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Management of Federally Owned Grasslands in the Climate Change Era

Robert L. Glicksman*

Abstract

The federal government owns and manages substantial tracts of grasslands, which provide ecosystem services worth trillions of dollars. These include seed dispersal, mitigation of droughts and floods, nutrient cycling, control of pests and disease-carrying organisms, maintenance of biodiversity and wildlife habitat, soil preservation, climate stabilization, watershed and water body protection, pollination, carbon sequestration, and recreational opportunities. Like most ecosystem types found on federal lands, grasslands ecosystems are vulnerable to ongoing and predicted changes in climate.

The land management agencies that administer federal grasslands face novel management challenges that require development of climate change adaptation strategies, some of which they have begun to implement. In responding to and anticipating climate-related threats, a principal goals of grasslands managers should be to protect the integrity of well-functioning grasslands. The management strategies under consideration should include exclusion of or restrictions on uses likely to exacerbate the threats posed by climate change to healthy grasslands, abandonment of efforts to preserve historic conditions that climate change has irreparably altered, and active management of at least some areas in which non-intervention has to date been the norm.

Table of Contents

Introduction
I. Grasslands on Federal Public Lands
II. The Impacts of Climate Change on Grasslands and Grasslands Management
    A. Grasslands Value
    B. Climate-Related and Other Threats to Grasslands Integrity
III. Federal Grassland Managers' Responses to Climate Change
    A. What the Agencies Are Doing
        1. Programmatic and Strategic Actions
        2. Location-Specific Assessments and Management Approaches
    B. What the Agencies Need to Do
        1. Exercises of Substantive Legal Adaptive Capacity
        2. Exercises of Procedural Legal Adaptive Capacity
Conclusion

INTRODUCTION

If asked to name an outdoor location that is owned by the federal government, the places that would most likely first come to the minds of most Americans would be iconic landscapes

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such as the Grand Canyon, Old Faithful at Yellowstone National Park, Half Dome at Yosemite National Park, or one of the national parks in the majestic mountain ranges of the Rockies, the Sierra Nevadas, or the Cascades. But the nation's publicly owned lands[1] include a wide variety of ecosystem types.[2] Millions of acres of federal lands are comprised not of mountains, canyons, forests, cascading waterfalls, or roaring rivers, but of grasslands.

Scenic vistas and wildlife viewing opportunities await those who visit the National Grasslands administered by the U.S. Forest Service (USFS) or the grasslands found in the national parks or wildlife refuges or on the remaining public lands.[3] Before settlers killed more than 50 million of them, the grasslands of the North American Great Plains provided habitat for thundering herds of bison.[4] Today, these grasslands host the much reduced bison population, and a rich variety of other species, including pronghorn antelope, gophers, prairie dogs, wolves, coyotes, foxes, badgers, and many different bird species.[5] Visitors to federally owned grasslands also can engage in a multitude of recreational activities, including hiking, camping, horseback riding, photography, canoeing, fishing, hunting, and backpacking.[6]

The value of grasslands extends well beyond the wildlife habitat and recreational opportunities they provide. As Professor John Head has explained, grasslands (also sometimes referred to as prairie or savannas or shrublands) are "of enormous importance in keeping the entire natural system in balance."[7] Unfortunately, grasslands ecosystems, both in the United States and elsewhere, are at risk,[8] in large part because of human activity, including conversion to agricultural use, development, habitat fragmentation, and anthropogenically induced climate

[1] This Article refers to lands owned by the federal government as federal lands. A subset of those lands are "public lands," which are lands administered by the Interior Department's Bureau of Land Management (BLM) under the Federal Land Policy and Management Act (FLPMA), 43 U.S.C. §§ 1701 to 1787 (2012). *See id.* § 1702(e) (defining "public lands" as "any land and interest in land owned by the United States and administered by the Secretary of the Interior through the Bureau of Land Management"). For discussion of the differences between the two terms, see 1 GEORGE CAMERON COGGINS & ROBERT L. GLICKSMAN, PUBLIC NATURAL RESOURCES LAW § 1:13 (2d ed. 2007).

[2] *See, e.g.*, COGGINS & GLICKSMAN, *supra* note 1, § 1:2 (referring to "the richness, diversity, and splendor of the publicly-owned lands"); Ashley Palomaki, T*he Battle over Competing Land Uses Within National Wildlife Refuges: The Klamath River Basin As A Case Study*, 20 HASTINGS W.-N.W. J. ENVTL. L. & POL'Y 159, 167 (2014) (referring to the wide variety of ecosystem types found in the national wildlife refuges); Nell Green Nylen, Note, *To Achieve Biodiversity Goals, the New Forest Service Planning Rule Needs Effective Mandates for Best Available Science and Adaptive Management*, 38 ECOLOGY L.Q. 241, 247 (2011) ("National Forest System and BLM lands spans a variety of ecosystem types, including most regions dominated by sagebrush . . . .").

[3] *See, e.g.*, Nat'l Park Serv., San Juan Island National Historical Park, Washington, Scenic Vistas, https://www.nps.gov/sajh/learn/nature/scenicvistas.htm (describing scenic vistas in prairie "studded with glacial erratics"); U.S. Forest Serv., Pike and San Isabel National Forests Cimarron and Comanche National Grasslands, https://www.fs.usda.gov/activity/psicc/recreation/natureviewing/?recid=12403&actid=64 ("The Cimarron, Comanche National Grasslands offer expansive views of scenic prairies . . . .").

[4] Nat'l Geographic, American Bison, http://www.nationalgeographic.com/animals/mammals/a/american-bison/.

[5] Defenders of Wildlife, Fact Sheet, Grasslands, http://www.defenders.org/grasslands/temperate-grasslands.

[6] *See, e.g.*, U.S. Forest Serv., Dakota Prairie Grasslands, Recreation, https://www.fs.usda.gov/recmain/dpg/recreation.

[7] JOHN W. HEAD, GLOBAL LEGAL REGIMES TO PROTECT THE WORLD'S GRASSLANDS xvi (2012).

[8] *See* Nat'l Park Serv., Gettysburg National Military Park, Pennsylvania, Prairies and Grasslands, https://www.nps.gov/gett/learn/nature/prairies.htm ("Grasslands are considered by many as one of the most endangered ecosystems globally.").

change.[9] In the United States, grasslands (and the plants and wildlife found there) have been adversely affected by rising temperatures and shifts in precipitation that have resulted in droughts, increased wildfire activity, invasive species encroachments, and pest infestations.[10] The resulting changes in ecological functioning present novel challenges to the federal agencies charged with managing the grasslands found on federal lands. These agencies have begun taking steps to adapt their management strategies to maintain or restore healthy grasslands ecosystem functioning, but the challenges that lie ahead appear to be daunting.

This Article provides an overview of the impact of climate change on federally owned grasslands. Part I describes the grasslands found in the national parks, forests, and wildlife refuges and on the public lands administered by the BLM. Part II outlines the ecological importance of healthy grasslands and the benefits they provide to people. It also explores the principal threats to grassland integrity, focusing on the present and likely future influence of climate change on federally owned grasslands.

Part IIIA surveys the strategies and actions that the federal land management agencies have embarked on to accommodate climate change in ways that will minimize its disruptive influence on grasslands. Part IIIB then analyzes the directions that management of federal grasslands should take in the face of climate change. I argue that the land management agencies should use the legal adaptive capacity afforded them by their organic statutes to prioritize protection of the integrity of well-functioning grasslands. Among the management strategies that the agencies will need to employ to do so are exclusion of or restrictions on uses likely to exacerbate the threats posed by climate change to healthy grasslands, abandonment of efforts to preserve historic conditions that climate change has irreparably altered, and active management of at least some areas in which non-intervention has to date been the norm. In addition, Part IIIB calls for the appropriate use of adaptive strategies that test new management approaches, monitor their progress, and make appropriate adjustments in future management efforts.

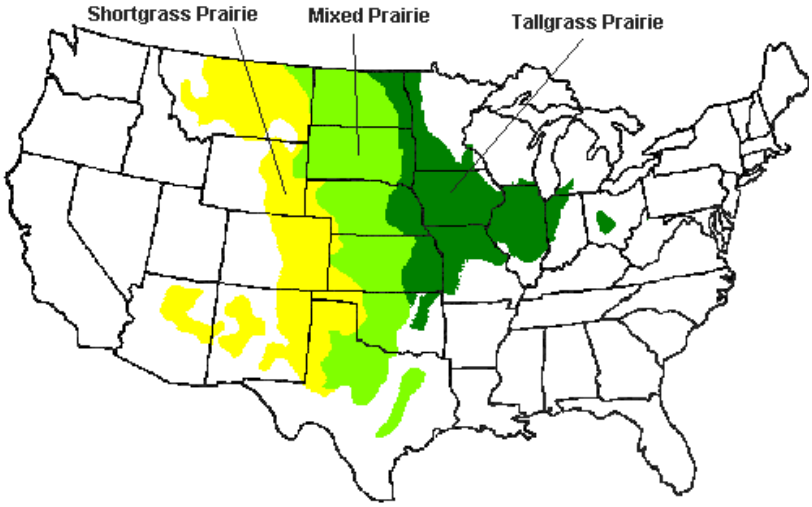
I. GRASSLANDS ON FEDERAL PUBLIC LANDS

Most of the world's grasslands exist in areas with temperate or tropical climates, with about 30 percent of temperate grasslands (about three million square kilometers) found in the North American Prairie that covers portions of Mexico, the United States, and Canada.[11] In the United States, extensive grasslands tracts are found in Texas, Arkansas, Kansas, Nebraska, and the Dakotas,[12] but they also appear in other states.[13] According to the USFS, "the greatest stretch

[9] The scientific consensus that climate change is occurring and has been primarily driven by human activity is overwhelming. *See, e.g.*, U.S. NAT'L CLIMATE ASSESSMENT, U.S. GLOBAL CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL ASSESSMENT 7 (2014) (stating that the "evidence tells an unambiguous story: the planet is warming, and over the last half century, this warming has been driven primarily by human activity"); *see also Summary for Policymakers*, *in* CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, CONTRIBUTION OF WORKING GROUP I TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 4-5 (2013). If climate change were a hoax, *see* Louis Jacobson, *Yes, Donald Trump did call climate change a Chinese hoax*, POLITIFACT, June 3, 2016 (quoting speech by Donald J. Trump in which he said of climate change that, "It's a hoax. I mean, it's a money-making industry, okay? It's a hoax, a lot of it."), then a lot of plant and animal species must have been recruited to go along with the ruse.
[10] *See infra* Part IIB.
[11] HEAD, *supra* 7, at note 4-5, 6-7.
[12] Id. at 9.

of grassland is the prairie" located between the Appalachian and Rocky Mountains, as depicted in Figure 1 below.[14]

Figure 1
Prairie in the United States



Source: U.S. Forest Service, Grasslands & Prairies, https://www.fs.usda.gov/detail/midewin/learning/nature-science/?cid=stelprdb5156639

Although grasslands can be defined in different ways, one description is that they are

> open landscapes where grasses, or grass-like plants, are the dominant vegetation; grasslands are generally found in arid areas where there is more precipitation than in deserts but not enough to support forests, and where frequent, low-severity fires occur naturally.[15]

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[13] "Grasslands, desert scrub, and all the other types of realty that land managers refer to as 'rangelands' constitute some . . . 50% of the surface land area of the United States." Jamison E. Colburn, *The Indignity of Federal Wildlife Habitat Law*, 57 ALA. L. Rev. 417, 498 n.204 (2005).

[14] The USFS divides the prairie into tallgrass, mixed, and shortgrass prairie. U.S. Forest Serv., Grasslands & Prairies, https://www.fs.usda.gov/detail/midewin/learning/nature-science/?cid=stelprdb5156639 [hereinafter USFS, Grasslands].

[15] HEAD, *supra* note 7, at 27; *see also* Nat'l Geographic, Grasslands: Terrain of Many Names, http://environment.nationalgeographic.com/environment/habitats/grassland-profile/ ("What all [grasslands] have in common is grass as their naturally dominant vegetation. Grasslands are found where there is not enough regular rainfall to support the growth of a forest, but not so little as to form a desert.").

Temperate grasslands are characterized by low annual moisture (most of which occurs in the summer), frequent fire, and conversion of dead grass left from the previous year being incorporated into the soil when warm, moist conditions return in the spring.[16]

The grasslands located on land owned by the federal government are managed by several agencies. Grasslands tracts are located on lands under the jurisdiction of the USFS within the Department of Agriculture, and the BLM, the Fish and Wildlife Service (FWS), and the National Park Service (NPS) within the Department of the Interior. The USFS treats grasslands units as a recognizable group of the lands it administers, although, as noted below, it manages them under many of the same rules and principles that apply to the national forests. The other three agencies do not group lands under their jurisdiction that include grasslands in similar fashion, at least not officially. Nevertheless, both the BLM and the FWS manage significant tracts of grasslands, with smaller grasslands tracts appearing in the National Park System.

The USFS is responsible for managing twenty National Grasslands spread across twelve states west of the Mississippi, as depicted in Figure 2.[17] The National Forest System (NFS) includes the national grasslands administered under the Bankhead-Jones Farm Tenant Act of 1937.[18] That Act authorizes the Secretary of Agriculture "to develop a program of land conservation and land utilization, in order . . . to assist in controlling soil erosion, and conserving surface and subsurface moisture, protecting the watershed of navigable streams, and protecting the public lands, health, safety, and welfare . . ."[19] The Act also authorizes the Secretary to regulate the use and occupancy of lands covered by the Act "in order to conserve and utilize it or advance" statutory purposes.[20] About 3.8 million acres of land acquired by the federal government pursuant to the Bankhead-Jones Act are designated as national grasslands.[21]

Figure 2
The National Grasslands Administered by the U.S. Forest Service

[16] HEAD, *supra* note 7, at 31-32.
[17] U.S. Forest Serv., The National Grasslands Story, https://www.fs.fed.us/grasslands/aboutus/index.shtml. These include the Cedar River National Grasslands, the Little Missouri National Grassland, and the Sheyenne National Grassland in North Dakota; the Grand River National Grasslands, the Buffalo Gap, and the Ft. Pierre National Grassland in South Dakota; the Thunder Basin National Grassland in Wyoming; the Ogallala National Grassland in Nebraska; the Cimarron National Grassland in Kansas; McClelland Creek, the Caddo National Grasslands, LBJ National Grasslands, and Rita Blanca National Grassland in Texas; the Black Kettle National Grassland in Oklahoma; the Kiowa National Grassland in New Mexico; the Crooked River National Grassland in Oregon; the Butte Valley National Grasslands in California; the Curlew National Grasslands in Idaho; and the Pawnee and Comanche National Grasslands in Colorado. The Little Missouri National Grassland is the largest of these, comprising just over a million acres. *Id*. *See also* 36 C.F.R. § 213.1(e); HEAD, *supra* note 7, at 99-100 (listing the National Grasslands).
[18] 16 U.S.C. § 1609(a) (2012); *see* Coby C. Dolan, *The National Grasslands and Disappearing Biodiversity: Can the Prairie Dog Save Us from an Ecological Desert?*, 29 ENVTL. L. 213, 220 (1999). For discussion of the history of the formation of the national grasslands, see Elizabeth Howard, *Management of the National Grasslands*, 78 N.D. L. REV. 409, 416-26 (2002).
[19] 7 U.S.C. § 1010 (2012).
[20] *Id*. § 1011(f).
[21] John W. Head, *Grasslands, Agriculture, and International Law – A Survey of Proposed Reforms*, 24 KAN. J. L. & PUB. POL'Y ___, ___ (2017) [MS at 16.]

Source: U.S. Forest Serv., The National Grasslands Story, https://www.fs.fed.us/grasslands/aboutus/index.shtml

The National Grasslands might be viewed as the forgotten stepchild of the NFS.[22] Although the USFS initially managed the national grasslands separately from the national forests, in the 1970s it began placing increased emphasis on wildlife and watershed protection and recreational use of the grasslands.[23] After Congress enacted the National Forest Management Act of 1976 (NFMA),[24] the USFS applied a single set of regulations to grazing in the national forests and national grasslands.[25] USFS regulations currently require that the national grasslands "be administered under sound and progressive principles of land conservation and multiple use, and to promote development of grassland agriculture and sustained-yield management of the forage, fish and wildlife, timber, water and recreational resources of which the National Grasslands are a part."[26] They also provide that regulations adopted by the USFS under the NFMA for the protection, use, occupancy, and administration of other units of the NFS also apply to the National Grasslands.[27] Both the national forests and the

[22] *See* Dolan, *supra* note 18, at 221 (asserting that "little attention has been paid to the Forest Service's management of the National Grasslands").
[23] Howard, *supra* note 18, at 426-27.
[24] 16 U.S.C. §§ 1600 to 1687 (2012).
[25] Howard, *supra* note 18, at 426; *see also id*. at 436 (explaining that in 1974, the date of enactment of the Forest and Rangeland Renewable Resources Planning Act, "Congress incorporated the national grasslands into the National Forest System. The outstanding purpose of this action was to simply declare that the diverse lands administered by the Forest Service were part of a unitary system.").
[26] 36 C.F.R. § 213.1(c); *see also id*. § 213.1(d) (requiring management "so as to maintain and improve soil and vegetative cover, and to demonstrate sound and practical principles of land use for the areas in which they are located").
[27] 36 C.F.R. § 213.3(a).

national grasslands are subject to a multiple use, sustained yield management standard.[28] As a result, consumptive and extractive uses occur on national grasslands, including grazing and energy development.[29]

The BLM also manages significant grasslands acreage under its organic statute, FLPMA, though it does not conveniently label its tracts as such, as the USFS does. The lands managed by the BLM include grasslands and tundra, with significant portions of BLM acreage devoted to rangeland use.[30] One observer has claimed that, "[w]ith very few exceptions, BLM administers arid grasslands."[31] According to Professor George Coggins,

> the similarities among the various BLM tracts far overshadow their differences. The great majority are arid or semiarid: an estimated ninety-five percent of them receive less than fifteen inches of rainfall annually, and they have few rights of access to available water. Prior to European settlement, most BLM lands were grasslands—sparse, compared to true prairie, but grasslands nevertheless. The great majority is now depleted. A century of overuse and abuse has destroyed native grasses, caused severe erosion, and assisted invasions by hardy shrubs that crowd out the grass.[32]

According to one account, the BLM manages approximately 170 million acres of rangelands.[33] FLPMA requires the BLM to manage its lands in accordance with the same multiple use, sustained yield mandate that governs management of the national forests under NFMA.[34]

The FWS is responsible for managing the national wildlife refuges under the National Wildlife Refuge System Improvement Act of 1997.[35] Unlike lands managed by the USFS and

[28] 16 U.S.C. § 528 (2012) (Multiple-Use, Sustained Yield Act of 1996); 16 U.S.C. §§ 1600(3), (5), 1601(d)(1), 1604(e) (2012) (NFMA); *see* Robert L. Glicksman, *Sustainable Federal Land Management: Protecting Ecological Integrity and Preserving Environmental Principal*, 44 TULSA L. REV. 147, 162-65 (2008).

[29] *See, e.g.*, Head, *supra* note 21, at ___ [MS at 17] (discussing open-pit coal mining in Thunder Basin National Grassland).

[30] Bradley C. Karkkainen, *Biodiversity and Land*, 83 CORNELL L. REV. 1, 24 (1997); *see also* Kelly Nolen, *Residents at Risk: Wildlife and the Bureau of Land Management's Planning Process*, 26 ENVTL. L. 771, 774 (1996). BLM regulations governing grazing on public lands are at 43 C.F.R. pt. 4100.

[31] Peter M. Lacy, *Our Sedimentation Boxes Runneth Over: Public Lands Soil Law as the Missing Link in Holistic Natural Resource Protection*, 31 ENVTL. L. 433, 453 (2001); *cf.* James L. Huffman, *The Inevitability of Private Rights in Public Lands*, 65 U. COLO. L. REV. 241, 252 (1994) (noting that the BLM has "responsibility for the protection of public grasslands and the administration of a grazing lease program").

[32] George Cameron Coggins, *The Law of Public Rangeland Management I: The Extent and Distribution of Federal Power*, 12 ENVTL. L. 535, 546-47 (1982).

[33] Colburn, *supra* note 13, at 467 n.204; *cf.* Steven C. Forrest, *Creating New Opportunities for Ecosystem Restoration on Public Lands: An Analysis of the Potential for Bureau of Land Management Lands*, 23 PUB. LAND & RESOURCES L. REV. 21, 25 (2002) (estimating that the BLM has jurisdiction over about 14 million acres of rangelands east of the Rocky Mountain Front).

[34] 43 U.S.C. §§ 1712(c)(1), 1732(a) (2012); *see* Glicksman, *supra* note 28, at 161-62. The Public Rangeland Improvement Act of 1978 (PRIA) sought to improve public rangeland conditions. 43 U.S.C. § 1901(b)(2) (2012); *see* 3 COGGINS & GLICKSMAN, *supra* note 1, § 33:38. PRIA exempts the National Grasslands from its provisions. 43 U.S.C. § 1907.

[35] Pub. L. No. 105-57, 111 Stat. 1252 (codified at 16 U.S.C. §§ 668dd to 668ee).

the BLM, Congress established a dominant use management standard for the refuges.[36] The mission of the National Wildlife Refuge System (NWRS) is to conserve, manage, and restore the fish, wildlife, and plant resources and their habitats found in the refuges for the benefit of present and future generations of Americans.[37] Wildlife-dependent recreational use of the refuges is allowed to the extent that it is compatible with the overall System mission and the purposes of individual refuges.[38] Other uses, including non-wildlife-dependent recreational use and consumptive uses such as grazing, are prohibited if they are not compatible with the purposes of the NWRS as a whole or of individual System units, or if they would materially interfere with wildlife-dependent recreational uses.[39]

Many refuges include grasslands habitat.[40] The Shawangunks Grasslands in New York, for example, is a 597-acre refuge established in 1999 to support grasslands-dependent migratory birds and wintering raptors.[41] The Grasslands Wildlife Management Area in California includes both private land in which the FWS holds conservation easements and two national wildlife refuges that include wetlands and grasslands that provide habitat for goose and duck species.[42] The Hart Mountain National Antelope Refuge in Oregon[43] and the Sheldon National Wildlife Refuge in Nevada include sagebrush grasslands and other kinds of high desert terrain.[44] The Santa Ana National Wildlife Refuge in Texas includes grasslands that provide habitat for migratory birds, ocelots, and pumas.[45] The Optima National Wildlife Refuge in Oklahoma includes tallgrass prairie that hosts deer, coyotes, turkeys, and quail, among other species.[46] The Sevilleta National Wildlife Refuge in New Mexico includes shrub steppe, sagebrush, and saltbush that support the Gunnison prairie dog.[47] Bison and a variety of grassland birds make their home amidst the grasslands at the Neal Smith National Wildlife Refuge in Iowa.[48] The Big Stone National Wildlife Refuge in Minnesota is comprised of 11,000 acres of wetlands, tallgrass

[36] For a description of the difference between dominant and multiple use land management statutes, see Robert L. Glicksman, *Wilderness Management by the Multiple Use Agencies: What Makes the Forest Service and the Bureau of Land Management Different?*, 44 ENVTL. L. 447, 448-49 (2014).
[37] 16 U.S.C. § 668dd(a)(2) (2012).
[38] *Id*. § 668dd(a)(3).
[39] 3 COGGINS & GLICKSMAN, *supra* note 1, § 24:5.
[40] According to the FWS, "[g]rasslands include tallgrass prairie, cattle pastures, and ephemeral prairie pothole wetlands that function as the primary breeding grounds for ducks." NAT'L FISH, WILDLIFE & PLANTS CLIMATE ADAPTATION P'SHIP, NATIONAL FISH, WILDLIFE, AND PLANTS CLIMATE ADAPTATION STRATEGY 34 (2012), https://www.wildlifeadaptationstrategy.gov/pdf/NFWPCAS-Final.pdf [hereinafter FWS STRATEGY].
[41] U.S. Fish and Wildlife Serv., Shawangunks Grasslands, https://www.fws.gov/refuge/shawangunk_grasslands/.
[42] U.S. Fish and Wildlife Serv., Grasslands Wildlife Management Area, https://www.fws.gov/refuges/profiles/index.cfm?id=81653. The area is closed to public use. *Id*.
[43] U.S. Fish and Wildlife Serv., Hart Mountain National Antelope Refuge, https://www.fws.gov/nwrs/threecolumn.aspx?id=2147560592.
[44] Nat'l Wildlife Refuge Ass'n, Beyond the Boundaries: Sagebrush Steppe, http://refugeassociation.org/sagebrush-steppe/.
[45] Library of Congress, Grassland within the Santa Ana National Wildlife Refuge, on the Rio Grande River border with Mexico in Hidalgo County, Texas, https://www.loc.gov/item/2014630445/.
[46] U.S. Fish and Wildlife Serv., Optima National Wildlife Refuge, Wildlife and Habitat, https://www.fws.gov/refuge/Optima/wildlife_and_habitat/index.html.
[47] U.S. Fish and Wildlife Serv., Sevilleta National Refuge, Wildlife & Habitat, https://www.fws.gov/refuge/Sevilleta/wildlife_and_habitat.html.
[48] U.S. Fish and Wildlife Serv., Neal Smith National Wildlife Refuge, Wildlife and Habitat, https://www.fws.gov/refuge/Neal_Smith/wildlife_and_habitat/index.html.

prairie, and riverine habitat that support numerous native plant and animal species.[49] Four thousand acres of prairie in the Turnbull National Wildlife Refuge in Washington support numerous animal species.[50] The J. Clark Salyer National Wildlife Refuge in North Dakota includes mixed grass prairie used by migratory birds.[51] California's San Luis, Pixley, and Merced National Wildlife Refuges provide nesting habitat in its grasslands for birds and habitat for different types of mammals.[52]

The NPS manages national parks and national monuments under the National Park Service Organic Act.[53] Like the FWS, the NPS manages the lands and resources for which it is responsible under a dominant use standard. The declared purpose of the National Park System[54] is "to conserve the scenery, natural and historic objects, and wild life in the System units and to provide for the enjoyment of the scenery, natural and historic objects, and wild life in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."[55] Although Congress establishes national parks and the President declares national monuments under the Antiquities Act,[56] "the basic NPS mandate treats parks and monuments alike for basic management purposes."[57] The NPS must "promote and regulate the use of the National Park System by means and measures that conform to the fundamental [conservation and recreation] purposes of System units."[58]

Some units administered by the NPS include grasslands terrain. Among these are some of the national parks and national monuments in the Colorado Plateau.[59] The badlands in

[49] U.S. Fish and Wildlife Serv., Big Stone National Wildlife Refuge, Wildlife and Habitat, https://www.fws.gov/refuge/Big_Stone/wildlife_and_habitat/index.html. https://www.fws.gov/refuge/Turnbull/wildlife_and_habitat/.
[50] U.S. Fish and Wildlife Serv., Turnbull National Wildlife Refuge, Wildlife and Habitat, https://www.fws.gov/refuge/Turnbull/wildlife_and_habitat/.
[51] U.S. Fish and Wildlife Serv., J. Clark Salyer National Wildlife Refuge, Wildlife and Habitat, https://www.fws.gov/refuge/J_Clark_Salyer/about.html.
[52] U.S. Fish and Wildlife Serv., San Luis National Wildlife Refuge, Wildlife and Habitat, https://www.fws.gov/Refuge/San_Luis/wildlife_and_habitat/index.html; U.S. Fish and Wildlife Serv., Pixley National Wildlife Refuge, Wildlife and Habitat, https://www.fws.gov/refuge/Pixley/wildlife_and_habitat.html; U.S. Fish and Wildlife Serv., Merced National Wildlife Refuge, Wildlife and Habitat, https://www.fws.gov/Refuge/Merced/wildlife_and_habitat/index.html.
[53] 54 U.S.C. §§ 100101 to 104907 (2016).
[54] The System includes "any area of land and water administered by [the NPS] for park, monument, historic, parkway, recreational, or other purposes." *Id.* § 100501. "The Secretary shall prescribe such regulations as the Secretary considers necessary or proper for the use and management of System units." *Id.* § 100751(a).
[55] 54 U.S.C. § 100101(a) (2016); *see also id.* § 100101(b)(2) (reaffirming and directing "that the promotion and regulation of the various System units shall be consistent with and founded in the purpose established by subsection (a), to the common benefit of all the people of the United States").
[56] 54 U.S.C. §§ 320301 to 320303 (2016).
[57] 3 COGGINS & GLICKSMAN, *supra* note 1, § 23:2.
[58] 54 U.S.C. § 100101(a) (2016).
[59] For a list those parks and units, see Nat'l Park Serv., Colorado Plateaus, https://www.nps.gov/articles/coloradoplateaus.htm. *See, e.g.*, Nat'l Park Serv., Aztec Ruins National Monument, Plants, https://www.nps.gov/azru/learn/nature/plants.htm (referring to grasslands within the Monument); Capitol Reef National Park, Grasses, https://www.nps.gov/care/learn/nature/grasses.htm (describing grasslands in the Park).

Theodore Roosevelt and Badlands National Parks includes grasslands, among other terrains.[60] So does Scotts Bluff National Monument in Nebraska.[61] The NPS administers the Tallgrass Prairie National Preserve in Kansas, which, according to the NPS, "protects a nationally significant remnant of the once vast tallgrass prairie and its cultural resources. Here the tallgrass prairie takes its last stand."[62] The Preserve is "the only unit of the National Park System dedicated to the rich natural and cultural history of the tallgrass prairie ecosystem."[63] Most National Park System units, however, do not feature grasslands ecosystems.[64]

II. THE IMPACTS OF CLIMATE CHANGE ON GRASSLANDS AND GRASSLANDS MANAGEMENT

The scope of the management challenges facing federal land managers whose responsibilities include administering lands with grasslands habitat depends on the functions that grasslands ecosystems serve and the nature and extent of the threats posed to those functions by activities and conditions on federal lands. This Part briefly discusses the ecological value of grasslands in general and the principal threats to their continued sound functioning. It focuses on the threats most relevant to federal land management, and particularly on climate change.

A. Grasslands Values

[60] Nat'l Park Serv., Theodore Roosevelt National Park, Plants, https://www.nps.gov/thro/learn/nature/plants.htm; Ethan Shaw, *National Parks & Monuments Found in the Grassland Biome*, http://traveltips.usatoday.com/national-parks-monuments-found-grassland-biome-15236.html.

[61] Shaw, *supra* note 60; Nat'l Park Serv., Scotts Bluff National Monument, Prairies and Grasslands, https://www.nps.gov/scbl/learn/nature/prairies.htm ("Natural prairie grasses are the predominant vegetation cover of the Monument's more level areas. Approximately 40% of the 3,003 acre Monument is mixed-grass prairie.").

[62] Nat'l Park Serv., Tallgrass Prairie National Preserve, Last Stand of Tallgrass Prairie, https://www.nps.gov/tapr/index.htm.

[63] *Id*.

[64] *See* Karkkainen, *supra* note 30, at 37 (quoting Douglas O. Linder, *"Are All Species Created Equal?" and Other Questions Shaping Wildlife Law*, 12 HARV. ENVTL. L. REV. 157, 191 (1988)) (stating that grasslands are "substantially underrepresented" in the parks). *Cf.* Dave Foreman, *The Wildlands Project and the Rewilding of North America*, 76 DENV. U. L. REV. 535, 552 (1999) (stating that "a few sizable grasslands are preserved in wilderness areas and national parks"). For a list of NPS and NWRS units that include prairie potholes or grasslands, see Nat'l Park Serv., Understanding the Science of Climate Change, *Talking Points: Impacts to Prairie Potholes and Grasslands* 3-4, NPS/NRPC/NRR—2009/138 (2009), http://climatechange.lta.org/wp-content/uploads/cct/2015/02/PrairieGrasslandsTP.pdf. In 2016, 400 acres of meadow habitat was donated to Yosemite National Park. Niraj Chokshi, *Yosemite Will Undergo Largest Expansion Since 1949*, N.Y. TIMES, Sept. 9, 2016.

Some have lobbied for the creation of new parks with grasslands habitat. *See, e.g.*, John H. Davidson, *The New Public Lands: Competing Models for Protecting Public Conservation Values on Privately Owned Lands*, 39 ENVTL. L. REP. NEWS & ANALYSIS 10368, _____ (2009) (arguing that "there should also have been established a "Great Prairie Grasslands Pothole National Park"); Tyler Sutton & Joel Sartore, *Renewing the Great Plains: Towards A Greater Black Hills Wildlife Protected Area*, 5 GREAT PLAINS NAT. RESOURCES J. 1, 5 (2001) ("The National Parks and Conservation Association recently identified the grasslands of [the Greater Black Hills area of Nebraska and South Dakota] as worthy to include in a new park proposal."); John P. La Velle, *Rescuing PAHA SAPA: Achieving Environmental Justice by Restoring the Great Grasslands and Returning the Sacred Black Hills to the Great Sioux Nation*, 5 GREAT PLAINS NAT. RESOURCES J. 40 (2001) (supporting creation of a Greater Black Hills Protected Area).

Degradation or destruction of grasslands can impair their value for critical functions such as protecting water quality, buffering storms and floods, promoting soil conservation,[65] providing wildlife habitat, and enhancing biodiversity.[66] Grasslands also serve as carbon sinks.[67] The late Joe Feller divided the functions of grasslands vegetation into two categories, internal and external:

> Internal functions are those functions, such as soil conservation, moisture retention, and fire propagation, that are necessary to the sustenance of the grassland itself. External functions are those functions, such as provision of wildlife habitat, water quality, and scenic and aesthetic values, that serve ecological and societal needs beyond grassland maintenance. Management that fails to maintain internal functions results in the degradation or loss of the grassland and eventually results in the loss of external functions as well. Management that maintains internal functions but fails to maintain external functions may result in significant loss of social and ecological values even though the grassland itself is maintained.[68]

The USFS provides a more complete list of the ecosystem services provided by grasslands, which include seed dispersal, mitigation of droughts and floods, nutrient cycling, waste detoxification and decomposition, agricultural pest control, maintenance of biodiversity, generation and preservation of soils and renewal of their fertility, climate stabilization, regulation of disease-carrying organisms, reduction of soil erosion, watershed and water body protection, pollination of natural vegetation,[69] carbon sequestration, and provision of aesthetic beauty,

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[65] "Despite being exposed to recurrent droughts and occasional torrential rains, most grasslands in their natural state are not subject to substantial soil erosion." Head, *supra* note 21, at ___ [MS at 11].

[66] HEAD, *supra* note 7, at 3. Grasslands "help maintain a rich diversity of species on Earth." Head, *supra* note 21, at ___ [MS at 12].

[67] "[T]he overall potential of carbon sequestration by grasslands compares favorably with the potential for carbon sequestration by rain forests." HEAD, *supra* note 7, at 63; *see also* Anthony B. Schutz, *Toward A More Multi-Functional Rural Landscape: Community Approaches to Rural Land Stewardship*, 22 FORDHAM ENVTL. L. REV. 633, 644 n.39 (2011) (citing John H. Davidson, *North America's Great Carbon Ocean: Protecting Prairie Grasslands Keeps Carbon in the Soil and Slows the Pace of Climate Change*, 29 SAVING LAND 19 (2009)); Susan E. Meyer, *Restoring and Managing Cold Desert Shrublands for Climate Change Mitigation* [hereinafter Susan E. Meyer], *in* U.S. Forest Serv., Rocky Mountain Research Station, CLIMATE CHANGE IN GRASSLANDS, SHRUBLANDS, AND DESERTS OF THE INTERIOR AMERICAN WEST: A REVIEW AND NEEDS ASSESSMENT 21 (Deborah M. Finch ed., 2012), https://www.fs.fed.us/rm/pubs/rmrs_gtr285.pdf [hereinafter Finch Review]; Marya Torrez, *Cows, Congress, and Climate Change: Authority and Responsibility for Federal Agencies to End Grazing on Public Lands*, 14 VT. J. ENVTL. L. 1, 6 (2012) ("Healthy grasslands and forests could mitigate much of the impact of climate change by sequestering carbon."); John Meyer, *Using the Public Trust Doctrine to Ensure the National Forests Protect the Public from Climate Change*, 16 HASTINGS W.-N.W. J. ENVTL. L. & POL'Y 195, 196 (2010) "[G]rasslands play a 'critical role' in mitigating climate change by driving the global carbon cycle—sequestering carbon dioxide through photosynthesis and releasing it through respiration.").

[68] Joseph M. Feller & David E. Brown, *From Old-Growth Forests to Old-Growth Grasslands: Managing Rangelands for Structure and Function*, 42 ARIZ. L. REV. 319, 325-26 (2000).

[69] "One third of human food comes from plants pollinated by wild pollinators. The value of pollination services from wild pollinators in the United States alone is estimated at four to six billion dollars per year." U.S. Forest Serv., Ecosystem Services from National Grasslands, https://www.fs.fed.us/grasslands/ecoservices/index.shtml.

wildlife habitat,[70] wetlands and playas, recreational opportunities, and research opportunities.[71] The agency estimates that these services "are worth many trillions of dollars."[72]

B. Climate-Related and Other Threats to Grasslands Integrity

Given the valuable ecosystem services that grasslands provide, Professor Head's description of grasslands worldwide as being "in peril" is extremely troubling.[73] Generally, the culprits include urbanization, land conversion, species encroachment,[74] genetic pollution,[75] habitat fragmentation,[76] and climate change.[77] Some of these threats are not relevant or minimally relevant to grasslands found on federal lands. Neither urbanization nor large-scale conversion to agricultural use is likely to occur. Some of these threats do affect grasslands on federal lands, however, including overgrazing[78] and recreational use.[79] Excessive grazing can disrupt microclimates needed to support key soil microorganisms, prevent natural fires, exacerbate soil erosion, and impair wildlife habitat, water and nutrient cycles, and aesthetic values.[80] Recreational use also may pose problems. USFS officials have identified unregulated

[70] "National Grassland units contain the largest representation of threatened and endangered species." *Id*.
[71] *Id*.
[72] *Id*; *see also* FWS STRATEGY, *supra* note 40, at 33 ("Grassland function is tied directly to temperature, precipitation and soil moisture; therefore, climate change is likely to lead to shifts in the structure, function, and composition of this system. Grasslands also store significant amounts of carbon, primarily in the soil.").
[73] HEAD, *supra* note 7, at xvi. According to Professor Head, "[g]rasslands abound on Earth, but humans have damaged them profoundly." *Id*. at 3.
[74] Some grasslands in North America reportedly support 10 to 20% of non-native plant species. *Id*. at 48.
[75] Exotic grasses may displace native grasslands because "the native species never needed to develop strong dispersal capabilities in their original environment." Fred Bosselman, *A Dozen Biodiversity Puzzles*, 12 N.Y.U. ENVTL. L.J. 364, 440 n.387 (2004).
[76] HEAD, *supra* note 7, at 46-47.
[77] *Id*. at xvi.
[78] *See id*. at 3 (referring to inappropriate grazing practices as a form of abusive grasslands practices). According to Professor Head, inappropriate grazing and agricultural conversion are "the two principal ways in which humans have brought about momentous alteration of the world's grasslands." Head, *supra* note 21, at___ [MS at 9]. Although grasslands are a source of food production, agricultural use of grasslands is not a primary activity on federal lands, other than grazing of animals that supply food. On the threats that grazing poses to public lands with minimal precipitation, see generally HEAD, *supra* note 7, at 41-43; DEBRA L. DONAHUE, THE WESTERN RANGE REVISITED: REMOVING LIVESTOCK FROM PUBLIC LANDS TO CONSERVE NATIVE BIODIVERSITY (1999). *See also* Rob Schmitz, *How Your Cashmere Sweater Is Decimating Mongolia's Grasslands*, NPR, Parallels (Dec. 9, 2016), http://www.npr.org/sections/parallels/2016/12/09/504118819/how-your-cashmere-sweater-is-decimating-mongolias-grasslands (describing degradation of Mongolian grasslands due to grazing). Rangeland has been defined as "land on which the indigenous vegetation is predominantly grasses, grass-like plants, forage, or shrubs and is managed as a natural ecosystem . . . includ[ing] natural grasslands, savannas, shrub-lands, many deserts, tundras, alpine communities, marshes and meadows." Edith Sanders, *Alternative Ranch Experiments: Better Than the BLM*, 27 WM. & MARY ENVTL. L. & POL'Y REV. 265, 268 (2002). Grazing on BLM lands is not confined to domesticated animals. The BLM has sought to protect Western grasslands from overgrazing by wild horses and burros by killing or selling them, generating opposition from animal rights organizations. *See* Clyde Hughes, *BLM Wild Horse Plan: Kill, Sell 44,000 to Protect Grasslands*, NEWSMAX, Sept. 14, 2016, http://www.newsmax.com/TheWire/blm-wild-horses-grasslands/2016/09/14/id/748155/.
[79] *See* HEAD, *supra* note 7, at 3 (referring to "recreational frivolity" as a source of grasslands degradation); *id*. at 54-55 (describing impacts of use of mountain bikes, all-terrain vehicles, and other forms of off-road uses).
[80] Feller & Brown, *supra* note 68, at 321; *see also* Fred Bosselman, *What Lawmakers Can Learn from Large-Scale Ecology*, 17 J. LAND USE & ENVTL. L. 207, 257 n.338 (2002) (stating that "destructive changes to some Western grasslands caused by climate change and overgrazing may already have caused collapse by crossing a threshold to a new ecological state that could not easily be reversed even if grazing were ended").

motorized recreation (particularly off-road vehicle use) as one of the four principal threats to both the national forests and the national grasslands.[81]

The focus of this Article is the impact of climate change on federally managed grasslands, and what the land management agencies can do and should be doing in the face of climate-related threats to protect the healthy functioning of grasslands ecosystems. According to Professor Jessica Owley, "[s]cientists have identified grasslands as one of the terrestrial habitats most vulnerable to climate change."[82] The USFS concurs, having characterized climate change as "one of the greatest challenges to sustainable management of forests and grasslands and to human well-being we have ever faced, because rates of change will likely exceed many ecosystems' capabilities to adapt naturally."[83]

The impacts of climate change on grasslands, as on other ecosystem types, will be location-specific.[84] Generalizations are nevertheless possible.[85] In some areas, temperatures will increase and precipitation will decrease, creating a risk of persistent drought. As the Washington

[81] Antony S. Cheng, *Build It and They Will Come? Mandating Collaboration in Public Lands Planning and Management*, 46 NAT. RESOURCES J. 841, 857 (2006); John C. Adams & Stephen F. McCool, *Finite Recreation Opportunities: The Forest Service, the Bureau of Land Management, and Off-Road Vehicle Management*, 49 NAT. RESOURCES J. 45, 46 n.4 (2009); *cf*. Craig L. Shafer, *The Unspoken Option to Help Safeguard America's National Parks: An Examination of Expanding U.S. National Park Boundaries by Annexing Adjacent Federal Lands*, 35 COLUM. J. ENVTL. L. 57, 77 (2010) ("The impacts of all forms of recreational use on species and their habitats are only beginning to be understood, but ORVs have been accused of doing more such damage than any other recreational activity.").

[82] Jessica Owley, *Conservation Easements at the Climate Change Crossroads*, 74-Fall L. & CONTEMP. PROBS. 199, 202 (2011).

[83] U.S. DEP'T OF AGRIC,, FOREST SERV., STRATEGIC FRAMEWORK (2008), http://www.fs.fed.us/climatechange/message.shtml [[https://perma.cc/8KFZ-V689].

[84] *See, e.g.*, Washington Dep't of Fish and Wildlife and Nat'l Wildlife Fed'n, Summary of Climate Change Effects on Major Habitat Types in Washington State: Shrub-Steppe and Grasslands Habitats 26-27 (2011), http://climatechange.lta.org/wp-content/uploads/cct/2015/03/WDFW_Grassland.pdf [hereinafter WDFW] ("Although climate influences community composition and dynamics at broad spatial scales, topography, soils, and landforms control local variation in ecosystem structure and function within a given elevational zone (i.e., moisture/temperature regime). . . . To predict vegetation response to climate change, it is necessary to understand these complex relationships among topography, soil, soil hydrology, and plant response."); Cameron N. Carlyle et al., *Response of grassland biomass production to simulated climate change and clipping along an elevation gradient*, 174 OECOLOGIA 1065 (2014) ("[C]hanges in plant production due to climate change will be dependent on disturbance, management and location.").

[85] According to one such summary:

> Observed and predicted climate change impacts to grasslands include:
>
> - Increased frequency and severity of droughts.
> - Loss of wetland habitats, such as prairie potholes, due to drought.
> - Greater risk of severe wildfire.
> - Reduced snowfall and snow cover, as well as a shorter winter season.
> - Diminished agricultural production — crops and livestock — due to more frequent droughts and floods.
> - Species migration. In some regions, trees and shrubs are expected to encroach on grassland, which may force grassland species to relocate.
> - Greater risk of disease and insect pests, including the potential for these stressors to shift their ranges into regions where they previously could not survive.

Conservation in a Changing Climate, Mange Grasslands and Prairie Habitats for Climate Change, http://climatechange.lta.org/manage-grasslands/ [hereinafter Mange Grasslands].

Department of Fish and Wildlife found, "[s]light changes in temperature and precipitation can substantially alter the composition, distribution, and abundance of species in arid lands, and the products and services they provide."[86] At least some researchers have found that the combination of warming temperatures and declining precipitation will decrease grasslands biomass production.[87] Vegetation types are likely to change significantly in grasslands locations affected by climate change. Researchers have found, for example, that in the interior West, sagebrush, Joshua tree, saguaro, and creosote bush will all shift northwards; species with small distributions, such as smooth Arizona cypress and the perennial MacFarlane's four-o'clock, may experience complete climate disequilibrium early in the 21st century; invasive species, such as buffelgrass, Lehmann lovegrass, spotted knapweed, and leafy spurge, will expand as a result of climate change; and invasive annual grasses such as cheatgrass will shift northward with increased risk in Idaho, Montana, and Wyoming but reduced risk in southern Nevada and Utah.[88] Rising temperatures and evaporation rates coupled with drought may increase mortality for existing vegetation and facilitate the spread of invasive plant species.[89] Although rising carbon dioxide concentrations can increase plant growth of some types, the result may be a reduction in biodiversity as faster growing species crowd out other species.[90] Climatic shifts are likely to cause mismatches in timing between insects and their host plants, perhaps reducing populations of arthropods such as butterflies, which serve as pollinators.[91]

These changes could threaten the viability of wildlife species such as waterfowl by impairing their habitat,[92] increasing fire risk,[93] pest infestations,[94] and disease.[95] Model

[86] WDFW, *supra* note 84, at 25.

[87] *See* Carlyle et al., *supra* note 84 (concluding, however, that the impacts of climate change on grasslands are likely to differ depending on grasslands type); *cf.* Petr Holub et al., *Biomass Production of Different Grassland Communities under Artificially Modified Amount of Rainfall*, 63(3) POLISH J. OF ECOL. 320 (2015) (finding that the ratio of total below-ground biomass to above-ground production is likely to significantly increased in highland grasslands due to enhanced rainfall associated with climate change, but that the opposite will occur in lowland grasslands).

[88] Megan M. Friggens et al., *Modeling and Predicting Vegetation Response of Western USA Grasslands, Shrublands, and Deserts to Climate Change*, *in* Finch Review, *supra* note 67. The authors also found that semi-desert grassland habitat will expand northward and occupy an area nearly four times that of the present; habitat suitable for Great Basin shrub/grassland will decrease by 40% and become fragmented; great Basin montane scrub habitat will experience moderate decline and displacement; and Mohave Desert, Sonoran Desert, and Chihuahuan Desert scrub vegetation types are all projected to expand as a result of climate change. *Id*. at 1-2.

[89] WDFW, *supra* note 84, at 31-32 (2011).

> For plant communities in the Great Basin and Intermountain regions, the temperature increases predicted by general circulation models may create the potential for increased annual grass establishment into areas where it is still a minor component of the A. tridentata ecosystem. There are also indications that cheatgrass is more competitive with native species under elevated CO_2 levels. A warmer environment coupled with a winter precipitation regime and greater CO_2 levels would likely permit invasion and dominance by cheatgrass, particularly if fire disturbances increase.

Id. at 45. *See also* Deborah M. Finch et al., *Climate Change, Animal Species, and Habitats: Adaptation and Issues*, *in* Finch Review, *supra* note 67, at 65 ("The projected increase in drought conditions will likely alter grassland composition and productivity, disturbance requirements, and erosion.").

[90] U.S. Forest Serv., Climate Change Resource Center, Grasslands and Climate Change, https://www.fs.usda.gov/ccrc/topics/biomes/grasslands [hereinafter USFS, Grasslands and Climate Change].

[91] Sandra L. Brantley & Paulette L. Ford, *Climate Change and Arthropods: Pollinators, Herbivores, and Others*, *in* Finch, *supra* note 67, at 35.

[92] *See* W. Carter Johnson et al., *Vulnerability of Northern Prairie Wetlands to Climate Change*, 55 BIOSCIENCE 863 (2005).

simulations show that drought may result in habitat loss for breeding waterfowl in the Prairie Pothole Region, which produces up to 80 percent of the continent's ducks.[96] Existing habitat fragmentation will limit the ability of species to move to accommodate climate change.[97] Movement of adversely affected plant species may be rarer still.[98] Prolonged drought can reduce vegetation cover, increasing soil erosion, which in turn will increase stream sedimentation, degrade water quality, and threaten native aquatic species.[99] Increasing temperatures will cause more evaporation and deplete aquifers, threatening species in water-dependent habitats.[100] Changes in temperature and precipitation also may cause an increase in soil pH and ammonium and a decrease in nitrification potential, which "could alter the microbial and plant community structure and function of [grasslands ecosystems] and cause [them] to move in the direction of desertification."[101]

Researchers have also predicted that climate change will significantly increase the load of windblown dust in arid and semiarid regions as vegetation cover declines, generating more dust from grazing and other activities that disturb surface soils. This increase would adversely affect human health as a result of increased exposure to particulate matter.[102] Dust increases also may create a negative feedback loop, exacerbating climate change by causing mountain snow cover to

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[93] Conservation in a Changing Climate, Climate Change Impacts on Grasslands, http://climatechange.lta.org/impacts-to-grasslands [hereinafter CC Impacts]; Bryce A. Richardson et al., *Plant Vulnerabilities and Genetic Adaptation*, *in* Finch, *supra* note 67, at 51 ("The status of fire-intolerant sagebrush and its communities is threatened not only by wildfire and the incursion of exotic annuals, but also by the encroachment of native conifers, in part due to fire control and northerly movement of Mojave vegetation in response to warming temperatures."); Finch, *supra* note 89, at 60 ("Wildfire frequency is likely to increase due to changes in temperature and precipitation and invasion of combustible exotic species such as cheatgrass . . . . The interrelation among temperatures, moisture, biological invasions, and fire could trump direct impacts of climate change, leaving species and ecosystems with even less time to adapt.").

[94] As the climate warms, pests will be able to thrive in areas in which they could not previously survive. *See* Mange Grasslands, *supra* note 85; Richardson et al., *supra* note 93, at 50 ("Ecological disturbances creating large-scale plant mortality, such as insect and disease outbreaks, could be symptomatic of underlying plant stress due to climate change.").

[95] Jason Schaefer, *A Market-Based Approach: The Best Way to Transition to A New Energy Economy While Meeting the Responsibility to Address Global Climate Change—A North Dakota Perspective*, 85 N.D. L. REV. 849 , 864 (2009); Owley, *supra* note 82, at 202. *See also* Finch, *supra* note 89, at 66 ("Warmer temperatures and changes in precipitation will likely increase the frequency and severity of disease outbreaks," potentially resulting in "massive waterfowl mortality").

[96] CC Impacts, *supra* note 93. According to the FWS, as a result of climate change, "the prairie pothole region of the Great Plains will become a much less resilient ecosystem, with western areas (mostly in Canada) likely becoming drier and eastern areas (mostly in the United States) having fewer functional wetlands." FWS STRATEGY, *supra* note 40, at 34.

[97] USFS, Grasslands and Climate Change, *supra* note 90.

[98] WDFW, *supra* note 84, at 33 ("Evidence suggests that vegetative range adjustments are episodic in response to climatic conditions, occurring rapidly when conditions are suitable and slowly or not at all otherwise.").

[99] CC Impacts, *supra* note 93; WDFW, *supra* note 86, at 26.

[100] USFS, Grasslands and Climate Change, *supra* note 90; Finch, *supra* note 89, at 60 ("Because of its dependence on ground and surface water, riparian vegetation is sensitive to hydrological effects of climate change.").

[101] WDFW, *supra* note 84, at 37. "Climate change is capable of changing . . . grasslands to deserts . . . ." Robert L. Glicksman, *Ecosystem Resilience to Disruptions Linked to Global Climate Change: An Adaptive Approach to Federal Land Management*, 87 NEB. L. REV. 833, 891 (2009); *see also* HEAD, *supra* note 7, at 54 (reporting prediction that climate change will transform the Great Plains into a desert).

[102] On the negative human health effects of exposure to particulate matter, see ROBERT L. GLICKSMAN ET AL., ENVIRONMENTAL PROTECTION: LAW AND POLICY 424-25 (7th ed. 2015).

melt more quickly in the spring.[103] That kind of shift in the timing of snow melt would reduce yield from the mountain watersheds that provide important sources of water for human use.[104]

In other areas, precipitation may increase, increasing nutrient cycling and facilitating the spread of invasive species, and increasing the frequency of flooding, which can contribute to soil erosion and nutrient loss.[105] Intense run-off events may decrease retention of organic matter and flush out aquatic organisms in wetlands.[106]

These kinds of changes will affect those who use federal grasslands in various ways. They may impair the value of grasslands as grazing habitat, resulting in potentially significant economic losses to ranchers that use multiple use lands to feed their animals.[107] These aspects of climate change also may reduce the value of grasslands for recreational uses such as hunting, fishing, and recreation, which contribute to the vitality of the economies of areas that contain federal grasslands.[108]

A particularly unfortunate aspect of the relationship between climate change and grasslands destruction is the capacity of some grasslands uses to contribute to grasslands degradation twice over – directly, through their immediate impacts, and indirectly because of their contributions to climate change. According to Professor Head, "the causal connection between grasslands destruction and climate change is *indirect* in the sense that some of the major factors leading to grasslands degradation – namely conversion of grasslands to agricultural production and livestock grazing – are themselves very large causes of global climate change."[109]

The foregoing discussion illustrates that grasslands ecosystems, including those on federal lands, provide immense value. Unfortunately, they are vulnerable to a host of threats and challenges, one of the most significant of which is the impact of a climate that is changing as a result of activities that include those that produce anthropogenic greenhouse gas emissions and that destroy ecosystems that act as carbon sinks.[110] The obvious next question is what is being done and can be done to adapt to these changes in ways that ameliorate the adverse effects of climate change.[111] The next Part addresses that question.

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[103] Particulate accumulation in snow reduces its light reflecting ability. Susan E. Meyer, *supra* note 67, at 29-30.
[104] *Id*. at 29-30.
[105] Owley, *supra* note 82, at 202. For further discussion of the impacts of extreme rainfall events on grasslands, see Philip A. Fay et al., *Changes in Grasslands Ecosystem Function Due to Extreme Rainfall Events: Implications for Responses to Climate Change*, 14 GLOBAL CHANGE BIOLOGY 600 (2008), http://onlinelibrary.wiley.com/wol1/doi/10.1111/j.1365-2486.2008.01605.x/abstract.
[106] CC Impacts, *supra* note 93. The FWS has projected that in the Texas Panhandle, "the projected increases in precipitation are unlikely to be sufficient to offset overall decreases in soil moisture and water availability due to increased temperature and water utilization by plants as well as aquifer depletion." FWS STRATEGY, *supra* note 40, at 34.
[107] Felicity Barringer, *Home, Home ... on Less Range*, GREEN BLOG, N.Y. TIMES (Jan. 23, 2012), http://green.blogs.nytimes.com/2012/01/23/home-home-on-less-range/.
[108] Schaefer, *supra* note 95, at 863.
[109] HEAD, *supra* note 7, at 143.
[110] The relationship between these activities and climate change is the subject of extensive literatures whose analyses and conclusions it is not the purpose of this Article to replicate or summarize. *See supra* note 9.
[111] The manner in which humans may mitigate future climate change such as by reducing greenhouse gas emissions is also outside the scope of this Article, although, as mentioned above, grasslands preservation may increase its capacity to sequester carbon and prevent its release into the atmosphere.

III. FEDERAL GRASSLAND MANAGERS' RESPONSES TO CLIMATE CHANGE

The disruptive effects of climate change on federally owned grasslands are likely to be extensive. Although scientists have provided significant information about the broad parameters of the likely impacts of climate change on grasslands, the precise location, nature, extent, interactions, and cumulative impacts of those impacts are more difficult to project. It is clear that status quo management techniques will be inadequate if the land management agencies' goal is to enhance the resilience of grasslands ecosystems so that the continued flow of the valuable services we are accustomed to enjoying from them is not disrupted, notwithstanding unprecedented climatic changes. The agencies instead will need to adapt their management tools and methods. This Part summarizes some of the steps the land management agencies are taking to adapt to climate change in their management of grasslands as well as additional strategies they are authorized to take and should consider pursuing.

A. What the Agencies Are Doing

As Professor Alex Camacho and I have documented elsewhere, all four federal land management agencies have begun to plan for and implement climate change adaptation measures.[112] These measures are reflected in broadly applicable programmatic actions such as strategic frameworks, land use planning regulations, and guidance documents, as well as in location-specific measures such as unit plans and implementing actions and pilot projects. I do not seek to replicate here the analysis of the agencies' adaptive actions Professor Camacho and I have provided in earlier work. Instead, the discussion below illustrates some of the approaches the agencies are taking to craft adaptation strategies specific to the grasslands they administer.

1. *Programmatic and Strategic Actions*

The USFS announced nearly a decade ago in its *Strategic Framework for Responding to Climate Change* that one of its principal goals is to sustain ecosystem services "as forests, grasslands and communities are successfully adapting to climate change."[113] The agency recognized that "[m]any of the most urgent forest and grassland management problems of the past 20 years," including fires, insect infestations, and changing water regimes, "have been driven in part by changing climate."[114] Nothing in the *Framework* distinguished between forests and grasslands in its description of adaptation goals or strategies. The USFS's 2012 planning regulations[115] likewise for the most part treated climate-related threats to forests and grasslands

[112] Alejandro E. Camacho & Robert L. Glicksman, *Legal Adaptive Capacity: How Program Goals and Processes Shape Federal Land Adaptation to Climate Change*, 87 U. COLO. L. REV. 711 (2016). These agency-specific actions supplemented and were often taken in response to directives issued by President Obama or the Departments that house the land management agencies. *Id*. at 747-53.

[113] U.S. DEP'T OF AGRIC., FOREST SERV., STRATEGIC FRAMEWORK 3 (2008), https://www.fs.fed.us/climatechange/documents/strategic-framework-climate-change-1-0.pdf; *see also id*. at 6 ("Adaptation to the effects of climate change is essential if we are to sustain forests and grasslands to provide ecosystem services and continue to mitigate greenhouse gases"); *id*. at 7 (identifying as one of seven key goals "[e]nhanc[ing] the capacity of forests and grasslands to adapt to the environmental stresses of climate change and maintain ecosystem services").

[114] *Id*. at 3.

[115] National Forest System Land Management Planning, 77 Fed. Reg. 21,162 (Apr. 9, 2012).

generically,[116] although the regulatory preamble made limited reference to the management needs of the national grasslands.[117] Even the more specific *Land Management Planning Handbook* does not differentiate between forests and grasslands in its descriptions of climate strategies.[118]

The BLM has a less developed track record in formulating adaptation strategies for climate change.[119] Its 2016 resource management planning regulations, which do address climate change, are a step in the right direction. The agency concluded in its preamble to the regulations that "the proliferation of landscape-scale environmental change agents such as climate change, wildfire, and invasive species create challenges that require the BLM to develop new strategies and approaches to effectively manage the public lands."[120] In issuing those regulations, the BLM cited a series of Interior Department "directives related to climate change [that] emphasize the importance of collaboration, science, adaptive management, and the need for landscape-scale approaches to resource management."[121] The regulations address identification of areas of potential importance in a planning area to help inform planning issues and the development of resource management alternatives. These "areas of ecological importance might include refugia or migratory corridors identified to help sensitive species respond to the effects of climate change or wetlands that help to buffer the effects of weather fluctuations by storing floodwaters and maintaining surface water flow during dry periods."[122] The regulations also provide that ecological processes such as climate change should inform formulation of alternatives and the need for adaptive management.[123] According to the agency, it "will consider relevant resource management concerns, such as climate change and the need for climate change adaptation, when assessing the baseline condition, trend, and potential future condition and when identifying the planning issues for any given resource management plan."[124] None of these provisions differentiates among different kinds of ecosystems or terrains.[125]

Comment [P1]: Editors: There is a good chance the Republicans in Congress will overturn this regulation under the Congressional Review Act. I will need to make minor edits if that happens.

[116] *See, e.g.*, *id*. at 21,183 (refusing to respond to comments that "have been determined to be outside the scope of the development of a planning rule, because they discuss aspects unique to specific forests, grasslands, or municipalities"); *see also* 36 C.F.R. § 219.1(c) ("The purpose of this part is to guide the collaborative and science-based development, amendment, and revision of land management plans that promote the ecological integrity of national forests and grasslands and other administrative units of the NFS.").

[117] *See* 77 Fed. Reg. at 21,212 (noting that "maintaining or restoring shortgrass prairies on national grasslands in the Great Plains contributes to the conservation of black-tailed prairie dogs (regional forester sensitive species (RFSS) of the Rocky Mountain Region), mountain plovers (proposed threatened), and burrowing owls (RFSS), in addition to supporting common species that depend on the shortgrass prairie ecosystem"). The Forest Service Manual includes a series of directives addressed specifically to rangeland management. Forest Service Manual (FSM) Directive Issuances pt. 2200, https://www.fs.fed.us/im/directives/dughtml/fsm2000.html. Those provisions lack a single reference to climate change, however.

[118] *See, e.g.*, U.S. DEP'T OF AGRIC., FOREST SERV., DIR. 12.31(2), LAND MANAGEMENT PLANNING HANDBOOK 23.13c(4)(c) (2012), https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5409939.pdf (listing as an example of circumstances not within the inherent capability of the plan area "Current and projected changes in climate that may affect a national forest or grassland's ability to maintain or even contribute to viable populations of some species").

[119] *See* Camacho & Glicksman, *supra* note 112, at 809-15 (comparing USFS and BLM efforts).

[120] Resource Management Planning, 81 Fed. Reg. 89,580, 89,583 (Dec. 12, 2016).

[121] *Id*. at 89,584.

[122] *Id*. at 89,626 (citing 43 C.F.R. § 1610.4(d)(5)(iv)).

[123] 43 C.F.R. § 1610.4(d)(6).

[124] 81 Fed. Reg. at 89,657 (citing 43 C.F.R. § 1610.5-1).

[125] Neither the preamble nor the regulations themselves refers to grasslands or prairies.

The FWS issued a climate adaptation strategy in 2012.[126] Among the seven broad climate adaptation goals enunciated in the strategy are enhancing the capacity for effective management, supporting adaptive management, reducing non-climate stressors to help ecosystems adapt, conserving habitat to support healthy populations and ecological functions, and managing species and habitats to protect ecological function and provide sustainable use.[127] The strategy aims not "to keep current conservation areas as they are, but rather to ensure that there is a network of habitat conservation areas that maximizes the chances that the majority of species will have sufficient habitat somewhere."[128]

These broad goals and approaches are not aligned with specific ecosystem types. The strategy, however, does identify problems specific to grasslands. It predicts, for example, that "[g]rasslands and shrublands are likely to be invaded by non-native species and suffer wetland losses from drier conditions, which would decrease nesting habitat for waterfowl."[129] It identifies as observed and projected ecological changes relating to climate change the spread of invasive species, changing fire and insect patterns, species range shifts, loss of nesting habitat, changing pest and disease epidemiology, declining forage quality, changes in species composition, and reduced snowpack for grasslands. It attributes most of these same threats, in addition to increased fire frequency (which may favor grasses over shrubs), increased evapo-transpiration and related drought stress, more variable soil and water content, and loss of wetlands, to shrublands.[130] The strategy applauds efforts by state and local agencies to replant beetle-killed areas that have become grasslands with spruce and lodgepole pines to reduce fire hazards for nearby communities.[131] The strategy does little, however, to devise management approaches to deal with these problems that are unique to grasslands.

With fewer units that include grasslands than the other agencies, it is not surprising that the NPS's efforts to understand and address the management challenges linked to climate change have not focused on grasslands. Neither the agency's 2010 *Climate Change Response Strategy*[132] nor its 2012-2014 *Climate Change Action Plan*[133] mentions grasslands.

2. *Location-Specific Assessments and Management Approaches*

The programmatic documents described above do little to stake out management approaches specific to grasslands threatened by climate change. On a more granular level, however, all four of the agencies have engaged in efforts to maintain grasslands functions in the

[126] FWS STRATEGY, *supra* note 40.
[127] *Id*. at 54. An earlier planning-related document did not refer to grasslands. U.S. FISH & WILDLIFE SERV., PLANNING FOR CLIMATE CHANGE ON THE NATIONAL WILDLIFE REFUGE SYSTEM (2008), https://www.fws.gov/refuges/vision/pdfs/PlanningforClimateChangeontheNWRS.pdf. One of its recommendations was to develop a climate change implementation plan to provide guidance for conducting vulnerability assessments of climate impacts to refuge habitats and species, but this document itself did not focus on climate change.
[128] FWS STRATEGY, *supra* note 40, at 54.
[129] *Id*. at 3.
[130] *Id*. at 28-30.
[131] *Id*. at 16.
[132] NAT'L PARK SERV., CLIMATE CHANGE RESPONSE STRATEGY (2010), https://www.nature.nps.gov/climatechange/docs/NPS_CCRS.pdf.
[133] NAT'L PARK SERV., CLIMATE CHANGE ACTION PLAN, 2012-2014 (2012), https://www.nature.nps.gov/climatechange/docs/NPS_CCActionPlan.pdf.

face of climate change. The USFS posits that "[m]anagement options to sustain grassland ecosystems under global [climate] change are many," but acknowledges that they "are mostly untested in their ability to maintain or enhance resource values into the future."[134]

The agencies have engaged in various projects to anticipate the ravages of climate change on grasslands and lay the foundations for increasing the resilience of affected landscapes. All of the agencies are gathering information to assist them in developing management options for adapting to climate change in grasslands ecosystems. The BLM, for example, has conducted rapid ecoregional assessments (REAs) to gauge risks to areas of high ecological value.[135] The REAs "establish landscape-scale baseline ecological data to gauge the effect and effectiveness of future management actions," and the results will help craft management strategies.[136] The BLM prepared pilot REAs for the Northern Great Basin, Wyoming, and Chihuahuan Desert ecoregions,[137] all of which include grasslands.[138] The REAs devoted considerable attention to the existing and projected impacts of climate change, as well as the relationship of climate change to other "change agents."[139]

The NPS has also prepared climate change vulnerability assessments for units that include grasslands, such as Badlands National Park, in which grassland and sparse badlands plant communities comprise nearly 90 percent of the Park (the other ten percent being woodlands and shrublands).[140] As the NPS describes it, such "an assessment of the likelihood and extent to which projected climatic shifts (including such variables as precipitation and temperature) will have adverse or beneficial influences on a given natural or cultural resource" is "a key tool for providing resource managers with information that can be used to aid adaptation planning efforts for vulnerable natural and cultural resources."[141] The agency elaborated as follows:

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[134] USFS, Grasslands and Climate Change, *supra* note 90.

[135] Bureau of Land Mgmt., The BLM's Proposed Landscape Approach for Managing Public Lands 2, https://www.blm.gov/style/medialib/blm/wo/Communications_Directorate/public_affairs/landscape_approach.Par.32078.File.dat/landscape_approach.pdf.

[136] *Id*.

[137] *Id*; *see also* SCIENCE APPLICATIONS INT'L CORP., ECOREGIONAL ASSESSMENT REPORT, NORTHERN GREAT BASIN RAPID ECOREGIONAL ASSESSMENT ES-1 (June 2013), https://www.blm.gov/style/medialib/blm/wo/Communications_Directorate/public_affairs/landscape_approach/landscape4.Par.42937.File.dat/NGB_REA_Main_Report_and_App_A1.pdf [hereinafter Northern Great Basin REA] ("The purpose of the REA is to identify, assemble, synthesize, and integrate existing information about natural resources and environmental change agents to provide information that will help BLM land managers in the ecoregion understand resource status and the potential for change from a broad landscape viewpoint.").

[138] Northern Great Basin Rapid Ecoregional Assessment (REA), https://www.blm.gov/wo/st/en/prog/more/Landscape_Approach/reas/nbasinrange.html#location; Wyoming Basin Rapid Ecoregional Assessment (REA), https://www.blm.gov/wo/st/en/prog/more/Landscape_Approach/reas/wybasin.html; Chihuahuan Desert Rapid Ecoregional Assessment (REA), https://www.blm.gov/wo/st/en/prog/more/Landscape_Approach/reas/chichuahuan.html#location.

[139] *See, e.g.*, Northern Great Basin REA, *supra* note 137, at 6-12 to 6-15; U.S. GEOLOGICAL SURVEY & BUREAU OF LAND MGMT., WYOMING BASIN RAPID ECOLOGICAL ASSESSMENT 165-203 (Natasha B. Carr & Cynthia P. Melcher eds., 2015), https://landscape.blm.gov/REA_General_Docs/WYB_Report.pdf.

[140] NAT'L PARK SERV., BADLANDS NATIONAL PARK: CLIMATE CHANGE VULNERABILITY ASSESSMENT, Natural Resource Report NPS/BADL/NRR—2012/505, xiv (2012) [hereinafter Badlands CCVA]. The Badlands CCVA served as a pilot project for applying climate change vulnerability methodology for natural resource managers needing similar assessments. *Id*. at 276.

[141] *Id*. at 3.

> Traditional conservation strategies were largely developed before climate change had become a major consideration for natural resource managers. However, recent science has increased our awareness of the ecological consequences of climate change, and managers now are tasked with adapting and refining conservation approaches that work to best protect natural resources from the influences of changing climate. Essential to the adaptation effort is identifying and, when possible, quantifying the comparative vulnerabilities of important ecological resources, such as through a CCVA.[142]

Likewise, the FWS created a pilot project to perform Refuge Resource Vulnerability Assessments (RRVAs) in order "to develop and test a methodology for assessing the vulnerability of refuge resources to stressors, primarily climate change, and for developing management alternatives to help resolve conflicts and issues."[143] The agency chose to conduct the initial assessments at two refuges that include grasslands, the Eastern Shore of Virginia and Fishermen Island National Wildlife Refuge[144] and the Sheldon-Hart Mountain National Wildlife Refuges Complex.[145]

The agencies have begun using the information generated by these studies and assessments of existing and anticipated impacts of climate change to fashion adaptive responses. The USFS has identified low risk or "no regrets" options that include reducing non-climate stressors that pose threats to ecosystem resilience, such as altering grazing patterns to increase plant biodiversity.[146] USFS researchers have proposed a framework and guidelines for assisted migration (also known as managed relocation) of plant species vulnerable to climate change.[147] The agency has also noted the benefits of combating habitat fragmentation by establishing corridors to promote connectivity.[148] The USFS has listed contingency planning as a way to prepare for and mitigate the consequences of extreme weather events.[149]

The FWS has also developed active management strategies based on its RRVAs. The strategies for the Eastern Shore and Fishermen Island Refuges, for example, include increasing the availability of forage and cover habitat to migratory birds and butterflies; using monitoring and adaptive management to maintain the long-term productivity, integrity, and function of

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[142] *Id*. at 285.
[143] U.S. Fish and Wildlife Serv., National Wildlife Refuge System, Introduction to the Refuge Resource Vulnerability Assessments, https://www.fws.gov/refuges/whm/IntroRefugeResourceVulnerabilityAssessments.html.
[144] RESOURCE VULNERABILITY ASSESSMENT AND STRATEGIES FOR MANAGEMENT OPTIONS FOR THE EASTERN SHORE OF VIRGINIA AND FISHERMAN ISLAND NATIONAL WILDLIFE REFUGES: FINAL ASSESSMENT REPORT 24 (2011), https://www.fws.gov/refuges/whm/pdfs/EasternShoreVirginiaNWR_RVA_Report.pdf (describing grasslands resources in the refuges).
[145] VULNERABILITY ASSESSMENT AND STRATEGIES FOR THE SHELDON NATIONAL WILDLIFE REFUGE AND HART MOUNTAIN NATIONAL ANTELOPE REFUGE COMPLEX: FINAL REPORT (2011), https://www.fws.gov/refuges/whm/pdfs/SheldonHartNWR_RVA_Report.pdf.
[146] USFS, Grasslands and Climate Change, *supra* note 90.
[147] U.S. Dep't of Agric., Rocky Mountain Research Station, Grassland, Shrubland, and Desert Ecosystems Program, GSD Update 5 (Mar. 2016), https://www.fs.fed.us/rm/pubs_journals/2016/rmrs_2016_finch_d002.pdf [hereinafter Rocky Mountain Research].
[148] USFS, Grasslands and Climate Change, *supra* note 90. "The widespread fragmentation of grasslands makes this an especially critical consideration for anticipating species response." *Id.*
[149] *Id*.

marsh and interdunal communities; prioritizing protection of migratory bird stopover habitat; adjusting the scope and locations of permissible hunting to aid habitat management efforts and decrease pressure on stressed vegetation; and educating the public about the importance of healthy refuges to the local tourist-based economy.[150] For the Sheldon-Hart Refuge Complex, the RRVA provided the basis for a range of management options that included halting grazing by wild horse and burro populations altogether or in newly created connecting areas between the two refuges; control of invasive species; minimization of juniper tree encroachment on other vegetation types; closing roads and consolidation of campgrounds to lessen disruption of native species and decrease the likelihood of non-native plant dispersals; and locating renewable energy projects in areas of low conservation potential or creating buffer zones around known eagle nests and other vulnerable resources.[151]

The land management agencies have taken action to assist in the restoration of grasslands ecosystems damaged by climate change. The USFS has embarked on a research project to assess the suitability of native seeds for different climates whose aim is to identify the most robust seeds that will become the foundation for restoration projects to rebuild ecosystems after wildfires.[152] It has also established guidelines for the restoration of sagebrush ecosystems through seed transfers and improvement of seed purity.[153] USFS scientists have used species distribution models and climate change vulnerability assessments to identify riparian habitats likely to be disrupted as a result of climate change.[154] Aquifer recharge in areas in which climate change has increased aridity is another potential management tool.[155]

B. What the Agencies Need to Do

The four land management agencies have been busy building an informational foundation for assessing and responding to climate-related threats to grasslands for years. This informational infrastructure is a necessary prerequisite to informed and effective management actions that will conform to the agencies' resource protection and management responsibilities in the face of the novel challenges presented by a changing climate. Not surprisingly, the agencies do not appear to be as far along in identifying and implementing location-specific responsive actions as they have been in determining how climate change will affect federal grasslands and in devising broad-based strategic approaches. Agency planning regulations, manuals, and other guidance documents will provide a general framework, but they will afford land managers considerable discretion in fashioning and implementing land use plans at the regional or unit level. The discussion below addresses considerations relevant to the exercise of that discretion.

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[150] *Id*. at 80-86.
[151] *Id*. at 96-116.
[152] Rocky Mountain Research, *supra* note 147, at 2-3; *see also* U.S. Dep't of Agric., Rocky Mountain Research Station, Grassland, Shrubland, and Desert Ecosystems Program, GSD Update 10 (Mar. 2015), https://www.fs.fed.us/rm/pubs_journals/2015/rmrs_2015_finch_d001.pdf (concluding that "human-mediated dispersal of seed will be need to keep pace with climate change"). *See generally* U.S. Dep't of Agric., Rocky Mountain Research Station, Grassland, Shrubland, and Desert Ecosystems Program, Ushering in a New Age of Genetics to Restore Lands and Conserve Species (May 2013), https://www.fs.fed.us/rm/pubs_other/rmrs_2013_finch_d002.pdf.
[153] Rocky Mountain Research, *supra* note 147, at 12-13.
[154] *Id*. at 14-15.
[155] USFS, Grasslands and Climate Change, *supra* note 90.

1. *Exercise of Substantive Legal Adaptive Capacity*

Professor Camacho and I have argued that the extent to which the land management agencies have discretionary authority to meet the unprecedented challenges posed by climate change depends largely on the degree of substantive legal adaptive capacity afforded them by their organic statutes, implementing regulations, and other sources of law. As we envision it, substantive legal adaptive capacity is

> the extent to which a legal regime's goals are capable of responding to changed conditions. An agency with a high degree of substantive legal adaptive capacity has the authority under its organic legislation to adjust its interpretation of regulatory goals or the means of pursuing them to meet new challenges or accommodate changed circumstances.[156]

The multiple use agencies have greater substantive legal adaptive capacity than the dominant use agencies. Both the USFS and the BLM have ample substantive legal adaptive capacity under their multiple use, sustained yield organic statute mandates to address the threats to grasslands posed by climate change.[157] NFMA's mandate to promote long-term ecological sustainability and diversity afford the USFS the flexibility needed to manage in ways that accommodate ecological change.[158] The statute specifically requires the agency to include in its periodic resource assessments "an analysis of the potential effects of global climate change on the condition of renewable resources on the forests and rangelands of the United States."[159] NFMA also requires the USFS to "account for the effects of global climate change on forest and rangeland conditions, including effects on the geographic ranges of species, and on forests and rangeland products."[160] Thus, the statute requires both climate change assessments and responsive actions, although it leaves the nature of those actions largely to agency discretion.

FLPMA, while lacking similar specific references to climate change, vests in the BLM similarly expansive authority to adapt its management approaches in response to shifting resource conditions. The statute's definition of multiple use, for example, refers to management that "provide[s] sufficient latitude for periodic adjustments in use to conform to changing needs and conditions."[161]

The NPS has less flexibility in that its statutory mandate commits it (or at least the agency has at times interpreted that mandate as requiring it) to protect resources in their historical condition, which may become increasingly impossible as climate change triggers irreparable changes in resource conditions.[162] The NPS has also presumed that management

[156] Camacho & Glicksman, *supra* note 112, at 724. Legal adaptive capacity also has a procedural component, which "measures the degree to which a legal regime's process is able to adjust to new policy directions or information or changed factual circumstances." *Id*. at 729. For further discussion of procedural legal adaptive capacity, see *infra* Part IIIB.2.
[157] Camacho & Glicksman, *supra* note 112 at 753-58 (USFS), 766-68 (BLM).
[158] *Id*. at 753.
[159] 16 U.S.C. § 1601(a)(5) (2012).
[160] *Id*. § 1602(5)(F).
[161] 43 U.S.C. § 1702(c) (2012).
[162] Camacho & Glicksman, *supra* note 112, at 789-91.

actions should avoid intervening in natural biological or physical processes unless necessary to restore natural ecosystems functioning that has been disrupted by human activity.[163] Even if the agency adheres to that posture, it ought not to hamper pursuit of adaptive responses given that anthropogenic greenhouse gas emissions have caused or contributed to the climate-related disruptions to ecosystem functioning that research into the current and projected future conditions of grasslands within the federal land systems has revealed.

The FWS, the other dominant use agency, has what Professor Camacho and I have characterized as a "moderate level of flexibility in selecting management goals and the means to achieve them" in light of its mandate to conserve and restore refuge resources.[164] A plausible reading of the organic statute for the refuge system is that "the FWS's duty is to conserve function, not a pre-existing resource mix or state."[165] Although the agency has insisted that its organic statute obliges it to maintain "historic conditions" to promote biological integrity, diversity, and environmental health, it had defined those conditions to focus on ecosystem functioning rather than a static set of particular conditions.[166] Indeed, the FWS recognized as much in its 2012 climate adaptation strategy which, as noted above, aims not to "keep current conservation areas as they are," but rather to create a network of habitat conservation that provide suitable habitat for the majority of species.[167]

In exercising the adaptive capacity afforded them under governing statutes, regulations, land use plans, and other sources of legal authority and constraint, the land management agencies' efforts to preserve the value of grasslands under climate-related stress should emphasize promotion of ecological health. That goal entails protecting the integrity of grasslands ecosystems or essential biological processes, including but not limited to preserving the flow of the numerous valuable functions provided by well-functioning grasslands.[168] To the extent their mandates allow them to do so, the agencies should shift away from management strategies that seek to preserve historical norms if climate change has made those norms impossible to sustain or restore.

For the multiple use agencies, such a shift ought to include reducing or eliminating extractive and consumptive uses such as grazing in grasslands areas that already reflect impaired ecological functioning or which scientists predict are likely to do so. Changes of that kind fall into the category of "no regrets" management actions[169] because mitigation of co-stressors such as unsustainable grazing activities will improve grasslands conditions even without regard to climate change. In other words, the agencies should displace multiple use management with

[163] *Id*. at 791.
[164] *Id*. at 774-75 (citing 16 U.S.C. §§ 668dd(a)(2), (3)(A) (2012)); *see also id*. at 807.
[165] *Id*. at 775 (citing 16 U.S.C. §§ 668dd(a)(4)(C), 668ee(4) (2012)).
[166] U.S. FISH & WILDLIFE SERV., THE FISH AND WILDLIFE SERVICE MANUAL pt. 601 FW3 § 3.6(d) (2001), http://www.fws.gov/policy/601fw3.html [https://perma.cc/DXL9-9AFU]; *see* Camacho & Glicksman, *supra* note 112, at 784-85.
[167] *See supra* 128 and accompanying text.
[168] For a list of those functions, *see supra* notes 69-72 and accompanying text.
[169] *See supra* note 146 and accompanying text.

dominant use management on grasslands tracts on which the combination of extractive use and climate change puts continued ecosystem integrity at risk.[170]

The multiple use statutes are fully consistent with such an approach. Statutory definitions of "multiple use" include wildlife and watershed, as well as "natural . . . scientific . . . values."[171] If climate change threatens the viability of a wildlife species whose existence is integral to the healthy functioning of its grassland habitat, the agencies should be able to restrict other multiple uses that are inconsistent with protection of that species. The inclusion of watershed as a multiple use is particularly revealing. Professor Coggins and I have described the meaning of that amorphous term, which is not defined in the multiple use statutes:

> The term evidently is shorthand for the vegetation systems that regulate and stabilize water quantity while protecting water quality and land integrity. Watershed is both the elements comprising the ecosystem—soil, water, flora, and fauna—and the resource relationships within the ecosystem. . . . Watershed, essentially, is the ecological stability of the soils, water, vegetation, and biota that comprise the river drainage. Watershed protection largely amounts to leaving sufficient vegetation in place to avoid the consequences of insufficient land cover.[172]

Consistent with that analysis, we concluded that "multiple use, sustained yield management, while not synonymous with ecosystem management, is related to it and may implicitly encompass it."[173] FLPMA, for example, declares a policy of managing public lands "in a manner that will protect the quality of . . . ecological, [and] environmental . . . values[ ] that, where appropriate, will preserve and protect certain public lands in their natural condition.'"[174] Multiple use management does not require that every listed multiple use be authorized in every area.[175] FLPMA explicitly provides that BLM management decisions may include total elimination of one or more principal uses.[176] As one court put it, "'[i]f all the competing demands reflected in FLPMA were focused on one particular piece of public land, in many instances only one set of demands could be satisfied. A parcel of land cannot both be preserved in its natural character and mined [or grazed].'"[177]

Short of carving out grasslands tracts that are off limits to uses that will exacerbate the stresses resulting from climate change, the protection of grasslands integrity will require the two multiple use agencies to restrict and condition those uses (such as grazing or off-road recreational use) that would otherwise disrupt grasslands ecological health. FLPMA provides that, in managing the public lands, the BLM "shall, by regulation or otherwise, take any action

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[170] *Cf.* Head, *supra* note 21, at ___ [MS at 25] (urging creation of wilderness areas to protect certain grasslands or adoption of prohibitions on extractive and consumptive uses).
[171] 16 U.S.C. § 528 (2012); 43 U.S.C. § 1702(c) (2012).
[172] 3 COGGINS & GLICKSMAN, *supra* note 1, § 35:10.
[173] *Id.* § 30:3.
[174] 43 U.S.C. § 1701(a)(8) (2012).
[175] New Mexico ex rel. Richardson v. Bureau of Land Mgmt., 565 F.3d 683, 710 (10th Cir. 2009).
[176] 43 U.S.C. § 1712(e)(1) (2012). The BLM must report to Congress any management decision that totally eliminates one or more principal use for two years or more on a tract of 100,000 acres or more. *Id.* § 1712(e)(2).
[177] Rocky Mtn. Oil & Gas Ass'n v. Watt, 696 F.2d 734, 738 n.4 (10th Cir. 1982) (quoting Utah v. Andrus, 486 F. Supp. 995, 1003 (D. Utah 1979)).

necessary to prevent unnecessary or undue degradation of the lands."[178] That standard is a disjunctive one, requiring the agency to eliminate not only unnecessary (i.e., avoidable) degradation, but also degradation that, while it would necessarily accompany an otherwise permissible multiple use, would be undue or excessive.[179] FLPMA also requires the BLM to give priority to areas of critical environmental concern in the development of resource management plans.[180] If grasslands on the public lands include such areas,[181] the agency must protect them from the adverse effects of conflicting uses. Some areas designated by the BLM as areas of critical environmental concern include shrublands.[182]

The principal relevant constraint on the USFS's management discretion imposed by NFMA may be the mandate that land and resource management plans "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives."[183] Uses, such as grazing, of national grasslands that interfere with the preservation of diversity that has already been adversely affected or is projected to be so affected should be curtailed to comply with this mandate. In addition, the Bankhead-Jones Farm Tenant Act directs the USFS to "correct maladjustments in land use" to assist in controlling soil erosion, preserving natural resources, protecting fish and wildlife, mitigating floods, conserving soil moisture, protecting watersheds of navigable streams, and protecting the public lands.[184] As indicated in Part IIB above, climate change presents challenges in achieving all of these objectives. If curtailing or conditioning otherwise permissible multiple uses is capable of reducing those threats, the agency's imposition of constraints would be consistent with the Bankhead-Jones Act's directive.[185] Notably, that Act authorizes the USFS to "protect[ ] the watershed of navigable streams," as well as "the public lands, health, safety, and welfare . . . ."[186]

Use exclusions or constraints are also likely to be called for on the dominant use land systems. The National Wildlife Refuge System Administration Act requires the FWS to

[178] 43 U.S.C. § 1732(b) (2012).
[179] *See* Mineral Policy Ctr. v. Norton, 292 F. Supp. 2d 30, 43 (D.D.C. 2003). *But cf*. Theodore Roosevelt Conservation P'ship v. Salazar, 661 F.3d 66, 76 (D.C. Cir. 2011) (emphasis added) (concluding, with no supporting citations or analysis, that "by following FLPMA's multiple-use and sustained-yield mandates, the Bureau will often, *if not always*, fulfill FLPMA's requirement that it prevent environmental degradation because the former principles already require the Bureau to balance potentially degrading uses—e.g., mineral extraction, grazing, or timber harvesting—with conservation of the natural environment").
[180] 43 U.S.C. § 1712(c)(3) (2012).
[181] Areas of critical environmental concern are "areas within the public lands where special management attention is required . . . to protect and prevent irreparable damage to important . . . fish and wildlife values or other natural systems or processes . . . ." *Id*. § 1702(a).
[182] *See* Bureau of Land Mgmt., Areas of Critical Environmental Concern, https://www.blm.gov/nv/st/en/fo/lvfo/blm_programs/lvfo_recreation/accessing_your_public/acec_information.html (listing and describing such areas, including Amargosa Mesquite ACEC, Ash Meadows ACEC, Coyote Springs ACEC, Mormon Mesa ACEC, and Piute/Eldorado ACEC).
[183] 16 U.S.C. § 1604(g)(3)(B) (2012).
[184] 7 U.S.C. § 1010 (2012).
[185] The Bankhead-Jones Tenant Farm Act "has guided and directed national grasslands administration since 1937." Howard, *supra* note 18, at 410; *see also* 36 C.F.R. § 213.1(b) ("The National Grasslands shall be a part of the National Forest system and permanently held by the Department of Agriculture for administration under the provisions and purposes of title III of the Bankhead-Jones Farm Tenant Act.").
[186] 7 U.S.C. § 1010 (2012).

"provide for the conservation of fish, wildlife, and plants, and their habitats" within the National Wildlife Refuge Administration System.[187] It also requires the agency to "ensure that the biological integrity, diversity, and environmental health of the System are maintained.[188] If other uses, including favored wildlife-dependent recreational uses such as hunting, interfere with pursuit of those objectives, they ought to be precluded. Climate change may reduce wildlife or plant populations in a refuge to levels that would be unsustainable if recreational uses were to continue, but not if such uses were restricted. Other uses, including non-wildlife-dependent recreational uses and commercial uses,[189] deserve little if any accommodation under such circumstances. NPS management of National Park System units with grasslands should follow a similar path, given its organic statute mandate to "promote and regulate the use of the [System] by means and measures [that] conserve . . . natural and historic objects, and wild life in the System units and to provide for [their] enjoyment . . . in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."[190]

Although active management in undisturbed areas is not without costs, the dominant use agencies also should consider moving away from non-interventionist management preferences that may be ineffective at staving off climate-related disruptions that threaten continued ecological health.[191] As Professor Camacho and I have argued, "[c]limate change substantially increases the costs in ecological function of absolute bars and/or significant impediments to active management strategies."[192] A failure to pursue active measures such as assisted migration of plant and animal species to replace those ravaged by climate change is likely to redound to the detriment of grasslands health and integrity.

2. *Exercise of Procedural Legal Adaptive Capacity*

Although this Article has focused on the substantive aspects of agency decisions concerning management of federal grasslands, brief consideration of the procedural component of legal adaptive capacity is in order. Many scholars and policymakers have urged greater

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[187] 16 U.S.C. § 668dd(a)(4)(A) (2012).
[188] *Id*. § 668dd(a)(4)(B).
[189] The FWS has allowed limited grazing in the refuges. *See* John D. Leshy & Molly S. Mcusic, *Where's the Beef? Facilitating Voluntary Retirement of Federal Lands from Livestock Grazing*, 17 N.Y.U. ENVTL. L.J. 368, 388 (2008) (discussing limited extent of grazing in the refuges); Cam Tredennick, *The National Wildlife System Improvement Act of 1997: Defining the National Wildlife Refuge System for the Twenty-First Century*, 12 FORDHAM ENVTL. L.J. 41, 103 n.303 (2000); *see also* Schwenke v. Secretary of the Interior, 720 F.2d 571 (9th Cir. 1983) (holding that the National Wildlife Refuge Administration Act of 1976 did not override executive order authorizing forage in a refuge). Other commercial uses of the refuge are similarly restricted. *See* Richard J. Fink, *The National Wildlife Refuges: Theory, Practice, and Prospect*, 18 HARV. ENVTL. L. REV. 1, 28 n.180 (1994).
[190] 54 U.S.C. § 100101(a) (2016); *see also id*. § 100101(b)(2) (emphasis added) ("The authorization of activities shall be construed and the protection, management, and administration of the System units shall be conducted in light of the high public value and *integrity of the System* and shall not be exercised in derogation of the values and purposes for which the System units have been established, except as directly and specifically provided by Congress.").
[191] *See* Camacho & Glicksman, *supra* note 112, at 818-19 (discussing possible administrative changes by the FWS that would shift management priorities away from maintenance of historical baselines and toward protecting ecosystem integrity). The costs of active management may be greatest in wilderness areas, where undisturbed landscapes provide economic, scientific, psychological, and spiritual values. *Id*. at 822.
[192] *Id*. at 823.

reliance on adaptive management as a decisionmaking technique.[193] Adaptive management is an "evolutionary" decisionmaking framework that relies "on iterative cycles of goal determination, model building, performance, standard setting, outcome monitoring, and standard recalibration."[194] Adaptive management is not an appropriate decisionmaking technique in all circumstances. Just as choosing whether to shift from passive to active management strategies requires consideration of the costs and benefits of doing so,[195] agencies should be cognizant of both the upsides and downsides of adaptive management. Among its potential costs are greater uncertainty about governing legal rules, reduced public participation, a less accountable decisionmaking process, and lost time if experimental approaches fail to bear fruit.[196]

Adaptive management, however, also provides agencies with flexibility and may permit quicker decisions than a more front-loaded decisionmaking approach would do. Its benefits may be greatest "in regulatory contexts where there is incomplete understanding and the regulated system is changing."[197] Climate change presents exactly those circumstances.[198] The rewards of pursuing experimental approaches, followed by monitoring to gauge their success or failure, followed by adjustments in the face of those observations, may be especially rewarding in light of the unprecedented nature of the ecological shifts that climate change has and will continue to spur. All four land management agencies have pursued adaptive management strategies,[199] and the courts have endorsed their use.[200] Especially in the initial stages of efforts to adapt to the impacts of climate change on federal grasslands, when information on both conditions and the effectiveness of management strategies is likely to be least developed, agencies should continue to consider using adaptive management strategies. That approach may be especially attractive if the agency using it can minimize its costs, such as by establishing metrics for triggering required further action that will help promote accountability.[201]

CONCLUSION

Grasslands ecosystems on federal lands, like mountain, coastal, desert, and other terrains, are under considerable stress because of climate change, and the challenges facing land managers

[193] *See id*. at 732 n.83 (listing sources).
[194] 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, 1391 (2011); *see also* Robin Kundis Craig & J.B. Ruhl, *Designing Administrative Law for Adaptive Management*, 67 VAND. L. REV. 1, 20 (2014) (stating that adaptive management's goal "is "to reduce uncertainty through integrative learning fostered in a structured, iterative decisionmaking process").
[195] *See supra* notes 189-90 and accompanying text.
[196] *See* Camacho & Glicksman, *supra* note 112, at 737-38.
[197] *Id*. at 738.
[198] Adaptive management may be a poor fit, however, "when an area is expected to be fairly ecologically stable notwithstanding climate change, is exceptionally pristine, or has poorly understood ecological function." *Id*. at 824.
[199] *See id*. at 757-58, 760-61 (USFS), 768-69, 773 (BLM), 781-82, 788 (FWS), 792-93, 796 (NPS).
[200] *See, e.g.*, *id*. at 758 n.240 (citing cases involving the USFS), 767 n.308 (citing cases involving the BLM); *see also* USFS, Grasslands and Climate Change, *supra* note 90 (listing as one of the tenets of managing climate change response "evaluat[ion of] the success of current management programs, implementing anticipatory actions, and maintaining the flexibility to modify strategies. Local climate alterations may also affect management decisions such as when prescribed fires can be applied.").
[201] For discussion of the use of adaptive management processes by local governments in Florida seeking to address sea level rise attributable to climate change, see David L. Markell, *Emerging Legal and Institutional Responses to Sea-Level Rise in Florida and Beyond*, 42 COLUM. J. ENVTL. L. 1, 49-56 (2016).

are likely to get steeper as the temperatures continue to warm and precipitation patterns shift. The federal land management agencies not only have powerful legal tools at their disposal to address those challenges. The statutes from which they derive their management authority also dictate that they take steps to facilitate the capacity of the grasslands resources they manage to adapt to a changing climate, though they largely leave the nature of those efforts to agency discretion.

The touchstone of climate change adaptation actions should be to promote grasslands ecosystem integrity, as measured by their capacity to continue to perform as healthy and well-functioning ecosystems that serve the needs not only of humans but of other species that call grasslands home. Achieving this goal will entail eliminating some impairing, disruptive uses historically allowed in system units that contain grasslands, imposing protective conditions on uses that continue to be allowed, abandonment of historical norms that climate change has made impossible to sustain or restore, and a shift toward greater reliance on active intervention in natural processes to counter the destructive impacts of anthropogenic greenhouse gas emissions.

Grasslands ecosystems are in peril across the globe. The federal land management agencies have an opportunity to set an example of successful grasslands management in the face of climate change. Using the architecture of the federal land management laws in the ways suggested here would benefit current and future use of federal grasslands by humans and other species. It would also provide guidance to grassland managers, public and private, in other areas susceptible to the impacts of climate change.