Conservation Planning in Sheridan County and Northeast Wyoming

Bighorn National Forest (USDA)

Sheridan Community Land Trust
Ucross High Plains Stewardship Initiative
Yale School of Forestry & Environmental Studies
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Sheridan Community LAND TRUST

Yale SCHOOL OF FORESTRY & ENVIRONMENTAL STUDIES

Ucross High Plains Stewardship

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Introduction

The Sheridan Community Land Trust (SCLT) is a nonprofit land trust based in Sheridan, Wyoming that works to conserve ecologically significant landscapes, protect areas of historical and cultural significance to northeast wyoming, and to expand the recreational opportunities in the region. SCLT was founded in 2006 and seeks conservation options with willing landowners in Sheridan County to pursue conservation easements on private lands or fee acquisition of lands that meet its organizational goals.

Sheridan County contains an array of significant natural resources worthy of long-term protection, such as wildlife habitat of statewide and regional importance, agricultural resources of regional and national importance, incredible recreational opportunities, and unique community values.

Conservation Mapping and Planning

Charlotte Stanley, Lauren Stoneburner, Michael Storace and Sophie Tyack worked in partnership with SCLT to develop a conservation planning mapping tool to guide future private land conservation efforts. They incorporated a variety of spatial data from public sources to help SCLT prioritize and direct its funding and outreach in cooperation with its organization's goals to protect wildlife and working ranches in Sheridan County.

Conservation mapping helps to identify existing land use types, property ownership status, and level of existing protection. The research team also analyzed opportunities to protect habitat connectivity to the important ecological areas that are managed by state and federal agencies. As climate change continues to affect wildlife habitat and vegetation composition of natural communities, connectivity across the landscape will be critical to protecting wildlife species.

Planning for the future of conservation is critical to ensuring the long-term protection of the future of the landscape and its diverse conservation benefits. Conservation can be a time intensive and expensive process. Therefore, it remains critical that conservation organizations effectively utilize their often limited funding opportunities to secure properties that exhibit the best conservation benefits that may be under threat of development or subdivision. In the wake of a future filled with unpredictable weather patterns, conservation will need to protect resilient ecosystems that can ensure the future of wildlife and people coexisting on the landscape. Student researchers focussed their work on highlighting existing conservation values rather than risk of development due to the priorities exhibited and communicated by SCLT. Expanded analysis that could be done to weigh the risks of development or subdivision would need to consider factors such as proximity to towns or roads, gentle terrain lacking steep or unbuildable slopes, and viewshed quality (Ruckelshaus Institute, 2015). However, analysis of threat from development is challenging on a macroscale due to variability surrounding population demographics, housing market trends, and other metrics. Additionally, information regarding development was incorporated into mapping efforts involving sage grouse habitat and habitat connectedness.

Methods of Conservation Value Analysis

Sheridan County in northeastern Wyoming contains unique environmental factors, and SCLT sought assistance to identify existing conservation values on the landscape in line with its organizational management goals to help guide future conservation efforts. The conservation

mapping and planning analysis focused on a range of environmental datasets and maps based on existing geospatial data for the State of Wyoming and independent geospatial analysis. Analysis considered the following environmental variables, including existing land ownership in the county, land protection status, wildlife habitat, habitat connectivity, agricultural soils, and existing agricultural land uses. Detailed analysis for each set of environmental variables will be included below.

Mule Deer (Odocoileus hemionus)

Mule deer inhabit states west of the Missouri River, and their populations are especially concentrated in the Intermountain West (National Wildlife Federation, 2018). Their primary habitat requirements include steep and rugged topography with brush-like vegetation. Their home ranges vary widely, with a variation from 74 acres to 34,000 acres (Innes, 2013). They are very mobile during short periods in fall and spring during migration, and some deer have home ranges that support year-round habitat. Escape cover or hiding cover is a key habitat component in their summer range that supports fawning. Escape cover is defined as vegetation that protects 90% of mule deer individuals from view at a distance of 200 feet. Density of vegetation is an important indicator of hiding cover, and this cover type typically consists of a variety of trees, shrubs, and grasses. Mule deer winter home ranges rely on evergreen shrubs for a food source that can be accessed above the snow (Olson, 1992).

Mule deer are primarily browsers, with a majority of their diet comprising of forbs (broad-leaved, non-woody plants) and browse (leaves and twigs of shrubs and trees). Instead of eating large quantities of low-quality feed like grass, deer must select the most nutritious plants and parts of plants. (WGFD: Mule Deer Working Group, 2015). Mule deer do not need large amounts of free-standing water, but they tend to stay within a few kilometers of a viable water source, especially during fawning season. They require a stable water source in their summer and fall ranges. Constructed water development projects for mule deer may be able to improve animal distribution and resource use. (Boroski & Mossman, 1996).

Mule Deer Conservation Map - Methodology

Human-created obstacles to wildlife migration patterns are a large problem in the American West. Fencing around ranches/housing lots and large roadways can impede the ability of wildlife to traverse the landscape and arrive at their seasonal habitat ranges. In addition, active well sites for oil and gas development can also limit potential migration corridors. Research indicates that ungulates tend to skirt active well sites at a distance of 800m or more. Additional anthropogenic disturbances include tourism, urban sprawl, highway mortality, and habitat fragmentation (Lendrum et al., 2013). SCLT was particularly interested in mule deer because it is a high-interest species in the community, and sought further information on migration corridors to contribute towards the assessment of potential landowners for outreach regarding the installation of wildlife friendly fencing. Mule deer analysis focused on two components: enabling better visualization of mule deer behavior regarding active oil wells, and interactions with assessor-provided parcel data (which is indicative of fencing).

Mule deer migration assessment considered the following inputs: active oil well sites, Sheridan County parcel data, migration lines, and buffer distances from active oil well sites. Geospatial methodology consisted of buffering active oil well sites to visualize the impact on mule deer

migration, dissolving parcels to eliminate boundaries, and highlighting parcels that intersect mule deer migration line. Mule deer migration assessment generated the following outputs: buffered well sites that help users visualize where likely migration corridors would occur, a shapefile dissolved by land ownership, and a migration corridor shapefile that features the intersection of the mule deer migration route with Sheridan County parcels. The tool helps SCLT to identify landowners located along mule deer migration routes who would be good candidates for outreach related to installing wildlife friendly fencing.

Greater Sage-Grouse (Centrocercus urophasianus)

Greater sage-grouse reside in eleven states with semi-arid climates in the western United States, including Wyoming. Their primary habitat requirement consists of sagebrush, although they also rely on other shrublands, grasses, and open landscapes throughout the year (Sage Grouse Initiative 2018). Sage-grouse have specific seasonal habitat needs, and the species' home range varies significantly depending on the proximity of their seasonal habitats (FWS 2010). Some migratory sage-grouse have ranges over 230 square miles, while others may live entirely within 40 square miles. Sage-grouse are highly threatened by disturbances, including infrastructure development—such as roads, power lines, and energy—as well as agriculture, livestock grazing, and invasive species (Sage Grouse Initiative 2018; USGS 2018).

Sage-grouse occurrences depend heavily on their spring breeding sites, called leks. The ideal lek is within an open space—for example, low sagebrush, bare soil, ridges, or burned lands—and is surrounded by dense sagebrush vegetation (Sage Grouse Initiative 2018, FWS 2010). Sage-grouse select leks with extremely low development density, 0.2 miles away from any disturbances, and over 2 miles away from energy extraction sites (WGFD 2007). Each individual remains loyal to their lek, returning to the same site annually for the mating season. After mating, sage-grouse nest in an area within 5 miles of the lek (FWS 2010). The nesting site generally includes taller sagebrush (up to 3 feet high), more plant diversity including grasses and forbs, and less than 3% density of development (Sage Grouse Initiative 2018, FWS 2010). In the summer, sage-grouse seek out habitats with moisture, such as wet meadows or irrigated sites. The birds then require sagebrush for connectivity to their winter habitat, made up of 20 to 40% sagebrush density, as well as tall sagebrush for protection from winter weather (Sage Grouse Initiative 2018).

Greater Sage-Grouse Conservation Map - Methodology

The sage-grouse conservation map combines six environmental layers, portrayed in Table 1, that represent relevant sage-grouse habitat: leks, distance from leks, sagebrush density, land cover, disturbances, and development density. Each data layer was processed in ArcGIS to receive a habitat ranking, from 1 (worst sage-grouse habitat) to 10 (best sage-grouse habitat). The study area extends 15 miles beyond the Sheridan County border to include the effects of nearby land cover and development.

Name	Description
Leks	As active leks contain known species habitat, the breeding sites are the most important locations for continued sage-grouse conservation. The analysis

	implemented the recommended USGS buffer surrounding each active lek, of 0.6 miles, and scored known lek locations as ideal habitat. (WGFD 2019)
Distance from Leks	Sage-grouse require high-quality habitat near leks for their spring nesting, and require connectivity to leks in other seasons. Using the Euclidean distance analysis, areas closer to leks received higher scoring habitat, and areas farther from leks received lower scoring habitats. (WGFD 2019)
Vegetation	Sagebrush is the most important vegetation factor in determining habitat quality. Sage-grouse require varying density of sagebrush throughout the year. This analysis calculated the density of sagebrush throughout the county, and areas with higher sagebrush density received a higher habitat score. (Xian et al. 2015)
Land Cover	Land cover provides an assessment of natural vegetation throughout the county. As shrubland and herbaceous land hold ideal year-round habitat for sage-grouse, these land cover types received rankings of 10. Pasture and crops received the next highest scores, as sage-grouse are known to use these lands for habitat in late spring and summer. Next, wetlands and water, which provide good summer habitat during the dry season, received the third highest habitat scoring. Finally, all remaining land types do not contain quality sage-grouse habitat and received the lowest possible score. (MRLC, 2011)
Disturbances	The disturbance layer combines data on two threats to sage-grouse: energy extraction and roads. The energy data includes locations of "shut in wells" and "well spudded" wells near Sheridan County. The species habitat is then scored based on the distance from wells and roads. Further distances are scored higher, as locations near these sites make poor sage-grouse habitat. (BLM 2011 & WY DOT 2016)
Development	To account for variations in development intensity, the analysis assigned values based on density of development; low-density development was valued as a lower threat than high-density development. The scored layer then combined these values by calculating the density of development. Areas with the lowest density of development received the highest scores, with a gradual decline in score for higher levels of development. (MRLC 2011)

Table 1. Sage-Grouse Conservation Map Environmental Layers

The scores were combined using a weighted average based on the layer's relative importance for the species' habitat. As lek location and sagebrush density are the most important factors in determining sage-grouse habitat, they received the largest weights. Development density and disturbances received the second highest weights. Finally, each parcel in Sheridan County receives a compilation conservation score based on the parcel average. The sage-grouse map displays the parcel scores for sage-grouse habitats.

Important Ecological Areas in Northeastern Wyoming

The Wyoming Game and Fish developed its State Wildlife Action Plan in 2017, which outlines critical wildlife species in the State of Wyoming and describes the unique terrestrial and aquatic wildlife habitat types that support these animal species. The goal of the plan is to maintain and improve the health and diversity of wildlife species in the state (Wyoming Game and Fish, 2017). The Wyoming Game and Fish State Wildlife Action Plan outlines habitat priority areas throughout the State, and makes two major distinctions between the quality of habitat. It identifies Crucial Habitat Priority Areas and Enhancement Habitat Priority Areas. Geospatial layers that included these crucial and enhancement habitat priority areas were included in conservation mapping and planning for Sheridan County.

Crucial Habitat Priority Areas, see Table 2, contain significant biological or ecological values and their protection warranted to maintain viable healthy populations of terrestrial and aquatic life. These areas contain habitat values such as crucial winter range, sage grouse core area, seasonal habitats, species of greatest conservation need, vegetation quality for communities, or movement corridors. These Crucial Habitat Priority Areas are high priorities for protection (Wyoming Game and Fish, 2017). Sheridan and the neighboring Counties contain the following Crucial Habitat Priority Areas:

Habitat Area	Conservation Values
Bighorn National Forest Riparian and Aspen Communities	Support high biodiversity of aquatic and terrestrial wildlife, including food and cover. Reduction of stream and river erosion. Provide habitat and dam-building materials for beaver and associated wildlife species.
Black Hills Aspen and Riparian Communities	Aspen and willow communities provide riparian habitat to serve as food and habitat for fish and other wildlife species, such as beaver. These areas help store water, mitigate flood damage, and improve water quality.
Powder-Tongue Rivers and Tributaries Cottonwood-Willow Riparian Ecosystem	Cottonwood-willow riparian provides critical habitat for wildlife. It is an uncommon natural community type across Wyoming.
South Bighorn Mountain Foothills Shrub and Pine Communities	Provide critical winter habitat for mule deer and elk. Exhibits unique transition habitats that include conifer cover, deciduous species for browse, and diverse topography.
Foothills Stream and Riparian Corridors	These streams support fish migrations, riparian habitats, flood mitigation, water storage, and natural water quality management. Watersheds include portions of the Tongue River, Clear Creek, Crazy Woman Creek, and the Middle Fork of the Powder River.

Sage Grouse Connectivity and Core Areas	These areas provides important food sources for multiple wildlife species, including sage grouse, pronghorn, and mule deer.
Prairie Stream and Riparian Corridors	These streams support fish migrations, riparian habitats, flood mitigation, water storage, and natural water quality management. Watersheds include portions of the Tongue River, Clear Creek, Crazy Woman Creek, Powder River, Little Powder River, Little Missouri River, and Cheyenne River.
Yellowstone Cutthroat Trout Restoration Watersheds	These streams support fish migrations, riparian habitats, flood mitigation, water storage, and natural water quality management. Watersheds include portions of Lodge Grass Creek, West Fork Little Bighorn River, Elkhorn and Red Gulch Creeks, North and South Forks West Pass Creek, and the Little Tongue River.

Table 2 - Conservation Values of Crucial Habitat Areas

Enhancement Habitat Priority Areas (Table 3) are defined as areas that contain a realistic potential to improve, enhance, or restore wildlife habitat. Wyoming Game and Fish identified these habitat areas as those facing ecological and anthropogenic concerns to habitat, such as loss of aspen communities, habitat fragmentation, development, loss of connectivity, water quality effects, water quantity limitations, or beetle killed conifer. Enhancement Habitat Priority Areas are considered a lesser priority than Crucial Habitat Priority Areas (Wyoming Game and Fish, 2017). Sheridan and the neighboring Counties contain the following Enhancement Habitat Priority Areas:

Habitat Area	**Conservation Values**
Crucial Elk Winter Ranges with a high probability of being encroached	These areas provide critical elk habitat, especially for their winter and transition habitats.
Powder and Tongue Rivers	These floodplain areas exhibit high wildlife species habitat, including mule deer, bald eagle, turkey, beaver, sharp-tailed grouse, burrowing owl common loon, ferruginous hawk, greater sage-grouse, mountain plover, northern goshawk, and Townsend's big-eared bat. The area is also at risk to urban and rural development.
Upper Powder River Mule Deer Herd Enhancement Area	This habitat areas exhibits transition habitats that include conifer cover, deciduous species for browse, and diverse topography. Area provides significant recreation opportunities for the public, including the hunting community.

Northern Campbell County Forests Enhancement Area	Has experienced loss of plant diversity, such as woody species and sagebrush, due to conifer encroachment. Provides habitat for mule deer, sage grouse, and elk.

Table 3 - Conservation Values of Enhancement Habitat Priority Areas

The Bighorn National Forest

The Bighorn National Forest comprises a large block of critical habitat area that is managed by the United States Forest Service within the United States Department of Agriculture (USDA). The Forest consists over 1 million acres and over 1,200 miles of recreational trails. The Bighorn National Forest Management Plan, which was last amended in 2013, includes the major goals to ensure sustainable ecosystems including forests, grasslands, and watersheds; to ensure multiple benefits to people, including uses, values, products, and services; to provide scientific and technical assistance; and to ensure effective public service (USDA: USFS, 2013). The Forest Management Plan additionally outlines existing forest conditions and desired future conditions of the Bighorn National Forest to determine appropriate areas for timber harvesting.

The Cloud Peak Wilderness is a sub-section contained within the Bighorn National Forest consisting of 189,039 acres. It has been managed as a primitive area since 1932, and was officially designated a wilderness area in 1984 through the Wyoming Wilderness Act. The national Wilderness Act defined it as “an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain...an area protected and managed so as to preserve its natural function” (USDA:USFS, 2018). The area is managed for these uses, and it is not subject to extractive uses such as logging, mining, or grazing. The Cloud Peak Wilderness spans 27 miles along the ridge off the Big Horn Mountain Range, and it includes Cloud Peak, the largest mountain in the range at 13,167 feet in elevation. On the eastern side of Cloud Peak lies the last glacier in the Bighorn National Forest.

Focus Counties in Northeastern Wyoming

This study focuses on four counties in northeastern Wyoming (Figure X), primarily Sheridan, Campbell, Bighorn, and Johnson Counties.

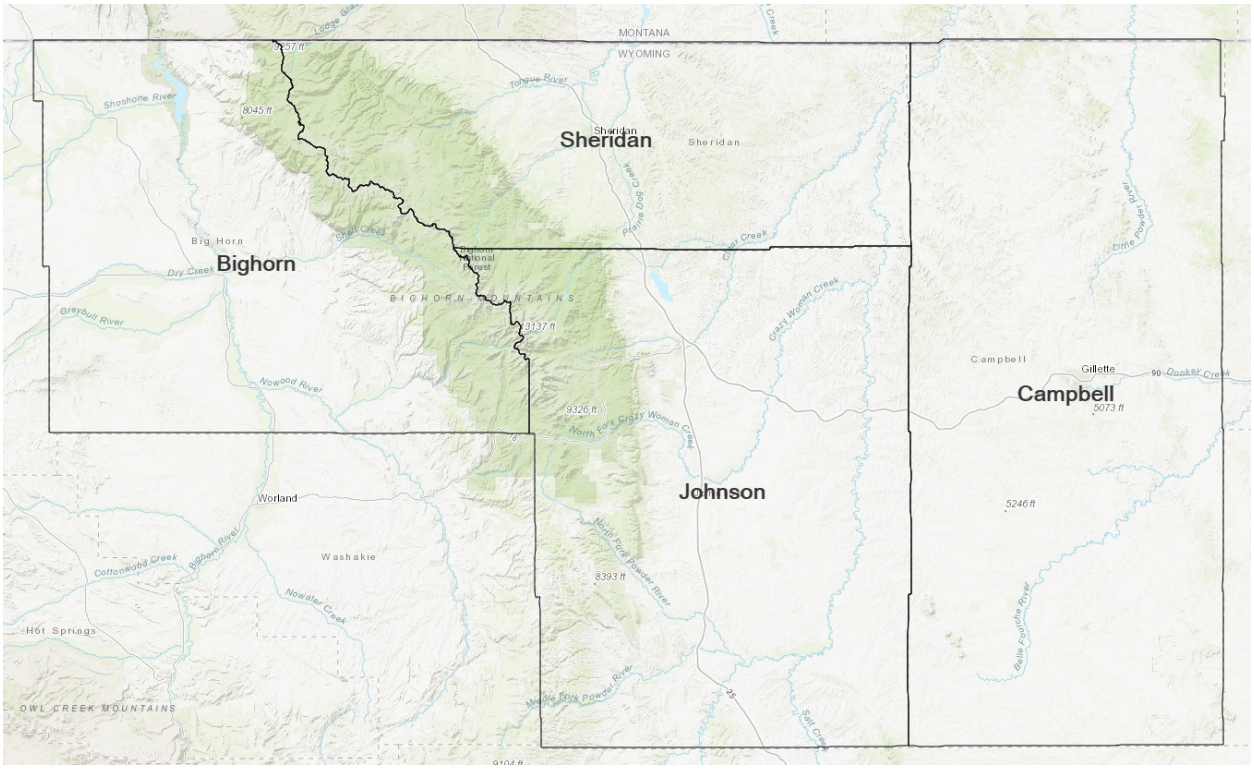

Figure 1. Focus counties in northeastern Wyoming

Sheridan County is the second largest of the four analyzed counties in Wyoming, and has a population of 29,116 people. The City of Sheridan is the largest municipality in the county, it is the county seat, it is the sixth largest city in the State of Wyoming, and it has a population of 17,444.

Campbell County is located to the east of Sheridan County, and has a population of 46,133 people. It contains the City of Gillette, which is the fourth largest municipality in Wyoming. Gillette has a population of 29,087 and it is the county seat.

Big Horn county is located to the west of Sheridan County, and it has a population of 11,668 people. The county seat is the town Basin, and the largest Town is the town of Lovell, which has a population of 2,360 people.

Johnson county is located to the south of Sheridan county, and it has a population of 8,569 people. The City of Buffalo is county seat and it has a population of 4,585 people.

Agriculture and Soil Type

A key organizational goal of the SCLT works towards the advancement, promotion, and preservation of agricultural and working land uses within Sheridan County. In recent years, Sheridan County has experienced increasing population and development pressures, including a 3.8% population increase from to 2010 to 2018. This followed a significant population increase of 9.65% from 2000-2010.The 2017 Joint Planning Area Land Use Plan update contains a policy to "maintain a firm urban edge to promote continued compact development within urban areas" so that "working agricultural lands and open space will remain the primary land uses" outside of urban areas. Additionally it encourages a compact development pattern for the City of Sheridan so that the "city can grow while conserving agricultural lands." The Plan also "will continue to support and encourage land conservation efforts." (Sheridan County, City of Sheridan, & Orion Planning and Design, 2017). Due to the high local and community value of agricultural areas, agricultural soil types were incorporated into the conservation values identified in this conservation mapping assessment (Table 4).

Agricultural Land Uses - Methodology

Data layers that were utilized for this analysis consisted of prime agricultural land as developed by the Natural Resources Conservation Service (NRCS) and agricultural land uses as determined by the National Land Cover Database (NLCD). These geospatial data layers are described in Table 4. Figure 2 portrays prime agricultural land in Sheridan County.

Name	Description
Prime Agricultural Land	Land that has the best combination of physical and chemical characteristics for producing food, feed, forage, and other crops. These areas have the combination of best quality, growing season, and moisture supply to produce high crop yields (USDA-NRCS, 2000). Characteristics of this land type include favorable temperature and growing season, dependable water source, beneficial balance of acidity, alkalinity, and sodium content. These lands types are not easily erodible, they are not saturated for long durations, and they are relatively protected for frequent flooding (USDA-NRCS, 200
National Land Cover Database (NLCD)	The NLCD provides land cover data for the United States derived from satellite imagery. The latest installment of this database was aggregated in 2011, with an update anticipated to occur in 2019-2020. The database characterizes land cover into the following categories: open water, perennial ice/snow, developed-open space, developed-low intensity, developed-medium intensity, developed-high intensity, barren land, deciduous forest, evergreen forest, mixed forest, dwarf scrub, shrub/scrub, grassland/herbaceous, sedge/herbaceous, lichens, moss, pasture/hay, cultivated crops, woody wetlands, and emergent herbaceous wetlands.

Table 4 - Land Use and Agricultural Values

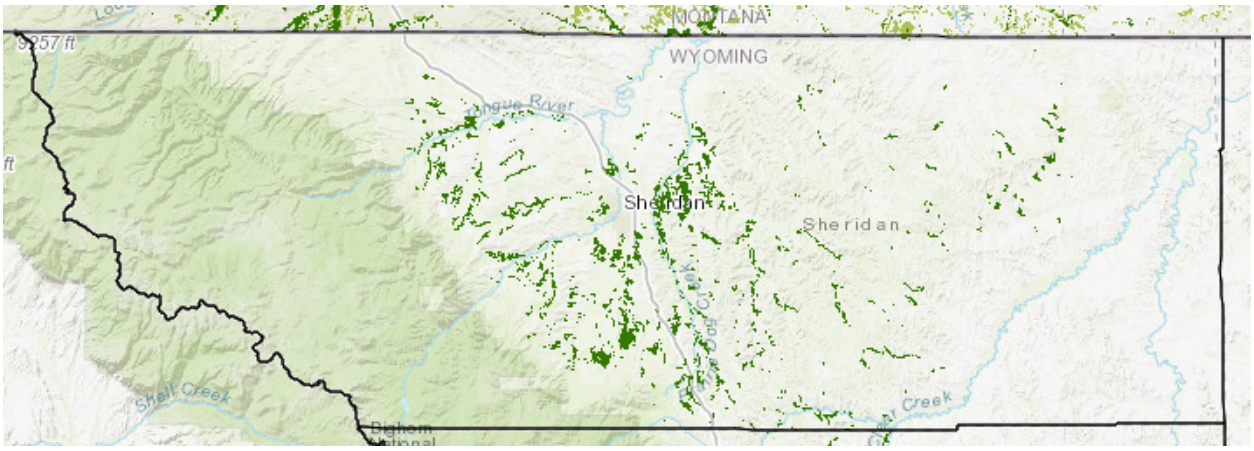

Figure 2. Prime Agricultural Farmland in Sheridan County (shown in dark green)

For the purposes of this GIS analysis the cover types consisting of cultivated crops, hay/pasture, grassland/herbaceous, and shrub/scrub were utilized to assess agricultural land uses in Sheridan County. Table 5 describes the agricultural land cover types, and Figure 3 portrays agricultural land uses in Sheridan County.

Land Cover Type	Description
Cultivated Crops	Areas used for the production of annual crops consisting of greater than 20% of vegetation
Hay/pasture	Areas of grasses, legumes, or a mixture of the two which are planted for livestock grazing, or the production of seed or hay crops. Hay or pasture must consist of greater than 20% of vegetation of the land use area.
Grassland/Herbaceous	Areas dominated by gramanoid or herbaceous vegetation, which consists of greater than 80% of total vegetation.
Shrub/Scrub	Areas dominated by shrubs that are less than 5 meters tall with shrub canopy that consists of greater than 20% of total vegetation.

Table 5: National Land Cover Types as Defined by the Multi-Resolution Land Characteristics (MRLC) consortium

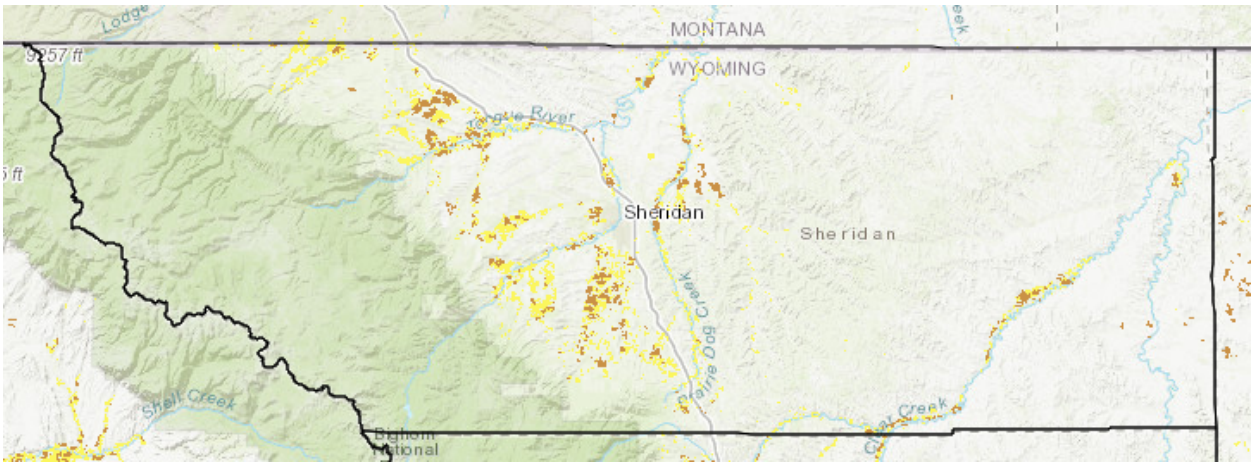

Figure 3. NLCD Agricultural Land Cover Types Portraying Pasture/Hay in Yellow and Cultivated Crops in Brown

Subsequent geospatial analysis was conducted utilizing the NRCS layer and the Sheridan County parcel layer to determine the areas and percentages of prime agricultural land located in each parcel. Higher percentages indicate parcels that contain significant areas of prime agricultural lands worthy of protection. Additionally, when NLCD agricultural land cover types are overlaid with NRCS prime agricultural land, geospatial users can determine which parcels exhibit prime agricultural land but are not currently being utilized for agricultural land uses. Figure 4 shows NLCD and Prime Agricultural soils overlaid together.

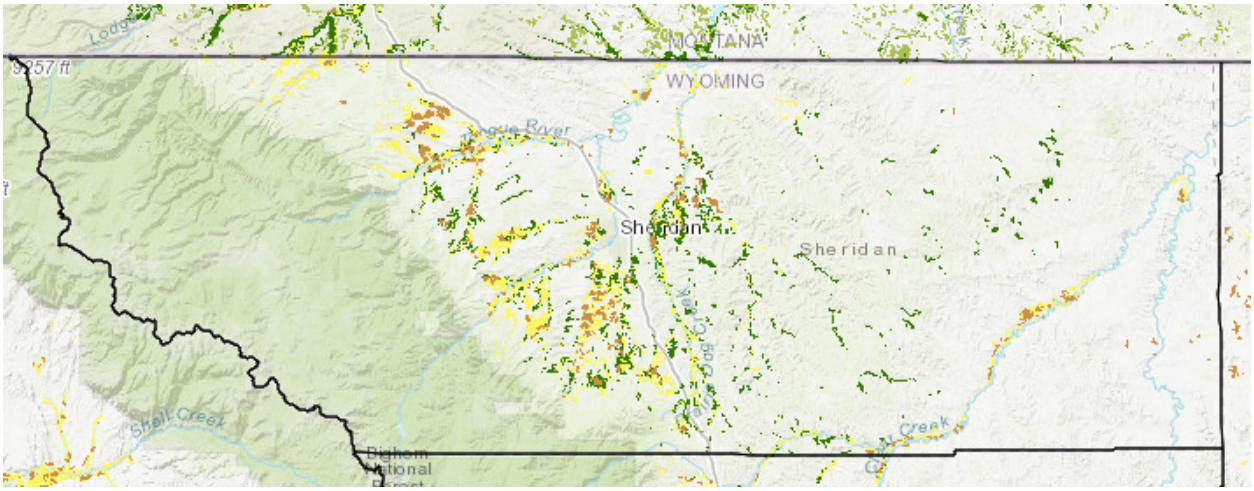

Figure 4. Prime Agricultural Land and NLCD overlaid together

Landscape Connectedness

The Nature Conservancy has developed an innovative method to model landscape resilience to climate change in their Resilient and Connected Landscapes report (Anderson et al. 2016). These analyses have not been conducted for the Intermountain West region of North America, so student researchers created an original model based on The Nature Conservancy's methods to measure landscape connectedness across Sheridan County. The Nature Conservancy considers landscape connectedness and landscape permeability an important variable for approximating the ability for species and ecological processes to move across the landscape as the climate change

in variable ways across North America. While habitat connectivity models, such as Circuitscape's electric circuit theory (McRae & Shah 2009), consider the ability for species to move from one node to another according to species-specific environmental barriers to movement, landscape connectedness considers a continuous surface to consider the degree to which landscapes are conducive to species movement and the flow of ecological processes.

The model developed by student researchers developed a grid of Sheridan County that mapped resistance to the flow of species and ecological processes. High intensity development received the highest resistance weight; roads, railroads, transmission lines, and other infrastructure received moderate resistance weights; agricultural land uses received moderately low resistance weights; and natural habitats received the lowest resistance weights. The model then calculates an inverse distance-weighted average to determine how difficult it would be for a species or element to disperse from any given location. The final score, scaled from zero to 100, reports how well connected each parcel is to the natural landscape around it.

Parcel Ownership and Conservation Status

The United States Geological Survey's Gap Analysis Project (GAP) aims to analyze species data, land cover data, and protected areas data for the United States. GAP serves as a tool that includes information regarding the conservation of wildlife species and natural land cover types to assist landowners with making land management decisions. Sheridan County contains a unique array of private and public land ownership. As a supplement to the GAP data, specific information regarding conservation easements in Sheridan County was obtained through the Executive Director of the Sheridan Community Land Trust and the Wyoming Geographic Information Science Center. Existing land ownership and protection status will assist SCLT staff members with identifying private parcels that are potential candidates for future conservation opportunities.

The USGS defines a protected area as an area that is "dedicated to the preservation of biological diversity and to other natural (including extraction), recreation, and cultural uses, managed for these purposes through legal or other effective means" (USGS, 2019). The Status Code field represents this level of protection, and it is further described in Table 6.

Name	Description
1. Managed for biodiversity: disturbance events proceed or are mimicked	An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events are allowed to proceed without interference or are mimicked through management
2. Managed for biodiversity: disturbance events suppressed	An area having permanent protection prom conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.

3. Managed for multiple uses	Subject to extractive uses, such as mining or logging, or off-highway vehicle (OHV) use: An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type, such as logging or off-highway vehicle use, or localized intense uses, such as mining. These areas include protection to federally listed endangered and threatened species.
4. No known mandate for protection	These areas do not have a public or private institutional mandate or legally recognized easement or deed restriction held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. These areas generally allow conversion to unnatural land cover or management intent is unknown (USGS, 2019).

Table 6. USGS GAP Land Protection Status

The Protected Area Database of the United States also includes an additional classification system of protection levels through the International Union for the Conservation of Nature's Protected Area (IUCN) Categories System, which is described in Table 7.

Name	Description
1a. Strict Nature Reserve	Protected areas set aside to protect biodiversity and geological features. Human visitation, use, and impacts are controlled and limited to ensure protection of conservation values.
1b. Wilderness Area	Large, unmodified, or slightly modified areas, retaining natural character and influence without permanent or significant human habitation. These areas are protected and managed to preserve natural condition.
2. National Park	Large natural or near natural areas set aside to protect large-scale ecological processes, along with the associated species and ecosystems characteristic of the area, which provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitation opportunities.
3. Natural Monument and Feature	Areas set aside to protect a specific natural monument, usually consisting of a landform or geological feature.
4. Habitat/Species Management Area	The major management goal of these areas is to protect particular species or habitats.
5. Protected Landscape	A protected area where the interaction of people and nature over time has produced an area of distinct character with significant, ecological, biological, cultural, and scenic value.

6. Protected Area with Sustainable Use of Natural Resources:	These areas conserve ecosystems and habitats together with cultural and traditional natural resource management systems. These areas are typically large with most of the area in a natural condition, where a proportion of the area is features sustainable natural resource management or low-level non-industrial use of natural resources (IUCN, 2019).

Table 7. IUCN Protection Status

Conclusions and Recommendations for Conservation Priorities

The culmination of this research and analysis is an ArcGIS Online tool to help SCLT make informed decisions about where to pursue projects in Sheridan County. The tool incorporates a range of important environmental variables in Sheridan County–wildlife habitat, sage grouse habitat, agricultural land, and landscape resilience–and overlays them against existing protected areas. The analysis also results in a composite score, combining all conservation values, to give a broad overview of general conservation prioritizations across the county. Depending on the goals of a specific project, SCLT can filter the tool based on each variable to focus conservation efforts. This tool will support SCLT in targeting projects that achieve an array of conservation values, while allowing for flexibility to adapt based on landowner and stakeholder interests.

Student Biographies

Charlotte Stanley is a Master of Environmental Management student at the Yale School of Forestry & Environmental Studies, focusing on improving conservation efforts and mitigating climate change through geospatial analysis. For her summer internship at F&ES, Charlotte mapped community conservation areas and analyzed land cover change in Eastern Zambia to obtain carbon credits for sustainable farmers. Prior to F&ES, she coordinated public education on recycling and sustainability for the NYC Department of Sanitation and managed curriculum development at Urban Green Council. She holds a Bachelor of Science degree in Environmental Science from UCLA.

Lauren Stoneburner is a Master of Environmental Management candidate at the Yale School of Forestry and Environmental Studies, focusing her studies on urban ecological conservation. Having grown up in southern California, she is intimately familiar with reconciling L.A.'s dual identity of being known for its magnificent nature and urban sprawl. In her career, Lauren hopes to manage protected areas in a way that preserves the landscape's ecological viability, fosters smarter urban growth, and enables people of all backgrounds to connect meaningfully with nature.

Michael Storace is a Masters of Environmental Management candidate at the Yale School of Forestry and Environmental Studies studying ecosystem conservation and land management. He is interested in planning conservation to achieve landscape scale habitat connectivity for both ecological function and social benefit. With Ucross, Michael is conducting geospatial analysis of conservation planning and prioritization in northeastern Wyoming. Michael graduated from the University of Vermont with a BS in environmental studies and focused on environmental policy and water quality.

Sophie Tyack is a second year MBA/MEM candidate at the School of Management and School of Forestry and Environmental Studies and is interested in the intersection of data analytics and sustainable development. Prior to Yale, Sophie worked as a research analyst at an environmental consulting firm where her work ranged from natural resource damage assessment cases to system dynamics modeling. Originally from Boston, Sophie holds a B.A. with High Honors from Princeton University, where she studied Classics and Environmental Studies.

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