steps must be followed and the right substantive analyses produced—is of course an important one. Procedures take time and money; substantive standards (the necessity and minimal impact findings) will constrain agency discretion to some extent. Advocates for more aggressive active management in wilderness areas might believe that these costs and constraints are not worth it.

We disagree. Restraint is an important and powerful tool in the effort to adapt to climate change, particularly in the relatively intact ecosystems that

483 *See, e.g.*, *Lyng II*, 663 F. Supp. 556, 560 (D.D.C. 1987) (deferring to the agency's determination that beetle control measures were "reasonably efficacious"); High Sierra Hikers Ass'n. v. U.S. Forest Serv., 436 F. Supp. 2d 1117, 1132 (E.D. Cal. 2006) (deferring to the agency's technical conclusions concerning the effects of operation of dams on species in wilderness areas).

484 *See* Appel, *supra* note 39, at 113 tbl. 1 (noting that most of the cases agencies lose in court involve agency efforts to impose less protection on wilderness areas by conducting active management).

485 However, other federal laws might require active management steps by agencies. For example, where climate change threatens to eradicate an endangered species located only in a particular wilderness area, the Endangered Species Act may require action. *See* Ruhl, *supra* note 60, at 26–27.

comprise most wilderness areas. Moreover, restraint is an important and powerful tool to respond to political, legal, economic, or bureaucratic pressures that might produce ineffective or even counterproductive responses to climate change. These concerns are not just speculative. It appears that agencies have already spent millions of dollars on timber harvest projects to control climate change-triggered pine beetle epidemics. Yet there is tremendous uncertainty about whether those projects are at all effectual, and many of them may have caused significant negative impacts on native ecosystems and species.[486] But the pressure to just "do something" to respond to climate change—particularly given the economic and political appeal of timber harvest projects—has been strong.

We argue that procedural and substantive hurdles for active management for climate change adaptation in wilderness areas are an important check against this impulse to "do something." They encourage more thoughtful, reflective responses that reduce the risk of agency action that produces ineffectual or counterproductive active management steps, and also reduce negative impacts on other wilderness values.[487] At the same time, the Act allows for responses in the situations where we are more certain that actions will be effective and the benefits of active management are worth the costs.

Overall then, our conclusion is that even a relatively inflexible law like the Wilderness Act is not a major obstacle to climate change adaptation, and that the law's inflexibilities may in fact facilitate more productive and effective adaptation efforts.

What lessons does this case study have for the broader debates about the importance of legal flexibility in allowing for climate change adaptation? There are surely situations where flexibility is warranted, and there will surely be situations where specific laws and policies should be revised to encourage more flexibility, both procedural and substantive. But broad statements that environmental law in general requires more flexibility are, we believe, overstated and indeed problematic. The need for flexibility depends on the particular context of the climate change adaptation problem and the legal and policy regime at issue—ecological, scientific, economic, political, legal, and bureaucratic. Moreover, any move towards flexibility must consider the political, legal, and bureaucratic costs of flexibility, as we have in this case study. In a number of situations, we believe that those costs will weigh in favor of less, rather than more, flexibility to ensure better adaptation to the impacts of climate change.

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486 *See* Six et al., *supra* note 9, at 104.

487 *See, e.g.*, ARTHUR CARHART NATIONAL WILDERNESS TRAINING CENTER, MINIMUM REQUIREMENTS DECISION GUIDE, OVERVIEW (2012), *available at* http://www.wilderness.net/MRDG/documents/MRDG_overview.pdf (federal wilderness management training center guide noting that the Wilderness Act does not otherwise provide for the "use of 'quicker, cheaper, and easier' as criteria for authorizing" prohibited uses in wilderness areas, and one of the purposes of the analysis of whether prohibited uses can occur is to change "[h]abits that make us think that motorized equipment is the best choice.").

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Table 1: Climate Change Adaptation Actions Prohibited and Permitted by the Wilderness Act

Action	Permitted by Wilderness Act?
• Permanent roads • Commercial activities (unless for recreational purposes) *Examples:* • Commercial timber harvesting to control insect infestation in order to protect commercial timber production outside of wilderness area	*Prohibited*
• Actions to facilitate realignment by using tools otherwise prohibited by Section 4(c) *Examples*: • Use of mechanized vehicles to facilitate or monitor translocation of species to new location outside of historic range • Construction of artificial water supply or other structures to support translocation of species to new location outside of historic range • Construction of temporary roads to facilitate translocation of plant species to new location outside of historic range	*Possibly Permitted* (most uncertain) • Requires finding of necessity and goals consistent with the Act
• Actions to restore or protect existing native biodiversity and maintain forest health using tools otherwise prohibited by Section 4(c) *Examples:* • Construction of artificial water supply or other structures to maintain existing population of native species • Use of mechanized equipment and chemicals to control or eliminate nonnative invasive species • Use of mechanized equipment to thin forests and improve forest health • Use of prescribed burns to restore historic fire regimes and reduce fuel loads • Use of temporary roads to facilitate efforts to maintain existing population of native species • Actions to control fire, insects, and disease in forests pursuant to Section 4(d)(1)	*Possibly Permitted* (less uncertain) • Requires finding of necessity and goals consistent with the Act

• Use of mechanized equipment and chemicals to control forest beetle or disease infestation	
• Actions to facilitate realignment by using tools not prohibited by Section 4(c) *Examples:* • Use of hand tools and non-mechanized transport to translocate plant species to new location outside of historic range	*Possibly Permitted* (more uncertain) • Requires finding that goals are consistent with the Act
• Passive Management *Examples:* • Creation of buffer areas or corridors outside of wilderness areas to facilitate native biodiversity conservation • Allowing naturally-ignited fires to burn in wilderness areas to restore historic fire regimes and reduce fuel loads • Control of public use of a wilderness area in order to protect rare or endangered species	*Permitted*
• Actions to restore or protect existing native biodiversity or restore forest health using tools not prohibited by Section 4(c) *Examples:* • Use of hand tools and non-mechanized equipment to control nonnative invasive species • Use of hand tools and non-mechanized equipment to protect or restore native species or ecosystems • Use of hand tools and non-mechanized equipment to manage naturally-ignited fires	*Permitted*

Table 2: Management Actions That Might Be Permitted or Prohibited Under the Wilderness Act

Management Category/Action	Wilderness Act Standard
Resistance and Resilience • Use of non-prohibited tools (hand-tools, chemical treatments, non-mechanized equipment) to restore and protect native species and ecosystems, control invasive species, restore and maintain healthy native forests	*Generally Permitted* (possibly limited by Section 4(b))
Resistance and Resilience • Use of otherwise prohibited tools (temporary roads, mechanized and motorized equipment, temporary or permanent structures) to restore and protect native species and ecosystems, control invasive species, restore and maintain healthy native forests	*Possibly Permitted* (less uncertain) (requires use of exemptions under 4(c) and 4(d)(a))
Resistance and Resilience • Methods to achieve resistance and resilience goals that have the "purpose and effect" of advancing commercial activities	*Prohibited*
Realignment • Use of non-prohibited tools (hand-tools, chemical treatments, non-mechanized equipment) to assist the adaptation of species and ecosystems to a new climate outside of historic parameters (e.g., assisted migration)	*Possibly Permitted* (more uncertain) (requires finding goals are appropriate under Act and use of exemptions under 4(c) and 4(d)(a))
Realignment • Use of otherwise prohibited tools (temporary roads, mechanized and motorized equipment, temporary or permanent structures) to assist the adaptation of species and ecosystems to a new climate outside of historic parameters (e.g., assisted migration)	*Possibly Permitted* (most uncertain) (requires finding goals are appropriate under Act and use of exemptions under 4(c) and 4(d)(a))
Realignment • Use of commercial activities to achieve realignment goals, or methods that have the "purpose and effect" of advancing commercial activities	*Prohibited*
Restraint • Passive Management	*Permitted*