

U.S. Sea Level Trends
1900-2000

Proceedings of the 2010 Land Policy Conference



CLIMATE CHANGE AND LAND POLICIES

Non-Point Source CO₂ emissions by Hours
a Percentage of Daily Total

335,609	24,272	26,299
22,932	70,832	75,326
65,955	114,747	121,659
~ 432	22,280	88,611
		61,640

Geographic Diversity and Storage

1 2 3 4 5

13 14 15 16

16 Day

= CO₂ after red

Edited by Gregory K. Ingram and Yu-Hung Hong

Composite Output with Ge...

1900 1910 1920 1930 1940 1950

Climate Change and Land Policies

Edited by

Gregory K. Ingram and Yu-Hung Hong

 LINCOLN INSTITUTE
OF LAND POLICY
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Climate Change and the Management of Federal and State-Owned Land in the United States

Christopher McGrory Klyza

The U.S. government owned nearly 655 million acres of land, or about 29 percent of the nation, in 2009.¹ It acquired the vast majority of this land millions of acres at a time through purchases, treaties, and wars, culminating with the purchase of Alaska in 1867. By this point, the federal government had acquired nearly 1.8 billion acres of land. Throughout the nineteenth century, it passed hundreds of laws designed to transfer this land into the private sector. Transfers included general land sales, grants to soldiers, railroad grants, and homesteading grants. The federal disposal policy began to change in the late 1800s, when the government decided to retain ownership of some of this land in the form of national parks and forests. A few decades later, it began to purchase

Thanks to Steve Trombulak for his helpful comments.

1. Total federal land ownership figures are hard to come by. Until 2000, the Bureau of Land Management (BLM) published these data in its annual *Public Land Statistics*. The data were then available through the General Services Administration (GSA). In response to a 2004 executive order, the GSA now collects and publishes only a subset of the data. The 2009 figure is based on adding data from the GSA, BLM, Fish and Wildlife Service, Forest Service, and National Park Service (GSA 2009; NPS 2009; U.S. Bureau of Land Management 2009c; USDA Forest Service 2009b; U.S. Fish and Wildlife Service 2009). These sources were also used to construct the total for the 12 western states. A BLM employee working on the National Integrated Land System, a geographic information system (GIS) for all federal land, shared his most current GIS data with me. Those data indicated federal ownership of 657 million acres, but the totals by agency often differ by several million acres.

land for conservation purposes, again primarily to create national forests, national parks, and wildlife refuges (Gates 1968). Today four agencies manage the bulk of these conservation lands: Bureau of Land Management, Fish and Wildlife Service, National Park Service, and the Forest Service (see table 16.1). The first three agencies are housed in the Department of the Interior, the last in the Department of Agriculture (USDA). The Army Corps of Engineers and the Bureau of Reclamation also manage millions of acres of conservation lands surrounding their water projects. The Department of Defense owns nearly 19 million acres as well, although its land is not managed primarily for conservation. Most of this land is located in the 11 westernmost continental states and Alaska. In 2009 the federal government owned more than 596 million acres in these states, accounting for 53 percent of the land there.

The first permanent national land conservation system in the United States, the national park system, can be traced back to either 1864 or 1872. The federal government transferred Yosemite Valley to the State of California to be managed as a park for “public use, resort and recreation” in 1864. California returned the land to the federal government in 1905, when it was incorporated into Yosemite National Park. In 1872 Congress created Yellowstone National Park, the nation’s first national park, “as a public park or pleasuring ground.” Although Congress continued to designate new national parks, it did not establish the National Park Service (NPS)—charged with administering these parks—until 1916. This organic act, still the foundation for park management, directed the agency “to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations” (Runte 1987, 28, 46, 104). The tensions inherent in this directive—preservation versus enjoyment—have resonated throughout the history of the NPS (Sellars 1997).

The amount of land managed by the NPS has grown over the past century, primarily by designating existing public land as national parks, but in some cases, especially in the eastern half of the nation, through purchasing or receiving donated private land (e.g., Acadia National Park and Shenandoah National Park). The most significant expansion of park land came in 1980, with the passage of the Alaska National Interest Lands Conservation Act. The law more than doubled the land managed by the NPS nationally, creating ten new national park units and expanding three existing parks and monuments, adding nearly 44 million acres to NPS lands (Allin 1982). In addition to the growth in acreage, Congress has created many new designations under the NPS, ranging from national battlefields to national historic sites to national seashores. In 2009 the agency managed 392 units totaling more than 80 million acres. The most significant management types, in order of acreage, are national parks, national preserves, and national recreation areas (NPS 2009).

Although Congress designated the first national park earlier, the national forest system is the oldest of the land management systems. The Forest Reserve Act, passed in 1891, granted the president the power to establish forest reserves from

Table 16.1
Federal Public Land in the United States, 2009

Major Conservation Agencies	Units	Acreage	Percentage of Federal Public Land
Bureau of Land Management			
Total (included in the total are holdings in the following selected programs)		253,366,500	38.7
National Landscape Conservation System	860	42,782,840	6.5
Fish and Wildlife Service			
Total (included in the total are holdings in the following selected programs)		92,458,018	14.1
National wildlife refuges	548	91,428,073	14.0
Forest Service			
Total (included in the total are holdings in the following selected programs)		192,778,459	29.4
National forests	155	188,096,259	28.7
National grasslands	20	3,838,436	0.6
National Park Service			
Total (included in the total are holdings in the following selected programs)	392	80,437,525	12.3
National parks	58	50,393,633	7.7
National preserves	18	22,886,202	3.5
National recreation areas	18	3,146,877	0.5
Subtotal		619,040,502	94.5
Other Major Landholdings by Agency			
Department of Defense		18,945,287	2.9
Army Corps of Engineers		7,861,982	1.2
Bureau of Reclamation		6,580,468	1.0
Subtotal		33,387,737	5.1
Other agencies		2,494,121	0.4
Total		654,922,360	100
Percentage of federally owned land in the United States		28.83	

Sources: NPS (2009); U.S. Army Corps of Engineers (2006); U.S. Bureau of Land Management (2009a, 2009c); U.S. Bureau of Reclamation (2010); USDA Forest Service (2009b, table 1); U.S. Department of Defense (2009); U.S. Fish and Wildlife Service (2009).

existing public land. Over the next several decades, Congress placed the Forest Service in charge of administering these reserves, renamed the reserves national forests, rescinded the power of the president to designate new national forests, and authorized the purchase of private land to be part of national forests (via the Weeks Act, passed in 1911). The Weeks Act was especially significant in that it allowed for the expansion of national forests to states in the Northeast, Southeast, and Midwest and established the precedent of federal land purchases for conservation purposes (Steen 1976). By 1910 the 149 national forests comprised more than 168 million acres. Although the number of acres of national forest land fluctuated over the next hundred years, the system grew to 155 national forests totaling 188 million acres in 2009. Over time, the Forest Service came to administer several other types of land as well. In terms of total acreage, however, the only significant type other than national forests is national grasslands. These 20 units, created in 1960 with land acquired in response to the Dust Bowl of the 1930s, cover nearly 4 million acres. In total, the Forest Service administered nearly 193 million acres in 2009 (USDA Forest Service 2009b, tables 1 and 21).

The Forest Service has stressed managing its land for multiple use and sustained yield, with special significance given to timber management. This land management philosophy and practice, however, grew increasingly controversial over time. By the 1960s, national forest land management became a center of conflict among commodity users, preservationists, recreationists, and resource managers (Clary 1986; Hirt 1994). After a successful lawsuit challenging Forest Service timber management practices, Congress passed the National Forest Management Act in 1976. This law provides the statutory basis for national forest management today. As is the case with the other government land management agencies, the Forest Service must deal with a host of other laws when managing national forests. The most important of these are the National Environmental Policy Act, which requires environmental impact statements for major federal actions significantly affecting the environment, and the Endangered Species Act.

President Theodore Roosevelt, central to the expansion of the national forest, national park, and national monument systems, established the nation's first wildlife refuge, Pelican Island in Florida, in 1903. He created 50 more reserves during his presidency. The number of refuges grew sporadically over the next several decades, although the refuges lacked an organic act or central policy to guide management (Zaslowsky and Watkins 1994). As was the case with the national park system, the national wildlife refuge system grew dramatically with the passage of the Alaska National Interest Lands Conservation Act in 1980. The law designated more than 55 million acres of new national wildlife refuges, more than doubling the national system (Allin 1982). Congress finally passed an organic act for the refuge system in 1997, the National Wildlife Refuge System Improvement Act. The law established the conservation and preservation of fish, wildlife, and plants as the primary purpose of the refuges, while recognizing hunting and recreation as priority activities when they are compatible with conservation. The law also required a comprehensive conservation plan for each

refuge. Since the wildlife refuge system lacked a unified, statutory directive before 1997, the refuges are host to a variety of uses beyond wildlife conservation and recreation. These include the cultivation of crops, energy development, and livestock grazing. The Fish and Wildlife Service owned more than 92 million acres in 2009, nearly all of which were in 548 national wildlife refuges (U.S. Fish and Wildlife Service 2009).

The Bureau of Land Management (BLM) manages the most land of any federal agency, 253 million acres in 2009 (U.S. Bureau of Land Management 2009c). Unlike the land managed by the other conservation agencies, most of the BLM land was not selected specifically for conservation purposes. Rather, this land is part of the original public domain that was not transferred into the private sector or designated for other conservation purposes, such as national forests or national parks. The federal government first indicated it would retain ownership of most of the remaining public domain land when it passed the Taylor Grazing Act in 1934, and it formalized this commitment of permanent ownership in the Federal Land Policy and Management Act (FLPMA) of 1976. The BLM mission before passage of the FLPMA was focused on natural resource utilization: grazing, energy development, mining, and timber harvesting. Although the FLPMA explicitly recognized the continued importance of these activities, it also stressed preservation as a purpose for this land. The law required the agency to review its landholdings for wilderness designation and established a special conservation management area covering millions of acres of California desert (Klyza 1996). More recently, the Clinton administration sought to elevate the status of conservation land managed by the BLM (namely, national monuments, national conservation areas, wilderness areas, and wilderness study areas) by creating the National Landscape Conservation System in 2000. Congress codified the system, now encompassing more than 42 million acres, in 2009 (Skillen 2009; U.S. Bureau of Land Management 2009a).

Two additional land management systems are layered on top of the areas administered by these four agencies: wilderness and national monuments. The Forest Service established an administrative wilderness system on national forests in the 1920s, providing the foundation for a broader national system. After eight years of work, Congress passed the Wilderness Act in 1964. The law designated 9 million acres of national forests as wilderness and established a process for the review and designation of wilderness areas on land managed by the Fish and Wildlife Service, the Forest Service, and the National Park Service. The FLPMA extended the provisions of the Wilderness Act to BLM land. Wilderness is defined “as an area where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain.” Such areas are uninhabited and lack permanent improvements (e.g., roads or structures). Timber harvesting is not allowed in wilderness areas, although established livestock grazing may continue, and, under certain circumstances, other management activities may be launched. The wilderness system has grown to encompass more than 109 million acres (see table 16.2). Like the park and refuge systems, the wilderness system

Table 16.2
Wilderness Areas in the United States, 2009

	Units	Acreage	Percentage of Wilderness
Bureau of Land Management	221	8,739,646	8.0
Fish and Wildlife Service	71	20,702,350	18.9
Forest Service	439	36,160,078	33.0
National Park Service	60	43,890,517	40.1
Total	791	109,492,591	100.0

Source: Wilderness.net (2010).

grew tremendously with the passage of the Alaska National Interest Lands Conservation Act, which designated 56 million acres of wilderness (Allin 1982; Wilderness.net 2010).

In 1906 Congress passed the Antiquities Act, which gave the president the power to designate “historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest that are situated upon the lands owned or controlled by the Government of the United States to be national monuments.” The first several national monuments were tens to thousands of acres, but President Theodore Roosevelt designated Grand Canyon National Monument, encompassing more than 800,000 acres, in 1908. Since that time, presidents have established 127 national monuments. (Congress can also create national monuments; it has created 43.) Many of these monuments were later converted to national parks. The Antiquities Act was used most recently by President Bill Clinton, who designated 19 national monuments totaling nearly 6 million acres, and President George W. Bush, who designated five new national monuments, including four marine reserves covering nearly 215 million acres. The vast majority of the national monuments are administered by the NPS, but reserves are also managed by the BLM, Fish and Wildlife Service, and Forest Service (see table 16.3). Management of the monuments varies based on the specific language for each monument’s establishment. Typically, national monuments administered by the NPS have little or no resource development, while those administered by the BLM or Forest Service often allow grazing, existing mining, and timber harvesting (NPS 2006; Rothman 1994).

Overall, we can view the range of uses permitted on public land along a continuum. Beginning with the most protected, the order is NPS, Fish and Wildlife Service, Forest Service, and BLM. The areas managed by the NPS and Fish and Wildlife Service each have a priority use: preservation and recreation for the NPS and wildlife conservation for the Fish and Wildlife Service. Although there are certainly exceptions, especially on the national wildlife refuges, and large-scale tourism and recreation have significant ecological effects, these areas are

Table 16.3
National Monuments, by Agency, 2009

	Units	Acreage	Percentage of National Monument Acreage
Bureau of Land Management	15	4,807,849	23.5
Fish and Wildlife Service	3	10,029,892	49.0
Forest Service	5	3,806,466	18.6
National Park Service	74	1,840,858	9.0
Total	97	20,485,065	100.0

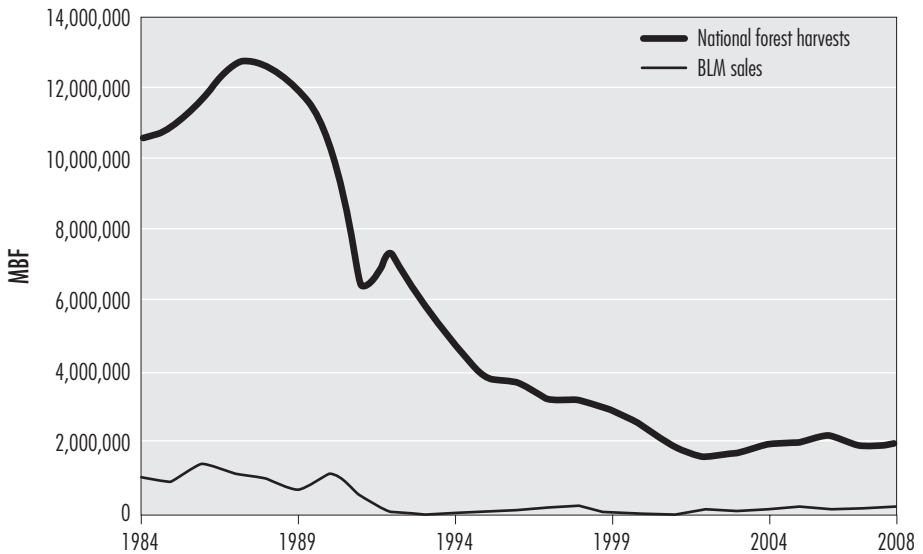
Note: These figures do not include marine national monuments. Although the Fish and Wildlife Service technically administers three national monuments, these monuments have been incorporated into the national wildlife refuge system.

Sources: NPS (2009); U.S. Bureau of Land Management (2009a); U.S. Fish and Wildlife Service (2009); Williams (n.d.).

not managed for commodity production. This is an important distinction as we contemplate public land management and climate change. The areas under the Forest Service and BLM are managed explicitly for “multiple use.” Defining this phrase at a particular time and in a particular place can generate tremendous controversy. In the Multiple Use Sustained Yield Act (1960), uses were specifically enumerated as “outdoor recreation, range, timber, watershed, and wildlife and fish purposes.” The Forest Service recognized mining and wilderness as legitimate multiple uses as well (Steen 1976). As mentioned earlier, the BLM lacked an overarching management directive until the passage of the FLPMA. Before the FLPMA, the BLM focused almost exclusively on resource exploitation: grazing, mining, and, in some places, timber harvesting. Following the FLPMA, grazing and mining remained the most significant multiple uses, but these were joined by the other multiple uses pioneered by the Forest Service—fish and wildlife management, recreation, watershed management, and wilderness (Skillen 2009).

Turning to the wilderness and national monument systems, the 109 million acres designated as wilderness are the most strongly protected federal land. No timber harvesting, commercial development, or energy leasing can take place on this land. Congress grandfathered existing hard rock mining claims and grazing operations in wilderness areas, although no mining has yet occurred. Resource development activities on national monuments vary, but generally these areas feature minimal development. On the continuum discussed earlier, national monuments fall between national parks and national wildlife refuges.

The major natural resources managed on federal public land are timber, forage, energy resources, and hard rock minerals. The vast majority of timber harvested on federal land comes from national forests (see figure 16.1). The amount of timber harvested peaked in 1987 and 1988, when more than 12.5 million mbf (thousand board feet) were cut each year. For a variety of reasons, including the

Figure 16.1**Timber Harvested on National Forest Land and Sold on BLM Land, 1984–2008 (thousand board feet)**

Note: BLM data for 1984–1998 are for sawtimber sold; data for 1999–2008 are for sawtimber offered for sale.

Sources: U.S. Bureau of Land Management (1984–2008); USDA Forest Service (2009a).

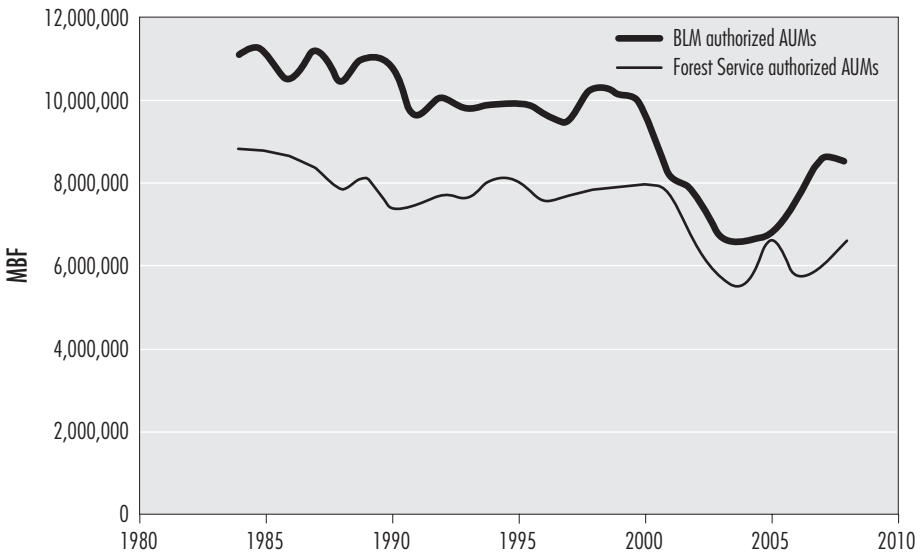
listing of the northern spotted owl as a threatened species, the volume cut has declined significantly, to a nadir of 1.7 million mbf in 2002, before a slight rebound to more than 2 million mbf by 2006 (USDA Forest Service 2009a). The BLM manages millions of acres of forest land in Oregon, where the bulk of its timber harvesting occurs. Averaging more than 1.1 mbf of timber sales per year from 1984 to 1990 (more than 90 percent from western Oregon), BLM sales declined precipitously in the 1990s as well, reaching a low of 60,000 mbf in 1993 before rebounding to more than 200,000 mbf from 2005 to 2008 (U.S. Bureau of Land Management 1984–2008). Although BLM volumes are much smaller than Forest Service volumes, the trend of timber harvesting for both agencies has been similar: a dramatic decline since the late 1980s.

Both the BLM and Forest Service manage millions of acres of land for livestock grazing. Grazing management is at the root of the BLM's birth, and although the Forest Service's grazing program is much smaller than its timber management program, grazing management dates back to the Forest Service's founding, and the volume of forage consumed by livestock is nearly as large as that consumed on BLM land. Both agencies measure the forage resource in animal unit months (AUMs). One AUM is "a standardized unit of measurement for range livestock that is equivalent to one cow, one horse, five sheep, five goats, or four reindeer,

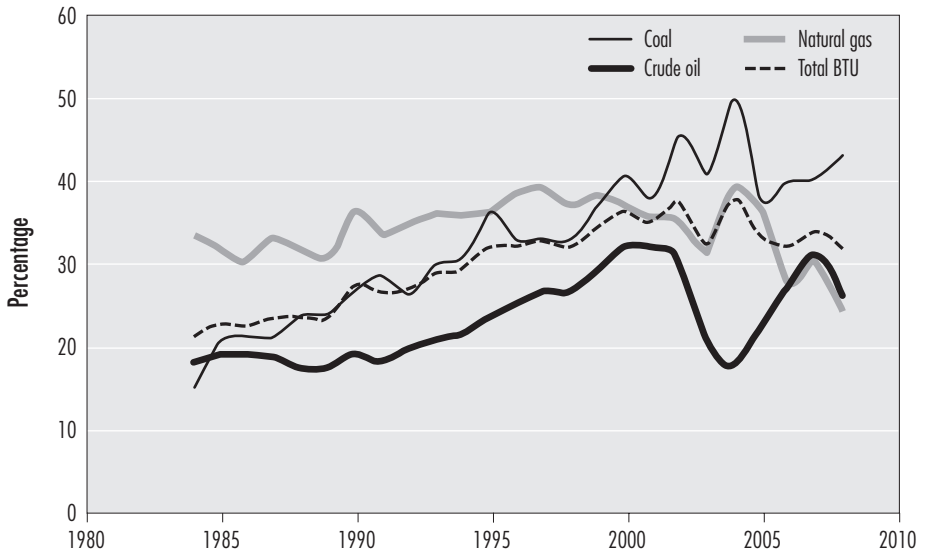
all over 6 months of age” (U.S. Bureau of Land Management 2008). Over the past 25 years, BLM-authorized AUMs have declined from more than 11 million annually to approximately 8 million annually (see figure 16.2) (U.S. Bureau of Land Management 1984–2008). AUMs authorized by the Forest Service have followed a similar pattern, starting at 8.8 million annually in the mid-1980s and declining to approximately 6 million annually more recently (USDA Forest Service 1984–2008). Although this decline in resource use has not been as sharp as that in timber harvesting, it has nevertheless been a clear decline.

Turning to energy resources, since 2000 more than one-third of the fossil fuel energy produced in the United States (as measured in BTUs) came from land administered by the federal government (see figure 16.3). This is true for each of the major fossil fuel sources: coal, oil, and natural gas. These resources are largely governed by the Mineral Leasing Act; companies lease land from the government and pay royalties based on production. By the 2000s, more than 40 percent of U.S. coal was coming from federal land. In 2005 the BLM leased nearly 500,000 acres of federal land for coal production. Much of the oil and natural gas from federally administered land comes from the outer continental shelf. For instance, in 2005 most oil and nearly half of the natural gas from federal land came from

Figure 16.2
BLM and Forest Service Authorized AUMs (animal unit months), 1984–2008



Note: Forest Service data for 1984–1992 are for AUMs actually grazed; data for 1993–2008 are for AUMs authorized.
Sources: U.S. Bureau of Land Management (1984–2008); USDA Forest Service (2009a).

Figure 16.3**Percentage of Fossil Fuel Production from Federal Public Land, 1984–2008**

Note: Data for 1984–2000 are for the calendar year; data for 2001–2008 are for the fiscal year.

Source: EIA (2009).

offshore sources. In that year, nearly 36 million acres was under lease for oil and gas exploration and production (EIA 2009).

There are two other significant economic uses of public land that merit some discussion. The BLM administers hard rock mining on all federal land open to such mining, essentially a subset of BLM and Forest Service land. The mining on this land is largely governed by the 1872 Mining Law: individuals or companies stake a claim to the land, giving them the right to explore and mine it. Any minerals taken from these claims belong to the miners; the federal government receives no royalties from these minerals. Since the passage of the FLPMA in 1976, all such claims need to be recorded with the BLM. Over the past 25 years, the number of cumulative recorded claims grew from 1.9 million to 3.3 million in 2008. Beginning in 1992, Congress required that claim holders pay an annual fee of \$100 to keep the claim active. From 1998 to 2008, the number of active claims has fluctuated between 196,182 (2002) and 397,590 (2008), with the variation reflecting the value of minerals such as gold and copper (U.S. Bureau of Land Management 1984–2008). The effects of climate change on hard rock mining and possible policy responses are not at all clear.

Recreation is the final area of widespread use of federal public land. The forms of recreation are varied, from hunting and fishing, to hiking and camping,

to off-road vehicle use, to mountain biking and alpine skiing. The four land management agencies hosted more than 377 million visitor days in 2008 (NPS 2008; U.S. Bureau of Land Management 2008; USDA Forest Service 2010; U.S. Fish and Wildlife Service 2008). Management for most of these activities does not directly cause climate change, although some of the activities (e.g., travel to national parks or off-road vehicle use) do cause secondary effects on climate change. Many of these activities, however, will likely be significantly altered by climate change; for example, snowfall affects skiing, and warmer waters affect trout habitat.

Climate Change and Emerging Issues in Public Land Management

As climate change accelerates, five major issues affecting federal public land management will become increasingly important: (1) biological diversity; (2) fire regimes; (3) hydrology; (4) carbon sequestration; and (5) energy management, all of which overlap and influence one another to some degree. An additional expected change is sea-level rise. This does not pose a significant problem for federal public land, since most of these areas are located in the interior western United States. There are exceptions, however, namely national seashores, several national parks (such as Everglades National Park), and coastal Alaska.

Climate change will have a clear, and in places dramatic, effect on plant and animal species ranges, population sizes, and ultimate viability. As climate changes, many species will need to move to new locations, and how public land is managed, both specifically and as part of the larger landscape, will play a crucial role in this process. A recent study on conservation planning and climate change examined the significance of ecological reserves, most of which are public land. The study concluded, “More general approaches that involve managing the matrix lands (the lands between reserves) to increase the availability of habitat and facilitate movement have the potential to increase the connectivity of the landscape for a wider range of species.” In addition to the importance of these matrix lands, “protected areas are still likely to be one of the best tools we have for protecting biodiversity in a changing climate” (Lawler and Hepinstall-Cymerman 2010, 343–344). In the western United States, where the federal government owns more than half of the land, its agencies can manage reserves such as national parks, national monuments, and wilderness areas, as well as the matrix lands managed by the BLM and Forest Service, with these shifting biodiversity conservation needs in mind. A related biological concern is the changing distribution of exotic and native species in response to climate change. Distribution changes can have tremendous ecological effects (e.g., the spread of the mountain pine beetle).

In the western United States, fire is the most important natural ecological disturbance. A recent study of the effects of climate change on fire in the West reached four main conclusions: (1) “warmer, drier summers, on average, will

produce more frequent, more extensive fires in forest ecosystems”; (2) “reduced snowpack and earlier snowmelt in mountains will extend the period of moisture deficits in water-limited systems”; (3) “fire return intervals are likely to be shorter in savanna, shrublands, and chaparral, increasing their vulnerability to invasion by weedy or annual species adapted to frequent fire”; and (4) “in the cases of many rare taxa that are adapted to specific habitats, any significant alteration of the fire regime may pose a serious threat” (McKenzie et al. 2004, 897–898). Changing fire regimes also will affect human communities, endangering human life and property and impacting the management of timber and grazing resources. In addition, more large wildfires will significantly influence the role of forests in the carbon cycle, likely shifting them from carbon sinks to atmospheric carbon sources (Westerling et al. 2006). Fighting fires also is increasingly expensive, often costing more than \$1 billion per year (“Burning Money” 2006). Public land fire policy is already a contentious issue. Altering the policy to take climate change into account will likely make it even more so.

Much of the interior western United States is arid, and evidence indicates that climate change is already affecting the region’s hydrologic cycle, with more winter precipitation falling as rain instead of snow and earlier snowmelt, resulting in changing stream flows. The authors of a recent study concluded that these changes foretell “water shortages, lack of storage capability to meet seasonally changing river flow, transfers of water from agriculture to urban uses, and other critical impacts” (Barnett et al. 2008, 1082). Changes in the hydrologic system will have wide-ranging effects on western public land, from irrigated agriculture to salmon recovery to forest fires to forage quantity for wildlife and livestock.

Studies indicate that forests throughout North America are carbon sinks—that is, they help sequester carbon by taking more of it out of the atmosphere than they release into the atmosphere. This is true of forests both in the eastern United States, predominantly privately owned with some national forests, and in the western United States, where public land ownership prevails (Munger, Barford, and Wofsy 2004). A recent study estimates that 20–40 percent of the carbon uptake in the lower 48 states takes place in the West at elevations above 2,500 feet—landscapes most likely to be in public ownership. The functioning of this carbon sequestration is especially sensitive to fire suppression: as the United States has fought forest fires aggressively over the past century, fewer fires have burned, and they have released less carbon into the atmosphere. Increased fires, or significant changes in fire suppression efforts, will likely reduce carbon sequestration (Schimel and Braswell 2005). Furthermore, a recent study concluded that carbon sequestration on public timberland increased substantially under a no-harvest management approach compared to existing management patterns. Increasing harvesting to 1980s levels would move these public forests from carbon sinks to carbon sources (Depro et al. 2008).

Finally, there are two distinct components of public land energy management related to climate change. First, given that more than one-third of fossil fuel

production in the United States comes from federally administered land, the federal government could work to gradually reduce access to these sources to help move the nation away from fossil fuel use. This is especially true regarding coal. Such an overall policy shift would likely be quite difficult to achieve and would be helpful in reducing greenhouse gas (GHG) emissions only if the use of fossil fuels was actually reduced rather than supplied from beyond the public lands. The second component is the use of public land to generate renewable energy: biomass, geothermal, solar, and wind. Favorable treatment of these energy resources on public land could speed the transition away from fossil fuels, but such policies face challenges as well. Any effort to increase the use of biomass would significantly overlap with biodiversity, fire, and carbon sequestration policy concerns. The BLM manages more than 600 leases for geothermal energy, with 29 plants producing 1,280 megawatts of power (approximately 9 percent of the nation's total geothermal production). A recent study estimated the potential for 5,540 megawatts of new geothermal electricity on public land by 2015, making it no more than a minor energy player nationally. In the Southwest, the BLM manages more than 20 million acres with the potential for utility-scale solar energy production. Currently, the agency is considering more than 200 applications covering 1.5 million acres of land for projects generating 97,000 megawatts. The agency manages more than 20 million acres with wind potential, and it has approved 28 wind projects with an installed capacity of 437 megawatts, just 2 percent of national wind production. The BLM is also in the process of completing a series of environmental impact statements for geothermal, solar, and wind projects designed to accelerate renewable energy development across public land (U.S. Bureau of Land Management 2009b). The large-scale solar and wind projects have run into significant opposition, however, from environmentalists, recreationists, and some property owners upset about the degradation of their views and the industrialization of the rural landscape.

Changing Policy to Address Climate Change on Federal Public Land

Since 1990 Congress has largely been in a state of gridlock when it comes to passing or amending significant conservation and environmental policy. This shift to gridlock after the period of tremendous legislative activity from 1964 to 1980 has been due to five main causes: (1) increased partisanship regarding the environment; (2) increased interest group mobilization on the environment; (3) more pervasive media; (4) the changing nature of environmental issues; and (5) public opinion on the environment that reflects widespread support, but low salience. This gridlock makes congressional action to change laws for public land management, such as the FLPMA or the National Forest Management Act, extremely difficult. Congressional gridlock has not, however, translated into policy gridlock. Rather, policy change over the past two decades has shifted onto several

other pathways, including budget and appropriations politics, executive politics, judicial politics, and state politics (to be discussed later in this chapter) (Klyza and Sousa 2008).²

Thus far, budget and appropriations politics has been used primarily in an effort to block policy change related to climate change. For instance, Senator Lisa Murkowski of Alaska sought to block the Environmental Protection Agency from issuing rules to reduce GHG emissions under the Clean Air Act by amending the agency's annual spending bill in the fall of 2009 and a bill to increase the federal debt ceiling in January 2010.

Efforts to change policy to deal with the effects of climate change on the other pathways are already under way. On the executive politics pathway, Secretary of the Interior Ken Salazar issued a secretarial order in September 2009 to establish "a Department-wide approach for applying scientific tools to increase understanding of climate change and to coordinate an effective response to its impacts on tribes and on the land, water, ocean, fish and wildlife, and cultural heritage resources that the Department manages." Among the issues the order explicitly focuses on are water management, wildlife, fire threats, invasive exotic species, and carbon storage. The order established the Climate Change Response Council within the department to coordinate this work. Furthermore, the department will explicitly work to develop landscape conservation cooperatives, both among agencies within the department—the BLM, NPS, and Fish and Wildlife Service—and with other public agencies and private landowners, to address "wildlife migration and related needs for new wildlife corridors, the spread of invasive species and wildfire risks," each of which extends beyond the borders of areas managed by specific agencies. A final major provision of the order is the DOI (Department of the Interior) Carbon Storage Project. The U.S. Geological Survey will lead department agencies "to enhance carbon storage in geologic formations and in plants and soils in a manner consistent with the Department's responsibility to provide comprehensive, long-term stewardship of its resources" (Secretary of the Interior 2009).

Many western Republicans quickly opposed the initiative, arguing that it "puts into question past and future management agreements related to oil and gas development, renewable energy development, recreational use, grazing, hunting on public and private property, and wildlife protection" (Straub 2009). This focus on climate change is reflected in the Interior Department's fiscal year 2011 budget proposal. According to a spokesperson for the Fish and Wildlife Service, "This budget does reflect a change in our priorities. Our primary focus is

2. Any congressional action to transfer authority over federal public land to the states would be at least as controversial and difficult as passing legislation dealing with public land management and climate change generally. The issue of state control and influence over federal land has been extremely contentious since the early twentieth century.

reorienting the agency so that we can address climate change. We need to start looking at climate change in everything we do” (Reis and Winter 2010). Some of the funds would go toward land acquisition as part of landscape conservation cooperatives. As of August 2010, these Interior Department initiatives were moving forward, but it was still too early to tell how much they would alter public land policy to deal with climate change.

The Forest Service also has been moving forward on climate change policy through the administrative route. The agency completed its Strategic Framework for Responding to Climate Change in October 2008, and Forest Service chief Tom Tidwell issued a memo to agency leadership in November 2009 geared toward translating the framework into agency-wide operations. “Climate change is dramatically reshaping how we will deliver on our mission of sustaining the health, diversity, and productivity of the Nation’s forests and grasslands for present and future generations,” Tidwell wrote. “The most vulnerable and pivotal ecosystem services being affected by climate change are related to water.” He went on to charge five regional groupings to develop landscape conservation strategies and action plans by March 2010 (Tidwell 2009). Shortly after, however, Tidwell testified before Congress that “carbon will not likely be the primary management objective of the Forest Service” (Leber 2009). The chief explained that carbon would be one among many forest management goals for the agency, fitting into the Forest Service’s multiple-use philosophy.

With Congress unable or unwilling to deal with climate change, who runs the executive branch and its agencies does matter. The Interior Department and Forest Service under President Barack Obama are behaving quite differently regarding climate change than they did under President George W. Bush. Yet it is difficult to move agencies and policies too far without congressional action. President Clinton’s “roadless rule” is a good example. This was a bold effort to protect nearly 60 million acres of national forest land through rule making. Almost nine years after the rule appeared in the *Federal Register*, it is still in administrative and legal limbo due to a string of lawsuits and judicial decisions, as well as additional rule making by the Bush administration. Policy has drifted in the direction favored by Clinton and his environmental allies, but it is nowhere near as secure as if Congress had acted.

Although Congress has not passed any laws specifically dealing with climate change, it has been central in creating the “green state”: the basic policy commitments of the U.S. government focused on conservation, environmental protection, and natural resource management that are rooted in laws, institutions, and expectations developed over time (Klyza and Sousa 2008). Frustrated by Congress’s inaction on climate change, environmental groups have sought to use two wide-ranging environmental laws from this green state to shift public land management.

The Center for Biological Diversity (CBD), which focuses on protecting animals and plants through litigation under the Endangered Species Act (ESA), initiated legal campaigns to protect the polar bear and the American pika, a small

alpine mammal. In both cases, the CBD argued that the species were endangered directly because of climate change. In May 2008, the Interior Department listed the polar bear as threatened due to the decline in sea ice. Although the listing was clearly tied to climate change, Interior Secretary Dirk Kempthorne made it clear that he would not allow the listing to lead to regulation of GHG emissions. “That would be a totally inappropriate use of the Endangered Species Act. . . . ESA is not the right tool to set U.S. climate policy,” he said (Howell 2008). The CBD later filed a suit against the Fish and Wildlife Service for its failure to list the American pika as endangered. According to CBD biologist Shaye Wolf, “As temperatures rise, pika populations at lower elevations are being driven to extinction, pushing pikas further upslope until they have nowhere left to go” (Reis 2009). The Fish and Wildlife Service announced in February 2010 that it would not list the species. Environmental groups may sue again in an attempt to reverse the decision. Wolf said, “Listing the pika would have forced the Obama administration to take a hard look at climate change, and a very important part of that is bringing the Endangered Species Act tool kit to the fight against global warming” (Reis 2010). Regardless of whether the ESA can or cannot be used to affect GHG emissions, the listing of species due to climate change will alter the management of federal public land.

The second law used by environmental groups to affect public land management is the National Environmental Policy Act (NEPA), which requires an environmental impact statement (EIS) for any federal action significantly affecting the environment. Thus far, the federal government has not required that EISs consider how federal actions would affect climate change, but a 2007 court case ruled that climate change should be considered in EISs. In February 2010, the Council on Environmental Quality issued draft guidance requiring agencies to consider GHG emissions under the EIS process, but it does not apply to land and resource management actions. Noting the lack of “established federal protocol” to assess the effects of land management on carbon, the guidance instead invited public comment on the issue (Straub 2010). Although existing law and the courts may be able to drive significant change in some aspects of public land management, it is hardly a rational or comprehensive way to shift management in response to climate change.

Current congressional deadlock on efforts to control GHG emissions illustrates that Congress is not likely to pass meaningful legislation on public land management and climate change anytime soon. This does not mean that policy on the ground will not change. Agency leaders will no doubt use their discretionary authority, and existing laws and judicial decisions will likely lead to policy responses. But policy changes can only go so far, and they are likely to be unstable, as they are often uncoordinated and not prioritized. Administrations change, and leadership directives frequently change with them. Court decisions can conflict with one another. Although public land policy will respond to climate change, the response will be far from coherent and comprehensive without congressional action.

State-Owned Public Land

Although the states do not own nearly as much land as the federal government, they do own and manage substantial amounts of land. Data on state public land are even more difficult to find than data on federal land, and the state totals are quite dynamic. With these caveats in mind, a very good estimate of state-owned land in 2010 is 180 million acres, or 7.9 percent of the nation's land.³ The amount of state-owned land, how it was acquired, and how it is managed differ significantly across the country. In general, western states own the most land—in terms of both acreage and percentage of land in a state. This land came to the states in three major ways: (1) as grants from the federal government to support education and other activities; (2) as land forfeited to the state for failure to pay taxes; and (3) as land purchased for conservation, especially for parks and wildlife management areas. The school trust land granted to the states by the federal government typically has strict management requirements, which are often part of state constitutions. Although state-owned land policies differ, in today's constrained fiscal environment, any climate change-driven land acquisition or policy change that requires funding is likely to be extremely difficult to achieve in the short term. A comprehensive discussion of state land management and climate change in all 50 states is beyond the scope of this chapter. Instead, the five states owning the most land in different regions of the country—New York, Florida, Minnesota, Arizona, and Montana—are used to illustrate state land management.

NEW YORK AND THE NORTHEAST

In 1999 the nine northeastern states owned 10.5 million acres of conservation land, 10 percent of the states' landmass. They acquired this land through either purchase or tax forfeiture, and the land is managed primarily as state forests, state parks, and wildlife management areas (Klyza 2001). Pennsylvania (3.8 million acres) and New York own the most land. In 2009 New York owned 2.9 million acres in the Adirondack and Catskill forest preserves; 780,000 acres of state forests; 324,000 acres of state parks; and 200,000 acres of wildlife management areas. It held conservation easements on an additional 750,000 acres. These holdings total 4.9 million acres, accounting for 16 percent of the state (New York State DEC 2010; New York State DEC and OPRHP 2009).

The Adirondack and Catskill forest preserves are protected as "forever wild" under the New York state constitution (the land "shall not be leased, sold or exchanged, or be taken by any corporation, public or private, nor shall the timber thereon be sold, removed or destroyed"). Hence, the management of this

3. This state total comes from a variety of sources: figures on state Web sites, agency annual reports, wildlife action plans, statewide outdoor recreation plans, and "gap" analysis reports. Although the data range from 1998 to 2010, data from 40 of the states are from 2005 or later.

land would be extremely difficult to alter for any reason. Fortunately, this wild land can play a significant role in carbon sequestration and as protected wildlife habitat in a changing climate. New York recently adopted a state open space plan with three explicit goals related to climate change and public land management: (1) “to combat global climate change by sustainable stewardship of our State’s forests for carbon sequestration and air quality enhancement”; (2) “to combat climate change by protecting our State’s coastlines, and broad riparian corridors and wetlands”; and (3) “to maintain an interconnected network of protected lands and waters allowing wildlife to be able to shift range with climate change to follow natural migration patterns” (New York State DEC and OPRHP 2009, 1–2, 12–24). These goals make it clear that New York is explicitly thinking about climate change in managing its substantial landholdings. The challenge for New York and other states today is implementing these policies in a period of fiscal stress. When new management calls for more active management and increased land acquisition, it will be extremely difficult to achieve. When management changes are more passive (e.g., less active forest management for timber to further carbon sequestration), policies are more likely to be successfully implemented.

FLORIDA AND THE SOUTHEAST

Few of the southeastern states own substantial amounts of land. The exceptions are Texas (2.2 million acres) and Florida, which in 2009 owned 4.8 million acres of conservation land, nearly 14 percent of the state. The state holds conservation easements on more than 500,000 additional acres. The major land classifications are state forests (more than 1 million acres), water management districts (1.4 million acres), and wildlife management areas (1.4 million acres) (Florida Natural Areas Inventory 2009). Due to its geography—a low-elevation peninsula surrounded by ocean—Florida is arguably the state that will be most significantly affected by sea-level rise. It is also characterized by a rich biodiversity, regular droughts, and fire-prone landscapes. In sum, the state should be at the forefront in managing its considerable public landholdings with climate change in mind.

Florida is a leading state in land acquisition for conservation. Its Preservation 2000 and Florida Forever initiatives (both funded by state bonds backed by a real estate transfer tax) acquired millions of acres of land guided by conservation science. In addition, the legislature created the Energy and Climate Commission in 2008. The state has not adopted a comprehensive land policy response to climate change, however. In 2008 the Fish and Wildlife Conservation Commission sponsored a summit on wildlife and climate change, which resulted in a set of policy recommendations. The Division of Forestry, meanwhile, has not embraced climate change effects in its management policy for state forests.

MINNESOTA AND THE MIDWEST

Since most of the land in the Midwest is well suited for agriculture, there is relatively little public land in these states. The exceptions are Michigan (4.5 million

acres), Wisconsin (1.7 million acres), and Minnesota (5.5 million acres). The main land classifications in Minnesota are state forests (2.1 million acres) and wildlife management areas (1.1 million acres), with total state conservation land accounting for 10.8 percent of the state (Minnesota DNR 2008). Minnesota acquired this land in three main ways. First, the federal government granted more than 8 million acres to the state to support local schools and its university and to pay for internal improvements and swamplands to be drained. Although most of this land was sold or granted to railroads, Minnesota maintains ownership of approximately 2.5 million acres. Second, in the 1920s and 1930s, owners of 6–8 million acres of private land could not (or chose not to) pay their property taxes and forfeited ownership of their land to the state. Much of this land was eventually returned to private ownership, but the state still owns approximately 1.6 million acres (county governments own another 2.8 million acres). Third, the state acquired more than 1.3 million acres for state forests, state parks, and wildlife management areas (Minnesota DNR 2000).

Like New York, Minnesota has taken a comprehensive approach to land management in response to climate change. The Department of Natural Resources (DNR), which manages the state's conservation land, began a strategic planning process in 2007, resulting in "A Strategic Conservation Agenda 2009–2013." In this plan, climate change is explicitly identified as a major trend affecting "Minnesota's forests, grasslands, wetlands, lakes, and streams. Climate change can also intensify the negative effects of other factors influencing natural resources, such as frequency and intensity of wildfires, the spread of invasive species, and the impact of fish and wildlife diseases." The DNR's response to climate change includes adaptation "efforts to create wildlife corridors, improve habitat connectivity, and expand habitat buffers to facilitate plant and animal migration as climate changes," in order to reduce ecosystem and wildlife vulnerability. In recognition of increasing demand, the DNR also plans to focus increased attention on sustainable biomass harvesting from its land (Minnesota DNR 2009).

ARIZONA, MONTANA, AND THE WEST

As mentioned earlier, the vast majority of land owned by individual states—that is, approximately 136 million of the 180 million acres—is located in the western United States. The largest share of this, 90 million acres, is owned by Alaska, which received this land through a series of statutes related to its statehood. Outside Alaska, seven western states own more than 3 million acres each, led by Arizona (9.6 million acres) and New Mexico (9.1 million acres). Across the West, the states own 12.2 percent of all the land. This land, combined with federally owned land (53 percent), accounts for nearly two-thirds of the land in the western United States. The federal government granted most of this land to these states (except Alaska) in support of education. Although they have disposed of varying amounts of public land and have acquired hundreds of thousands of acres for wildlife management areas and state parks, school trust land still makes up nearly 90 percent of state-owned land. School trust land is governed under a set

of constitutional, statutory, and judicial provisions that in general require the land to be managed under a trust arrangement to the benefit of a specific entity—e.g., K–12 schools or a particular state university. A variety of administrative forms exist, typically a state land department or office, which is sometimes overseen by elected officials or boards. The land is leased, predominantly for grazing, timber, and agriculture, although many states have significant subsurface mineral leasing programs as well. Revenues from these programs are used to finance the land office, go directly to beneficiaries, or go into a permanent fund, with returns from this fund distributed to the beneficiaries (Souder and Fairfax 1996). From a climate change perspective, this fiduciary trust relationship makes it difficult to alter how the land is managed, unless there is a clear financial benefit to the beneficiaries. Some policy analysts have suggested compensated ecosystem services, such as watershed protection, mitigation banking, and carbon sequestration, as options to introduce management goals beyond traditional commodity development into the trust land equation (Davis 2006).

The Arizona State Land Department administers the state's trust land, which accounts for more than 96 percent of all state-owned land. According to its 2009 annual report, "Since the State Land Department's inception, its missions have been to manage the Land Trust and to maximize its revenues for the beneficiaries. All uses of the land must benefit the Trust, a fact that distinguishes it from the way public land, such as parks or national forests, may be used." The state earned more than \$16 million from its trust land in 2009, through agricultural, grazing, and mineral leasing and sales. In 1996 the state legislature passed the Arizona Preserve Initiative, which established a framework for the lease and sale of state trust land for conservation purposes, although the land's value cannot be reduced for conservation sale. Since the law's passage, the state has sold more than 5,000 acres of conservation land. In sum, because trust land must be managed to maximize the financial interest of the beneficiaries, the only way land management will change is if climate change is seen as a threat to current land management values or can produce substantial financial returns. There is no indication that this has happened yet (Arizona State Land Department 2009). Arizona's state park system illustrates the fiscal challenges faced by many states today. The state parks board is in the process of closing 17 of its 27 parks due to budget cuts (Arizona State Parks 2010).

Montana owns 5.5 million acres of land, almost 6 percent of the state. The overwhelming majority of that land, 5.2 million acres, is trust land, with the remainder in wildlife management areas and state parks. The trust land is managed by the Department of Natural Resources and Conservation (DNRC), overseen by the Board of Land Commissioners (which consists of the state's top elected officials). In 2009 trust land generated more than \$75 million through agricultural and grazing leases, recreational leases, timber sales, and mineral leases and royalties. The DNRC is charged with managing the state's "trust land resources to produce revenues for trust beneficiaries while considering environmental factors and protecting the future income-generating capacity of the land." Although

this suggests some discretion in land management, the fiduciary trust relationship is foremost, limiting the ability of the DNRC to alter land management due to climate change. Although there is no evidence that the DNRC is changing land management in response to climate change, it is leasing land for significant wind energy developments (Montana DNRC 2009).

In closing, state public land ownership and management varies across the country. Although the federal government owns more than three times the acreage of the 50 states, state governments do control 8 percent of the nation's land. Outside the western United States, most of this land is managed for conservation as state forests, state parks, and wildlife management areas. Today the states are suffering from a lack of financial resources to manage this land, due to the deep economic downturn, although in the past states such as Florida, New Jersey, and New York have used dedicated conservation bonds to support land acquisition and management. The states may, however, find it easier than the national government to alter land management policy in order to address climate change. The biggest challenge for state land management is the requirement that the tens of millions of acres of trust land must be managed based on fiduciary responsibility. Altering management of this land to address climate change can occur only if the changes explicitly address that responsibility.

Conclusions

The national and state governments of the United States own nearly 37 percent of the land in the country. These governments have no choice but to adjust their management of this land to reflect climate change. The main issues that climate change will bring to the fore are biological diversity, fire, hydrology, carbon sequestration, and energy management. Each of these issues requires more and better management at the landscape level, suggesting better coordination among various federal agencies, state governments, municipal governments, and private landowners to address these concerns. The Interior Department's proposed landscape conservation cooperatives explicitly seek to do this, as do a number of state programs. These promising initiatives need to be nurtured. The federal government has made tentative steps in that direction through ecosystem management, with mixed results (Layzer 2008). Climate change, however, is likely not to be forgiving of failures.

The Yellowstone to Yukon Conservation Initiative (Y2Y) is illustrative of the many programs making use of landscape-level thinking aimed at conserving and enhancing biological diversity. The Y2Y region covers more than 300 million acres in Canada and the United States, approximately 10 percent of which is protected as park, wilderness, or wildlife refuge. A major focus for Y2Y and its partner groups is to improve connectivity for plants and animals to be able to move between protected areas, which is crucial as climate changes. Y2Y is also seeking to improve interagency coordination and collaboration in light of climate

change (Y2Y 2010). As the major landowners in the western states, the federal and state governments must play a central role in these and other landscape-level initiatives in order to move forward proactively in climate change adaptation.

Fundamental policy change in public land management to reflect a changing climate is not on the horizon in Congress. Before any such change can take place, Congress must pass a comprehensive climate change law. Federal policy change is happening, but it is driven by agency leadership and court decisions. While such change is useful, it is also much more difficult to coordinate and institutionalize than congressional action. Coordination is also a challenge when the 50 state governments and their landholdings are factored in. State policies on climate change vary tremendously, and it is likely that explicit land management policies related to climate change will do the same in the near term. The challenge the United States faces is to simultaneously address a changing climate and coordinate the actions of hundreds of agencies across millions of acres, as well as the actions of innumerable private landowners. Several initiatives to do this are under way, and it is clear that these efforts will need to span the federal and state governments as well as civil society. Coordinating such sweeping change is a daunting task, but the changes on the ground will not wait for us to act.

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