Aspen/Deciduous Forest

Photos courtesy of WGFD

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Habitat Description

Deciduous trees and shrubs occur in a number of Wyoming's State Wildlife Action Plan (SWAP) habitat types in varying proportions. For the purposes of this plan, the Aspen/ Deciduous habitat type is defined as the four NatureServe Ecological Systems where aspen, bur oak, Gambel oak, or bigtooth maple are dominant (Table 1). It spans a range of sites from pure upland to almost completely riparian in nature. A review of the NatureServe land cover classification (NatureServe 2010) reveals several other ecological systems that support deciduous vegetation in Wyoming. Common dominant species in these systems include narrowleaf and plains cottonwood, green ash, box elder, elm, choke cherry, Rocky Mountain maple, alder, and peachleaf willow. Importantly, these cover types are almost exclusively riparian in nature and are thus covered in the SWAP's Riparian Area habitat type description (page III-8-1).

Quaking aspen provides important wildlife habitat in Wyoming. It is the most widely distributed deciduous tree in North America (Little 1971), and about 467,000 acres (190,000 ha) of it occur throughout Wyoming (Nicholoff 2003). The largest concentrations are found on the Sierra Madre, Wyoming, Wind River, and Gros Ventre ranges with sizable stands also occurring in the Medicine Bow and Laramie Mountains of southeastern Wyoming. Relatively little contiguous aspen occurs in the Black Hills and Bear Lodge Mountains, Bighorn Mountains, Absaroka Range, Teton Range, or the Yellowstone Plateau (Nicholoff 2003). Aspen tends to be found in smaller and more isolated stands in Wyoming than elsewhere in the West. An exception would be the west slope of the Sierra Madre Mountains.

Very small and isolated aspen stands occur in Wyoming's intermountain basins as well, typically where large and persistent snowdrifts collect through the winter and provide abundant moisture into the growing season. These small stands often support unique forest wildlife species that otherwise would not occur in these dry, sagebrush-dominated landscapes (Jones 2009).

Aspen occurs where annual precipitation exceeds evapotranspiration. Typically, these sites have at least 15 inches of annual precipitation, but more than 20 inches is common (Jones and DeByle 1985). At these sites winters, are often cold with deep snowpack, but the growing season is reasonably long (Jones and DeByle 1985). Aspen communities commonly occur in riparian or spring/seep situations where there is permanent or semi-permanent surface water. The restriction of aspen to moist areas is probably more related to the intolerance of aspen seedlings to drought, as opposed to conditions needed by mature trees (Knight 1994).

Aspen is one of the few plants that can be found in all mountain vegetation zones from alpine tundra to the basal plains (Daubenmire 1943). Elevation limits of aspen in the western United States range from 5,200 to 10,500 ft (Mueggler 1988). At low elevations, aspen growth is often restricted by the availability of moisture, while at higher elevations the length of the growing season is the limiting factor. As a result, at lower elevations, aspen frequently occurs as stringers or small islands on the fringe of the semi-arid sagebrush-grass steppes (Jones 2009). At intermediate elevations, aspen commonly occur on northerly and easterly exposures or in swales or draws which collect moisture (Mueggler 1988). At the higher elevations, persistent stands of aspen are frequently restricted to southern exposures.

Successful regeneration of aspen is associated with natural and human-caused disturbances and gaps in the vegetation canopy. This is due to the inability of aspen to compete in low light environments (Manier and Laven 2001). Natural disturbances include blowdowns, landslides, flooding, and disease, but fire is probably the most important (Nicholoff 2003). Over time, aspens are often replaced by Engelmann spruce, subalpine fir, Douglas fir, blue spruce, lodgepole pine, and ponderosa pine. The conversion back to conifer-dominated species can occur in less than 100 years or take as long as 400 years depending upon disturbance factors, proximity to conifer seed sources, site conditions, and rate of conifer seedling growth (Nicholoff 2003). At higher elevations, aspens can persist as a subdominant species within lodgepole pine and spruce-fir communities. At intermediate elevations and on deep soils, aspen can occur as scattered stands of successionally-stable, climax woodlands within coniferous forests (Nicholoff 2003).

The location of aspen groves is highly related to microsites that provide favorable moisture and soil site conditions. The tendency of aspen to grow in stands is also influenced by the ability of new trees to be formed by genetically identical sprouts or suckers (Knight 1994). Although individual trees or shoots die after about a hundred years, the clonal root system can survive for thousands of years (Barnes 1975). Single clones can be as large as 200 acres (Kemperman and Barnes 1976). The fact that aspen stands are typically composed of genetically identical trees explains why nearby stands of aspen often turn color at different times in the fall.

Aspen suckers sprout most vigorously following disturbance, with more than thirty thousand sprouts per hectare especially following hot fires; however, many do not survive (Brown and DeByle 1989, Bartos and Mueggler 1991). Aspen sprouts have access to relatively large amounts of stored carbohydrates, allowing them to grow quickly and providing them with a competitive advantage over trees that reproduce by seeds (Knight 1994). The majority of aspen sprouting occurs during the first three to six years after a disturbance which contributes to the formation of even-aged stands. Multiple age classes can occur when older stands begin to die and the canopy opens, stimulating the production of new suckers (Nicholoff 2003). The sexual reproduction of aspen in the Rocky Mountain West is extremely rare. Some speculate that proper conditions for seedling establishment may exist at intervals of 200–400 years (Jelinski and Cheliak 1992). Therefore, when aspen is lost from the landscape it may not re-establish from seed over a management-relevant time scale (Dale 2001).

A broad range of plant species can be found in association with aspen because of the diverse elevation and topography at which it occurs. A characteristic element among nearly all aspen communities is the lush understory of plants when compared to nearby coniferous forests. The abundance and diversity of plants found in the aspen understory results in very high forage availability for both wildlife and livestock. This understory produces insect biomass as well.

Aspen can be considered a keystone species because of the relatively high diversity of plant and animals that depend on them (Dale 2001). Aspen have declined from 50–96% throughout the West (Bartos and Mitchell 2000). It has been estimated that aspen loss in Wyoming since European settlement is as high as 53% (Stam et al. 2008), but there is some debate by researchers over such high estimates. A recent study estimated an average of only 10% loss in the Greater Yellowstone Ecosystem (Brown et al. 2006). Current extensive mortality of conifers from bark beetle infestations may benefit aspen regeneration and expansion in much of Wyoming.

Due to their productivity and species diversity, aspen communities are one of the most valued western habitat types. Besides wildlife habitat and livestock forage production, aspen contribute to maintaining water quality and quantity, provide valued recreational sites, and are appreciated for their aesthetic beauty.

Other deciduous woody species commonly found in association with aspen in Wyoming foothills escarpments are bur oak (in northeastern Wyoming only), Gambel oak (in south central Wyoming only), choke cherry, box elder, and wild plum. Paper birch co-occurs with aspen in the upper elevations of the Wyoming Black Hills. Like aspen, these species occur on wetter sites with deeper soils. The wetter nature of these sites is most commonly due to greater snow accumulation, more summer precipitation, or runoff from adjacent slopes.

Oak-dominated woodlands are found only in small areas of the northern and eastern slopes of the Black Hills (bur oak) and on the east side of the Sierra Madre (Gambel oak) (Knight 1994). Spring frost and summer drought have limited the spread of Gambel oak northward (Neilson and Wullstein 1983). Both bur oak and Gambel oak woodlands are fire prone, but the species re-sprout vigorously and may increase in density after fire (Harper et al. 1985). Fire suppression has enabled these species to locally expand into less fire-adapted communities, including Rocky Mountain juniper and ponderosa pine. Such mixed communities often present a multi-tiered canopy, with oak species forming a prominent deciduous mid-layer between the understory and conifer canopy. This physical habitat arrangement is rather rare in Wyoming and is perhaps more reminiscent of eastern North American woodlands. Its value to wildlife communities in the West is not well understood and may be a valuable topic for future research.

Portions of northeastern Wyoming support moist ravines and draws dominated by bigtooth maple and a suite of associated deciduous shrubs. These rather productive communities are most common in the foothill zones of the eastern Bighorn Mountains and Black Hills, and are more typical in the northern Great Plains to the north and east of Wyoming.

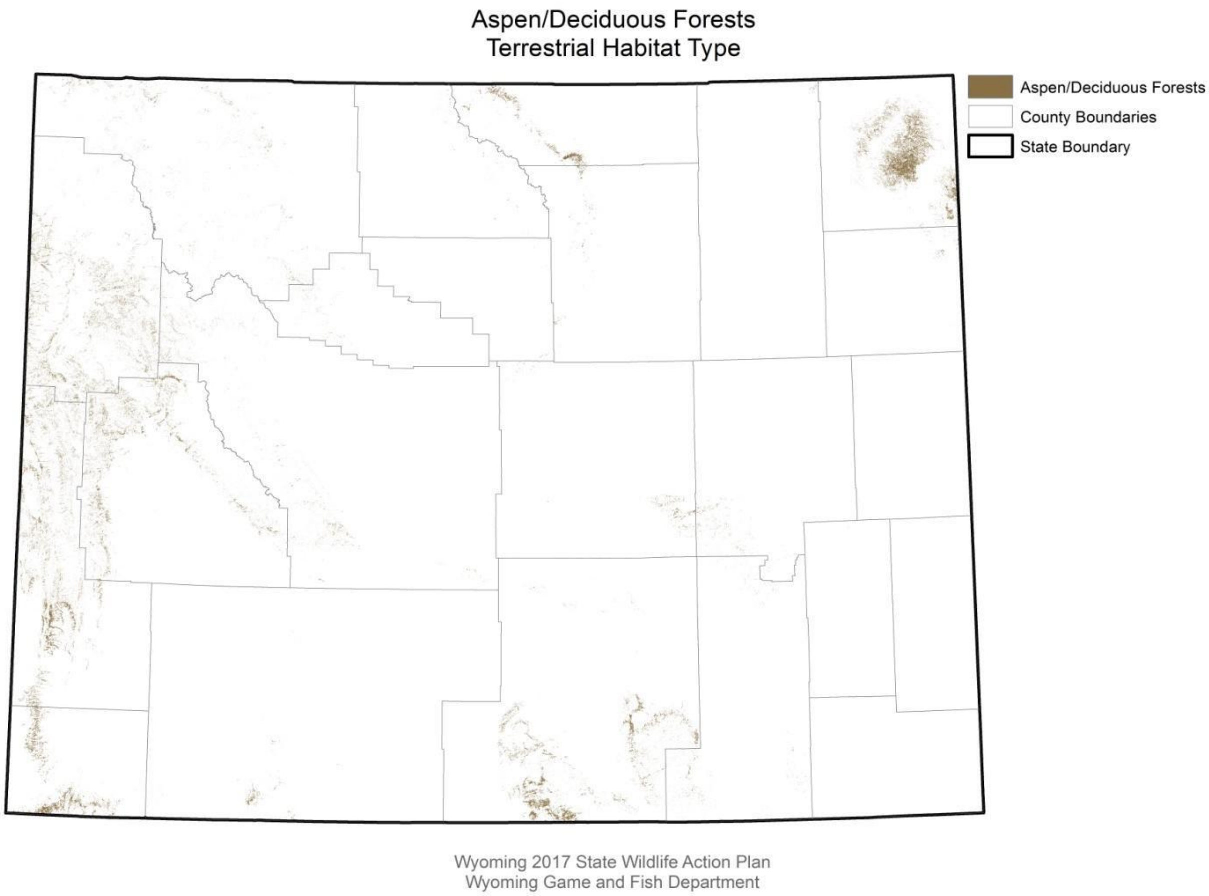


FIGURE 1. Wyoming Aspen/Deciduous

TABLE 1. Wyoming Aspen/Deciduous Forest NatureServe Ecological Systems[1]

1. Rocky Mountain Aspen Forest and Woodland
2. Western Great Plains Dry Bur Oak Forest and Woodland
3. Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland
4. Rocky Mountain Bigtooth Maple Ravine Woodland

[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, VA. http://www.natureserve.org/explorer.

TABLE 2. Wyoming Aspen/Deciduous Forest Species of Greatest Conservation Need

Mammals
Dwarf Shrew
Eastern Red Bat
Fringed Myotis
Little Brown Myotis
Long-eared Myotis
Long-legged Myotis
Moose
Northern Long-eared Myotis
Pallid Bat
Pygmy Shrew
Spotted BatTownsend's Big-eared Bat
Western Small-footed Myotis

Birds
American Kestrel
Boreal Owl
Calliope Hummingbird
Clark's Nutcracker
Columbian Sharp-tailed Grouse
Flammulated Owl
Great Gray Owl
Lewis's Woodpecker
MacGillivray's Warbler
Northern Goshawk
Purple Martin
Pygmy Nuthatch
Red-headed Woodpecker
Rufous Hummingbird
Williamson's Sapsucker

Reptiles
Black Hills Red-bellied Snake
Plains Gartersnake
Red-sided Gartersnake
Smooth Greensnake
Valley Gartersnake

Amphibians
Columbian Spotted Frog
Wood Frog
Western Toad

Aspen/Deciduous Forest Wildlife

Aspen communities are valued for high water yield and high biomass productivity, and are ranked second only to riparian areas in wildlife diversity (Kay 1997). These attributes result in aspen having the second highest priority for habitat improvement projects in the Wyoming Game and Fish Department (WGFD) Strategic Habitat Plan (SHP).

Aspen stands typically support high grass and forb production in their understories, providing important foraging sites for large and small herbivores such as mule deer, elk, moose, black bear, blue grouse, chipmunks, and snowshoe hares. High productivity conditions usually also produce large numbers of invertebrates, which make aspen forests important foraging sites for insectivores such as shrews, bats, and many bird species.

About 88 species of birds potentially use aspen habitats in Wyoming (Nicholoff 2003). Bird communities within aspen stands include species which spend the majority of their time within the aspen community itself, as well as species that visit aspen stands periodically for foraging or other specific purposes while also using surrounding habitats. Breeding bird density in aspen stands is related to surface water and ground moisture levels, the number and size of insects in the aspen understory, and the structure and species diversity of plants found on the border of adjoining habitat types (Nicholoff 2003). Bird diversity has been positively correlated to the size (Johns 1993) and maturity of aspen stands (McGraw-Bergstrom 1986), and mature stands of aspen have greater bird diversity than younger stands and those being invaded by conifers. Mature aspen stands are particularly important to cavity nesting birds, as the trees have soft wood and are prone to infection and decay. The trunks of deciduous trees are often excavated by primary cavity excavators, such as woodpeckers, which are then followed by secondary cavity nesters including bluebirds, swallows, and wrens.

Deciduous and aspen forests are especially important to bats. Generally, activity increases as the proportion of deciduous vegetation bordering streams and moth abundance increase. Bat diversity is greater in deciduous habitats than in coniferous habitats. Proximity to open water may provide a critical element for many bats that use deciduous forests. The greatest resources that aspen woodlands provide for bats are cavities for roosting. Aspen trees greater than 40 years of age almost always harbor heart rot while they are alive and provide excellent conditions for primary cavity excavators (such as woodpeckers) and natural-cavity formation. These live trees are potentially more important to bats in this habitat type than snags (Hester and Grenier 2005).

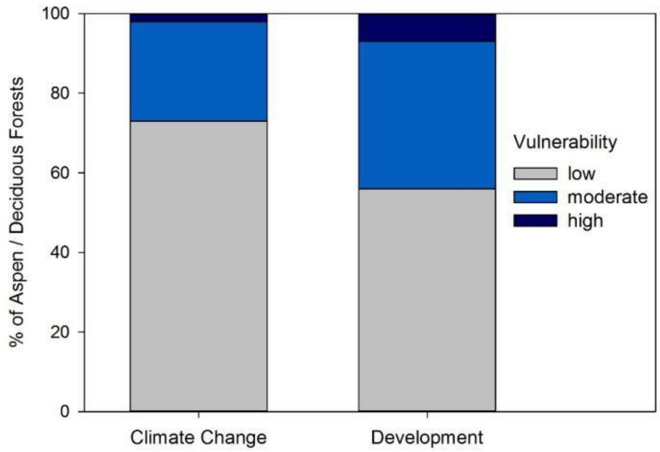
The northern pocket gopher and beaver serve as keystone species in aspen communities by increasing local productivity and site diversity. Northern pocket gophers accomplish this through constant soil disturbance and root herbivory, which facilitates nutrient cycling, air and water penetration into the soil, and creates a fine-grained patchwork of understory plant communities in various stages of vegetational succession. In riparian and spring/seep situations, beavers create wetlands through damming, which can drown some aspen stems but can also increase adjacent soil moisture, which favors aspen growth. Beavers also affect aspen successional dynamics by browsing aspen heavily. Over time, older beaver ponds fail and drain, leaving moist soils and meadows that can be reclaimed by aspen.

In addition to cover, the acorns of bur oak and Gambel oak provide energy-rich food for wildlife including deer, elk, turkey, bear, and squirrels. Old stands of Gambel oak contain large amounts of dead crown wood and hollow boles and limbs that provide nesting sites for small mammals and birds (Nicholoff 2003). Co-occurring plant species such as choke cherry, box elder, black hawthorn, and wild plum are also important food and cover sources for wildlife. These same species commonly co-occur in bigtooth maple ravines as well. As previously discussed, mixed communities in which oak forms a prominent mid-story between a herbaceous layer and conifer canopy are rather rare in Wyoming and may play an important role in providing a unique habitat for some wildlife.

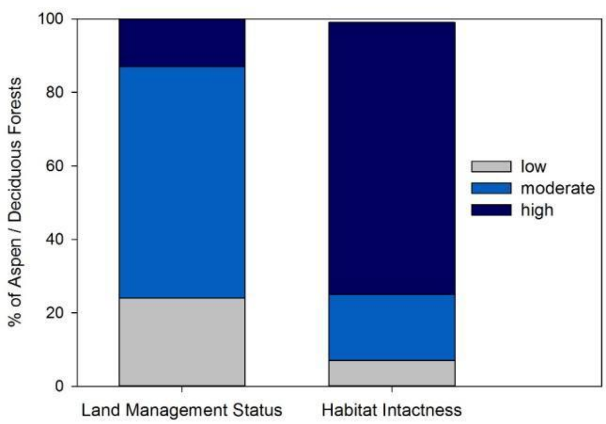
One of the largest remaining populations of Columbian sharp-tailed grouse in western North America spans the Colorado-Wyoming border in the vicinity of Baggs, Wyoming, and extends as far north as I-80. These birds depend heavily on aspen/deciduous forest habitat in this area, including sites dominated by Gambel oak and other associated species like choke cherry and serviceberry. The habitat in this area also supports smooth green snakes and, occasionally, band-tailed pigeons—both species are rather rare in Wyoming. White-tailed deer throughout Wyoming are often found in, or in close proximity to, aspen/deciduous forest habitat.

Aspen/Deciduous Forest Habitat Threats

Figure 2. Aspen/Deciduous Forest 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%).

Lack of aspen stand regeneration due to disruption of historic disturbance regimes – High

Aspen stands require periodic disturbance to become established and regenerate. Extensive fire episodes during the late 1800s and early 1900s resulted in many aspen stands being from 80 to +130 years old (Gruell 1980). Since this time, fire suppression and reduction of intentionally set human fires has reduced fire frequency in aspen communities. Many aspen stands are now reaching maturity and are increasingly vulnerable to disease or senescence. Colorado, Utah, and Wyoming have recently experienced major episodes of aspen death suspected to be related to both age and climate stress (U.S. Forest Service 2008). Recent increases in conifer mortality in Wyoming may create more opportunities for aspen regeneration.

Overbrowsing and trampling by wild and domestic ungulates can also have a negative impact on aspen regeneration, particularly in riparian areas and in areas with limited aspen groves. Both cattle and sheep browse on aspen leaves and twigs, but sheep typically eat four times as many aspen sprouts as cattle (Stubbendieck et al. 1986, U.S. Department of Agriculture, Forest Service 1937). Deer and moose can impact aspen regeneration, but elk are usually the most damaging because elk typically winter in or near mid-elevation zones where aspen forests are most common. Additionally, elk populations in Wyoming have increased dramatically over the last century. Moose, which can spend the entire winter within a single aspen patch, can also cause significant, localized damage.

Fire suppression works in concert with overbrowsing to reduce aspen regeneration. As aspen stands mature and sprouts become less common, browsing pressure intensifies on sprouts that remain. Furthermore, the removal of fine fuels by browsing and grazing can reduce fire frequency.
Fire suppression and overbrowsing, along with other factors such as disease, drought, and natural succession, often lead to the replacement of aspen by conifers. A decrease in plant diversity and water yield is common as conifers begin to dominate aspen stands (Dale 2001). Water loss can be as much as 5% (Harper et al 1981; Gifford et al. 1984). This results in less water being available for undergrowth and groundwater recharge. Over time this water loss reduces overall site productivity. Although conifer mortality from the current bark beetle epidemic may encourage aspen growth at some sites, the heavy fuel loads created by beetle kill may increase wildfire risk and intensity. Intense fires may overcome the natural fire resilience of aspen stands, resulting in significant above-ground stand mortality and possible below-ground mortality of parent rootstock, although aspen regeneration is often closely linked to the level of ungulate herbivory in the area (Bartos and Mueggler 1981).

Although browsing may not be of such concern in oak and bigtooth maple communities, successional dynamics related to fire are just as critical. Oak, in particular, regenerates vigorously after fire. Depending on site conditions, conifers and other vegetation can replace oak under scenarios of fire suppression; in other situations, fire may be used to reduce oak invasion of other vegetation types.

Drought and climate change – High

Drought has been known to cause the loss of seral aspen stands and contribute to a decline in aspen regeneration. In recent years, there have been dramatic die-offs of aspen in a number of locations in the West including Wyoming, Colorado, and Utah. The phenomenon has been termed Sudden Aspen Decline (SAD). SAD has been differentiated from known past aspen die-offs as it occurs on a landscape scale as opposed to within individual stands, displaying rapid mortality, and involving pathogens and insects which previously have not been a significant threat to aspen.

The onset of SAD has been linked to drought. Aspen stands located at low elevation, on south to west aspects, or with open canopies, are the most vulnerable to SAD, possibly due to higher localized temperatures (U.S. Forest Service

2009). During drought, aspen close off openings in their leaves as a survival measure to reduce water loss. This closure also slows the uptake of carbon dioxide which reduces the rate of photosynthesis. It is speculated that this may cause trees to absorb stored energy from their roots, eventually killing the roots and preventing the growth of new aspen sprouts (Worrall et al. 2008). Simultaneously, drought-weakened trees are more susceptible to attack from disease and insects, which would not be fatal for healthy trees.

In 2008 and 2009, U.S. Forest Service Aerial Detection Survey concluded that approximately 48,300 acres were affected by SAD in Wyoming within USDA Forest Service Region 2. Of this, 63% was in Carbon County, 12% in Converse County, and 9% in Albany County. SAD is a relatively new phenomenon and its causes are not fully understood. The phenomenon is particularly unusual because it appears to weaken even moderately vigorous root systems. A drier, warmer climate, which some climate models project for Wyoming (Christensen et al. 2007), may further impact the health of aspen communities in the state.

Aspen woodlands in riparian situations may be suffering drought-like effects from the historic reductions in beaver numbers and distribution. Fur trapping in the 19th century greatly reduced beaver numbers, extirpating them from many areas in Wyoming. By the late 20th century beavers re-occupied most of their historic range, but only at roughly 10% of pre-European-contact densities (Naiman et al. 1988). Among other important effects, beaver ponds raise water tables and increase the size of the riparian zones near surface water, which increases habitat quality for aspen. Ponds and adjacent banks also store snowmelt for release later in the year, increasing flows, riparian quality, and aspen habitat quality downstream. Although beaver browsing and ponding can reduce aspen numbers at times, over the long term a healthy beaver population forms a dynamic mosaic of patches of varying aspen seral stages along a stream network.

Small and isolated stands of aspen in Wyoming's intermountain basins are likely completely dependent on soil moisture from locally-formed snowdrifts, and thus are predictably threatened by drought (Jones 2009). Other deciduous tree communities in the West that rely on soil moisture may also be threatened by changing climate conditions, including warming temperatures and extended drought.

Lack of industry infrastructure – Moderate

The wood products industry has been a valuable contributor to aspen habitat improvement projects through removing encroaching conifers as part of aspen regeneration projects, lopping and scattering slash to augment fuel in aspen stands for broadcast burning, and using equipment to create control breaks for broadcast burning. Proceeds from timber sales on both U.S. Forest Service and Bureau of Land Management (BLM) lands have also been used to fund aspen habitat treatments.

Poor market conditions due to a depressed economy has resulted in the closure of timber mills and delayed harvest of timber sales under contract. Travel distances for sawmills that remain open can make timber harvest uneconomical. In many areas of Wyoming there is currently a lack of access to biomass, wood pellet, engineered wood products, or pulp industries to offset the loss of timber saw mills. The influence of beetle kill on the quality and amount of pine sawtimber will further alter the future of the wood products industry in Wyoming by having less usable sawtimber, but large amounts of dead biomass available.

Rural subdivision and development – Moderate

Rural subdivision and development can reduce, degrade, and fragment aspen and deciduous forest 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 that compete with native vegetation on site and, eventually, throughout a given region (Maestas et al. 2002).

Wildlife commonly abandons or alters 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 like raccoons (U.S. Department of Agriculture 2007).

Rural subdivisions make accessing deciduous habitats for habitat treatments difficult. The number of private landowners from whom permission must be obtained to gain access to some public lands increases. Some new landowners are absentee landowners who reside in other states or countries, are often unaware of the need for habitat treatment, and tend to be initially opposed to cutting conifers.

Additionally, gaining the involvement of a sufficient number of private landowners to make the size of treatments ecologically and economically feasible can be difficult. This is often true of projects that involve portions of both public and private lands. This problem is particularly relevant for the BLM, which manages hundreds of isolated parcels that are landlocked by private properties and which have no legal access easements. The number, size, and condition of many deciduous stands in these areas are unknown.

Clearly, fire management options are greatly restricted in the vicinity of rural subdivisions, and, as previously discussed, fire is a large factor in determining the presence and persistence of aspen, oak, and other deciduous types. Fire managers have little choice but to suppress wildfires and avoid prescribed fires near subdivisions.

Current Aspen/Deciduous Forest Conservation Initiatives

A number of both public and private organizations have worked independently and cooperatively on aspen regeneration and habitat improvement projects. They include the Wyoming Game and Fish Department (WGFD), U.S. Forest Service, BLM, Wyoming State Forestry Division, Native American Tribes, the wood products industries, local conservation districts, and nonprofit wildlife conservation organizations such as the Rocky Mountain Elk Foundation. Coordination among these organizations is increasing as habitat improvement projects are more often implemented across administrative boundaries including public and private lands.

Considerable research has been conducted on aspen regeneration treatments over the last 30 years. The most common methods include prescribed fire, wildfire management, and mechanical techniques.

Fire can be more cost-effective for larger projects than mechanical treatments. An exception is when the conifer removal portion of some aspen regeneration projects generates commercially valuable timber, which can offset the cost of mechanical treatment.

Mechanical treatments through conifer removal are often coordinated with activities of the wood products industries. The BLM has been able to establish such projects with the cooperation of multiple private landowners in order to increase timber volumes to levels that are economically feasible. The establishment of the wood products biomass energy industry may provide new opportunities for aspen regeneration projects, both as a mechanism to administer treatments and as a funding source. To support the development of the biomass industry in Wyoming, several studies have researched forest products transportation costs, generating woody biomass energy at facilities associated with local sawmills, and building wood pellet manufacturing plants in the Bighorn Basin.

Funding and technical assistance for aspen regeneration projects in areas that are not commercially viable has come from timber sale proceeds, hazardous fuels reduction programs, the Wyoming Wildlife and Natural Resource Trust, Wyoming Game and Fish Trust Fund, Rocky Mountain Elk Foundation, and the Wyoming Conservation Corps. These treatments are often conducted using service contracts or seasonal BLM and U.S. Forest Service labor.

The U.S. Forest Service has been re-evaluating all grazing allotments for the last 10 years and is close to completing this effort. Where degraded habitat conditions have been caused by livestock overgrazing, grazing management strategies have been enacted. Local conservation districts and the Natural Resources Conservation Service (NRCS) have provided technical and financial support for activities such as water development or fence construction to support the implementation of grazing plans. Inventory and monitoring of the condition of allotment, including aspen, is conducted by U.S. Forest Service range staff during annual inspections and during the 10-year allotment reviews. Many aspen stands proposed for regeneration are identified by these inspections.

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 areas for mule deer often encompass sagebrush habitat, particularly on mule deer winter range. In 2007, the MDWG drafted the *Wyoming Mule Deer Initiative* which was adopted by the Wyoming Game and Fish Commission. Among other topics, the initiative addresses habitat issues pertaining to crucial mule deer habitat improvement, the implementation of strategies to minimize negative impacts of energy development, and habitat monitoring to ensure that deer populations do not negatively impact plant species on which they browse. Beginning in 2016 the Wyoming Game and Fish Commission began allocating $500,000 per year through the 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.

The WGFD has instituted liberal elk hunting seasons for the last decade in some hunt areas, in part, to reduce the impact of overbrowsing by elk on aspen communities. Additionally, aspen/deciduous forest habitat has been identified in the WGFD Strategic Habitat Plan (SHP) as one of eight priority habitats to enhance or maintain. The WGFD began the North Laramie Habitat Restoration Project in the Deer Creek watershed in 2007 to create aspen stands with more age-class diversity using mechanical techniques and prescribed burns. Relatively few conservation initiatives have been aimed directly at oak and bigtooth maple communities, likely because these communities cover significantly less area and show fewer signs of decline than do aspen communities.

Recommended Aspen/Deciduous Forest Conservation Actions

Conduct a statewide inventory of aspen stands to identify priority sites for aspen regeneration projects.
Stand-specific information is essential in identifying and prioritizing aspen stands for regeneration treatments. Flights or aerial photos during the fall, when the colorful leaves of aspen causes them to stand out, can be a cost-effective way to conduct initial surveys to determine status of overstory trees (mortality, defoliation, etc.). On-the-ground stand assessments are necessary to determine a community's seral stage, evaluate the extent of conifer encroachment, and assess the amount and species composition of the understory.

The presence of SAD and levels of regeneration and conifer encroachment should be used to prioritize aspen habitat treatments. Highest priority should go to stands where conditions will allow for successful establishment of mature aspen stands based on topographic and environmental conditions in order to prevent rapid conifer succession from overwhelming regenerating aspen shoots. The chance of success at regenerating stands with high levels of mortality can be low, but the possibility of limited success must be balanced against the possibility of permanent loss of aspen regeneration once an aspen clone dies.

Increase the number of treatments to regenerate aspen stands and create a mosaic of tree age classes.
Prescribed fire can be applied to closely resemble historic disturbance patterns and is often the most biologically and economically effective method to treat large aspen stands. It is important that fire not only occurs within the stands, but also around the stands to reduce seed cast from adjacent conifer. Conifer-encroached stands, with commercial-size conifers, can be effectively treated in a two-stage process in which a mechanical treatment or commercial harvest is used to put slash on the ground, which is then followed by broadcast burning. Slash can facilitate the spread of fire through more open aspen stands. Mechanical treatment may be the only option in stands where fire is not feasible due to safety, invasive species, or other concerns.

Whenever possible, treatments should be conducted after landscape level assessments have been completed. To reduce impacts on wildlife species dependent upon large contiguous forests, adequate planning is needed to determine spacing and timing of aspen treatments . This will often involve cooperation among multiple landowners and agencies. The Wyden Amendment can be used to support these efforts. This law allows U.S. Forest Service and BLM money to be spent on non-federal lands as long as the project benefits fish, wildlife, and other resources on National Forest or BLM lands within an affected watershed (Public Law 105-277, Section 323 Public Law 104-208, Section 124, and Public Law 105-277, Section 136). Additional funding can be obtained through partnering with non-profit conservation organizations such as the Rocky Mountain Elk Foundation. Public education about the value and purpose of aspen regeneration treatments should occur to ensure ongoing support for aspen habitat improvement projects. Fire treatment can be used as a management tool for oak stands as well, with many of the above concerns applicable.

Encourage careful management of ungulates grazing in aspen habitats to facilitate regeneration.
Successful aspen recruitment in the presence of high ungulate use has been documented, but aspen sprouts can be destroyed by three successive years of browsing (Kilpatrick and Abendroth 2001, Keigley et al. 2002, Tew 1981). Several techniques are effective at managing ungulate browsing levels. Regenerating large amounts of aspen simultaneously and in close proximity to each other can disperse browsing pressure. Temporary solar-powered electric fences can be erected for several years after habitat treatments if browsing exceeds sucker growth. Timber slash placement can often mimic natural disturbances such as snags falling down following fire or bark beetle infestation and can be used as a fencing tool to inhibit ungulate access to the aspen regeneration sites. Within this context, resource managers should carefully consider stocking rates and other allotment specifications regarding livestock use of aspen-occupied areas, especially if such areas are undergoing or scheduled to undergo aspen treatments.

In cooperation with land management agencies and private landowners, reintroduce beavers into stream systems where they have been extirpated or occur at low densities and where appropriate food, security, and dam-building vegetation exists.

- Reintroduce beaver. Beaver dam-building activities can increase the size and quality of riparian habitats for a range of terrestrial and aquatic species (see Wyoming Leading Wildlife Conservation Challenges – Disruption of

Natural Disturbance Regimes), and create a shifting mosaic ofriparian aspen stands in different seral stages.

- Use enhanced GIS mapping of riparian areas or other means to identify suitable reintroduction locations. Careful consultation should occur with landowners on or adjacent to reintroduction sites prior to reintroductions to minimize unintended economic losses.
- Restore watersheds and develop aspen and willow vegetation (another preferred beaver forage) to levels that will support beaver in targeted areas.

Land management agencies should require reciprocal access easements for the purpose of habitat treatments where access to new subdivisions crosses agency lands.

To reduce habitat loss and fragmentation, land trusts should be encouraged to negotiate conservation easements or other land agreements on private lands within and adjacent to U.S. Forest Service, BLM, and state trust lands.

Efforts should be made to support the continued role of the wood products industry in aspen regeneration projects by providing grants, such as those that were available through the U.S. Forest Service Economic Action Program, for market feasibility studies and new business ventures.

Additional research should be conducted to gain a better understanding of the causes of SAD and the potential impacts of climate change on aspen communities.

Aspen/Deciduous Forest Monitoring Activities

Continue existing SGCN monitoring in aspen/deciduous forests and develop new protocols for species not being adequately surveyed.

Monitor the landscape distribution and habitat intactness of aspen/deciduous forests through remote sensing and work to improve accuracy of these methods.
Remote sensing is useful in tracking the size and distribution of this habitat type in Wyoming.
Information gathered would be helpful in determining the regeneration rate of aspen stands and the impact of SAD. Special attention should be given to monitoring the level and location of aspen death and regeneration in relation to the SWAP. This technique will require the further development of monitoring protocols and the identification of sample sites. Monitoring should be conducted in relation to the possible effects of climate change.

Inventory and monitor aspen stands in federal grazing allotments as part of annual inspections and during the 10-year allotment reviews.
Monitoring should include evaluation of aspen regeneration, community age and structure, conifer encroachment, plant understory composition, and whether or not SAD is present. Completed aspen treatments should be monitored to determine effectiveness of treatments, or whether the regeneration needs additional protection from excessive browsing for it to become established.

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