Foothill Shrublands

Photo courtesy of Jerry Altermatt, WGFD

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Habitat Description

The foothill shrublands habitat type, commonly known as mixed mountain shrubs, comprises diverse plant communities dominated by an equally diverse list of shrub species. NatureServe (2010) estimates over 4.1 million acres of foothills shrublands systems in Wyoming when the Inter-Mountain Basins Montane Sagebrush Steppe system is included. Typically found in patches of pure or mixed stands, predominant shrub species include true mountain-mahogany, curl-leaf mountain-mahogany, serviceberry, antelope bitterbrush, skunkbush sumac, currant, gooseberry, and snowberry. Mountain big sagebrush and silver sagebrush are also common. Choke cherry may also be present, sometimes in abundance in moist sites. Associated grasses and forbs include arrow-leaf balsam-root, bluebunch wheatgrass, hairy golden-aster, Junegrass, and lupine (Knight 1994).

Two types of mountain-mahogany commonly occur in Wyoming. True mountain-mahogany, a deciduous species, is found in the Black Hills and across the southern half of the state, while curl-leaf mountain-mahogany, an evergreen species, is in the foothills of the Bighorn Mountains and to the west and south (Knight 1994). These shrubs form dense thickets on rocky or shallow soils from the western Great Plains up to an elevation of 7,800 feet. Both species have the ability to fix nitrogen, which improves soil fertility over time (Hoeppel and Wollum 1971, Lepper and Fleschner 1977). Mountain-mahogany also plays an important role in erosion control because the shrubs are long-lived, produce extensive root systems, and survive well on dry steep slopes. Additional information on these two species has been compiled by Blauer et al. (1975); some is available on the Nature Serve (2010) web site, within the summary for the Inter-Mountain Basin Curl-leaf Woodland and Shrubland ecological system.

Saskatoon serviceberry is a common foothills shrub, but is scattered throughout the state. Utah serviceberry is found in drier foothill habitats in southern and western Wyoming at elevations from 5,000 to 9,000 feet (Harrington 1954). It is primarily found on dry ridges and slopes in association with big sagebrush, piñon pine, juniper, and aspen. Antelope bitterbrush is found in many of the same locations as serviceberry, including central Wyoming, but is often more confined to areas where snow accumulates, such as ravines, or in areas with higher precipitation. Snowberry is found along stream banks in Wyoming, in swampy thickets, moist clearings, and open forests at elevations from about 4,600 to 9,200 feet.

The quality and composition, including dominant species, of foothill shrublands have varied since European settlement (Nicholoff 2003). Many stands have declined through a combination of fire suppression and overbrowsing. Fire is a naturally occurring process in lower montane and foothill shrublands. Native fire regimes in these communities probably vary widely with local site factors. Severe, high-intensity fires are probably rare under natural conditions due to low and patchy fuel loads and relatively high site moisture (Decker 2007). Historically, foothill shrublands likely burned every 50 to >100 years (J. Derner personal communication 2010). In the absence of fire, foothill shrublands are often invaded by juniper and pine, and also increase in shrub density. Both changes can increase fire intensity and hinder post-fire recovery time.

The ability of true mountain-mahogany to resprout from the crown allows it to recover relatively quickly from fires. Alternatively, curl-leaf mountain-mahogany only regenerates from seed, which can result in extremely long fire recovery times (Kitchen 2008). Fire suppression is believed to be contributing to curl-leaf mountain-mahogany encroachment into adjacent communities (Arno and Wilson 1986); however, over time, some stands become decadent and are unable to compete with conifers (Nicholoff 2003). A similar trend of expansion has occurred within antelope bitterbrush in ponderosa pine communities. Likewise, serviceberry and skunkbush sumac

have declined with increasing shade from higher densities of mature trees (Nicholoff 2003).

Foothills receive considerable recreational activity, especially in the warmer seasons, including hiking, camping, hunting, and motorized vehicle use. Some locations are also popular for housing. Livestock grazing is common. Limited oil and gas development occurs in foothill shrublands, but wind energy development is increasing.

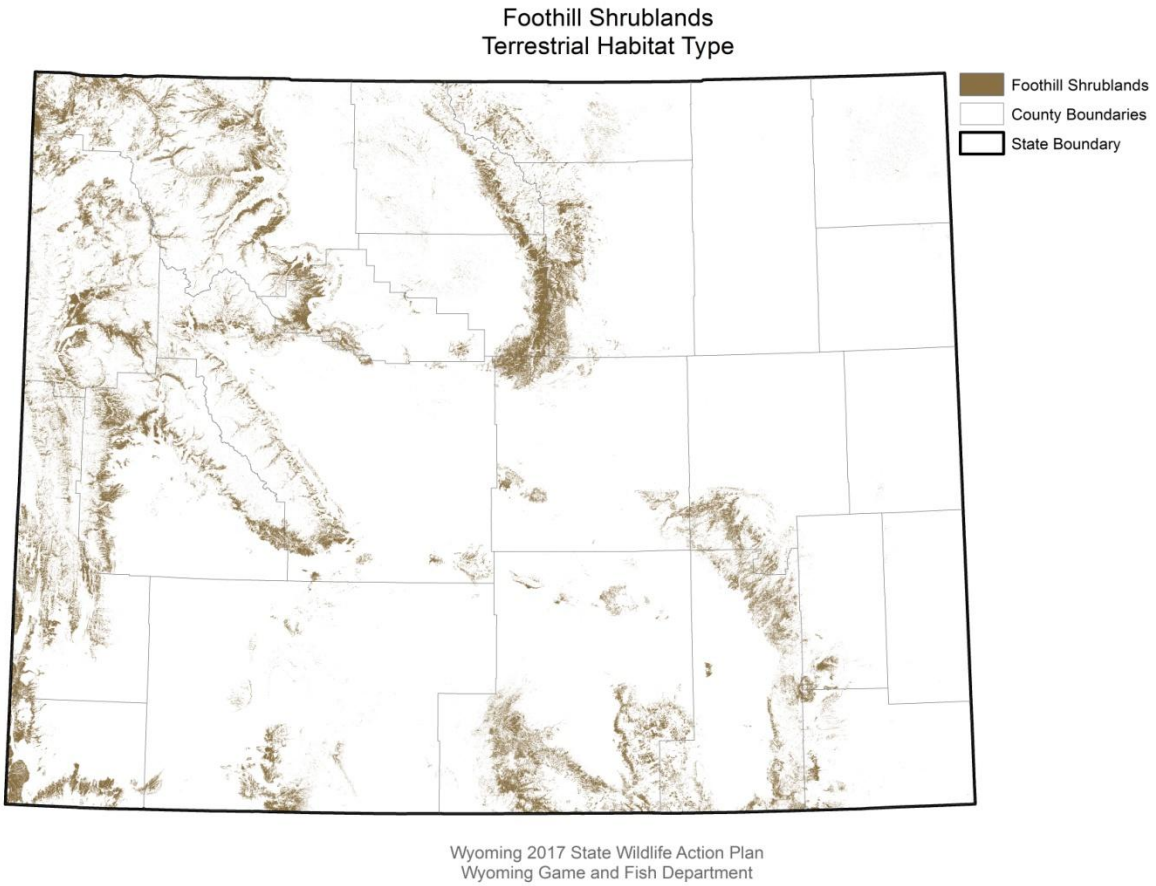


FIGURE 7. Wyoming Foothill Shrublands

TABLE 7. Wyoming Foothill Shrublands NatureServe Ecological Systems[1]

1. Harvested forest-shrub regeneration
2. Inter-Mountain Basins Mountain-Mahogany Woodland and Shrubland
3. Northern Rocky Mountain Montane-Foothill Deciduous Shrubland
4. Rocky Mountain Lower Montane-Foothill Shrubland
5. Western Great Plains Wooded Draw and Ravine
6. Inter-Mountain Basins Montane Sagebrush Steppe

[1] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer.

TABLE 8. Wyoming Foothill Shrublands Species of Greatest Conservation Need

Mammals
Bighorn Sheep
Dwarf Shrew
Eastern Spotted Skunk
Hispid Pocket Mouse
Idaho Pocket Gopher
Olive-backed Pocket Mouse
Silky Pocket Mouse
Yuma Myotis

Birds
Bewick's Wren
Black-throated Gray Warbler
Ble-gray Gnatcatcher
Brewer's Sparrow
Calliope Hummingbird
Canyon Wren
Columbian Sharp-tailed Grouse
Greater Sage-Grouse
Loggerhead Shrike
Sagebrush Sparrow
Sage Thrasher

Reptiles
Smooth Greensnake
Pale Milksnake
Rubber Boa
Valley Gartersnake

Amphibians
Northern Leopard Frog
Columbia Spotted Frog

Foothill Shrublands Wildlife

The mid-elevation position of foothill shrublands denotes a rather mesic environment which is not as cold and snowy as mountains, but not as dry and hot as basins. Thus, this habitat type is often more productive than the forests above it and the shrublands below it. It supports many berry-producing shrubs such as snowberry, currant, serviceberry, choke cherry, and Oregon-grape, which are important forage for many mammals, such as black bears and grizzly bears, and birds, such as dusky (blue) grouse and waxwings. Foothill shrublands also often encompass patches and stringers of trees, including aspen and conifers, that further increase cover and forage for wildlife. Frequent rock outcrops can serve as important substrates for bats, bighorn sheep, bushy-tailed woodrats, and other species. Foothill shrublands often occupy rough topography which provides cover for various wildlife, and also a high diversity of micro-climates, which in turn increases plant diversity. Many of these communities have been designated as crucial winter ranges for mule deer, elk, moose, and bighorn sheep.

Foothill shrublands provide habitats for bird species including Columbian sharp-tailed grouse, dusky (blue) grouse, Brewer's sparrow, gray flycatcher, dusky flycatcher, green-tailed towhee, common poorwill, Virginia's warbler, black-throated gray warbler, and Lazuli bunting (Nicholoff 2003). Presence of substantial amounts of sagebrush, typically mountain big sagebrush, promotes occupation by several sagebrush obligate wildlife species including sage-grouse, sage sparrow, and sage thrasher. In fact, in some seasons and conditions, like late summer and during droughts, the wetter foothill shrub communities may provide better habitat for sage-grouse than lower and drier communities of pure big sagebrush.

Foothill shrublands provide particularly important habitat for big game in winter and during seasonal migrations. Both species of mahogany are particularly favored by mule deer for browsing. Curl-leaf mountain-mahogany communities provide important wintering habitat for mule deer, elk, and bighorn sheep in Wyoming (Despain 1973, Olson 1992, Kauffman et al. 2009). It tends to grow on dry, steep slopes that are typically more accessible to big game and other wildlife during deep snow conditions. Curl-leaf mountain-mahogany maintains high levels of crude protein (Welch 1981) and is one of the few shrubs that meet big game protein requirements throughout winter.

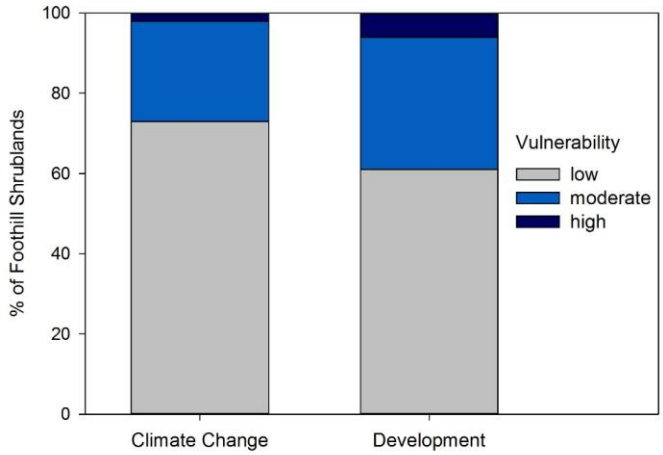
Antelope bitterbrush is another high-quality preferred forage for both big game and livestock, especially in fall and early winter (Austin and Urness 1983, Clements and Young 1997). It also provides cover for small animals and birds, including sage-grouse and Columbian sharp-tailed grouse. Antelope bitterbrush seeds

are important food for rodents, including kangaroo rats and deer mice (Evans et al. 1983). These rodents play an important ecological role in the natural regeneration of bitterbrush by planting seeds in caches.

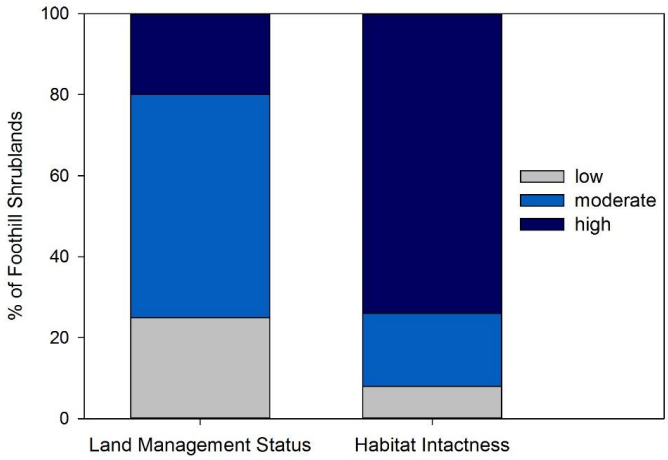
Snowberry is browsed by most wild ungulates, and its fruits are consumed by both black bears and grizzly bears, as well as many birds and small mammals (McWilliams 2000). It is particularly sought after by mule deer in spring. Skunkbush fruits, which persist through fall and winter, provide a food source when other fruits are scarce or unavailable. Serviceberry and currant are browsed by big game, and their berries are consumed by a variety of birds and small animals.

Foothill Shrublands Habitat Threats

Figure 8. Foothill Shrublands Vulnerability Analysis



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high vulnerability to climate change or development, based on classification of scores ranging from 0 to 1 into the following categories: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for climate change or development vulnerability were based on the land area of the habitat type classified as having high vulnerability: low (<10%), moderate (10-33%), or high (>33%). Vulnerability was calculated as exposure minus resilience. Development vulnerability includes existing and projected residential, oil and gas, and wind energy development. Further details are provided in the Leading Challenges section of this report and in Pocewicz et al. (2014).



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high land management status or habitat intactness. For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Rankings for land management status were based on the land area of the habitat type classified as having high status or legal protection: low (<10%), moderate (10-33%), or high (>33%). For habitat intactness, scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for intactness were based on the land area of the habitat type classified as having high intactness: low (<25%), moderate (25-75%), or high (>75%).

Drought and potential climate change - High
Periods of prolonged and extreme drought can have severe effects on foothill shrub species. These species tend to be deep rooted and can normally withstand short-term drought conditions; however, prolonged drought, especially a lack of winter or early spring precipitation that depletes deep soil moisture, can cause high plant mortality. Drought conditions that persisted throughout Wyoming from 2000 through 2006 caused heavy plant mortality in many shrub stands (A. Winward, personal communication, 2008), particularly where shrubs were growing in the more xeric portions of their range.

Many shrub species may have established their current range in Wyoming under a historic period of unusually wet climatic conditions. If the climate becomes warmer and drier in Wyoming, as some climate modeling predicts (Christensen et al. 2007), the distribution of some shrub species may recede from areas where growing conditions are currently marginal (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Conifer encroachment - High
Juniper and limber pine have been actively expanding into true mountain-mahogany and bitterbrush shrub communities in a number of locations in the state, including the Little Snake River and North Platte River Valleys and in the Ferris and Shirley Mountains (see Terrestrial Habitat Types – Xeric and Lower Montane Forests – Juniper). Ponderosa pine has also been encroaching in foothill shrubland communities, including stands of curl-leaf mountain-mahogany, in a number of areas around the state, particularly in the Bighorn Mountains. Shrub and overall plant diversity decreases as juniper begins to dominate. Under these conditions, suitable habitat for species that depend upon true mountain-mahogany and bitterbrush, including mule deer, may decline. If juniper densities reach a point where crown fires can be sustained, the post-burn plant community can become dominated by cheatgrass. On the west slope of the Bighorn Mountains, juniper and Douglas fir have encroached into curl-leaf mountain-mahogany communities. Curl-leaf mountain-mahogany, especially where it grows in more mesic environments, may be seral to these conifer species and thus require periodic burns or other tree removal for persistence. In many areas, limber pine encroachment is receding due to infestations of white pine blister rust and mountain pine beetles (see Terrestrial Habitat Types – Montane and Subalpine Forests, Threats – Disease and insects).

Wildlife browsing pressure - High
While most shrubs are stimulated by light to moderate browsing, high browsing pressure can negatively impact some shrub species. Many of these shrub species are highly palatable and are preferred by most big game species (Blauer et al. 1975). Excessive browsing is most common during late summer and fall and into the winter months. This is particularly true with curl-leaf and true mountain-mahogany, and also bitterbrush. These species are highly desired by mule deer and used in a much greater proportion than they are found on winter range. This makes eliminating the effects of overbrowsing difficult, since deer will continue to use such preferred shrubs even at low deer densities. High browsing pressure over time reduces the recruitment of young plants, and is often accompanied by juniper encroachment, which further reduces plant diversity and habitat quality (see Terrestrial Habitat Types – Xeric and Lower Montane Forests – Juniper). As plant understory decreases, there is an increase in bare ground, cheatgrass, and other annual weeds, as well as greater soil erosion and reduced site productivity.

Fire suppression - High
Fire has historically been a natural disturbance in foothill shrublands, but fire intensity and frequency has been altered due to many decades of fire suppression (Gruell et al. 1985). Although the impact to shrub communities is variable by shrub species, in general, fire promotes regeneration resulting in higher palatability and nutrition. With lack of naturally

occurring fire, these communities often become dominated by dense shrubs with a high level of decadence. Therefore, when fire does occur, it is often intense, resulting in slow recovery. Fire intensity in this community can also be exacerbated by annual invasives such as cheatgrass. And due to the presence of such invasives, prescribed fire as a management tool in this community is used with great caution (see below Threats - Invasive .plants species).

Rural subdivision and development – Moderate

Rural subdivision and development can reduce, degrade, and fragment foothill shrublands habitats (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development). Houses, outbuildings, and lawns directly replace native wildlife habitat. Soil disturbance from construction, year-round grazing of horses and other hobby livestock, and the use of non-native plants as ornamentals can facilitate the establishment of invasive species (Maestas et al. 2002).

Wildlife commonly abandons or alters their use of habitats with greater human, vehicle, and pet activity. Increased energy expenditures in avoiding people or greater use of lower quality habitats can decrease animal health and reproductive capacity. Greater road densities and traffic volume can increase wildlife–vehicle collisions. Predation on wildlife can intensify with greater numbers of domestic dogs and cats, as well as increases in generalist predatory species such as ravens, and human-commensal species such as raccoons (U.S. Department of Agriculture 2007). The frequent location of foothill shrublands within big game winter range and migration corridors intensifies concern about the impact of subdivisions where increases in human activity levels can significantly impact wildlife use (Feeney et al. 2004).

Invasive plant species - Moderate

Nonnative invasive plants can reduce shrub vigor and recruitment, and in some circumstances eliminate foothill shrublands communities (see Wyoming Leading Wildlife Conservation Challenges – Invasive Species). Cheatgrass is the most problematic invasive species in lower elevation bitterbrush habitats on sandy soils, as well as in true mountain-mahogany, curl-leaf mountain-mahogany, mountain big sagebrush, and antelope bitterbrush habitats.

Cheatgrass can form a dense understory that inhibits germination and survival of shrub seedlings. Additionally, cheatgrass can significantly increase fire frequency, which can result in the elimination of shrub species, especially those that respond poorly to fire such as curl-leaf mountain-mahogany and big sagebrush.

The threat of cheatgrass is reduced in some true and curl-leaf mountain-mahogany habitats with rocky substrate because bare rock limits cheatgrass establishment and the potential for fire. Serviceberry, snowberry, and mixed sagebrush/foothill shrub communities at higher elevations or on north- and east-facing slopes generally have high enough native plant cover to preclude invasion by cheatgrass.

Alyssum is an invasive plant species that has been invading lower elevation bitterbrush and true mountain-mahogany communities, particularly after prescribed burns intended to reduce mountain big sagebrush. Spotted knapweed, musk thistle, and leafy spurge are also important invasive plants in foothill shrublands communities.

Foothill shrublands are sometimes subject to prescribed burns, with the intent of increasing the cover and quality of forage species. It is critical that such treatments are conducted with an understanding of the likely responses of important invasive weeds, especially cheatgrass.

Incompatible energy development practices - Moderate

Energy development can result in the direct removal of native vegetation and habitat fragmentation through road building, well pad drilling, power line construction, buried pipelines, booster stations, and facility buildings (see Wyoming Leading Wildlife Conservation

Challenges – Energy Development). Wind energy development is increasing in Wyoming and will likely have an impact on foothill habitats located on ridge tops. Habitat loss and fragmentation also occurs indirectly through increased traffic and noise. Greater amounts of broken or bare ground, as well as greater vehicle traffic associated with the construction and production phases of energy development, can contribute to the spread of invasive plant species.

Incompatible livestock grazing practices - Moderate
Inappropriate livestock grazing can negatively impact shrub communities, particularly where livestock are grazed in areas with highly palatable shrubs. If livestock are allowed to graze for too long, especially during the hot season when they are seeking shade, shrub species such as serviceberry in wooded draws can be browsed out of existence (Girard et al. 1987). Grazing management practices that do not allow cool season grasses to recover can degrade habitat quality in foothill shrubland communities. Intensive grazing during the songbird nesting season (April through July) can increase nest loss through trampling, as well as brood parasitism by cowbirds if the grazing occurs near woody habitat (Nicholoff 2003). During late summer, fall, and early winter, browse levels on some shrub species such as mountain-mahogany and bitterbrush can be high and negatively affect plant vigor and health. However, it is also well documented that some level of browsing does prevent stagnation and increases the productivity of many shrub species.

Varying management goals, lacks of consensus on management strategies, and inadequate coordination and monitoring of management actions - Moderate
An evaluation of the effectiveness of management activities such as habitat treatments, big game herd population objectives, and livestock grazing is often hampered by a lack of baseline data, insufficient monitoring, and poorly articulated goals and objectives. There should be better coordination and planning among and between land management agencies, private landowners, and other interested groups prior to implementing management actions, including monitoring of enhancement or treatment projects.

Off-road vehicle use - Moderate
Off-road vehicle use, primarily by all-terrain vehicles (ATVs), continues to increase. Soil disturbance and the transportation of seeds can enhance the spread of invasive species, especially spotted knapweed and cheatgrass. This can lead to greater soil erosion, a reduction in water quality, and impacts to ecological processes within these systems. Wildlife often avoid areas of increased noise and disturbance from outdoor recreational vehicles, and riding off-road can destroy the nests, eggs, and young of ground-nesting birds, and fragment the habitat of area-sensitive species. These impacts can also lead to conflicts with hunting, wildlife viewing, and other forms of nature-based recreation. Off-road vehicle management generally remains controversial and difficult to manage, especially in more open and gentle terrain where new tracks are more easily created relative to forested areas or more rugged terrain. The increase in people collecting shed antlers has also increased off-road vehicle use, particularly affecting soil erosion on moderate to steep slopes as riders criss-cross the terrain to spot and retrieve antlers.

Foothill shrublands often do not accumulate enough snow to support much winter recreation such as skiing and snowmobiling, especially relative to adjacent montane systems. However, they often accumulate just enough snow to preclude road vehicle and foot-based recreation, especially relative to adjacent basin systems. This in-between character that precludes motorized use in the winter likely contributes greatly to the value of foothill shrublands as winter habitat for big game.

Current Foothill Shrublands Conservation Initiatives

Foothill shrublands have not been a primary focus of any statewide initiatives; however, this habitat type has been identified as a target habitat in the Wyoming Game and Fish Department (WGFD) Strategic Habitat Plan (SHP) (2015) and The Wyoming Mule Deer Initiative (2009). Localized management actions and projects, which provide direct or indirect benefits, are more common. The WGFD does some annual monitoring of shrub production and utilization on big game winter ranges within foothill shrublands systems.

Locations of invasive species infestations are often mapped and identified for treatment by the Bureau of Land Management (BLM), County Weed and Pest Districts, and/or private landowners. There are also a number of invasive species management efforts involving multiple land management agencies and landowners. Notable efforts include Weed Management Areas (WMA) organized by the County Weed and Pest Districts and Coordinated Resource Management teams (CRM), which are generally landowner-driven and facilitated by the Wyoming Department of Agriculture. Most of these collaborative efforts focus on managing or eradicating one or more invasive plant species and promoting native vegetation. Project areas are generally along watershed boundaries.

The Southeast Wyoming Cheatgrass Partnership was formed in 2005 to promote education, coordination, and communication between partners about research, monitoring, and cheatgrass control projects in Laramie, Goshen, Platte, Albany, and Carbon counties. Current membership includes representatives from the WGFD, U.S. Forest Service, BLM, Natural Resources Conservation Service (NRCS), various County Weed and Pest Districts, local conservation districts, as well as University of Wyoming and Colorado State University faculty and researchers.

There are continuing efforts from within the agricultural industry and by the BLM, NRCS, conservation districts, county extension, and sage-grouse working groups to promote best livestock management practices to improve rangeland health. Some holders of federal grazing leases are incorporating shrublands monitoring efforts into their grazing operations, in addition to monitoring conducted by agencies.

The use of prescribed burns, mechanical treatments, and chemical treatments are common in foothill shrublands systems to increase shrub production, improve stand age and structural diversity, and treat invasive species. Juniper removal and thinning is often a component of these treatments. Private land treatments to reduce big sagebrush and improve cattle forage within big game winter/spring ranges have locally led to increased amounts of mountain shrubs and more diverse shrub communities. Greater diversity of mountain shrubs may also be achieved on public lands with additional efforts such as the seeding or plantings of desired species. The use of prescribed burns in some locations is being re-evaluated due to the potential to spread cheatgrass, alyssum, or other invasive species. In these locations, tebuthiuron (Spike) is frequently used to avoid increasing invasive species.

The WGFD Mule Deer Working Group (MDWG) was established in 1998 to explore solutions to the many challenges confronting mule deer conservation and management. Crucial habitats for mule deer often encompass foothill shrublands ecosystems. Recent research has provided further evidence that foothill shrub communities provide an opportunity for mule deer to accumulate fat prior to winter thus improving overwinter survival. Beginning in 2016 the Wyoming Game and Fish Commission began allocating $500,000 per year through the Statewide Mule Deer Initiative with the intent of working collaboratively with partners to improve habitat conditions for mule deer as well as furthering knowledge on migration routes, corridors and stopover sites.

Highway underpasses such as the one installed north of Baggs on Highway 789 and those in Nugget Canyon near Kemmerer U.S. Highway 30 are part of on-going efforts to modify fences and improve highway passage for big game. These activities may help reduce animal concentrations and browse-use levels in some areas of crucial winter range. Enforcement of new state laws limiting the time when shed antlers can be collected west of the Continental Divide should help reduce disturbance to big game and foothill shrublands systems when they are prone to erosion in late winter and early spring.

The Wyoming Game and Fish Commission documents *Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats* (Wyoming Game and Fish Department 2010a) and *Recommendations for Wind Energy Development in Crucial and Important Wildlife Habitat* (Wyoming Game and Fish Department 2010b) provide guidelines for reducing the impacts of energy development on wildlife and their habitats. While energy companies are required to perform reclamation and mitigation, these activities are often difficult in arid habitats and during drought conditions.

Conservation easements are being used in some foothill shrublands habitats to maintain the open space, wildlife habitat, and agricultural land uses. Land use plans, such as those developed in Carbon County, promote development close to existing infrastructure, both to maintain open space as well as to provide more cost efficient public services (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development).

The BLM and other partners, including the WGFD, will be involved in developing transportation plans for special management areas on BLM lands, many of which were established primarily for wildlife and habitat conservation. The WGFD was a recent state cooperator with the Bridger-Teton National Forest in the development of summer travel management plans.

Recommended Foothill Shrublands Conservation Actions

Increase invasive species control efforts for foothill shrublands communities.
Specific activities to enhance invasive species control include:

- Continue watershed-scale weed management efforts, such as WMA Areas and Coordinated Resource Management teams, and initiate new efforts where they are needed. Larger scale, valley-wide planning and project implementation efforts are needed for effective long-term invasive species management.
- Increase funding of invasive plant management and continue to build partnerships to advance these efforts.
- Conduct inventory of invasive plants and prioritize areas that have the highest risk of shrub community replacement so projects can be directed to these locations.
- Where wildfire could be detrimental to shrub communities, especially where invasive plants that respond well to fire are present, implement projects such as fuel breaks and prescribed grazing to reduce fire risk. Tebuthiuron should be used for sagebrush control, instead of prescribed fire, in these locations.

Provide information, technical, and financial assistance to improve livestock grazing practices in foothill shrublands communities.
The Environmental Quality Incentives Program (EQIP) is a USDA Farm Bill programs administered by the NRCS that can provide resources and assistance to landowners to implement habitat improvement projects and grazing plans. On public lands or areas with mixed private and public ownership, cooperative habitat improvement projects should be established with federal agencies, private landowners, and livestock grazing permittees. The WGFD trust fund, wildlife

conservation organizations, and other sources have been used to fund such projects.

Prescribed fire or mechanical habitat treatments should be used to duplicate historic disturbance regimes to increase plant health, native species composition, structural diversity, and historic ecosystem processes and functions.
Habitat treatments should have clearly stated objectives and monitoring plans. Habitat treatments are particularly needed for true mountain-mahogany and bitterbrush habitats in transition and crucial big game winter ranges to improve habitat diversity and alleviate browsing pressure.

Big game populations should be managed within herd objectives to meet forage utilization levels.
Accomplishing this objective will require greater monitoring of production and utilization of important shrub stands. Utilization objectives for each shrub species should be set and adjustments to big game herd populations made if they are consistently exceeded. Herd population objectives should be set to account for preferred utilization levels, but if herd numbers cannot be reduced to meet utilization objectives, habitat treatments such as prescribed burns should be considered on adjacent habitat to entice animals away from these shrub communities.

Consult wildlife best management practices to improve energy development planning and mitigation design.
Energy-development mitigation plans should stress avoiding biologically sensitive areas within project sites and directing off-site mitigation funds to nearby high-value wildlife locations. WGFD SHP crucial areas can help guide these efforts. The implementation of mitigation measures and/or best management practices detailed within the Wyoming Game and Fish Commission's *Recommendations for Development of Oil and Gas Resources within Important Wildlife Habitats* (Wyoming Game and Fish Department 2010a) and *Recommendations for Wind Energy Development in Crucial and Important Wildlife Habitat* (Wyoming Game and Fish Department 2010b) should be encouraged. Mitigation plans should consider the need to reduce fragmentation of important habitats by using tools such as conservation easements in areas of high biological value. Management actions proposed by state and federal agencies involving foothill shrublands systems should be reviewed, and working closely with the Wyoming Governor's Office, industry, private landowners, and agency staff is recommended during early stages of energy development project plans.

Pursue conservation easements on high-wildlife-value foothill shrublands with willing landowners.
Conservation easements can be an effective and long-term method of securing and enhancing management of foothill shrublands systems on private lands while retaining ranching, outdoor recreation, and other compatible land uses (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development). The development of stewardship plans for conservation easement lands can contribute to effective long-term habitat management.

Increase educational effort to agencies, private landowners, and the public about the importance of various shrubs to wildlife and the factors that threaten the integrity of shrub communities.

Foothill Shrublands Monitoring Activities

Continue monitoring foothill shrublands SGCN in order to detect population trends or changes in distribution that may reflect habitat problems. This information should be used to guide future monitoring and research.

More inventory and monitoring work should be conducted to document current locations, habitat conditions, and the effects

of management practices upon foothill shrublands communities.
More intensive mapping of foothill shrublands habitats is needed. Past large-scale mapping efforts often lump foothill shrublands species with sagebrush community types. Voluntary monitoring efforts on private land should be encouraged.

Monitor the landscape distribution and habitat intactness of foothill shrublands through remote sensing.
Remote sensing is useful in tracking the size, distribution, and fragmentation level of this habitat in Wyoming. Information gathered would be helpful in determining the cumulative impacts of activities and events such as energy development, rural subdivision, and wildfire. This technique will require the further development of monitoring protocols and the identification of sample sites.

Monitor the establishment and spread of invasive plant species in cooperation with County Weed and Pest Districts and other federal and state agencies.

In cooperation with state and regional research entities, monitor the effects of climate change including extended periods of drought or pluvial cycles.
All of Wyoming's habitat types may be impacted by changing climate conditions. Wildlife and habitat managers may be better positioned to develop and implement mitigation and/or adaptation strategies with a better understanding of how changing climate factors are impacting the resources and landscapes that they manage.

Literature Cited

ARNO, S. F. AND A. E. WILSON. 1986. Dating past fires in curl-leaf mountain-mahogany communities. Journal of Range Management. 39:241–43.

AUSTIN, D. D. AND P. J. URNESS. 1983. Summer use of bitterbrush rangelands by mule deer. *In*: Tiedemann, A R., and K. L. Johnson, compilers. Proceedings—research and management of bitterbrush and cliffrose in western North America; 1982 April 13-15; Salt Lake City, UT. Gen. Tech. Rep. INT-152. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 203–212.

BLAUER, A. C., A. P. PUMMER, E. D. MCARTHER, R. STEVENS, AND B. C. GIUNTA. 1975. Characteristics and hybridization of important intermountain shrubs. I. Rose family. USDA, Forest Service Research Paper, INT-169.

CHRISTENSEN, J. H., B. HEWITSON, A. BUSUIOC, ET AL. 2007. Regional climate projections. *In*: Climate change 2007: The physical science basis. Contribution of working group I to the fourth assessment report of the intergovernmental panel on climate change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

CLEMENTS, C. D. AND J. A. YOUNG. 1997. A viewpoint: rangeland health and mule deer habitat. Journal of Range Management. 50(2):129–138.

DECKER, K. 2007. Rocky Mountain lower montane foothill shrubland ecological system: ecological integrity assessment. Colorado Natural Heritage Program. Colorado State University, Fort Collins, CO.

DESPAIN, D. G. 1973. Vegetation of the Big Horn Mountains, Wyoming, in relation to substrate and climate. Ecological monographs. 43(3):329–355.

EVANS, R. A., J. A. YOUNG, G. J. CLUFF, G. J. MCADOO, AND J. KENT. 1983. Dynamics of antelope bitterbrush seed caches. *In* Tiedemann, A. R. and K. L. Johnson, compilers. Proceedings—research and management of bitterbrush and cliffrose in western North America; 1982 April 13-15; Salt Lake City, UT. Gen. Tech. Rep. INT-152. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 203–212.

FEENEY, D., G. BEAUVAIS, R. COUPAL, S. LANNING, S. LIESKE, N. NIBBELINK, AND KIRK NORDYKE. 2004. Big game migration corridors in Wyoming. William D. Ruckelshaus Institute of Environment and Natural Resources. B-1155..

GIRARD, M. M., G. H. GOETZ, AND A. J. BJUGSTAD. 1987. Factors influencing woodlands of southwestern North Dakota. Prairie Naturalist. 19(3):189–198.

GRUELL, G. E., BUNTING, S. C., NEUENSCHWANDER, L. F. 1985. Influence of fire on curlleaf mountain-mahogany in the Intermountain West. In: Lotan, James E.; Brown, James K., compilers. Fire's effects on wildlife habitat - symposium proceedings; 1984 March 21; Missoula, MT. Gen. Tech. Rep. INT-GTR-186. Ogden, UT: USDA Forest Service, Intermountain Research Station. p. 58-72

KITCHEN, S. G. 2008. Mountain-mahogany (*Cercocarpus* Kunth) pp 381–384. *In* The woody plant seed manual. Franklin T. Bonner, Robert P. Karrfalt, eds. United States Department of Agriculture. Agricultural Handbook 727.

KNIGHT, D. H. 1994. Mountains and plains: the ecology of Wyoming landscapes. Yale University Press.

HARRINGTON, H. D. 1954. Manual of plants of Colorado. Second edition. Sage Books, Swallow Press Incorporated.

HOEPPEL, R. E. AND A. G. WOLLUM. 1971. Histological studies of ectomycorrhizae and root nodules from *Cercocarpus montanus* and *Cercocarpus paucidentatus*. Canadian Journal of Botany 49:1315–1318.

KAUFFMAN, M. J., A. B. COURTEMANCH, AND A. B. RUTLEDGE. 2009. Resource selection and group association of translocated bighorn sheep (ovis Canadensis) in north-central Wyoming: does source herd matter? U.S. Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit, Department of Zoology & Physiology Department, University of Wyoming, Laramie, WY.

LEPPER, M. AND G. M. FLESCHNER 1977. Nitrogen fixation by *Cercocarpus ledifolius* (Rosaceae) in pioneer habitats. Oecologia (Berl.) 27:333–338.

MAESTAS, J. D, R. L. KNIGHT, AND W. C. GILGERT. 2002. Cows, condos, or neither: what's best for rangeland ecosystems? Find out how plant communities vary across ranches, ranchettes, and nature reserves in one Colorado watershed. Rangelands 24(6):36–42.

MCWILLIAMS, J. 2000. *Symphoricarpos albus*. *In* U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, and Fire Sciences Laboratory. Fire Effects Information System. http://www.fs.fed.us/database/feis/plants/shrub/symalb/all.html.

NATURESERVE. 2010. NatureServe, Arlington, VA. http://www.natureserve.org/explorer.

NICHOLOFF, S. H., compiler. 2003. Wyoming bird conservation plan, version 2.0. Wyoming Partners In Flight. Wyoming Game and Fish Department, Lander, WY.

OLSON, R. 1992. Mule deer habitat requirements and management in Wyoming. B-965. Laramie, WY: University of Wyoming, Cooperative Extension Service.

POCEWICZ, A., H. E. COPELAND, M. B. GRENIER, D. A. KEINATH, AND L. M. WASHKOVIAK. 2014. Assessing the future vulnerability of Wyoming's terrestrial wildlife species and habitats. The Nature Conservancy, Wyoming Game and Fish Department, Wyoming Natural Diversity Database, Lander, Wyoming.

U.S. DEPARTMENT OF AGRICULTURE, NATURAL RESOURCES CONSERVATION SERVICE. 2007. Effects of exurban development on wildlife and plant communities, by Jeremy D. Maestas. Technical Note ,Washington, DC.

WELCH, B. L. 1981. Nutritive value of big sagebrush and other shrubs. *In* Proceedings—shrub establishment on disturbed arid and semi-arid lands symposium; 1980 December 2–3; Laramie, WY. Laramie, WY: Wyoming Game and Fish Department: 9–22.

WYOMING GAME AND FISH DEPARTMENT. 2015. . Strategic habitat plan. Cheyenne, WY. .

_____. 2010a. Recommendations for development of oil and gas resources within important wildlife habitats. Version 6.0. Cheyenne, WY.

_____. 2010b. Recommendations for wind energy development in crucial and important wildlife habitat. Cheyenne, WY. http://gf.state.wy.us/downloads/pdf/April%2023%202010%20Commission%20Approved%20Wind%20Recommendations.pdf

_____. 2009. The Wyoming mule deer initiative. Cheyenne, WY.