



Wyoming Conservation Easements: Lands, Services, and Economic Benefits

WYOMING OPEN SPACES INITIATIVE

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IN PARTNERSHIP WITH

Wyoming Stock Growers
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INTRODUCTION

Conservation easements are a voluntary tool available to private landowners to conserve open spaces and working landscapes by limiting residential and commercial development or subdivision of land (Perrigo and Iverson 2002). Easements can also protect important wildlife habitat. Landowners can benefit financially from easements through a reduced tax burden when the landowner donates the easement or through direct payment for the loss of development rights. Many landowners also enjoy the peace of mind that comes from knowing that a property is permanently protected from development.

While conservation easements can provide clear benefits to landowners, they can be expensive and sometimes involve substantial public investment. For instance, the Wyoming Wildlife and Natural Resources Trust—funded primarily through legislative appropriation to enhance and conserve wildlife and natural resource values—has invested over \$27 million in conservation easements since 2005 (WWNRT 2017). In addition, the Natural Resource Conservation Service has invested over \$100 million to purchase conservation easements

for the purpose of sage grouse conservation in Wyoming (USDA NRCS 2014). Investment in conservation easements can create opportunity costs by limiting development options and diverting limited funds from other conservation needs. Substantial public investment in the system of conservation easements warrants an analysis of the public benefits that accrue from private lands conservation.

Conservation easements are widely recognized for protecting working farms and ranches, scenic views, and open spaces throughout the West. A growing body of research shows that the open spaces protected through conservation easements provide even more than views and agricultural products. They yield a range of ecosystem services—“the conditions and processes through which natural systems, and the species that make them up, sustain and fulfill human life” (Daily 1997). For instance, intact open spaces may support wildlife populations, recreational fishing, drinking water sources, and other economically important services. Many of these ecosystem services have tangible and sizable economic benefits to the public (e.g., Holmes et al. 2015,

Conservation easements are widely recognized for protecting working farms and ranches, scenic views, and open spaces throughout the West.



Kovacs et al. 2013, Richardson et al. 2015). In Colorado, for example, conservation easements are estimated to generate \$4 to \$12 of public benefit for each dollar invested by the state (Seidl et al. 2017). The ecosystem services and resulting public benefits of conservation easements have not been inventoried or quantified for Wyoming.

Here, we inventory the types of resources, ecosystem services, and public benefits protected from development by conservation easements in Wyoming. We used geospatial analysis to quantify land cover—the vegetation types, development, water bodies, and other surface features present—on lands under conservation easement. We then used land cover and other data to quantify key ecosystem services that stem from conserved private lands. We focused specifically on services that support quality of life and the economy of Wyoming, including trout fisheries, big game habitat, protection of sensitive species, and drinking water quality. To determine how conservation easements contribute to conservation statewide, we also compared the land cover and services of easements to those provided by public lands and private lands without easements. Finally, we characterized the public economic benefits that stem from ecosystem services conserved by investments in conservation easements on private lands.

TAKING STOCK OF WYOMING LANDS—GEOSPATIAL ANALYSIS

Private lands under conservation easement

Easements are an important tool in Wyoming, where open spaces are jeopardized by rapid land conversion at a rate that exceeds that of other western states. Wyoming lost an estimated 2.8 million acres (4,300 square miles) of open space between 2001 and 2011 (Center for American Progress 2016) due in part to rural residential development (Hulme et al. 2009), which fragments lands and can be a net financial loss for counties (Coupal et al. 2002, Carruthers and Úlfarsson 2008). Of the 745 conservation easements

documented in the state, 58 percent of those were created since 2000 (NCED 2016)—evidence of strong interest in easements in recent years.

As of 2016, more than 17 land trusts, governmental entities, and other organizations held conservation easements protecting nearly 650,000 acres of private lands in Wyoming (Copeland and Browning 2016), representing 2.4 percent of all private lands and 1.0 percent of total land area of the state. For comparison, Colorado had 2.5 million acres (6.6 percent of all private lands; COMaP 2016), and Montana had 2.1 million acres of land (3.6 percent of all private lands; Montana Association of Land Trusts 2016) under conservation easement. Of Wyoming counties, Teton (31.1 percent), Sublette (19.0 percent), and Sheridan (6.5 percent) had the greatest percentages of private land area under easement (Figure 1).

Land trusts in Wyoming acquire conservation easements both opportunistically and strategically. Each land trust's mission provides a framework for evaluating potential conservation easement projects. For instance, The Nature Conservancy acquires conservation easements to protect biodiversity, maintain open space, and reduce the threat of fragmentation on private land to benefit people and nature. The Wyoming Stock Growers Land Trust is a statewide organization that conserves agricultural lands to also sustain Wyoming's history, culture, and economy. Other land trusts focus conservation efforts on certain geographic priorities. The Jackson Hole Land Trust, for example, targets most of their conservation efforts in the Greater Yellowstone Ecosystem, including Teton, Park, and Sublette Counties.

The mission-driven targeting of conservation easements can result in clustering in some locations, for instance, in crucial wildlife habitat or areas where development threatens the viability of working landscapes. Likewise, land trusts have targeted easements in places such as Jackson Hole and Sheridan (Figure 2), where high rates of residential development jeopardize remaining open space.

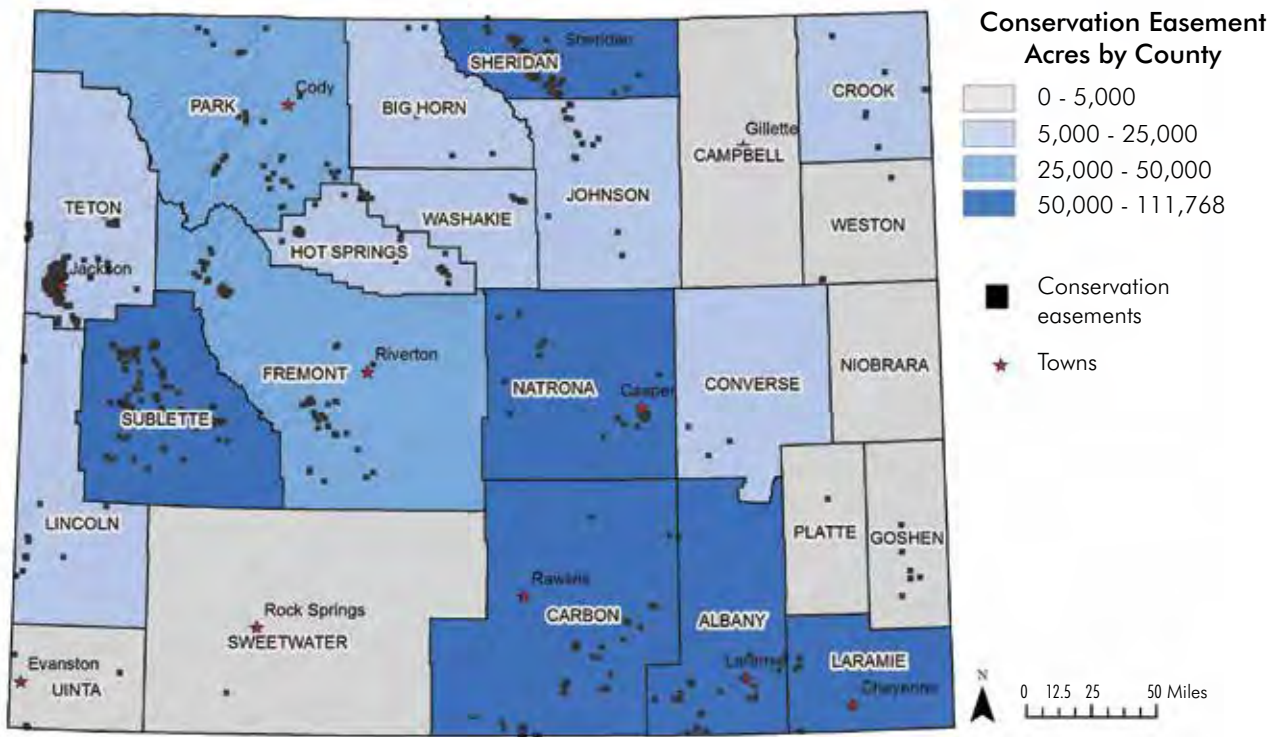


Figure 1. Acres of land under easement by county and distribution of easements within counties (easements not shown to scale).

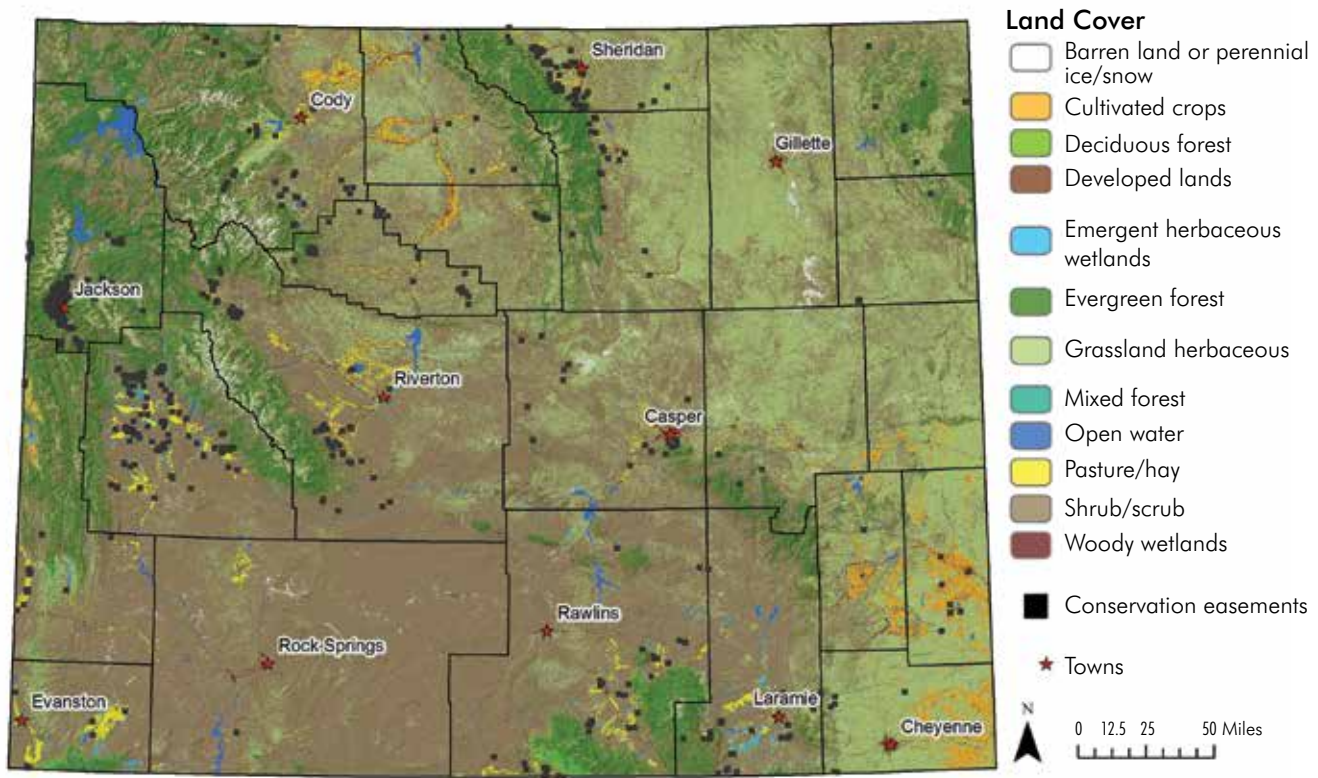


Figure 2. Land cover types of conservation easements in Wyoming (easements not shown to scale).

Table 1. Land cover types on private lands with easements, private lands without easements, and all public lands in Wyoming. Land cover types with higher than expected representation on private lands with easements (> 1 percent, the percent of Wyoming lands under conservation easement) are shown in bold.

Land cover	Ownership type			Statewide total ¹
	Private, easement	Private, no easement	Public	
Deciduous forest (acres)	7,705	75,515	233,101	316,479
Percent of statewide total	2.4	23.9	73.7	
Evergreen forest (acres)	45,331	1,013,540	6,163,030	7,231,187
Percent of statewide total	0.6	14.0	85.2	
Mixed forest (acres)	351	12,217	41,485	54,133
Percent of statewide total	0.6	22.6	76.6	
Shrub/scrub (acres)	315,595	11,769,100	20,170,500	32,294,850
Percent of statewide total	1.0	36.4	62.5	
Grassland/herbaceous (acres)	160,071	10,523,400	7,008,210	17,711,510
Percent of statewide total	0.9	59.4	39.6	
Woody wetlands (acres)	23,598	375,732	146,000	568,721
Percent of statewide total	4.1	66.1	25.7	
Emergent herbaceous wetlands (acres)	27,678	383,761	161,454	585,450
Percent of statewide total	4.7	65.5	27.6	
Pasture/hay (acres)	51,250	865,036	44,213	962,830
Percent of state	5.3	89.8	4.6	
Cultivated crops (acres)	4,585	871,563	31,151	908,476
Percent of statewide total	0.5	95.9	3.4	
Developed (acres)	4,542	417,445	124,348	547,846
Percent of statewide total	0.8	76.2	22.7	
Open water (acres)	1,637	28,955	38,586	402,796
Percent of statewide total	0.4	7.2	9.6	
Total	648,747	26,526,350	34,631,170	62,234,201
Percent of state	1.0	42.6	55.6	

¹Statewide totals are greater than the sum of the three land tenure categories due to mapped water features that were not represented within the individual land tenures.

Table 2. Aquatic services on private lands with easements, private lands without easements, and all public lands in Wyoming. Services with higher than expected representation (> 1 percent) on private lands with easements are shown in bold.

	Ownership type			Statewide total ¹
	Private, easement	Private, no easement	Public	
Drinking water sources¹				
Sensitive to pollution (acres)	74,792	2,080,501	293,970	2,485,732
Percent of statewide total	3.0	83.7	11.8	
Wetlands (acres)				
Wetlands (acres)	47,362	596,314	426,632	1,456,955
Percent of statewide total	3.3	40.9	29.3	
WGFD Blue Ribbon streams (miles)				
WGFD Blue Ribbon streams (miles)	69	339	280	622
Percent of statewide total	11.1	54.5	45.1	
All streams (miles)				
All streams (miles)	4,170	81,160	84,358	174,928
Percent of statewide total	2.4	46.4	48.2	

¹For all but Blue Ribbon streams, statewide totals are greater than the sum of the three land tenure categories due to mapped water features that were not represented within the individual land tenures.

While individual land trusts may consider a new easement acquisition in terms of the organization’s overall portfolio, it is also useful to consider what land types are protected or underrepresented in the statewide easement portfolio. We conducted geospatial analyses to determine the land cover and ecosystem services protected by conservation easements in Wyoming (methods provided in Appendix). In cases where land cover type or management designation protected by conservation easements exceeded one percent (the total land area protected by easements in Wyoming), we found that easements offer greater protection and provisioning of ecosystem services than expected by land area alone.

Land cover

Land cover is the physical land type at the surface of the earth, and includes everything from grasslands and forests to water bodies and developed areas. Land cover is the basis for wildlife habitat and the natural resources that support human populations.

Although conservation easements currently comprise one percent of Wyoming’s total land area, they include two percent of the state’s deciduous forests, four percent of woody wetlands, five percent of herbaceous wetlands, and five percent of hay or pasture agricultural lands (Table 1, Figure 2). As would be expected from protected lands, conservation easements comprise less than one percent of the state’s developed area and cropland.

Fisheries and water quality

More than 11 percent of the state’s Blue Ribbon trout fisheries—those designated as “special resources” by Wyoming Game and Fish Department (WGFD) and having a minimum of 600 pounds of sport fish per mile (WGFD 2016)—flow through the one percent of Wyoming’s land area that includes private lands with easements. Easements also protect from development three percent of Wyoming’s wetlands and three percent of areas designated as having sensitive groundwater used for drinking water (Bedessem et al. 2005).





Big game

Crucial winter ranges are identified by the WGFD as necessary for maintaining healthy populations of big game species such as mule deer, which typically use the same winter ranges each year. Many of these crucial winter ranges overlap with private lands, where conservation easements can protect economically important game species such as moose, elk, and mule deer.

The one percent of Wyoming land area protected by easements protects six percent of the state's moose crucial winter range (Table 3), which is consistent with the relatively high proportion of moose habitat, including wetlands, conserved by easements. Easements also protect three percent of elk and two percent of mule deer crucial winter range in the state. One percent of pronghorn and one percent of white-tailed deer crucial winter range are on private lands with conservation easements.

Like crucial winter range, the WGFD also defines migration corridors as vital habitat.

Migration allows big game species to exploit seasonal changes in forage availability, supporting robust populations (Box 1; Fryxell and Sinclair 1988). Suspected migration routes are those that WGFD has identified for potential designation as vital habitat but for which there may not be supporting radiotelemetry data that would provide detailed migration maps. Nineteen percent of conservation easements overlapped with suspected moose migration corridors, 15 percent with suspected mule deer migration corridors, 11 percent with suspected pronghorn migration corridors, and 5 percent with suspected elk migration corridors (Table 3).

Species of conservation concern

Species of conservation concern are those whose populations are thought to be declining or imperiled. Conservation of such species can support overall biodiversity in the state and reduce the need for listing under the Endangered Species Act.

To avert further population declines of greater sage-grouse and a potential listing under the Endangered Species Act, Wyoming adopted the Core Area Strategy (current version, Wyoming Executive Order 2015-4). Core areas limit development and disturbance in places to protect sage grouse populations. Private lands with easements overlapped with about one percent of the state's sage grouse core area.

In the 2010 State Wildlife Action Plan, the WGFD designated Species of Greatest Conservation Need—those that represent the health of the state's biodiversity—as management priorities. Habitat-based species models predict an average of 21 sensitive species across all private land with easements, comparable to other private lands (21 species predicted), and public lands (20 species).

Landscape connectivity

Easements provide an additional benefit by increasing connectivity among public and private land and water resources. Most conservation easements (94 percent) are adjacent to public

Table 3. Big game crucial winter range and migration corridors on private lands with easements, private lands without easements, and all public lands in Wyoming. Services with higher than expected representation (> 1 percent) on private lands with easements are shown in bold.

	Ownership type			Statewide total
	Private, easement	Private, no easement	Public	
Big game crucial winter range				
All species combined (acres)	293,160	5,319,999	8,933,888	14,596,470
Percent of statewide total	2.0	36.4	61.2	
Elk (acres)	111,897	1,121,798	3,099,171	4,336,560
Percent of statewide total	2.6	25.9	71.5	
Moose (acres)	72,432	418,217	781,177	1,283,611
Percent of statewide total	5.6	32.6	60.9	
Mule deer (acres)	132,919	2,510,591	3,627,582	6,295,564
Percent of statewide total	2.1	39.9	57.6	
Pronghorn (acres)	56,692	2,150,117	3,699,814	5,929,578
Percent of statewide total	1.0	36.3	62.4	
White-tailed deer (acres)	2,600	167,521	43,293	213,574
Percent of statewide total	1.2	78.4	20.3	
Suspected big game migration routes¹				
Elk (miles)	207	1,387	3,989	4,063
Percent of statewide total	5.1	34.1	98.2	
Moose (miles)	148	492	736	788
Percent of statewide total	18.8	62.4	93.4	
Mule deer (miles)	595	2,791	3,744	3,854
Percent of statewide total	15.4	72.4	97.1	
Pronghorn (miles)	351	2,353	2,897	3,096
Percent of statewide total	11.3	76.0	93.6	
White-tailed deer (miles)	0	64	64	96
Percent of statewide total	0.0	66.8	66.3	

¹The sum of the individual categories is greater than the statewide total because migration routes were selected by segments that could overlap with more than one land tenure category.

BOX 1. PRIVATE LANDS SUSTAINING BIG GAME MIGRATIONS

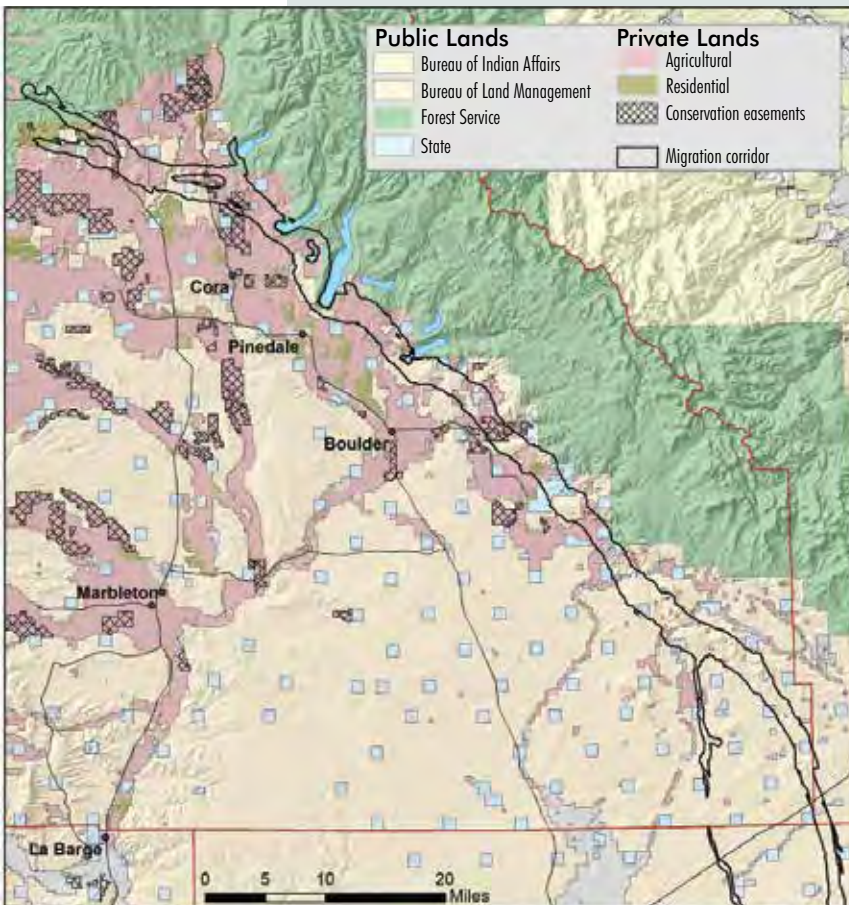
Many of Wyoming's big game populations migrate long distances between summer and winter ranges, capitalizing on critical forage resources along the way. Recent and ongoing radio telemetry and GPS collar studies provide detailed spatial data

for mapping migration routes. Such maps can inform conservation efforts by highlighting where migrating animals cross land parcels at risk of development.

For example, mule deer migrating 150 miles from the Red Desert to the Hoback Basin in western Wyoming navigate a narrow bottleneck in the corridor near Pinedale, Wyoming. The private parcel overlapping that bottleneck was put up for sale in 2014 with the expectation that it would be developed as a rural subdivision. Maps of the migration corridor highlighted this vulnerability, and a conservation organization purchased the parcel and donated it to the Wyoming Game and Fish Department, ensuring the long-term protection of the migration bottleneck.

Migratory big game populations are vulnerable to residential development, which can obstruct their migration corridors. In Sublette

County, which contains most of the Red Desert to Hoback mule deer migration corridor, 3 percent of private lands are protected by conservation easement and another 31 percent of the corridor is undeveloped and unprotected private agricultural lands. The migration's fate is tied to the future of those working landscapes. As biologists identify and map more migration corridors across the state, conservation easements can provide an incentive for landowners to voluntarily protect the open spaces that big game populations rely on, while allowing them to continue their agricultural practices.



The Red Desert to Hoback mule deer migration crosses multiple land ownership types (Sawyer et al. 2014, Rashford et al. 2015).

lands. The high level of adjacency to public lands can be attributed to strategic siting of easements by land trusts seeking to connect protected areas, as well as the checkerboard pattern of land ownership in some places where private lands border public lands.

Comparison of lands with conservation easements to other private lands and public lands

Ecosystem services are provided by the entire portfolio of land ownership in Wyoming, including 56 percent state, federal, and tribal lands (hereafter “public” lands), and 43 percent private lands without easements. These lands, and the one percent of Wyoming’s land area under conservation easement, have different proportions of land cover types, and presumably provide somewhat different types of ecosystem services. We used geospatial analyses to compare the land cover types and ecosystem services present on conservation easements, other private lands, and public lands in Wyoming (see Appendix for methods).

Land cover across management type

The large majority (96.3 percent) of public lands in Wyoming comprise three land cover types:

shrublands, grasslands, and evergreen forests.

Private lands under conservation easement show proportionally more representation of land cover classes present at low percentages on public lands, including woody wetlands, emergent herbaceous wetlands, and pasture and hay meadows (Figure 3). In terms of land area, public lands account for 351,667 acres of these land cover types.

Lands under conservation easement contribute an additional 102,526 acres of wetlands and pasturelands, making conservation easements an important contributor to the statewide total of wetlands and hay meadows that are important for water quality and some wildlife.

Ecosystem services across management type

Of the three management types analyzed, private lands with and without easements protect more Blue Ribbon trout streams than expected by stream miles on private lands. Although private lands comprise 44 percent of the state, they protect 66 percent of Blue Ribbon streams. Of the state’s 622 miles of Blue Ribbon streams, 69 miles (11 percent) flow through conservation easements.

The majority (84 percent) of the state’s over two million acres of sensitive drinking

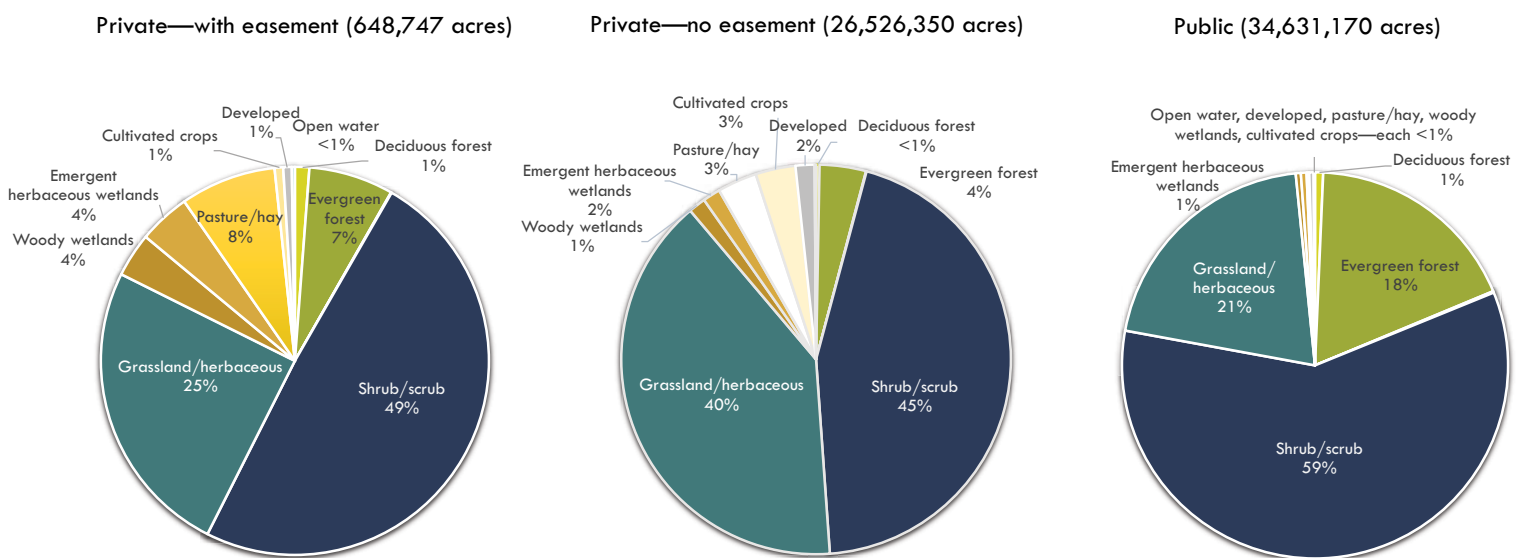


Figure 3. Land cover representation on private lands with easements, private lands with no easements, and all public lands in Wyoming.



water sources occur on private lands without easements, making many drinking water sources vulnerable to the effects of future development. Conservation easements contribute an additional 75,000 acres (3 percent). Public lands, the most abundant land management type in Wyoming, protect a relatively small proportion (12 percent) of Wyoming's sensitive drinking water sources.

Public lands protect nearly nine million acres, or 61 percent, of Wyoming's big game crucial winter range, substantially more than private lands (36 percent of the state total). In terms of total acres protected, public lands protect more elk, moose, mule deer, and pronghorn crucial winter range than private lands. By contrast, private lands support more white-tailed deer crucial winter range (78 percent of the state total) than public lands (20 percent).

All land management types are important for protection of big game migration routes, which traverse landscapes and property boundaries. For elk, moose, mule deer, and pronghorn, at least 93 to 98 percent of all suspected migration routes travel across federal lands. Suspected white-tailed deer migration routes are equally split between private and public lands.

Public lands account for the majority, or 69 percent, of sage grouse core area in Wyoming (9.9 million acres), with private lands contributing about half that much core area. The relative importance of public lands in sage grouse core area management is consistent with the fact that public lands represent nearly twice the shrub acreage of private lands.

ECONOMIC BENEFITS OF CONSERVATION EASEMENTS IN WYOMING

Conservation easements and the resources they protect—fisheries, water quality, habitat for big game and species of concern, agriculture, streams, and drinking water—have both private and public economic benefits (Figure 4). Here we distinguish private benefits as those that accrue directly to the landowner, and public benefits as

those that accrue to the rest of society. In either case, economic benefits include both monetary and non-monetary considerations.

Private benefits to the landowner include both direct monetary incentives and non-monetary benefits. Direct incentives include the payments and tax benefits landowners receive for entering an easement. Easements can also directly benefit landowners by reducing the challenges of transferring land to future generations as a result of estate-tax exclusions under the tax code. Lastly, private benefits also include non-monetary benefits, such as the value landowners place on preserving ecosystem services and on maintaining the rural culture supported by intact working lands (Box 2).

The public benefits of conservation easements can be diverse and difficult to explicitly value in monetary terms. To simplify, we characterize public benefits by distinguishing between those derived from the preservation of ecosystem services and those derived from other functions of easements, such as the preservation of working agricultural lands. Our focus here is on ecosystem service benefits, but we end this section by briefly summarizing some of the other potential benefits.

Characterizing the potential economic benefits of easements as we do below does not imply that the benefits of an easement will always outweigh its costs (Messer 2006). Such a detailed benefit-cost analysis would require a careful accounting of all the benefits and costs measured in monetary terms, including all the public and private benefits and costs. Costs should account for both the direct cost of the easement and the opportunity costs that result from not conserving the land, including restricted land-use options in perpetuity (Esseks 2003).

Public benefits of ecosystem services on private lands

Given the range of land cover types and natural resources protected in Wyoming, conservation easements preserve or enhance a wide array

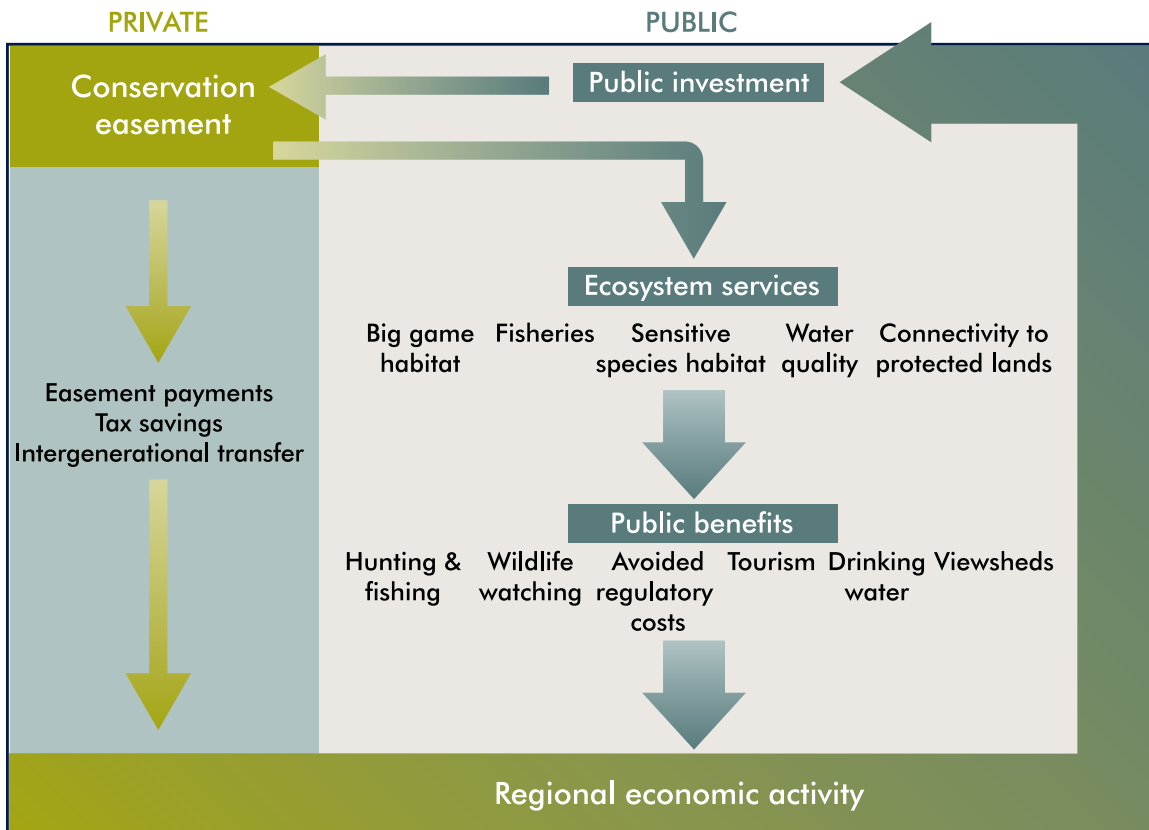


Figure 4. Public investments in conservation easements yield both private and public benefits.

of ecosystem services that can generate public benefits (Villamagna et al. 2015). Below we characterize some of the potential benefits associated with the inventory above, and provide context for considering their monetary value.

Land cover

The different land covers protected by easements in Wyoming support a range of ecological functions that can produce public benefits. Natural land covers, for example, are more effective than developed lands at controlling erosion and maintaining soil functions, such as nutrient cycling and carbon storage. Although it is difficult to accurately assign a monetary value to many of these ecological functions, a few studies have attempted to approximate the total ecosystem service values associated with conserving different land covers in the west (e.g., Sargent-Michaud 2009, Taylor et al. 2011). Annual per acre estimates range from \$20 to

\$600 for rangeland (shrub/scrub), \$20 to \$90 for grassland, and \$60 to \$900 for forestland. Such monetary valuation estimates have large ranges depending on the explicit ecosystem functions considered (e.g., water treatment vs. carbon sequestration vs. wildlife habitat), and can vary tremendously depending on parcel-specific land characteristics.¹

Fisheries and water quality

Conservation easements in Wyoming protect a disproportionate amount of the state's Blue Ribbon trout fisheries, which support an important component of Wyoming's recreation economy. The US Department of Interior (US DOI 2011) estimates that 303,000 people fished in Wyoming during 2011, with 3.1 million days spent afield. Anglers spend on average \$126 per

¹ Average value estimates for broad regions should not be used to determine landowner compensation under easements; determining fair compensation requires detailed and parcel-specific considerations.

BOX 2. LANDOWNER PROFILE BOX—SOMMERS FAMILY RANCH

The Sommers family has been raising cattle and growing hay in Sublette County, Wyoming, since 1907. To help fund their retirement, siblings Albert and Jonita Sommers sold conservation easements on property their family had held for over one hundred years.

“This easement will allow the land to remain undeveloped, which is a benefit to cattle and wildlife, and it will allow us to pass our ranch along to another generation of ranchers,” said Albert. “We are trying to create a future for this ranch.”



Aerial view of the Sommers Ranch under conservation easement.

RANCHLAND SUCCESSION PLAN AND LIVING MUSEUM

Placing a conservation easement on a ranch can also be an important estate planning tool, providing landowners retirement income and tax savings. With no family members to take over the operation, Albert and Jonita designed a private agreement enabling the neighbors' sons to acquire the historic ranch and associated grazing leases.

In addition to their ranchland succession plans, the Sommers family developed a living museum on the ranch with help from the Sublette County Historical Society. The museum includes historic ranch buildings and agricultural implements that provide

the public a glimpse of how ranch life was in the past. The family welcomes school groups and members of the public.

LAND COVER AND CONTIGUITY

The Sommers ranch consists of 1,000 acres of rangeland, 200 acres of irrigated pasture, 30 acres of wetland and 827 acres of hayland, straddling four miles of the

Green River. Interest in continuing their family’s conservation legacy led Albert and Jonita to enroll their land into a perpetual conservation easement, including 1,900 acres along the Green River, in 2010.

The Sommers ranch is contiguous with the 3,210-acre Todd Place, which is a part of the Grindstone conservation easement project. Together, the two easements provide an immense, unbroken landscape between two large tracts of Bureau of Land Management land.

MAINTAINING BIG GAME AND SAGE GROUSE POPULATIONS

The Sommers ranch provides crucial habitat and vital migration corridors for mule deer, pronghorn, and moose. The riparian areas are home to nesting songbirds, raptors, waterfowl, shorebirds, sandhill cranes, and blue herons. The ranch is also within sage grouse core area, and surrounding areas host sage-grouse leks.

RECREATIONAL ACCESS

At the request of the landowners, the Sommers-Grindstone project includes a public fishing access easement on the Green River, which is held by the Wyoming Game and Fish Commission. The area provides walking and boat access to nearly five miles of the river.

“Our family has always allowed fishing on our property,” said Albert Sommers. “With more and more ranches being bought as fishing estates, we wanted to include the access to continue our legacy of allowing the public to fish. Generations to come will see the vistas just as settlers did more than 100 years ago.”



The Sommers-Grindstone easement allows public recreational access.

day for total trip-related expenditures of nearly \$400 million. Many of the anglers in Wyoming (64 percent) are non-residents, suggesting the importance of healthy fisheries to the state’s tourism sector. Wyoming county-specific analyses also indicate that fishing spending makes important contributions to local economies. Previous studies estimated, for example, that fishing-related spending in 2015 contributed nearly \$11 million to local economic activity in Park County, \$7 million in Carbon County, and \$21 million in Teton County (Taylor 2016, Taylor and Foulke 2016, Taylor and Foulke 2017).

Intact wetland habitats also contribute to surface water regulation and groundwater protection, which are particularly important ecological functions given that easements in Wyoming disproportionately protect high percentages of drinking water sources and wetland land covers.

Big game

Conservation easements help sustain healthy big game populations that contribute to Wyoming’s recreation economy. Although rare, in some cases landowners may provide recreational access for the public (Box 2). Even when easements do not allow direct public access, the protection of big

game crucial winter range and migration habitat on easements helps to sustain the populations that are often found on public lands during the hunting season (Coupal et al. 2004).

Estimates using 2014 data indicate that 119,021 big game hunters spent 1.2 million days in the field in Wyoming (Southwick Associates 2017), spending an average of \$92 dollars per day for a total of \$190 million in trip-related expenditures. Wyoming county-specific analyses indicate that hunting and fishing spending are also important contributors to local economies. For example, hunting-related spending contributed nearly \$13 million to local economic activity in Park County (Taylor 2016), \$20 million in Carbon County (Taylor and Foulke 2016), and \$8.5 million in Teton County (Taylor and Foulke 2017).

Species of conservation concern

In addition to fish and big game, the conservation of wildlife in general and species of conservation concern in particular, can provide additional public benefits. The US Department of Interior (US DOI 2011), for example, estimates that 518,000 people in Wyoming participated in other wildlife-related recreation (435,000 participating “away from home”), such as wildlife

Table 4. Sage grouse core area and species of conservation concern on private lands with easements, private lands without easements, and all public lands in Wyoming.

	Ownership type			Statewide total
	Private, easement	Private, no easement	Public	
Species of conservation concern				
Sage grouse core areas (acres)	171,074	5,177,902	9,907,146	15,313,480
Percent of statewide total	1.1	33.8	64.7	
Average predicted number of terrestrial species of greatest conservation need	21.3	20.9	20.1	20.5
Average predicted number of Tier 1 terrestrial species of greatest conservation need	2.4	3.1	3.4	3.3

watching. Wildlife watchers participated in just over three million activity-days, and spent \$321 million in trip-related expenditures. These numbers suggest the importance of abundant and diverse wildlife populations, for the benefit of both residents and tourists.

Habitat protection also reduces the probability of listing under the Endangered Species Act. In Wyoming, private lands with easements support a large suite of species of greatest conservation concern. By supporting sensitive wildlife species and their habitats, conserved private lands may help the state avoid expensive regulatory measures. An endangered species listing for greater sage-grouse, for example, is projected to reduce state and local revenue by up to \$287 million per year, in addition to reducing commodity-related jobs and economic activity (Stoellinger and Taylor 2017). Such avoided costs should be factored in when considering the potential public benefits of private lands conservation.

Landscape connectivity

The high frequency of adjacency of Wyoming conservation easements to public lands creates large expanses of undeveloped open spaces that provide direct and indirect benefits to residents and the visitors that support Wyoming's tourism economy. Conserved agricultural land contributes directly to tourism through guest ranches and outfitting opportunities and by preserving the open spaces, wildlife, and cultural heritage that tourists associate with Wyoming. Tourism is an integral part of Wyoming's economy, with over 8.5 million visitors in 2016 spending over \$3.2 billion in local communities (Wyoming Office of Tourism 2017).

Other public benefits of private lands conservation

In addition to benefits derived from ecosystem services, easements can generate a host of other public benefits. The preservation of working agricultural lands, for example, can benefit local communities by supporting the



agricultural industry and thereby contributing to the preservation of the rural economy and culture. By supporting the agricultural industry, conservation easements can contribute to regional economic activity—the employment, taxes, and flow of dollars from one business to another that sustains local communities. Easement payments themselves and the economic activity from associated agricultural production or recreation, for example, generate spending in local communities that supports income and employment. Taylor et al. (2017) estimated that in 2014 agriculture was responsible for approximately \$4.2 billion in economic contributions to the state, supporting 33,348 jobs and nearly \$1 billion in labor income.

Economists use regional economic multipliers to capture the indirect effects of spending in one sector of the economy on other related sectors. The size of the multiplier depends on the multiplier type (income, spending, or employment) and the sector. Typical multipliers for agricultural production and outdoor recreation in Wyoming generally range from 1.35 to 2.00—every dollar spent generates an additional \$0.35 to \$1 of activity in the community (David Taylor, personal communication).

Even in a state with abundant public land resources, private lands protected by conservation easements support a set of cultural and ecosystem services that contribute substantially to conservation in Wyoming.

Preserving working lands can also have indirect effects on neighboring unprotected lands. Working lands that maintain the rural culture and preserve open space can be attractive to residential developers and homeowners. Conservation easements can therefore affect neighboring unprotected or already-developed land parcels by increasing residential development potential and thus property values (McConnell and Walls 2005). On the other hand, conversion of working lands to residential or other development can exacerbate natural pests or invasive weeds that cross property boundaries (Brunson and Huntsinger 2008). Similarly, the intermingling of residential and working lands can lead to conflicts between the alternative land uses that complicate agricultural production (e.g., farm noise and odor complaints). Thus, by reducing conflicts, easements can have positive indirect benefits for surrounding agricultural lands.

Added to the more tangible public benefits above, conserved open spaces also produce other less-tangible benefits—those enjoyed by members of the public even if they do not use the resources directly. Such benefits include having the option to use a resource in the future (“option value”); the benefit of simply knowing that a resource exists (“existence value”); and the value of preserving resources for future generations to enjoy (“bequest value”). These public benefits are difficult to explicitly value in monetary terms, but they exist nonetheless. Moreover, public benefits linked to option, existence, and bequest values associated with open spaces, wildlife, hunting opportunities, and agricultural heritage are central to public support for easements in Wyoming.

TYING IT TOGETHER

Our inventory shows that current conservation easements in Wyoming protect more Blue Ribbon trout fisheries, sensitive drinking water sources, big game winter ranges, and big game migration corridors than would be expected based on their land area. Further, most private

lands with conservation easements connect to public lands, contributing to a landscape that supports wide-ranging wildlife populations of economic importance. And finally, conservation easements contribute to a statewide conservation portfolio by protecting a suite of resources that is somewhat different from, and complementary to, that found on public lands. Even in a state with abundant public land resources, private lands protected by conservation easements support a set of cultural and ecosystem services that contribute substantially to conservation in Wyoming.

The resources protected by private lands, both with easements and without, generate public economic benefits. By protecting fish and big game populations, conservation easements contribute to Wyoming’s growing recreation and tourism industries and add to the economic diversity of the state. By conserving working landscapes, easements help to maintain Wyoming’s unique agricultural heritage and industry.

Together, public and protected private lands maintain open spaces and the ecosystem services they provide. But while the inventory of protected public lands remains mostly static, residential and other development continually ratchets down the quality and quantity of open space in Wyoming, making private lands conservation a priority.

Conservation easements are one tool for slowing the loss of Wyoming’s open spaces. Although easements currently comprise a small fraction of the state’s land base, our analyses show that public investment in easements can protect critical resources while yielding broader economic benefits. These public economic benefits should be considered along with the private benefits and transactional costs of easements to evaluate future public investments in private lands conservation. Future investments in easements could continue to grow these economic benefits if the public and policy makers target them effectively (Rashford et al. 2015).

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APPENDIX

GIS data and methods

We gathered conservation easement data in May 2016 from Wyoming land trusts (Copeland and Browning 2016) and the National Conservation Easement Database (<http://www.conservationeasement.us/>). We identified private versus public land tenure using the Bureau of Land Management's Surface Management Dataset (<https://www.blm.gov/wy>). We included tribal lands within the public lands category.

The extents of private lands with easements, private lands without easements, and public lands were intersected with resource datasets, in either raster (30-m resolution) or polygon format, to produce acreage or length summaries. To determine intersecting area or acreage, we used the “extract by mask” procedure in ArcGIS, where the land status dataset (e.g., easements) was the mask dataset. We did this for land cover classes (National Land Cover Dataset 2014, <http://www.mrlc.gov/nlcd2011.php>), drinking water sources sensitive to pollution (Bedessem et al. 2005), wetlands (National Wetland Inventory 2010), big game crucial ranges (<https://wgfd.wyo.gov/Wildlife-in-Wyoming/Geospatial-Data>, accessed Aug 2016), and sage grouse core area (Wyoming Game and Fish Department 2015, version 4).

To determine lengths of streams or migration routes, we used the “select by location” procedure in ArcGIS, where we selected all the streams or migration routes that intersected with the land status of interest and then summed the miles within that selection. We did this for streams (National Hydrology Dataset, 100k scale), Blue Ribbon streams (Wyoming Game and Fish Department 2013, <https://wgfd.wyo.gov/Wildlife-in-Wyoming/Geospatial-Data>), and suspected big game migration routes (<https://wgfd.wyo.gov/Wildlife-in-Wyoming/Geospatial-Data>, accessed Aug 2016).

Additionally, we calculated the average number of species of concern occurrences across each land status category. For each of the 131 terrestrial Species of Greatest Conservation Need, we accessed a raster dataset where predicted habitat for the species was assigned a value of 1 (Wyoming Game and Fish Department 2010). We summed the predicted habitat raster datasets across all species, which produced a raster summarizing the number of predicted species per pixel. Then, for each land status, we calculated the average number of species that occurred across all pixels belonging to that land status.



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