Resource plan	Description and Summary of effects
	fire adapted species may be particularly emphasized in these areas. Overall, the effect of the county plans would be to influence where treatments occur to contribute to desired vegetation conditions.
City of Helena Montana Parks, Recreation and Open Space Plan (2010)	This plan is relevant to an area that lies adjacent to NFS lands in the Divide GA, in proximity to the City of Helena. The plan emphases forest management and wildfire mitigation. This would be generally complementary and additive to management on some HLC NF lands, specifically the South Hills Special Recreation area (alternatives B, C, and D).

Conclusions

The following key points summarize the conclusions for fire and fuels management:

- Fire is a critical ecological function across the HLC NF that plays a central role in providing quality habitat for both plant and wildlife species. All alternatives would ensure fire remains a part of the ecological system and would move the forest toward desired future conditions. This is achieved through a variety of management actions including wildland fire and mechanical treatments.
- *Future vegetation treatments:* Alternative E would achieve the least amount of harvest and prescribed fire in forested areas, including in WUI areas due to focusing on maximizing timber harvest. Alternatives A, B, C, and D would tend to treat more dry forest types in WUI areas. However, there are also other factors that affect the number of acres treated to meet forest plan desired conditions relating to fire and fuels management. Some of these factors include budget allocation, climate and seasonal weather variation, and wildfire occurrence. Budget directly affects how much we are able to treat mechanically and with prescribed fire. Climate and seasonal weather variation affect the ability to conduct prescribe burns. Wildfire occurrence activity locally uses personnel and other resources that would be used for implementing mechanical and prescribed fire treatments.
- *Flexibility for fire management:* Different management designations, specifically RWAs, affect where different management tools, such as mechanical treatments and prescribed fire can be used. Alternatives B, C, and D would limit mechanical treatment options within RWAs, with D having the most area restricted. If these areas became designated wilderness then additional constraints on prescribed burning would exist. Under alternatives B, C, and D there may be increased opportunities and need to manage natural-wildfire to move toward desired future conditions because of the limitations on mechanical activities which would affect the use of prescribed fire. Alternative E has the greatest flexibility for fire and fuels management, but conversely may reduce the use of prescribed fire and wildfire managed for resource benefit because of the emphasis on timber production.
- *Future wildfire and fire regimes*: The projected levels of future wildfire, and their subsequent impact on fire regimes, is generally the same across alternatives. This is because vegetation over time is generally the same for all alternatives, and projected future treatments are also similar. Factors such as climate have a greater bearing on vegetation change and potential wildfire activity.

3.8 Terrestrial Vegetation

3.8.1 Introduction

The 2012 Planning Rule adopts a complementary ecosystem and species-specific approach, known as “coarse-filter/fine-filter”, to provide the natural diversity of plant and animal communities and ensure long-term persistence of native species in the plan area. Coarse-filter plan components are designed to maintain or restore ecological conditions for ecosystem integrity and diversity within agency authority and the inherent capability of the land. This section addresses the coarse filter characteristics of terrestrial ecosystems on the HLC NF, including both forested and nonforested plant communities. The coarse-filter approach addresses conditions at the ecosystem or plant community level in terms of providing for ecosystem integrity and diversity.

The key ecosystem characteristics listed in Table 41 were identified in the Assessment as measurable components of ecosystem integrity. They are measurable, quantitative or qualitatively. The desired condition for each characteristic and its relationship to the current and potential future conditions form the basis for this analysis.

Table 41. Terrestrial vegetation key ecosystem characteristics

Key ecosystem characteristic	Indicator(s)	Measure
Role of insects and diseases	Hazard ratings for mountain pine beetle, Douglas-fir beetle, western spruce budworm, and root disease	Percent of area
Vegetation composition	Cover types (forested and nonforested)	Percent of area
Tree species presence	Presence of at least 1 tree per acre	Percent of area
Forest size	Classes based on basal area weighted diameter	Percent of area
Large and very large trees	Presence of a set minimum trees per acre	Percent of area
	Total quantity	Trees per acre
Forest density	Classes based on canopy cover	Percent of area
Vertical structure	Classes based on canopy layers	Percent of area
Landscape pattern: early successional forest	Average and area weighted mean patch size	Acres

Several issues were identified through public scoping, and are also used to frame the analysis:

- Climate change
- NRV
- The role and effects of large fires
- The role of vegetation management (timber harvest, fuel reduction, restoration, and salvage)
- The importance of large trees
- The condition of specific plant species or types (whitebark pine, aspen, sagebrush, non-forested plant communities, spruce/fir)

3.8.2 Regulatory framework

Please refer to the introductory regulatory framework section of this chapter (3.3).

3.8.3 Assumptions

This analysis assumes that tree species evolved with specific fire frequencies that have been disrupted by fire exclusion. Relationships between climate, disturbances such as wildfire and insects, and human activities such as timber harvest and fire suppression are synergistic. Climate change presents uncertainty in future disturbance regimes and vegetative responses. Based on the best available science, this analysis assumes that future climates will be warm and dry.

The desired conditions for terrestrial vegetation are developed with an underlying assumption that the NRV provides context for future conditions, particularly conditions that occurred during warm, dry climate periods of the past. Assumptions associated with the NRV modeling, and the development of desired conditions, are detailed in appendix B.

The analysis relies on analytical vegetation models. By necessity, these models use assumptions to simplify ecosystem processes and potential silvicultural treatments as described in appendix B. In reality, silviculture prescriptions would be applied site specifically, designed to address forest conditions unique to the site, and therefore would be more variable in application and resulting vegetation conditions.

A further assumption of the analysis is that the vegetation strategies described in appendix C of the revised forest plan would generally be followed for all action alternatives.

3.8.4 Best available scientific information used

A variety of well documented data and analysis tools were used, as described in appendix B.

The data used represent the latest available, with the most recent plots being measured in 2016. The effects of more recent disturbances, including the wildfires of 2017, are not captured. However, the analysis includes the potential for future fire and therefore the relative comparisons for use at the programmatic scale remain valid.

This analysis draws upon the best available literature citations that are relevant to the ecosystems on the HLC NF. Literature sources that were the most recent; peer-reviewed; and local in scope or directly applicable to the local ecosystem were selected. Local studies and anecdotal information that are not peer-reviewed are included where appropriate to provide context.

Terrestrial ecosystems are highly complex and contain an enormous number of known and unknown living and nonliving factors that interact with each other, often in unpredictable ways. There are gaps in available information about ecological functioning. Vegetation is dynamic, changing constantly, and our ability to predict changes in the future is limited. The level of uncertainty depends on how predictable such factors as disturbances, climate change, or human activities may be.

3.8.5 Affected Environment

A primary goal of the revised forest plan (alternatives B/C, D, and E) is to provide for ecological integrity and sustainability, supporting the full suite of native plant and animal species, while providing for the social and economic needs of people.

The desired conditions for each key ecosystem characteristic reflect our best understanding of sustainable and resilient forest conditions based in large part on the NRV and take into account expected future climate by adjusting for past trends demonstrated during warm/dry climate periods. These desired conditions would not necessarily apply to alternative A, but are included in the analysis for all alternatives to provide for a comparison. Appendix B describes and displays the desired range of each characteristic as compared to the existing condition.

Broad potential vegetation groups

Terrestrial vegetation characteristics are stratified by *broad potential vegetation group (PVT)*, which identify sites of similar environmental conditions. These groups provide information on the inherent capability of the land to support vegetation and the nature of change in vegetative communities over time.

Figure 5 displays the proportion of each broad PTV forestwide, and in each GA. Three forested broad PVTs (warm dry, cool moist, and cold) are found on the HLC NF, and six nonforested types (alpine, riparian/wetland, xeric shrub/woodland, mesic shrubland, mesic grassland, and xeric grassland) plus sparsely vegetated areas. See appendix A for a map.

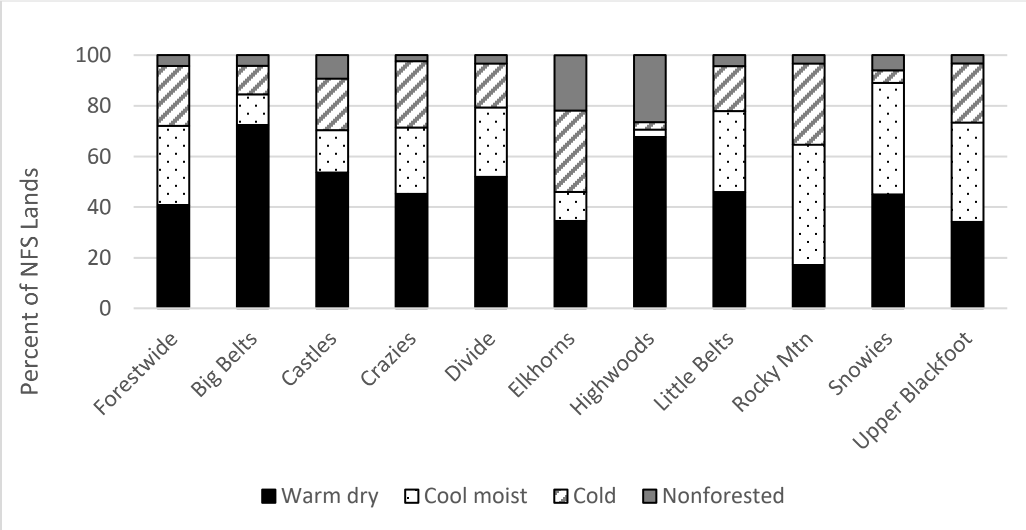

Figure 5. Percent of each broad potential vegetation type on NFS lands[1]

1. Data source: R1 Summary Database. Refer to appendix D of the draft forest plan and appendix B of the DEIS.

The warm dry broad PVT occupies the warmest and driest sites on the HLC NF that support forests. These sites support ponderosa pine and dry Douglas-fir habitat types. This group occurs at lower elevations, on warm southerly aspects, and/or on droughty soils. Forests are often dominated by Douglas-fir, ponderosa pine, or limber pine. Open forest savannas may occur on this group, where grasses or shrubs are dominant and trees are widely scattered due to repeated frequent fires.

The cool moist group comprises the most productive forest sites on the HLC NF. Moist Douglas-fir habitat types are in this group, along with lower subalpine fir and spruce habitat types. This setting occurs on mid to high elevation sites across all aspects. Lodgepole pine and Douglas-fir are the most common dominant species, with Engelmann spruce and subalpine fir common as well.

The cold broad PVT occupies the highest elevation areas that support forests. Some sites are cold, moist subalpine fir habitat types that support moderately dense forest cover. Remaining areas are cold, drier subalpine fir and whitebark pine types where growing conditions are harsher and tree density more open. Subalpine fir, Engelmann spruce, and whitebark pine are the most common species.

Nonforest broad PVTs consist of the persistent non-forested vegetation climax types. They occur on sites where establishment and growth of conifers is impeded, for example in areas of shallow or very droughty soils; very wet soils and high water tables; or very frequent disturbance. Persistent nonforested areas include alpine meadows, dry grasslands and shrublands, mesic grasslands and shrublands, and riparian areas. There are also areas on the forest that are non-vegetated, where very sparse or no vegetation grows, such as scree or barren areas. These are excluded from the analysis.

Ecosystem processes and disturbances

Vegetation is not static; it is constantly changing across space and time due to drivers such as climate, succession, fire, insects and diseases. The complex interactions between these processes over past centuries resulted in the vegetation that currently exists, and will influence changes into the future. Since the late 1990’s, national disturbance rates have been influenced primarily by natural disturbances (rather than anthropogenic ones), and increasing rates for forest decline have been concentrated in the western U.S. where extended droughts have coupled with increasingly high temperatures to create increasingly stressed and vulnerable forests (Cohen et al., 2016).

Climate

Climate strongly influences vegetation and ecosystem processes. Temperature and moisture patterns dictate what plants are able to establish and grow on a site, and influence factors such as growth rates and density. Drought can alter vegetation directly by killing plants, or indirectly, by increasing the frequency and/or severity of disturbances or rendering forests more susceptible to insect and disease. Over geologic time, changes in climate are natural; even so, as a consequence of climate change, forests may face rapid alterations in the timing, intensity, frequency, and extent of disturbances (Dale et al., 2001).

Considerable natural variation in climate has occurred historically. Future climate projections suggest that temperature increases will exceed the historical variation for average monthly maximum temperature. Specific changes in ecosystem components due to expected climate change are difficult to predict, and are highly uncertain, especially in the diverse terrain of the northern Rocky Mountain region.

In the western U.S., it is likely that water balance and disturbance dynamics will be more important than actual increased temperature in affecting vegetation. Longer, warmer growing seasons may increase growth rates; however, greater soil water deficits and increased evapotranspiration in the summer may offset this and increase plant stress. Growing sites on the HLC NF are generally moisture-limited as opposed to energy-limited. That is, there is plenty of sunlight, but growth is limited by moisture. Therefore, warm/dry climatic periods generally result in slower growth and decrease the ability of a site to support vegetation compared to cool/moist periods. Competition-based mortality increases during dry periods. Stress can also lead to higher mortality rates indirectly through susceptibility to insects or disease. Increasing soil water deficits can cause eventual shifts in species presence across the landscape as they become less able to regenerate or survive. Species located on sites at the margin of their optimal range would be most vulnerable. Species extent and distribution would be consequently impacted.

Climate changes are also expected to affect disturbances. There is a high degree of uncertainty associated with extrapolation of these effects to local sites. Persistent and recurring drought combined with high temperatures may give rise to “megadisturbances” in some areas that may cause tree mortality of a spatial extent, severity, and frequency surpassing that recorded during recent human history (Millar & Stephenson, 2015). Studies of potential effects of climate change on fire and insect/disease suggest the following may occur across the western U.S. (Halofsky et al., in press-b):

- Longer fire seasons, more days of high fire danger, increased frequency of ignitions, more frequent large fires, more episodes of extreme fire behavior, and increased average annual area burned.
- Given availability and spatial distribution of host species, there may be elevated levels of native insects and disease. Predicted increases in temperature and drought will probably serve to increase pathogen populations in the future because they are able to migrate to new environments at a faster rate than trees.

Vegetative succession

Vegetative succession is the sequential process of long-term plant community development. It entails the change in the composition, structure and function of plant communities over time, and is based on the concept that every plant species has a particular set of environmental conditions under which it will reproduce and grow.

The classical model of succession culminates in the climax community, a state of relative stability in composition, structure and function, with all existing species able to perpetuate themselves without disturbance. In disturbance-prone ecosystems (such as the HLC NF) the climax state may rarely be achieved because succession is interrupted by disturbances such as wildfire.

Successional pathways are complex and the rate of change can be variable; simplification of the process is necessary for analysis. The evaluation of forest size classes provide the means to evaluate successional change of forests over time. The early successional stage is characterized by the seedling/sapling size class. As trees grow, they transition from smaller size classes into larger size classes. Mid-successional forests are associated primarily with the small and medium forest size classes, but in some cases forests in the large size class are also mid-successional, depending on tree ages and species. Late successional forests are associated mainly with the large and very large forest size class.

Wildfire

Fire is a primary ecological process that has created, maintained, and renewed vegetation on the HLC NF. Table 42 briefly describes the effects of fire on the vegetation of the HLC NF based on fire regimes(Hann et al., 2008)(Hann et al., 2008).

Table 42. Fire severity effects on vegetation of the HLC NF (adapted from Hann et al., 2008)

Fire Regime	Severity, Frequency, and Vegetation Type	Fire effects on vegetation of the HLC NF
I	Low severity, 0-35 years, ponderosa pine and dry-site Douglas-fir	Open forest, woodland, shrub and savanna structures are maintained by frequent non-lethal fire. This regime also includes mixed severity fire that creates a mosaic of age classes. Low severity fires result in minimal overstory mortality (<25% of dominant overstory) and small patch size. The forests in this regime were often dominated by ponderosa pine or Douglas-fir; fire maintained these species and promoted open, often uneven-aged, structures. These species reforest gaps created by fire through the survival of fire-resistant seed bearing trees. These fires also maintained open, dry forest savannas and a shifting distribution of dry limber pine/juniper ecotone communities.
II	Stand-replacing, 0-35 years, Drier grasslands and cool-site sagebrush	Shrub or grasslands are maintained or cycled by frequent fire; fire typically removes nonsprouting shrubs, tops of sprouting shrubs and most tree regeneration. These fires are important in vegetation communities such as big mountain sagebrush.
III	Nonlethal and mixed severity, 35-100+ years, Interior dry-site shrub communities; moist-site Douglas-fir and lodgepole pine	A mosaic of ages, early to mid-seral forest stages, and shrub and herb dominated patches is maintained by infrequent fire. Mixed severity fires kill a moderate amount of the overstory, burning with a mosaic of severities but replacing <75% of the overstory. Highly variable patch sizes are created, with an irregular pattern with an abundant amount of edge. Fire tolerant species often survived fire, with large, old trees becoming prominent overstory components. These fires also resulted in unburned patches that could develop climax conditions dominated by shade tolerant species.
IV	Stand-replacing, high intensity, 35-100+ years, lodgepole pine	Large patches of similar aged forests are cycled by infrequent fire. Stand replacing fires kill most trees (>75%) over a large area. Lodgepole pine regenerates large areas by storing serotinous cones that open under intense heat. Mature lodgepole pine stands on the HLC NF generally exhibit a high degree of serotiny. Fire return intervals are generally long; however, shorter intervals also occur and forests may re-burn after dead trees have fallen. Lodgepole pine produces open cones at a young age to re-seed re-burned or understocked patches. Serotiny in fire-prone ecosystems is typically expressed from 30-60 years of age to ensure that seed is available after the next stand-replacing event.
V	Stand replacing, high intensity, 200+ years, boreal forest and high elevation conifer forest	Variable size patches of shrub and herb dominated structures, or early to mid to late seral forest occur depending on the biophysical environment and are cycled by rare fire events. These forests often have complex structures influenced by small gap disturbances and understory regeneration. Fires may result in the regeneration of lodgepole pine but also provide suitable sites for the establishment of whitebark pine at the highest elevations. Many sites become dominated by subalpine fir at the later stages of succession.

For much of the last century, wildfire area burned diminished relative to the historic condition. This was due to fire exclusion, forest management, and climate (Hessburg & Agee, 2003; Hessburg, Agee, &

Franklin, 2005; Westerling, Hidalgo, Cayan, & Swetnam, 2006). Roads, railroads, grazing, urbanization, agriculture, and rural settlement all influenced fire exclusion (Hessburg et al., 2005). Since 1940 most GAs on the HLC NF had a fraction of their area burn in any given decade. The consequences of this departure included:

- Fire in many dry forests shifted from low-intensity, high frequency to less frequent, moderate and high-severity, with increases in uncharacteristic large-scale stand-replacing fires (Lehmkuhl et al., 2007). Fires of higher intensity can kill fire-resistant seed bearing trees, thus disrupting the ability of these forests to regenerate.
- In higher elevation moist forests, changes to the natural regime were less pronounced. However, at the landscape scale, fire suppression in lodgepole pine may induce mosaic homogeneity in forests that previously contained a heterogeneous mix of age classes (Barrett, 1993; U.S. Department of Agriculture, Forest Service, Northern Region, 1990). In these areas fire suppression had the effect of decreasing acreage burned in normal fire seasons and reducing the variability in landscape patterns.
- Mixed severity fire regimes experienced changes described for both low and high severity regimes. Fire exclusion reduced stand- and landscape diversity in subalpine forests so that vegetation aged more uniformly and become less diverse, resulting in stand replacing fires that regenerate extensive areas that were mosaics historically (Barrett, Arno, & Menakis, 1997).
- Fire regimes in nonforested areas changed in large part due to conifer encroachment that has resulted from fire exclusion, grazing, and climate (Heyerdahl, Miller, & Parsons, 2006). The mosaic of sagebrush-grasslands with stable islands of Douglas-fir savanna that dominated by the past have been replaced by Douglas-fir forest in some areas (ibid).

On the HLC NF, increasingly large fires have been occurring since 1980. The increase may be due to: 1) fuel buildup in low severity regimes; 2) the influence of a warm/dry climate on vegetation, fire behavior, and effectiveness of suppression; and 3) fire policies that have allowed natural fires to burn in some areas. The increase in acres burned is consistent with the Regional climate shift (Marlon et al., 2012), and a trend of acres burned occurring throughout the West. Several GAs have had recent periods within the NRV for acres burned (Elkhorns, Rocky Mountain Range, and Upper Blackfoot).

Forest insects and diseases

There are many insects and diseases that affect forest vegetation. Most are native and usually exist at low population levels. Some insects can cause dramatic effects; but, more often, changes occur gradually. Insects and diseases that currently have the most notable impacts on the HLC NF are discussed here.

Bark beetles

The two primary bark beetles native to the HLC NF are the mountain pine beetle and the Douglas-fir beetle. Beetle populations may be favored by warm temperatures due to increased survival of beetles and increased stress of host species. Future bark beetle-caused mortality will depend not only on the spatial distribution of host trees, but also the ability of beetle populations to adapt to changing conditions. Beetle outbreaks can lead to changes in fire behavior (Jenkins, Hebertson, Page, & Jorgensen, 2008); Hansen et al 2015). The changes to fire behavior vary in post-outbreak stands depending upon when they occur; the net result is a substantial change in species composition and a highly altered fuels complex.

The NRV analysis compared the average acres infested per decade with recent acres infested from 2000-2009. Mountain pine beetle infestation was well above the natural range, while Douglas-fir beetle was at the lower end. Insect events are expected to be cyclic in nature with a wide range of variability. Severe bark beetle activity was at the high end of the natural range during warm and dry periods.

Mountain pine beetle hazard ratings are indicators of potential future beetle activity. Hazard represents the likelihood of an outbreak occurring in a specific time period and is a function of forest conditions.

Elevation, age, size and proportion/density of host pine species are factors used in the hazard rating; separate ratings are generated for lodgepole pine versus ponderosa pine (Randall & Bush, 2010). Although whitebark pine and limber pine may also be affected, no hazard rating is available.

Relatively few areas have hazard to mountain pine beetle in ponderosa pine because of the limited extent of this species. However, where ponderosa pine is present and hazards exists, most are at a moderate level, primarily in the warm dry broad potential vegetation group. Moderate and high hazard areas exist on the greatest proportions of the Big Belts, Little Belts, and Snowies GAs. Of particular interest are the ponderosa pine forests in the Snowies, which were largely untouched by the recent outbreak. Ponderosa pine forests on most other areas were impacted by the outbreak, and are at a lower hazard today as a result. The infestation was patchy in ponderosa pine, and scattered individuals and groups of susceptible trees survived.

Lodgepole pine forests are extensive on the HLC NF, and most have moderate to high hazard, particularly in the cool moist broad potential vegetation group. This is in part due to lodgepole on the east side of the forest sustaining light infestation during the recent outbreak. However, many areas especially on the west side of the forest were impacted by the outbreak and have a lower hazard today because many host trees were killed. The areas that sustained high mortality in the recent outbreak, such as the Divide, Big Belts, and Upper Blackfoot, now have small percentages of moderate or high hazard. It will be decades before these forests develop susceptible conditions. Conversely, GAs that still support extensive areas of mature pine, such as the Castles, Highwoods, and Little Belts have more moderate to high hazard.

In the short term, large-scale mountain pine beetle outbreaks are likely to be limited until lodgepole pine forests re-establish and mature. Some GAs, however, do contain potential for mountain pine beetle outbreaks in the short term, most notably the Snowies, Castles, Highwoods, and Little Belts.

The hazard, or likelihood of a Douglas-fir beetle infestation developing, is based on the average diameter of Douglas-fir trees, stand basal area, and percent composition of Douglas-fir (Randall & Bush, 2010). Where susceptible Douglas-fir are available, the hazard is primarily low and moderate. This may indicate a limited potential for a large scale outbreak; however, localized outbreaks are possible especially where disturbances cause elevated risk, and may impact high value stands such as old growth. The Highwoods GA in particular has a high proportion of its area at high hazard. Some amount of moderate to high hazard is present in most GAs based on the extent of mature Douglas-fir. This along with warm/dry climate and the stress caused by western spruce budworm give Douglas-fir beetle the potential to impact forests.

Western spruce budworm

Western spruce budworm is a native defoliator that historically has caused widespread damage on dry forests east of the Continental Divide. Defoliation has been widespread on the HLC NF over the last decade due to warm, dry climate and the availability of dense, layered forests of host species. In several areas, defoliation caused extensive mortality of mature trees, which is not typical of this insect. This was partly a result of the ongoing below-average precipitation and above-average temperatures (Kegley & Sturdevant, 2006). Budworm activity has varied in recent years due to wet springs and summers, but overall infestation remains at elevated levels at the writing of this report. The NRV analysis showed that acres infested from 2000-2009 were well above the NRV.

The hazard rating for defoliators is based upon basal area, percent composition of susceptible species, and trees per acre; high hazard stands are those in which a large amount of Douglas-fir and true fir defoliation is expected once an outbreak occurs (Randall & Bush, 2010). About three-quarters of the plan area contains hosts susceptible, and on these sites there is a fairly even distribution of high, moderate, and low hazard conditions. Due to the widespread distribution of Douglas-fir and dense stand conditions, defoliator hazard is prevalent on all GAs. The Crazies and Highwoods GAs contains the least hazard.

Root disease

Root diseases are caused by fungi that spread from the roots of diseased trees. The most common root pathogens known to occur on the HLC NF include armillaria root disease and schweinitzii root and butt rot. Douglas-fir and subalpine fir are the most susceptible species. At high infection levels, or over time, root diseases can kill trees. Other stressors such as bark beetles, secondary beetles, drought, or windthrow often contribute to mortality. In most cases root diseases kill trees gradually. Once established on a site, root disease can be essentially permanent, living for decades in roots and stumps (Hagle, 2006). To the best of our knowledge, the current level of root disease is within the NRV. Root disease is not especially prevalent on the HLC NF due to the relatively dry environment east of the Continental Divide. It is most commonly found within the cool moist broad potential vegetation group.

White pine blister rust

White pine blister rust is a non-native disease that entered the U.S. at the turn of the 20th century. Its primary host species on the HLC NF are whitebark pine and limber pine. As blister rust has moved into fragile, high-elevation ecosystems, successional pathways have been altered, hastening the conversion to climax species such as subalpine fir. Blister rust infections are expressed by cankers that progress from girdling branches to the boles of trees, killing them over time. The interaction of warming climates, mountain pine beetle, fire exclusion, and blister rust has resulted in a bleak outlook for whitebark pine in particular. Because it is non-native, all levels of blister rust infection are outside the NRV. There is no known method for eradicating the disease. A small percentage of host trees display one or more resistance traits that enable them to avoid or survive infection; encouraging regeneration from these seed sources provides hope for perpetuation of the species. White pine blister rust is generally present wherever five-needled pines are found on the HLC NF.

Vegetation treatments

In addition to natural ecosystem processes, human interventions change vegetation. Two broad categories of vegetation treatment are evaluated: timber harvest (which includes even-aged regeneration harvest, uneven-aged harvest, and intermediate harvest) prescribed fire and fuel reduction. Table 43 shows the acres of treatments conducted by decade since 1980, during the life of the current forest plans.

Table 43. Acres of vegetation treatments by decade, 1980-2017[4]

Decade	Harvest[1]	Prescribed Fire[2]	Fuel Reduction[3]
1980-1989	23,525	32,211	44,387
1990-1999	30,775	51,460	95,418
2000-2009	10,680	51,826	52,473
2010-2017	9,564	23,964	65,010

1. Harvest activities include even-aged, uneven-aged, and intermediate treatments.
2. Includes overlap of burning in harvested stands. Prescribed fire activities include broadcast burning, jackpot burning, site preparation burning, and underburning.
3. Fuel reduction treatments include burning of piled material, chipping of fuels, compacting/crushing of fuels, fuel break, miscellaneous treatment of natural fuels, piling of fuels, rearrangement of fuels, and thinning for hazardous fuels reduction.
4. Source: FACTS database, acres completed by fiscal year, up to April of 2017.

Salvage harvest

The term *salvage* indicates that trees being removed were killed by natural disturbance, most commonly wildfire or insects, and that one purpose of the treatment is to capture their economic value. Salvage typically only occurs on lands suitable for timber production. Salvage is not modeled as a vegetation treatment as part of the potential forest management solution, because it is unpredictable and would not contribute to estimated timber outputs as defined in the planning directives. In practice, the term salvage is only used when the treatment is intermediate in nature; that is, a fully stocked stand remains in place after the cutting. In the case of stand-replacing disturbance, salvage results in an even-aged regeneration silvicultural system, and is termed as such (i.e., clearcut, seed tree, or shelterwood harvest). Acres of “salvage”, both intermediate salvage and regeneration harvest, are included in the acres of harvest listed in Table 43. Salvage has occurred on approximately 2% of the wildfire acres burned since 1986.

Vegetation composition

The coarse filter for vegetation composition is portrayed by two indicators: cover types (forested and nonforested) and tree species distribution. Desired conditions are enumerated in the draft revised forest plan (alternatives B/C, D, and E). These desired conditions would not necessarily apply to alternative A, but are included in the analysis for all alternatives to provide for a consistent comparison.

Cover types are groupings of dominance types which are used to simplify analysis for the broad scale. There are eight coniferous cover types on the HLC NF and four nonforested cover types, which are described in detail in appendix D of the draft revised forest plan. Due to data limitations, all nonforested cover types are lumped together in the quantitative analysis. The western larch mixed conifer cover type is only present in the Upper Blackfoot GA (in negligible amounts) and is excluded from forestwide estimates. The cover types on the HLC NF include:

- Grass
- Dry shrub
- Riparian grass/shrub
- Mesic shrub
- Ponderosa pine
- Dry Douglas-fir
- Mixed mesic conifer
- Western larch mixed conifer
- Lodgepole pine
- Aspen/hardwood
- Spruce/fit
- Whitebark pine

Tree species presence indicates the proportion of an area where there is at least one live tree per acre of a given species. This measure gives an indication of how widely distributed the species is, although it is not necessarily dominant or even common in all the places it occurs. There are 11 native tree species found on the HLC NF: Rocky mountain juniper, limber pine, ponderosa pine, Douglas-fir, lodgepole pine, western larch, aspen, cottonwood, Engelmann spruce, subalpine fir, and whitebark pine.

Aspen, ponderosa pine, and whitebark pine cover types as well as individual species tend to be below the desired range, while Douglas-fir tends to be above the desired range. The warm dry broad potential vegetation group is the most departed from desired conditions for composition. The following sections provide a summary of the ecological role of each tree species and non-forested vegetation type on the HLC NF. Xeric ecotones and savannas, areas which straddle the concept of forested and nonforested PVTs, are also addressed.

Rocky mountain juniper

Rocky mountain juniper is a common component of xeric ecotones and dry forests. It is an important component of wildlife habitat. It also contributes to fire risk by functioning as a ladder fuel under forest canopies and can encroach into nonforested plant communities, where it would be killed by fire periodically under natural disturbance regimes. Although juniper dominance types are included in the ponderosa pine cover type, they are uncommon. While the NRV analysis estimated that juniper abundance is generally within the natural range, maintenance at the low end of the range is appropriate because this species tends to decline during the warm/dry periods, in favor of nonforested species promoted by fire. This species is essentially absent from the Crazies and Highwoods GAs, and in the other areas is present on small proportions of the landscape. Juniper is most prevalent in the Big Belts, and is notably above the NRV in that GA.

Limber pine

Limber pine is a relatively long-lived five-needled pine which grows primarily east of the Continental Divide. It is a key species on xeric ecotones and rocky areas as well as in alpine communities, and on the HLC NF its presence is often correlated to limestone substrates. On the HLC NF, it grows in association with whitebark pine in some places. Lower treeline limber pine woodlands serve as ecotones between sage/grass and forest/woodlands biomes; their expansion and contraction is due to relationships between vegetation, climate, and wildfire. On more mesic sites, mixed to high severity fires probably occurred much like the fire histories of whitebark pine; however, lower treeline limber pine woodlands are thought to have a more frequent disturbance regime. Limber pine is most prevalent in the warm dry broad potential vegetation group. Forestwide the distribution is within the desired range, but it is below the desired range in the warm dry broad potential vegetation group. By GA, it is generally at the low end or below the desired range except for the Snowies and Little Belts. Limber pine is present in all GAs, but does not feature prominently in the Elkhorns, Divide, or Highwoods. It is particularly abundant in the Little Belts and Snowies.

Aspen and Cottonwood

Persistent hardwood-dominated plant communities are rare but important on the HLC NF. Aspen is more common than cottonwood, which is confined to riparian areas with fluctuating water tables and is more common on the private lands outside of the forest boundary. It is desirable to maintain and promote cottonwood where it exists. Aspen may occur as a persistent community in riparian areas or as a transitional community in upland areas. These communities often dominate in the early stages of forest succession immediately after disturbance. Aspen historically relied on fire or disease to remove the overstory, kill encroaching conifers, and stimulate suckers from the existing clone root system (Shepperd, 1990).

Forestwide, the NRV analysis indicates that the aspen/hardwood cover type is generally within its natural range for abundance, although it is at the low end or slightly below its natural range in some GAs. The modeling also showed that at the forestwide scale, and in the warm dry and cool moist broad potential vegetation groups, aspen species distribution is below its natural abundance. At the GA level, aspen is below the desired condition in most GAs except the Divide, particularly in the Big Belts. The Divide and Rocky Mountain Range contain more aspen than the other GAs. The desired condition ranges reflect a desired trend of maintaining and increasing aspen. The highest levels of aspen correlated with past warm/dry climate periods.

Ponderosa pine

Ponderosa pine is a long-lived, windfirm early successional tree that most often occurs in the warm dry broad potential vegetation group. This species often grows in association with Douglas-fir, limber pine and/or juniper. On the driest sites, it may grow at very open densities and be present in the ecotone between forested and nonforested vegetation. As the most drought and fire tolerant species on the HLC NF, ponderosa pine is capable of surviving low to moderate severity fire even at a young age, and can regenerate on bare soils with high temperatures. As a large tree, it provides important wildlife nesting/feeding habitat, both when live and dead. Compared to associate species such as Douglas-fir, it is less vulnerable to root disease and other pathogens. It is shade intolerant and without disturbance to open the forest canopy, it is gradually replaced by Douglas-fir on most sites.

Ponderosa pine does not occur or is very limited in several GAs including the Rocky Mountain Range, Highwoods, and Crazies. The Little Snowies mountain range within the Snowies GA supports a ponderosa pine dominated community which is unique from other areas on the forest. Ponderosa pine also features prominently in the northern part of the Elkhorns and southern part of the Divide GAs. Ponderosa pine communities are also present in the Upper Blackfoot, Little Belts, and Big Belts GAs. The distribution and structure of ponderosa pine has been affected by fire exclusion and mountain pine beetle particularly in the Elkhorns and Divide GAs.

The NRV analysis indicates that the ponderosa cover type and species distribution is well below its natural range across most landscapes, except the Snowies. In GAs that have little to no existing ponderosa pine, the species could only be promoted through planting.

Douglas-fir

Douglas-fir is one of the most common species on the HLC NF due to the wide range of site and forest conditions under which it is able to compete. It is of high economic value for wood products. It is fairly tolerant of drought, moderately tolerant of shade, and capable of establishing and persisting in the dense forest conditions. Older, larger Douglas-fir are tolerant of fire. Trees can live for many centuries and grow to large diameters which provide wildlife habitat. Douglas-fir is one of the most susceptible conifer species to damage from insect and diseases.

Forestwide, the NRV analysis showed that Douglas-fir dominated cover types (dry Douglas-fir and mixed mesic conifer) are at the high end or above their natural ranges of abundance, as is the species distribution; the desired condition ranges indicate a desired decrease especially on the cool moist broad potential vegetation group. This trend holds true for many, but not all GAs; the Big Belts and Highwoods are below or at the lower bound of the desired range. Douglas-fir may be promoted with future drought on moist sites where it tolerates drought better than lodgepole pine, spruce, or subalpine fir, but conversely may retract on the dry sites where it competes with ponderosa pine. Douglas-fir abundance was at the lowest end of its NRV during warm and dry climate periods; therefore, in the future a presence at the low end of the range may be appropriate.

Western larch

On the HLC NF, western larch is only found in the Upper Blackfoot GA at the eastern end of its natural distribution. It grows primarily on the cool moist broad PVT. Western larch is of high value for its contribution to species diversity, forest structure, and ecosystem resilience. It has high resistance to many forest insects and pathogens. It is well adapted to surviving and regenerating under mixed and high severity fire regimes. It is very intolerant of shade. Western larch may live for several centuries and grow to very large diameter which provide wildlife habitat, both when live and dead. In the Upper Blackfoot GA, western larch is currently present on about 1% of the area. It is desirable to maintain and promote this species within its natural range as a rare but important component of diversity.

Lodgepole pine

Lodgepole pine is one of the most common tree species on the HLC NF, capable of growing under a wide range of conditions. It is shade intolerant and short lived compared to other conifers. Lodgepole is thin-barked and easily killed by fire, and it is also subject to mountain pine beetle once it reaches maturity. In fire-prone ecosystems such as the HLC NF, lodgepole pine has adapted by producing open cones at a very young age to re-seed re-burned or understocked patches, and then producing serotinous cones by the middle stages of development to ensure that seed is available after the next stand-replacing event. Nearly pure lodgepole stands are common across the landscape.

Forestwide, the NRV analysis indicated that the abundance of the lodgepole pine cover type is generally within or slightly below the natural range across the landscape, and specifically below the desired range in the cool moist broad potential vegetation group. This trend does not hold true for all GAs; in the

Crazies GA the lodgepole pine cover type is well below the natural range of abundance, whereas the Divide and Highwoods are above the range. Tree species distribution of lodgepole shows that it is a major component of most landscapes. In some GAs lodgepole pine is more extensive than it was historically (most notably the Castles, Divide, and Highwoods).

Subalpine fir and Engelmann spruce

Subalpine fir is common on high elevation moist sites across the HLC NF. Engelmann spruce is more limited, confined to riparian areas and moist sites. They fulfill similar ecological roles and often coexist. Both are very shade tolerant, and commonly most abundant in mid and understory canopy layers. These species are intolerant of drought and fire, with shallow roots, thin bark, and crowns that extend to the ground. Though they may regenerate into opening created by fire, they have slow growth rates. Their shade tolerance allows them to persist indefinitely and eventually, over time, they will dominate the site unless there is a stand-replacing disturbance. Spruce/fir forests provide valuable wildlife habitat, such as snowshoe hare and lynx habitat. They are also important components of riparian areas and other areas that are protected from disturbance. Forests dominated by subalpine fir and spruce tend to support high severity fires, due to the low fire tolerance, high tree densities, multiple canopy layers, and greater litter depths and fuel loads. These forests are susceptible to damage from insects and diseases as well.

The current amount of subalpine fir/spruce correlates to lack of fire and advancing succession. Maintenance of this cover type is desired within lynx habitat, generally on the cool moist broad potential vegetation group. In the cold broad potential vegetation group, however, the amount of subalpine fir and spruce represents a tradeoff with whitebark pine. The NRV analysis indicated that it the spruce/fir cover type is above its natural range of abundance in most GAs.

Whitebark pine

Whitebark pine is a candidate species for listing under the Threatened and ESA (see the Plants at Risk section). It is a five-needled pine that is a key ecosystem component at the highest forested elevations in cold, windy, snowy, and moist climatic zones (Arno & Hoff, 1989) that are difficult areas for plants and animals to inhabit. It usually occurs in association with subalpine fir, spruce, and sometimes lodgepole pine and limber pine on the HLC NF. As the most fire resistant and long lived species in these forests, it plays an important role in the stability of high elevation ecosystems and the quality of wildlife habitat. Its tolerance to cold, superior hardiness on harsh microsites, unique method of seed dispersal, and resistance to lower intensity fires allows it to compete successfully in the upper subalpine zone. On productive upper subalpine sites, whitebark is a seral species that is eventually replaced by more shade tolerant species; but in harsh upper subalpine forests and at treeline it can dominate as climax vegetation (Keane et al., 2012).

Whitebark pine primarily occurs on the cold broad potential vegetation group. Whitebark pine is present on all GAs except the Highwoods. Whitebark pine presence is below desired conditions. Whitebark pine tended to be at the higher end of its NRV during the warm/dry modeled climate periods. Future climates and disturbances may promote the whitebark pine cover type on the coldest, driest sites where it is hardier than other species, but the success of whitebark pine will also depend on interactions with white pine blister rust and restoration efforts.

Nonforested Vegetation

Persistent nonforested plant communities are widespread on many of the GAs on the HLC NF. These communities are maintained by site conditions that preclude establishment of trees, or by frequent disturbances such as fire. The most common communities found on the HLC NF are grasslands and shrublands, but wetlands, riparian areas, and alpine communities are also present. In some places, grass/forb/shrub communities occur as a transitional type in the earliest stages of forest succession.

The island mountain ranges of the HLC NF are separated by prairies; the degree to which prairie communities extend onto NFS lands varies by GA. On private valley-bottom lands adjacent to the forest, the trend has been to convert native grasslands to crop lands, rangelands for grazing, and developed lands, leading to the disruption of processes, such as fire, that played a role in maintaining them. Connectivity of grassland/herbaceous ecosystems has also been affected by development at these at lower elevations.

Nonforested vegetation communities have shifted in extent, composition, and structure, but are less explicitly represented and modeled with available data than forested types. Nonforested cover types have declined relative to the historical condition, including declines in acres of fescue, bunchgrass, sagebrush, and native forb cover types, largely attributable to agricultural development but also encroachment of woodland types such as juniper and exotic weeds (USDA 2003b). Grazing and associated reduction in fire frequency (due to the loss of fine fuels) are the primary causes of woodland expansion although climate change is also suggested as a contributing factor (Hessburg & Agee, 2003). Fire exclusion and drought have allowed conifers and/or sagebrush to invade grasslands, and altered the mosaic of conifer savannah and sagebrush steppe (Barrett 1997; (Heyerdahl et al., 2006). Invasive plants also are a primary threat to grass/forb/shrub communities. Historical and current grazing practices have contributed to shifts to nonnative species in these types, to an unquantified degree. For example, rough fescue is highly palatable throughout the grazing season. This type has been replaced by native oatgrass under moderate or heavy grazing pressure in some areas; and long-term heavy grazing on moister sites has resulted shifts to a nonnative Kentucky bluegrass/timothy/smooth brome type. High elevation grassland/herbaceous types are less likely to be substantially altered from historic conditions because factors such as grazing, agricultural development, and invasive plants are less common due to inaccessibility.

The desired condition ranges indicate the need to maintain or increase the abundance of nonforested cover types collectively on most GAs. This increase would primarily occur in the grassland or shrubland types, although the maintenance of healthy riparian, wetland, and alpine areas is also important. The desired condition includes maintaining the dominance of nonforested plant communities on nonforested potential vegetation groups, as well as on some forest potential vegetation groups - primarily the driest sites found in the warm dry broad potential vegetation group. Such areas would have been maintained in a nonforested condition, or one with very sparse tree cover by frequent fire. Increased conifer expansion in some of these areas is considered to be encroachment. In several GAs (Rocky Mountain Range and Upper Blackfoot), nonforested types are slightly above the NRV and desired condition; this is primarily due to areas that have not yet reforested after recent wildfire.

Xeric and Mesic Grasslands

Slope and moisture regimes divide grasslands into two general types in the plan area. The grasslands on the more moist north and east facing slopes, or at higher elevations, are generally dominated by Idaho fescue and rough fescue. The grasslands on drier sites (e.g., lower elevation and/or southwest facing slopes) are dominated by Idaho fescue and bluebunch wheatgrass. Grasslands range in size from small patches to large open parks located on montane to foothill zones. Grasslands are typified by colder winters, shorter summers, and younger soils derived from alluvial materials. They are dominated by cool-season perennial bunchgrasses and forbs, with sparse shrub and/or tree representation. Various shrub and tree species may occur with low cover (typically less than 10%).

The desired condition of xeric grassland communities is to have high diversity of tall and medium height, cool and warm season grasses (for example, bluebunch wheatgrass, green/Columbia/western needlegrass), and short grasses (e.g., Sandberg bluegrass). There should a variety of forbs in varying amounts, and the diversity of plant species present allows for drought tolerance. Individual species can vary greatly in the amount of production depending on growing conditions. Vegetation typically should have strong and robust root systems that allow production to increase considerably with favorable growing conditions. This plant community provides for soil stability and a properly functioning hydrologic cycle. Plant litter is a common component and is available for soil building and moisture retention. Plant litter is well distributed with little movement off-site and natural plant mortality is typically low. Bare ground is present because of the warm dry nature of these sites but at low amounts.

The desired condition of mesic grassland plant communities it to have greater amounts of mesic forbs, denser cover, and more species richness. The functional plant groups are characterized by long lived, moderately deep rooted cool and warm season grass species (for example, rough fescue, Idaho fescue, blue gramma, tufted hairgrass, etc.) with a wide variety of mesic forbs present in varying amounts. Shrubs may be present with minor cover and introduced species are rare. Bare ground should typically be low (less than 3%) across most sites with litter being a common component and available for soil building and moisture retention. Plant litter movement is expected to be limited with plant litter being properly distributed and rarely moving off-site.

Mesic and Xeric Shrubland/Woodlands

Mesic shrublands are often associated with coniferous forests and occur either as large landscape patches on moister sites or in smaller patches within grasslands. Mesic shrubland plant communities are more moist and productive than xeric sites. The desired condition is for species such as mountain big sagebrush and mesic deciduous shrubs (i.e., snowberry, ninebark, serviceberry) to be the dominant over story species with graminoid species and mesic forbs typically dominating the understory. Canopy cover may vary, but should typically be moderate to high, and may result in lower cover of understory species.

Xeric shrubland plant communities occur on drier sites, and the desired condition is to support shrub species such as Wyoming big sagebrush, basin big sagebrush, low sagebrush and black sagebrush. Overstory species vary by location and site type. The understory should typically be dominated by graminoid species such as needle-and-thread, Sandberg bluegrass and bluebunch wheatgrass. Canopy cover varies, but should typically low to moderate. Bare ground is present in higher amounts relative to mesic shrubland sites. Xeric woodlands are typically hot and dry or are steep, with shallow, skeletal soil. The dominant overstory species varies but includes Rocky Mountain juniper and mountain mahogany. Mountain mahogany is a specific site type which occurs in much lower amounts than juniper and is restricted to steep rocky soils and rock outcrops.

The shrub species below are of particular importance in shrublands and woodlands:

- Mountain big sagebrush (*Artemisia tridentata subsp. vaseyana*) dominates much of the shrub-steppe plant community across the HLC NF. This shrub is sensitive to encroachment by conifers (Grove, Wambolt, & Frisina, 2005; Gruell, Brown, & Bushey, 1986).
- Curl-leaf mountain mahogany (*Cercocarpus ledifolius*) generally occurs on limestone or sandstone stony slopes, cliffs, and rock outcrops from valleys to montane zones across the HLC NF. It provides an important food and cover source for a variety of wildlife year-round. With more frequent high severity fires, often related to increased fine fuel loads from exotic annual grasses, populations are declining in many areas throughout its range (Hanson et al 1999).
- Antelope bitterbrush (*Purshia tridentata*) infrequently occurs on stony or sandy soil of grasslands, shrub-steppe, and open ponderosa-pine forest from valley to montane zones across the HLC NF. As a shade intolerant, nitrogen-fixing shrub, bitterbrush is an early colonizer. It competes with nonnative, invasive grasses such as cheatgrass, which are spreading rapidly. This invasion has increased fine fuel loads, causing more frequent high severity fires during which bitterbrush (a weak sprouter) is often killed.

Riparian/Wetland Vegetation

Riparian systems occur along creeks and rivers and occupy floodplains, streambanks, islands in rivers, narrow bands in steep channels, and backwater channels. Riparian vegetation should be dominated by species that tolerate periodic flooding and an associated seasonally high water table. In wide valley bottoms, the vegetation typically should be a mosaic of all lifeforms with patterns reflecting the meander patterns of the stream/river. Key tree species include aspen, cottonwood, Engelmann spruce and subalpine fir; on drier sites, Douglas fir, and Rocky Mountain juniper may be present. Dominant shrubs may include mountain alder, various species of willows, river birch, dogwood, hawthorn, chokecherry, rose, silver buffaloberry, Rocky Mountain maple and/or snowberry. A wide variety of herbaceous species including, grasses, sedges, rushes, spikerushes, bulrushes, and forbs should be present in the understory. Threats to the riparian system include heavy grazing, invasive species, drought, recreation and climate change.

Wetlands are characterized by dominant vegetation adapted to saturated soil conditions. The vegetation complex should be represented by a mosaic of herbaceous and woody plant communities that provide excellent erosion control. Low willow species, bog birch and bog blueberry are often the representative woody species in a wetland system. Herbaceous species may be dominated by cattails, sedges, rushes, spikerushes or bulrushes. Bryophytes, including sphagnum, are often well represented in fens. Threats to wetlands include alteration of the original hydrology or hydric soils (i.e. diversion, draining, development, road construction, heavy grazing, etc), invasive species, and climate change.

Willows (*Salix spp*) are of particular interest in riparian and wetland plant communities because of their habitat value, limited extent, and pressures exerted by factors such as grazing and fire exclusion. Most species are shade-intolerant and those that occur along streams in narrow steep valleys will likely not persist if conifers overtop them. Browsing pressure by native and domestic ungulates can lead to loss of vigor and eventually death. Most willows germinate successfully in bare, moist, mineral substrate, i.e., stream bars. There are two main categories of willows: tall willows (up to 20 to 30 feet tall) which occur along streams in broad valley bottoms at low to mid elevations; and low willows (up to 4 feet tall) which occur in higher elevation valleys, usually associated with subalpine forests.

Alpine and rocky habitats

Alpine ecosystems occupy harsh high elevation sites, resulting in short stature and relatively slow growth for both shrubs and herbaceous species. Wetland communities are present in snowloaded depressions. Alpine ecosystems are mostly treeless, although some conifers may be present, often with a krummholz growth form. Vegetation cover should typically be low to moderate. The plant communities are dominated by a number of shrubs, forbs and graminoids.

Rocky habitats are often associated with the alpine PVT, including rock outcrops and scree. Vegetation is sparse or largely lacking. Bryophytes and lichens often occur in crevices and flourish on open rock surfaces. Rock outcrop and scree habitats may also be found at lower elevations. Rocky habitats are often fragile systems.

Xeric Ecotones and Savannas

On the HLC NF, the xeric ecotone represents the transition from nonforested xeric grass and shrub communities to dry forest communities. Scattered trees and shrubs including limber pine, ponderosa pine, Douglas-fir, Rocky Mountain juniper, sagebrush, mountain mahogany, and bitterbrush may be common. Herbaceous cover may be low due to limited soil development and dry conditions. Xeric ecotones overlap forested and nonforested PVTs. The plant communities found may shift between grass, shrub, and conifers based on climate and disturbances (mainly fire).

Savannas are a particular forest structure within xeric ecotones. Savannas are defined as communities found on either nonforested or the warm dry broad potential vegetation group which contain very open tree cover (5 to 10% canopy cover), and a dominance of grasses and/or shrubs. Historically, frequent fire would have maintained the dominance of grasses and shrubs while promoting the development of very large, widely scattered trees while limiting the establishment of small conifers. However, fire exclusion has resulted in the shift of some of these areas to more dense forests with a decrease in grass and shrub vigor. As this occurs, the large trees of the savanna become vulnerable to uncharacteristically severe wildfire or insect infestations.

It is desirable to promote the open character of forest savannahs and a dominance of grass and shrub communities in most xeric ecotones, particularly given expected future warm and dry climate conditions.

The desired extent of these plant communities is encompassed within the desired range of nonforested cover types.

Forest size class

Tree size is an indicator of the structure and age of forests across the landscape. Forest size classes are defined based on the predominant tree diameter in the stand (basal area weighted average diameter). The five size classes defined for this analysis are listed below, and are further described in appendix D of the draft revised forest plan.

- Seedling/sapling – 0 to 5 inches diameter at breast height
- Small – 5 to 8.9 inches diameter at breast height
- Medium – 9 to 14.9 inches diameter at breast height
- Large – 15 to 19.9 inches diameter at breast height
- Very large – 20 + inches diameter at breast height

The primary desired shift in size class is an increase in the large size class and a decrease in the small size class. Substantial proportions of the forest should be in the mid-successional stages of development (small to medium size classes). Many forest stands will never achieve a very large or very large size class, due to growing conditions and/or disturbances. Most GAs follow a similar trend as the forestwide ranges for the proportion of existing and desired size classes. Some, such as the Castles, have a higher proportion of the seedling/sapling tree class. Others, such as the Upper Blackfoot, have a more balanced proportion of all size classes. The large and very large tree classes are the least common classes on all GAs and are most prevalent in the Crazies, Castles, Divide, Big Belts, and Little Belts. The desired trend of size class across broad potential vegetation groups is summarized as follows:

- *Seedling/sapling:* Most GAs contain existing proportions of the seedling/sapling size class within or at the higher end of the NRV and desired condition because of recent fires and the mountain pine beetle outbreak. The most notable exception is the Highwoods, which contains essentially no seedling/sapling forests. The pattern and abundance of the seedling/sapling class is linked to stand-replacing fire regimes, and is most abundant in the cool moist broad potential vegetation group. Fire exclusion may have caused decreases in seedling/sapling forests.
- *Small:* Forestwide and in all GAs, the small tree size class is well above the NRV and desired condition, especially in the Big Belts, Castles, Divide, Little Belts, and Snowies GAs. Some of these GAs were impacted by the mountain pine beetle outbreak, which killed larger trees. High stand densities resulting from fire exclusion also contribute to the amount of the small size class.
- *Medium:* For most GAs, the existing proportion of the medium tree size class is within the NRV and desired condition. The exceptions are the Big Belts, Highwoods, and Little Belts, where the medium tree size class is more abundant than desired. Many of these forests were established following large fires and harvest at the turn of the last century. Not all of these will progress into the large size classes, such as lodgepole pine forests or densely stocked stands.
- *Large:* The large tree size class is underrepresented forestwide and in all GAs as compared to the NRV and desired condition. The disparity is especially notable in the Highwoods and Snowies, and in the warm dry broad potential vegetation group. Insect outbreaks recently killed many large trees. A lack of low-intensity disturbances has also caused a decrease in the large and very large size classes by perpetuating high densities that inhibit tree growth.
- *Very large:* Forestwide and in most GAs, the very large tree size class is rare and less abundant than in the NRV and desired condition, especially in the Snowies and Upper Blackfoot GAs. Several GAs, however, are either within or near the desired range, including the Castles and Crazies.

Large/very large tree concentrations and trees per acre

Large and very large diameter live trees, particularly long-lived fire tolerant ponderosa pine and Douglas-fir, are valuable whether they occur at low or high densities. These trees can survive low to moderate fire, contributing to the recovery of the forest after disturbance, promoting resilience, and providing long-term structural diversity. Where present in sufficient numbers they contribute to late successional forest and, in some cases, old growth. They can be of high economic value for wood products as well. They provide important wildlife habitat, both as live trees and when they die as snags and downed wood. Large trees develop where frequent disturbance maintains low density, and/or on productive sites which provide ample moisture and nutrients for individual tree growth.

The large and very large forest size classes reflect areas where large and very large trees occur in abundance. However, because forest size class is based on the basal area weighted average diameter of trees across the stand, it does not provide the full picture of the amount or distribution of all large and very large live trees. Large and very large trees may occur in forests dominated by smaller trees and therefore classified into smaller size classes. To address this, two additional indicators are considered:

- large and very large tree concentrations
- trees per acre of large and very large trees per acre across on the landscape

Large and very large tree concentrations are identified in places where large tree components are not necessarily dominant but do occur at certain minimum densities. These minimum densities are defined to reflect quantities meaningful for wildlife habitat and possible old growth. They are often referred to as subclasses of size class because they may occur in any of the five size classes. The criteria for large and very large tree concentrations on the HLC NF are displayed appendix D of the draft revised forest plan.

Figures found in appendix B display the existing and desired conditions for large and very large live tree concentrations. While the proportion of very large tree concentrations across the landscape are slightly lower than desired, the large tree concentrations are much more so, especially in the warm dry and cold broad PVTs. There are more acres with large and very large live tree concentrations present (14% and 7% respectively) than there are acres in the large and very large forest size classes (5% and 2% respectively). This is because large and very large trees are scattered irregularly across the landscape, including in stands dominated by smaller trees.

The final indicator for large and very large trees is the average trees per acre. These trees may be present as scattered individuals that are not captured in either the size class or concentration criteria. The large and very large trees on the HLC NF are most likely to be ponderosa pine or Douglas-fir, with some Engelmann spruce, subalpine fir, and whitebark pine. Figures found in appendix B display the current condition and desired large and very large trees per acre. The warm dry potential vegetation group contains the most very large trees, while the cool moist group contains the most large trees.

Forest density and vertical structure

Forest density is a measure of the area occupied by trees. The density of trees can influence tree growth and vigor; susceptibility to drought, insects and diseases, wildfires, and windthrow; and the rate of forest succession as well as other attributes such as vertical structure. These factors in turn affect whether the stand is suitable habitat for certain wildlife species. For this analysis, tree canopy cover is used as the measure of density. *Canopy cover* is the percentage of ground covered by a vertical projection of the outermost perimeter of the tree crowns, considering trees of all heights. The density classes used for the analysis are described in appendix D of the draft revised forest plan, and include the following:

- Nonforested – less than 10% canopy cover
- Low to medium – 10-39.9% canopy cover
- Medium high – 40-59.9% canopy cover

- High – 60% canopy cover

Vertical structure is categorized as single-storied (one canopy layer), two-storied (two canopy layers), or multistoried (three or more canopy layers). As with density, vertical structure is driven by succession, individual species traits, and disturbances. Some cover types, such as spruce/fir, naturally develop a continuous canopy made up of multiple layers of shade tolerant species. Other types, such as lodgepole pine, tend to grow in dense, single-storied stands. Desired conditions for forest density classes are enumerated in the draft revised forest plan, and vertical structures are addressed through narrative description.

The desired conditions indicate shifts toward decreasing forest density in general, depending on broad PVT. The NRV analysis indicated that the low/medium canopy cover class was common forestwide, especially on the warm dry broad potential vegetation group. Fire exclusion has resulted in higher canopy densities in dry cover types which would otherwise have been maintained at more open densities by frequent low intensity fire. Many forests on the cool moist sites also had low/medium density, which were likely forests in their early and mid-successional stages or older forests where disturbances removed trees and opened up the canopy. In all types, the shift toward higher densities reflects the impacts of fire exclusion and the increased abundance of shade tolerant species. Single-storied forests are more common than they were historically, while multi-storied forests are less common, especially in the warm dry and cold broad PVTs.

Most GAs follow the same trend as the forestwide averages. Some areas, such as the Big Belts and Upper Blackfoot, contain a fairly even proportion of classes. Others, such as the Castles and Snowies, have a high level of homogeneity in density class, dominated by the high tree cover class.

Landscape pattern: early successional forest openings

The spatial pattern of vegetation can affect ecological processes, including wildlife and plant habitat and dispersal; disturbance risk, spread and size; reforestation; watershed health; carbon storage; wildlife habitat quality; and aesthetic values. Connectivity can be affected by natural factors such as topography, soils, variation in precipitation, and wildfire but also by human developments and activities. It is also one of the most complex attributes of ecosystems to quantify. The goal of assessing connectivity and pattern is to better understand the mosaic of conditions that make up a resilient landscape.

Heterogeneity is the quality of consisting of dissimilar elements, as with mixed habitats or cover types occurring on a landscape (Turner, Gardner, & O'Neill, 2001). The ecological, social, and economic values that forests provide are heavily influenced by spatial patterns on the landscape (Turner, Donato, & Romme, 2012). Connectivity and pattern also influence the genetic flow of plant material, which has implications for the adaptability of vegetation. Seed dispersal strategies will depend on spatial heterogeneity and the suitability of future site conditions. Generally a resilient landscape is made up of a mosaic of age classes, composition, and successional stages because this ensures that not all areas are equally susceptible to the same drivers, such as wildfire and insects, at the same time.

It is impossible to effectively model and analyze all of the possible metrics of landscape pattern, or to capture all of those that would be meaningful for the variety of wildlife species in the plan area. The abundance, average, and range of sizes of *early successional forest patches* (transitional and seedling/sapling size classes) have been identified as the key ecosystem characteristics to represent landscape pattern because this condition is quantifiable, represents likely patterns of older forests, and is meaningful for many species. Openings in the forest are created after a stand-replacing disturbance, and are the most distinct and easily detectable structural conditions in a forested landscape because they are dominated by grass, forbs, shrubs, and short trees. They are meaningful to many wildlife species because of their distinctive composition and openness which affects the growth and survival of plants that wildlife depend on, and strong contrast to adjacent mid or late successional forest (e.g.“edge”). They also represent the initiation point in forest development, the foundation upon which rests the pattern of the future forest.

The NRV represents the desired condition. The existing condition of patch sizes is within this range, forestwide and in each broad potential vegetation group. Fragmentation and small patch size may be an issue in some areas, at smaller scales. Early successional patches in the warm dry and cold broad potential vegetation groups are smaller than in cool moist, due to a more frequent low severity disturbance regime which causes a complex mosaic of within-stand structures including small patches and canopy openings. Patches in the cool moist broad potential vegetation group tend to be larger, due to a preponderance of lodgepole pine and infrequent, high severity disturbances. The largest patch sizes are correlated with warm/dry climate periods.

Benefits to people

Terrestrial vegetation contribute directly to several multiple uses and key ecosystem services identified for the HLC NF, including timber products, forest products, and wood for fuel. The vegetation on the landscape also provides the ecological basis for other more intrinsic services, such as water quality and quantity, clean air, outdoor recreation, scenery, fish and wildlife, carbon sequestration, flood control, and erosion control.

3.8.6 Environmental consequences

The following sections describe expected trends for terrestrial vegetation indicators over a 50-year period. See appendix B for charts and detailed modeling results.

Effects common to all alternatives

Warm and dry climate, vegetative succession, wildfires, and insect and disease activity would be the primary shapers of vegetation under all alternatives. While planned treatments could vary by alternative and alter the probability and/or effects of some drivers, these processes will remain dominant. Recent studies have indicated that climate and drought coupled with natural disturbances have the potential to impact ecosystems much more so than human interventions, but that management within that context may be important to reduce the potential for forest decline and/or ease transitions into new, more resilient states (Cohen et al., 2016; Golladay et al., 2016; Millar & Stephenson, 2015) Halofsky & Peterson 2016).

Under all alternatives, vegetation characteristics will influence, and be influenced by, spatial heterogeneity of landscapes and interrelated drivers such as wildfires, climate, and insects. Fire suppression will continue to alter successional processes, although vegetation treatments may mitigate this influence somewhat. Fire exclusion would favor shade-tolerant species, small to medium size classes, and denser forests. Conversely, large fires will influence vegetation in a variety of ways such as reducing density, returning sites to an early successional stage, promoting large tree growth, and/or favoring fire tolerant species depending on the severity of fire. Warmer, drier climates will influence species distributions and successional processes in complex and uncertain ways. For example, species better adapted to warm, dry conditions such as ponderosa pine may gain a competitive advantage. Drought may inhibit tree growth in some areas.

Spatial heterogeneity will play particularly important roles for the production of wildlife habitat, with thresholds in habitat quality, habitat connectivity, and/or patch size apparent for many species (Turner et al., 2012).

The terrestrial vegetation indicators modeled into the future vary by alternative; however, this variance is very subtle at the broad scale. This is because all alternatives were modeled with a similar climate regime and similar levels of natural disturbance are projected. Natural disturbance regimes are the primary influences on vegetation across the vast majority of the HLC NF, due to the extent of areas where little active management occurs (such as wilderness, RWAs, IRAs, and primitive recreation settings). Vegetation management actions such as timber harvest projected by the Spectrum model were applied in the SIMPPLLE model. While these treatments undoubtedly result in modified vegetation characteristics where they occur, the overall level of treatment is not substantially different across alternatives, and impacts of treatments are generally outweighed by other influences when the key indicators are summarized at the broad scale.

Climate change

Climate is integrated into the SIMPPLLE model and a major driver of vegetation change and effects of the alternatives over time. There is a great deal of uncertainty surrounding climate change and its potential effect on vegetation conditions. However, best available science was used to guide both the integration of future climate conditions into the SIMPPLLE model, and the evaluation of the vegetation change related to direct and indirect effects of climate change. Whether it is invasive species (e.g., white pine blister rust), drought, uncharacteristic wildfires, elevated native insects and disease levels, unusually high forest densities, or some other agent or combination of agents that serves to stress trees and forest ecosystems; recent research suggests that climate change will likely exacerbate those stressors and “stress complexes” will continue to manifest themselves (Halofsky and Peterson 2016).

Vegetation Composition

Vegetation composition is expected to change through time as depicted in the following sections for forested cover types, tree species presence, and nonforested cover types. For all types, the expected trends are similar across all alternatives, and negligible when viewed at the forestwide scale.

The expected trend of some species would move towards the desired condition, including increases in tree species presence and cover types associated with limber pine and ponderosa pine, and decreases in tree species presence and cover types associated with Douglas-fir. Conversely, other results indicate a trend away from the desired condition, including reductions in the extent and dominance of lodgepole pine and increases in spruce and subalpine fir. Several key species, including aspen and whitebark pine, remain relatively static.

Rocky mountain juniper

Areas dominated by Rocky mountain juniper are rare, and are included in the ponderosa pine cover type; this type is expected to increase through time as discussed in the ponderosa pine section. As an individual tree species, the presence of juniper is projected to increase forestwide. The increase occurs on the warm dry PVT; the extent of juniper on the cool moist and cold broad potential types is relatively rare and remains static. Although it is an important component of the ecosystem and provides structure for wildlife habitat, juniper expansion can lead to the decline of grass and shrublands and result in altered fire regimes in both nonforested and forested vegetation communities.

Rocky mountain juniper is found in greatest abundance in the Big Belts GA, and in the future is expected to decline and move towards the desired condition for this GA. It is also expected to decline in the Rocky Mountain Range GA. Low to moderate increases in most other GAs would be within the desired ranges. There is no Rocky Mountain juniper known to occur in the Highwoods GA.

Limber pine

Areas dominated by limber pine are included in the ponderosa pine cover type; this type is expected to increase through time as discussed in the ponderosa pine section. As an individual tree species, the presence of limber pine is expected to increase slightly by the end of the model period forestwide. The increases occur in the warm dry broad PVT, with the amount in the cool moist and cold broad PVTs remaining static. By GA, the expected distribution of limber pine is generally expected to increase (trending towards or exceeding the desired ranges), with the exception of the Little Belts, Snowies, and Upper Blackfoot GAs, where it may decline.

Limber pine is subject to multiple threats. While the isolated locations and climate conditions of limber pine woodlands may have provided them some protection in the past, these lower treeline woodlands are just as, or more, susceptible to white pine blister rust infections and mountain pine beetle (Means, 2011). The natural fire regime, and the alteration thereof, is an important influence on the abundance and health of limber pine. The decline in health and mortality of this species has been observed throughout central and eastern Montana due to disease, winter damage, drought, and competition from other conifers (USDA 2003a). While it tended to increase historically during warm/dry periods, some sources indicate that limber pine expanded in some areas due to fire exclusion, and may be less viable on the driest sites in drought conditions (Halofsky et al., in press). Limber pine's position on the lower treeline and foothills in semi-arid climate systems is predicted to be particularly vulnerable to climate change (Means, 2011).

Aspen and cottonwood

Forestwide, the aspen/hardwood cover type is predicted to increase very slightly with all alternatives. The starting condition in SIMPPLLE is slightly below the actual condition estimated with plots. The projected increase would trend toward, but still remain below the desired range by the end of the modeling period. The slight increases occur in both the warm dry and cool moist broad PVTs.

Although it is known to occur, the presence of cottonwood is not well-represented by data or modeling. The presence of aspen is expected to increase slightly over time forestwide. The increase in extent would occur primarily in the warm dry broad PVT. Conditions would trend toward, but still below, the desired range forestwide and in the cool moist broad PVT, but possibly approach the lower bound of the desired range for the warm dry PVT.

Increases in the extent of aspen are expected to be particularly pronounced in the Big Belts and Highwoods GAs, with more moderate increases in the Elkhorns, Little Belts, Snowies, and Upper Blackfoot. Decreases may occur in the Castles, Divide, and Rocky Mountain Range.

Aspen is less common than it was historically because of encroachment and overtopping by conifers, overgrazing by cattle and large native herbivores, and the absence of fire (Shepperd, Bartos, & Mata, 2001); Kaye et al. 2005). The recent mountain pine beetle outbreak has reduced competition to aspen in some stands. Similarly, wildfires could stimulate new suckering to increase the vigor and extent of aspen, although other factors such as insects, disease, animal herbivory and genetics also play a role in long term success (Shepperd et al., 2001). The influence of a warming climate might be to increase the extent and severity of disturbances which could reduce the cover of conifers. However, dry conditions may also render some sites unsuitable for aspen. Cottonwood has also likely been reduced from historic conditions, and may suffer further in drought conditions (Halofsky et al., in press-b).

Ponderosa pine

The ponderosa pine cover type would primarily include areas dominated by ponderosa pine, but also limber pine, or some rare cases, Rocky Mountain juniper. This cover type is expected to steadily increase through time under all alternatives, with an abundance in 50 years that is trending towards but still below the desired range. The increases occur forestwide, as well as in the warm dry and cool moist broad PVTs, likely due to the expected warm climate conditions that favor ponderosa and limber pine over competitors such as Douglas-fir.

As an individual species, the presence of ponderosa pine is expected to increase forestwide as well, primarily starting in decade 3. This increase occurs primarily in the warm dry broad PVT, with the extent of ponderosa pine on cool moist types remaining static. The extent of ponderosa levels off and remains below the desired range at the end of the 50-year modeling period.

By GA, ponderosa pine presence is also expected to increase except in the Snowies, although this is in part an artifact of the variance in the existing conditions measured by plots versus what the SIMPPLLE model mapped as a starting condition. In all other GAs, the increases in ponderosa pine trend towards the desired ranges.

Ponderosa pine decline relative to the NRV has been due to a combination of factors, including fire exclusion and early harvesting. Stand structure has changed from open park-like stands to densely stocked areas undergoing stand conversion to more shade-tolerant species such as Douglas-fir (Gruell, Schmidt, Arno, & Reich, 1982; Pollet & Omi, 2002; Smith & Arno, 1999). High density also increases tree stress and decreases resistance to insect attack (Thomas E. Kolb, Holmberg, Wager, & Stone, 1998). Warm and dry climates along with natural disturbances and vegetation treatments may promote ponderosa pine where it can outcompete less drought-tolerant species.

Douglas-fir

There are two cover types dominated by Douglas-fir: dry Douglas-fir and mixed mesic conifer. Forestwide, both are expected to decrease through time with all alternatives. The decreases in dry Douglas-fir occur on the warm dry broad PVT at a rate and magnitude that generally mirrors the increases in the ponderosa pine cover type. The decreases in mixed mesic conifer occur primarily on the cool moist broad potential type, with moderate decreases on the warm dry type. The starting condition of SIMPPLLE for both types is above the actual existing condition, and the expected trend would likely result in conditions approaching or moving within the upper end of the desired range by decade 5.

Desired conditions for the Douglas-fir dominated cover types were developed for several GAs, because the NRV indicated slightly different trends than the forestwide ranges. In the Highwoods GA, the amount of the dry Douglas-fir cover type is predicted to increase and move into the desired range for this landscape. In the Rocky Mountain Range GA, the dry Douglas-fir type is predicted to increase slightly and move toward the upper end of the desired range, while the mixed mesic conifer cover type is predicted to increase and move above the desired range. Refer to appendix B.

The presence of Douglas-fir is also expected to decrease slightly forestwide. This decrease is more subtle than the decrease in the cover types (where Douglas-fir dominates) because Douglas-fir would remain a minor component within other cover types such as ponderosa pine, lodgepole pine, or spruce/fir. The decrease in Douglas-fir presence occurs primarily in the warm dry broad PVT, with its extent remaining fairly static on cool moist and cold types.

By GA, Douglas-fir is expected to decrease in the Castles, Crazies, Divide, Little Belts, and Snowies to a degree that moves toward or even exceeds the desired ranges. Increases are expected in the Big Belts, Elkhorns, Highwoods, and Rocky Mountain Range; this trend moves these GAs toward the desired ranges as well. Little to no change in the extent of Douglas-fir is expected in the Upper Blackfoot GA.

Relative to the NRV, fire exclusion has favored the expansion of Douglas-fir particularly on dry forest sites. The higher stand densities that have resulted also increase tree stress, which contributes to greater susceptibility of Douglas-fir to insects and diseases. Where dense Douglas-fir has filled in dry forest canopies, forest resilience is reduced and conditions support higher severity fires due to the higher tree densities, multiple canopy layers, greater fuels from tree mortality, and loss of the more fire resistant tree species. The future modeling indicates the potential that warm and dry climate conditions along with natural disturbances and management may decrease the abundance of Douglas-fir, although it would remain a common component on the landscape.

Western larch

Western larch is limited by its natural distribution range to the Upper Blackfoot GA. The western larch cover type is not represented by the existing condition or modeling, although it could occur in rare amounts. Modeling predicts that with all alternatives, the presence of western larch is anticipated to remain static. It is likely that the static condition would be within the desired range of conditions in the Upper Blackfoot GA.

Across its range, western larch is less abundant than it was historically due to fire exclusion and vegetation succession that favors more shade tolerant species such as subalpine fir and spruce. Because this species is so rare on the HLC NF, it is not well represented by modeling. The desired ranges call for maintenance or increase of this species within its natural distribution area.

Lodgepole pine

Forestwide, the lodgepole pine cover type is predicted to decrease slightly in abundance under all alternatives, which may trend slightly below the desired range. The highest magnitude of decrease would occur in the warm dry broad PVT; this decrease would actually trend toward the desired condition for that PVT and could be attributable to warm, dry climate conditions that promote other cover types like ponderosa pine. The expected trends on the cool moist broad PVT is cyclic and shows variation by alternative; the abundance of the lodgepole pine cover type would at times approach the desired range, but then decrease and move away from the range at other periods. The abundance of this cover type is also cyclic on cold PVTs, but remains above the desired range.

Desired conditions for the lodgepole pine cover type were developed for several GAs, because the NRV indicated slightly different trends than the forestwide ranges. In the Crazies and Divide GAs, the model indicates that the lodgepole pine cover type would increase in abundance and approach, but remain below, the desired condition. In the Highwoods, the model suggests that the abundance of this cover type would decrease and approach, but remain above, the desired condition. In the Snowies, the model suggests that increase in the lodgepole pine cover type would move this GA within its desired range. In the Rocky Mountain Range, slight reductions in this cover type would maintain a condition below the desired range.

The presence of lodgepole pine shows a similar trend to the cover type forestwide. The sustained decline may trend below the desired range forestwide and on the cool moist broad PVT, but would likely remain within or approach the desired condition for the warm dry and cold types. Unlike the fluctuating nature of the cover type abundance, the expected decline in lodgepole pine presence is gradual and sustained across all broad PVTs. The presence of lodgepole pine is expected to increase in the Big Belts, Elkhorns, and Snowies, while decreasing on all other GAs.

The modeling indicates that on the HLC NF the future may bring slight decreases in lodgepole pine depending on the other species associates present; but overall it will remain a major component.

Subalpine fir and Engelmann spruce

The spruce/fir cover type is anticipated to increase slightly under all alternatives, and trend away from the desired condition range. Desired conditions for the spruce cover type were developed for several GAs, because the NRV indicated slightly different trends than the forestwide ranges. In the Elkhorns GA, the model predicts a reduction in this cover type that moves its abundance within the desired range. Conversely, in the Divide GA, little change occurs in the abundance of this type and it remains above the desired range.

Individually, the presence of subalpine fir and Engelmann spruce is expected to remain fairly static, remaining above the desired extent. The fact that the cover type increases would indicate that spruce and fir become dominant over other species in areas where they are already present in minor amounts. This may be due to fire exclusion that allows these species to become dominant over competitors, and is likely related to a decline in lodgepole pine.

By GA, Engelmann spruce presence is predicted to increase most substantially in the Crazies GA, with more moderate increases in the Big Belts, Castles, Highwoods, Rocky Mountain Range, and Upper Blackfoot. Decreases are expected in the Elkhorns, Little Belts, and Snowies which move towards or achieve the desired ranges. Subalpine fir presence increases in the Castles, Highwoods, Little Belts, Rocky Mountain Range, and Snowies, but decreases in the Divide and Elkhorns while remaining fairly static in other GAs. The presence of subalpine fir remains above the desired ranges for all GAs except for the Snowies.

Based on available literature, the spruce/fir cover type would be expected to be maintained on the wettest sites but possibly decline overall given expected warm climates and fire activity. Both Engelmann spruce and subalpine fir were at the low end of their ranges during warm/dry climate periods in the NRV. However, the future modeling for the HLC NF indicates that forestwide and in some GAs, these types would be maintained or actually increase in the next 50 years.

Whitebark pine

The whitebark pine cover type is predicted to remain fairly static, and below the desired range, for the next 5 decades forestwide. While wildfire and vegetation treatments may promote it in some areas, it will also continue to face threats from mountain pine beetle, blister rust, and climate changes. The presence of whitebark pine is similarly expected to remain fairly static, with slight decreases and increases at the forestwide scale. These minor changes occur primarily in the cool moist broad PVT.

By GA, the presence of whitebark pine is expected to decrease in the Big Belts, Castles, Divide, Elkhorns, and Little Belts, while increases may be seen in the Rocky Mountain Range, Snowies, and Upper Blackfoot with little change in the Crazies. None is known to occur in the Highwoods. Most GAs remain within but are trending below the desired ranges.

Whitebark pine is less abundant than it was historically due to a number of factors including fire exclusion, mountain pine beetle, climate shifts, and white pine blister rust. Though whitebark pine still occurs, mature seed-bearing trees are scarce. The percentage of whitebark that are resistant to blister rust may increase slowly through the process of natural selection (Tomback, Arno, & Keane, 2001). The loss of whitebark has altered the structure, composition and pattern of high-elevation ecosystems, and threatened their long-term stability and integrity. On the HLC NF, the SIMPPLLE model predicts that with expected climate, disturbance, and vegetation management the abundance of whitebark pine may remain relatively static over the next 5 decades, although key losses may occur in some GAs.

Nonforested Vegetation, Forest Savannas, and Xeric ecotones

Nonforest cover types include all non-forested plant communities, including some open forest savannas where grasses and shrubs dominate, as well as recently disturbed areas where forest cover has not re-established. The existing abundance of nonforested cover types is approximately 14% forestwide, while the abundance of the nonforest/none density class is 22%, indicating that at least roughly 8% of the forest is in a very open forested condition. Additional savannas may occur in areas with a nonforested cover type as well, to an unknown degree. This condition is related to the concept of xeric ecotones, which can fluctuate between forest and nonforest cover depending on disturbance and climate regimes. In short, the expected trend of forest savannas is embedded within nonforested cover types and nonforested density classes.

At the forestwide scale, nonforested cover types are predicted to increase from decades 1 to 3 and then slightly decrease, but remain slightly above the existing condition. The starting condition for SIMPPLLE is below the actual condition estimated with plots, and the expected trend would likely result in conditions within but trending toward the lower bound of the desired range for most future decades at the forestwide scale, as well as in in the warm dry and cold broad PVTs. Conditions would be at the mid to upper end of the desired range in the cool moist broad PVT.

By GA, nonforested cover types are expected to decrease notably in the Highwoods and Rocky Mountain Range, with more moderate decreases in the Snowies, Crazies, and Upper Blackfoot – these decreases are generally consistent with desired conditions but move below the desired ranges in some cases. The decrease in nonforest cover types may occur as both a result of desirable reforestation of disturbed areas, as well as the loss of historic grass and shrubland communities to conifer encroachment. In no GA does the model predict that the abundance of nonforested cover types increase substantially.

At the broad scale, the expected effects of future warm, dry climate and drought include the maintenance or expansion of nonforested communities (particularly xeric types) as sites become too dry or frequently disturbed to support forest cover. At the local scale, modeling indicates that such a trend would not be substantially realized in the next 50 years, although the results are complicated by our inability to tease apart the relationship between the reforestation of disturbed forested sites, versus the expansion or loss of true nonforested plant communities. Further, other factors such as fire suppression play a role.

Xeric ecotones are among the most sensitive ecosystems to climate change (Means, 2011). Lower treeline woodlands are often thought to be “invading” desirable sagebrush and grass types due to fire suppression and grazing; however, ecotones also naturally move elevationally based on the dynamics of vegetation, climate and fire (ibid). Studies done near the HLC NF found that areas of mosaic sagebrush-grasslands with stable islands of Douglas-fir savannah have become dominated by Douglas-fir (Heyerdahl et al., 2006). Drivers of this trend include fire exclusion which would have killed encroaching trees when they were of a small size; grazing which reduced fine fuel loads and further influenced fire exclusion; and summer droughts that enhanced sagebrush which functioned as nurse plants for establishing conifers (ibid). Threats to the xeric ecotone include loss of tree species to disease, insects, and fire as well as shifts in warming and/or drying patterns as a result of climate change.

Forest size class

Forest size class is expected to change through time. Appendix B contains model output charts. For all types, the expected trends are similar across all alternatives, and negligible when viewed at the forestwide scale. The size class outputs from the SIMPPLLE model are not defined in the same way as the size classes in the R1 Classification System reflected in by plot data. The size classes from the SIMPPLLE outputs are therefore adjusted to be more analogous to how size class is represented on plots; refer to the planning record for more information on this process.

At the forestwide scale, the expected trend of size class distribution would generally move towards the desired condition, including increases in the large tree size class and decreases in the small and medium classes. These shifts may result in enhanced resilience to disturbance, structural diversity, and providing the array of successional stages for wildlife habitat as indicated by the NRV. The forestwide trends and conclusions do not apply to every PVT or every GA.

Seedling/sapling size class

Forestwide, SIMPPLLE modeling predicts that the seedling/sapling forest size class will fluctuate through time but remain overall relatively similar to the existing condition. The expected future trend forestwide is within the desired range of conditions, and is similar for all alternatives.

The trend varies by broad PVT, however. In the warm dry type, this size class trends fairly steadily upward and moves above the desired range. In cool moist broad PVTs, this size class is more cyclic but generally decreases overall by the end of the 50 year modeling period; these fluctuations appear to move to the lower end or just below the desired range. Cold types show similar fluctuations as the forestwide scale, which results in conditions that remain above the desired range for abundance of this size class.

Desired conditions for the seedling/sapling size class were developed for the Highwoods specifically, because the NRV indicated slightly different trends than the forestwide ranges. The modeling indicated that the seedling/sapling class would increase and move within the desired range for this GA under all alternatives. Alternative D resulted in the highest amount of seedling/sapling forests in this GA, while the other alternatives were similar.

Small tree size class

The small tree size class is predicted to decline forestwide to a similar degree under all alternatives over the 50 year modeling period. This trend would move towards but remain slightly above the desired range.

The trend of the small tree size class would be similar for all broad PVTs. The decreases in this class in the warm dry broad PVT would remain above the desired range; this decrease would correspond to desired increases in the larger size classes that are emphasized on these low severity, high frequency fire regimes. In the cool moist broad PVT, the decreases in this class are more subtle and achieve the desired range. The small tree size class is natural more prominent on these types due to the preponderance of lodgepole pine. On the cold broad PVT, the decrease in this class is relatively pronounced and also achieves the desired range; this shift is relatable to increases in the medium size class.

Medium tree size class

Forestwide, the expected trend of the medium tree size class is somewhat cyclic but overall declining with all alternatives. The expected trend would likely move this size class within and then below the desired range within the 50 year analysis period.

A decline in the medium tree size class was identified as most desirable on the warm dry broad PVT, where this class represented a mid-seral “bulge” that developed in large part due to fire exclusion, and corresponds to desired increases in larger size classes. As shown in appendix B, on the warm dry broad PVT the model predicts a fairly sustained and dramatic decline which would achieve the desired range. It is this trend that most substantially influences the decline noted at the forestwide scale, and is probably due to natural forest succession as well as disturbances or management that reduce tree densities to promote larger tree growth and/or remove smaller trees to increase the average tree size. In the cool moist broad PVT, the expected trend is more cyclic and results in an overall similar abundance of this type, generally within the desired range. In the cold types, the trend is also cyclic but slightly increasing, and above the desired range.

Desired conditions for the medium size class were developed for the Castles and Highwoods GAs specifically, because the NRV indicated slightly different trends than the forestwide ranges. The modeling indicated that the medium class would increase and move slightly above the desired range for the Castles GA. In the Highwoods GA, small to moderate increases are expected which perpetuate a condition above the desired range. The Highwoods in particular has a preponderance of this size class due to its disturbance history, and the model does not predict that disturbances or management would diversify the age class distribution to a great degree in the next 50 years under any alternative.

Large and very large tree size class

Forestwide, the model predicts an increasing trend in the large tree size class over time to a similar degree under all alternatives, which likely achieves the desired condition by the end of the 50 year analysis period. These increases correspond to the reductions in the smaller size classes as described above, attributable to natural succession as well as disturbances or management that reduce stand densities and/or remove smaller trees. The large tree size class, however, remains relatively rare and static over time, below the desired range.

All broad PVTs have predicted increases in the large tree size class over time, relatively steady and to a similar degree as the forestwide trend. This results in conditions that trend toward but remain somewhat below the desired range in warm dry, achieve the desired range in cool moist, and trend toward but remain fairly far below the desired range in the cold type. The expected trend for the very large tree sizes class is fairly static in all broad PVTs, similar to the forestwide depiction. This is within the desired range for the cold types, as this size class is naturally extremely rare, but is below the desired range for the warm dry and cool moist types.

Desired conditions for the very large class was developed for the Crazies GA, because the NRV indicated that increases were not desired as with the forestwide ranges. The modeling indicated that the very large class would have a fairly static condition, remaining within the desired range.

Large/very large tree concentrations and trees per acre

Forestwide, the expected trend of large and very large tree concentrations follows the same increasing trend as large and very large size classes, but the abundance is predicted to increase and achieve the desired range by the end of the analysis period. Very large tree concentrations remain fairly static and rare. The number of very large live trees is expected to increase through time under all alternatives.

In some areas (especially dry forest types), the presence of these components in stands of smaller size classes may indicate that fire exclusion allowed small trees to establish. Such areas provide short-term restoration opportunities for increasing the large and very large size class because removing some or all of the small trees would meet the desired condition without the need to wait for young trees to grow larger.

Forest density and vertical structure

For all PVTs, the expected trends of forest density and vertical structure are similar across all alternatives, and negligible when viewed at the forestwide scale. The expected trend of density class distribution would generally move towards the desired condition, including increases in the low/medium class and decreases in the high class. The expected trends are expected to be positive relative to forest resilience because, in general, the denser the forest the greater the likelihood that fuel characteristics could support a fast moving intense crown fire due to greater fuel quantities and the vertical and horizontal continuity of fuels. In addition, as density increases, trees lose their ability to withstand attacks by insects, pathogens, and parasites. Lower densities also support enhanced individual tree growth, and therefore the expected shifts likely contribute to the increases in the large tree size classes and concentrations. The forestwide trends and conclusions do not apply to every PVT or every GA; these variances are described in the sections below.

Low/Medium density

Forestwide, the model projects that the low/medium density class (10-39.9% canopy cover) would increase over time to a similar degree with all alternatives, and be within or at the upper range of the desired condition. This class steadily decreases in the warm dry type, to be at the low end or just below the desired range at the end of the analysis period; this decrease may contribute to the increases in the low/medium density class as dry forests are opened up by natural processes or management. Conversely, this class increases on cool moist types, which over time achieves the desired range; most forest types on these sites would naturally grow in this density condition at least in the later stages of stand development. This condition fluctuates on the cold broad PVT, remaining within the desired range.

Medium/High density

Medium/high density forests (40-59.9% canopy cover) are projected to fluctuate over time but remain at a similar abundance overall at the forestwide scale, and generally within the desired range. This class steadily decreases in the warm dry type, to be at the low end or just below the desired range at the end of the analysis period; this decrease may contribute to the increases in the low/medium density class as dry forests are opened up by natural processes or management. Conversely, this class increases on cool moist types, which over time achieves the desired range; most forest types on these sites would naturally grow in this density condition at least in the later stages of stand development. This condition fluctuates on the cold broad PVT, remaining within the desired range.

High density

Forestwide, the high density class (>60% canopy cover) decreases over time. This class moves into the desired range and possibly below it by the end of the modeling period. The decreases in the high density class likely correspond to the increases in the low/medium class across all broad PVTs, as well as the increases in the medium/high class in the cool moist broad PVT.

All broad PVTs include similar reductions of this density class. The trends in the warm dry and cool moist types would achieve and possibly move below the desired ranges by the end of the modeling period, whereas the decline would still be trending toward desired conditions in the cold type. Drought conditions and expected future disturbances are likely the main drivers of this reduction. The reductions of the high density class could result in higher forest resiliency to disturbances in many cases, and result in promoting large trees and shade-intolerant species. Conversely, in some cases shifts to lower densities could equate to the loss of habitats of interest (such as dense spruce/fir for lynx habitat).

Vertical structure

Vertical structure classes do not have desired conditions specified, as they are inherent within the mix of species composition, size classes, and density classes. This attribute is one of the most uncertain in terms of model classification, but is of interest for some specific conditions, and therefore results are described relative to the NRV.

The single storied vertical structure class includes seedling forests. It often, but not always, occurs in stands in the higher density classes. This structure is predicted to decline through time forestwide, to likely move into the upper end of the NRV. This will remain a common structure on the landscape, and the reductions are likely due to a diversification of structures that accompanies reduction in tree density and/or species composition. The abundance fluctuates a bit but remains relatively near the existing condition, and well above the natural range, in the warm dry type. This condition steadily decreases in the cool moist type to be within the natural range, and may indicate a diversification of structures and be related to the decrease in the lodgepole pine cover type. This class is predicted to decrease but is also somewhat cyclic in the cold PVT.

Two-storied vertical structures are relatively uncommon and the model predicts an increase over time, to remain above the NRV. This condition can develop in stands where the overstory canopy is opened up via a disturbance and a new age class of trees becomes established. These stands often progress into a multi-storied condition over time. The trend within the warm dry broad PVT is an overall decrease, to be within the NRV. In the cool moist and cold types, this class increases for the first few decades and then declines to again be within or just above the NRV.

Multistoried are predicted to increase forestwide through time, to approach or be within the NRV. This trend may be related to the increasing trends in certain cover types, such as spruce/fir, which commonly develop this structure; and/or where reduced densities allow additional canopy layers to become established. The increase in these structures is relatively small in the warm dry broad PVT, trending towards but below the NRV. The increases in this condition in the cool moist broad PVT are predicted to move above the NRV and may be tied to the increases in the spruce/fir forests which is also above the NRV. The increases in this condition in the cold broad PVT appear to be within the NRV.

Landscape pattern: early successional forest openings

The size of early successional forest openings is expected to change through time. The effects analysis was conducted allowing patches to be considered openings for as long as they remained in the seedling/sapling size class condition. The expected trends are similar across all alternatives, and negligible when viewed at the forestwide scale. Forestwide and in each broad PVT, the average size of early successional forest patches is projected to decrease through time. This trend remains within the desired range (and NRV) in all cases, but at the end of the projection in 50 years the average size within the cool moist broad PVT is at the lower bound of the range. If the trend continues, patch sizes may be smaller than the desired range within this PVT.

The area weighted mean patch size also generally declines over time, although some periods of increase are projected (decade 2 for forestwide and the warm/dry broad PVTs, and decade 3 for cold broad PVTs). At the forestwide scale and in the cool moist broad PVT, this decreasing trend remains within, but near the lower bound, of the desired ranges. For the warm dry broad PVT, the trend remains more squarely within the desired range. In the cold broad PVT, the existing condition is above the desired range, and the expected downward trend over time moves this metric within the desired range.

The primary cause of decreasing patch size of early successional forests is likely the growth and recovery of young forests that have been created by disturbance recently, coupled with projected future disturbances affecting the landscape in a finer grained mosaic. Timber harvest and prescribed burning also create early successional forest patches, but at the forestwide scale the extent of these activities would be minor and not likely to affect mean patch size to a large degree. The decrease in patch size is not likely due to landscape fragmentation associated with development or road building, because the pattern of NFS lands is expected to be maintained (not converted to other ownerships or uses), and little new permanent road building is anticipated.

The estimated patch sizes through time remain in the middle of the NRV for cold and warm dry broad PVTs; the average patch sizes in these types tend to be smaller and the tree species found there generally utilize reforestation strategies following disturbance that are dependent upon seed dispersal from surviving trees. Conversely, the patch size reductions estimated in the cool moist broad PVTs approaches the lower bound of the NRV. Lodgepole pine forests which are commonly found on this type are adapted to reforesting large openings following disturbances utilizing serotinous cones; a finer grained mosaic of patch sizes could provide for the maintenance of shade tolerant species such as spruce and fir in some areas.

Effects from forest plan components associated with:

Access and infrastructure

In all alternatives, limits related to road access on existing roads as well as construction of new roads (both permanent and temporary) could have an impact on the ability to conduct vegetation treatments that require road access, particularly mechanical treatments, across portions of the forest. Limited access to conduct desired vegetation treatments would affect the ability to achieve desired vegetation conditions in some areas. All alternatives are similar in terms of road access and infrastructure.

Livestock grazing

In all alternatives, livestock grazing would occur on portions of the HLC NF. Plan components would enable grazing activities to complement terrestrial vegetation management, such as reducing fine fuels to lower fire risk. While grazing and trampling from livestock can damage native plants and tree seedlings and saplings, plan components are in place that would ensure that grazing is managed to promote sustainable and vigorous native plant communities. Further, components are in place that would ensure that grazing does not adversely impact the regeneration of forests, or re-seeding of nonforested areas with desirable native vegetation. Plan components would also ensure that grazing is managed in a manner that would not lower site productivity (through damages such as compaction), and limits the spread of invasive plant species into native plant communities.

Air quality

The consequences to terrestrial vegetation from air quality related forest plan direction are the same for all alternatives. All alternatives have direction to meet air quality standards established by federal and state agencies and meet the requirements of state implementation plans and smoke management plans. The direction limits how much can be burned and when and where it can occur. The costs of conducting prescribed fires increases as a result of the burning regulations, which affect how much is burned. The ability to implement the vegetation treatments that would occur as a result of the alternatives is dependent upon prescribed burning as well as using natural, unplanned ignitions to meet resource objectives. Therefore, to the extent that air quality regulations may become more stringent in regards to the quantity and timing of smoke emissions, there could be limitations to conducting prescribed burning.

Mining and mineral extraction

Mining undergoes site-specific environmental analysis to determine effects and required mitigation, and effects to vegetation from mining is determined at the project level. Generally, the impacts to terrestrial vegetation from mineral extraction on the forest are localized, and insignificant at the forestwide scale.

Grizzly bear management

Under all alternatives, grizzly bear management would be guided by the Draft Northern Continental Divide Ecosystem Grizzly Bear Conservation Strategy ((U.S. Department of Agriculture, Forest Service, 2013c). Management direction from the Conservation Strategy would be amended to the existing plans for alternative A; or incorporated into all action alternatives. Refer to appendix I of the draft revised forest plan for the grizzly bear plan components.

Management for grizzly bears may affect terrestrial vegetation as a result of components that limit the miles of road access and duration of project activities such as timber harvest and prescribed fire. These restrictions would apply mainly to the primary conservation area and to Zone 1. On the HLC NF, the primary conservation area occurs only on portions of the Upper Blackfoot and Rocky Mountain Range GAs, and Zone 1 occurs only on a portion of the Upper Blackfoot GA.

Habitat management for grizzly bears would have a relatively small influence on future timber harvest. Further, it would not have an impact on reforestation or prescribed burning associated with harvest, because specific exceptions apply to allow access for these activities. Some specific project design elements would be applied to all vegetation management, such as reducing the risk of human-bear conflicts and retaining cover along a portion of grass/forb/shrub openings, riparian wildlife habitat, or wetlands. These design elements would not preclude achievement of desired conditions for terrestrial vegetation. Overall, the extent to which timber harvest and prescribed fire may be used to achieve desired terrestrial vegetation conditions is not greatly diminished by habitat management for grizzly bears.

Effects common to all action alternatives (B, C, D, and E)

All action alternatives contain revised forest plan components for vegetation composition, structure, and pattern. The revised forest plan would include quantitative desired conditions, and terrestrial vegetation would be managed to be consistent with the NRV and resilient to disturbance, with consideration for climate change vulnerabilities and adaptation options based on the best available science for the HLC NF (Halofsky et al., in press-b). The components in the revised forest plan that would guide management of terrestrial vegetation are summarized in Table 44.

Table 44. Summary of plan components relevant to terrestrial vegetation – revised forest plan

Plan Component(s)	Summary of expected effects
FW-VEGT-DC	The desired vegetation conditions for all broad potential vegetation groups summarize function, composition, structure, and pattern; states that vegetation should support at-risk species; and addresses connectivity and climate change. This guidance would ensure that all projects and activities share a vision of desired vegetation.
FW-VEGT-OBJ-01	This component specifies a minimum desired level of vegetation management to help move conditions toward the desired condition, and would ensure that active management occurs on the landscape.
FW-VEGT-GDL-01, 02, 03, 04	This suite of guidelines would provide for maintenance and/or re-establishment of desirable vegetation for both non-forested and forested plant communities after management or disturbances.

Plan Component(s)	Summary of expected effects
FW-VEGF-DC	This suite of components enumerates the quantitative desired conditions for forested vegetation composition, structure, pattern, and function. The effects would be similar as described for FW-VEGT-DC-01.
FW-VEGF-GDL-01	This standard prescribes minimum retention of large and very large live trees for vegetation management projects, and would ensure that these activities contribute towards the desired condition.
FW-VEGF-DC-07, 08, 09; and GDL-02, 04, 05, and 06	These components are specific to old growth, snags, and coarse woody debris. These components are complementary to the other desired conditions for forested vegetation, and provide specific guidance and limits on vegetation management.
FW-VEGNF-DC	These components enumerate desired conditions for nonforested plant communities. The effects are similar as described for FW-VEGT-DC-01.
FW-VEGNF-GDL-01	This guideline would refine where treatments in nonforested plant communities occur.
FW-PRISK-DC-02 and OBJ-01	This objective and guideline would ensure that restoration treatments occur for whitebark pine, and that key whitebark pine areas would exist to support the long term recovery of this species.
Invasive plants	The plan components for invasive plants would promote the health of native terrestrial vegetation, most especially nonforested plant communities.
Recreation Opportunities; Recreation Special Uses; Land Use	Plan components would guide vegetation conditions and management in developed recreation and special use areas. Managing these small areas for purposes such as public safety would not substantially add to or subtract from movement toward the desired conditions for vegetation.
Designated wilderness, RWAs, WSAs, RNAs, and IRAs	Plan components would ensure that vegetation change occurs primarily through natural processes. IRAs would be managed in a manner consistent with the 2001 Roadless Area Conservation Rule, which includes limitations on vegetation management.
Eligible WSRs, Nationally Designated Trails	The components include limitations for vegetation management. Managing these site specific areas for specific purposes would not substantially add to or subtract from movement toward the desired conditions for vegetation.
Carbon Storage and Sequestration	The desired condition would complement vegetation plan components by calling for resilient forests.
GA direction (Chapter 3)	These plan components provide more detail and/or describe the land allocations where forestwide components apply. These complement the vegetation effects described for forestwide components at the GA scale.

Alternative A, no action

The existing forest plans (1986) do not quantify desired vegetation conditions; rather, there are qualitative descriptions. Because the existing plans were developed over 30 years ago under a different planning rule and paradigm, a comparison to the revised plans is difficult. The plan content in the existing forest plans relevant to terrestrial vegetation is summarized in Table 45.

Table 45. Summary of plan components related to terrestrial vegetation – existing forest plans

Section	Summary of expected effects
HNF – Desired Future Condition	The desired condition is not consistent with those developed for the revised forest plan based on best available science.
HNF – Forestwide Standards – Big Game	The standards would require the maintenance or development of stand densities that may or may not be consistent with the desired vegetation conditions, depending on the landscape and vegetation type.
HNF – Forestwide Standards – Range	The plan components for grazing would promote the health of native vegetation, especially nonforested communities and riparian areas.
HNF – Forestwide Standards – Noxious Weeds	The plan components for noxious weeds would promote the health of native terrestrial vegetation, most especially nonforested plant communities.

Section	Summary of expected effects
HNF – Forestwide Standards – Revegetation	These standards prescribe seeding disturbed areas, and would ensure the re-establishment of native vegetation following natural disturbance or management.
HNF – Forestwide Standards – Timber and Firewood	The suite of timber standards are similar in intent as those in the revised plan. The maximum opening size limit is smaller, which would limit the achievement of desired forest pattern in some cases.
HNF – Forestwide Standards – Watershed	Guidance relative to vegetation removal and watershed cumulative effects would limit vegetation management in some areas.
HNF – Forestwide standards – Protection	Components would emphasize silvicultural treatments for insects and disease. Components for wildfire and prescribed fire would contribute to movement towards vegetation desired conditions.
HNF – Forestwide Standards – Riparian	Components provide guidance related to vegetative cover in riparian areas, with specifics for livestock grazing, and would contribute to desired vegetation conditions in riparian areas.
HNF and LCNF – Management Area Direction	The existing plan mapped management areas, including proposed wilderness areas, each with a unique management emphasis, and enumerated management standards for recreation, visuals, wildlife and fisheries, range, timber, water and soils, minerals, lands, facilities, protection, and riparian resources. This guidance would influence the types and magnitude of treatments allowed to achieve desired conditions.
LCNF – Forestwide Objectives and Desired Future Condition	The objectives and desired future condition do not describe the condition of vegetation over time. The plan would not necessarily guide the forest toward conditions similar to those described in this analysis.
LCNF – Forestwide standard C-1, Wildlife Habitat Management	Components specific to forage and winter range would maintain the health of nonforested vegetation in elk winter range specifically.
LCNF – Forestwide standard D-2	The plan components for noxious weeds would promote the health of native vegetation, especially nonforested plant communities.
LCNF – Forestwide standard D-1, D-3, D-4	Guidance related to grazing management would protect riparian areas (including vegetation), soils, and water quality.
LCNF – Forestwide standards E-1, E-2, E-3, E-4	These standards for timber, firewood, and reforestation, and are similar in intent to many revised forest plan components. Maximum opening sizes are not addressed.
LCNF – Forestwide standard F-3, Soil, Water, and Air	The guidance would generally protect watershed, soil, and air values. Prompt revegetation would occur.
LCNF – Forestwide standard P-1, Protection	This standard would guide the Forest toward harvesting stands at high risk to mountain pine beetle and other insects and diseases, and to utilize prescribed fire to achieve management goals.

Effects that vary by alternative

Ecosystem processes: projected wildfire and hazard to stand replacing fire

Wildfires are expected to have one of the most substantial influence on vegetation in the future. The expected acres of wildfire are generated by SIMPPLLE based on assumptions for fire suppression, future climate (warm/dry), vegetation conditions, and projected vegetation treatments. The differences in alternatives are a result of different land allocations, such as lands suitable for timber production, which influence the amount and type of vegetation management that is projected to occur. These differences resulted in only subtle variation in projected wildfire acres across the alternatives.

Though our best understanding of how fire behaves and its effects on vegetation were used to inform the model, there is an inherent degree of uncertainty. We cannot predict with high accuracy where and when fires will occur. There is a high degree of variation, spatially and temporally, in the amount and location of fire. The average wildfire acres shown in appendix B do not imply an “even flow” of acres burned over time. The estimated mean levels of fire activity are below the NRV for low severity fires, and at the low end within the NRV for mixed severity and stand replacing fires.

The hazard of stand replacing fire was also estimated with Spectrum. In all alternatives the model projects that the hazard of stand replacing fire in forested stands would be reduced over time. While this decrease is greatest with alternatives A and E, all alternatives would result in a reduction of hazard to stand replacing fire. This metric shows only the hazard of stand replacing fire, based on stand characteristics – it does not indicate fire risk or expected fire acres burned which depend upon many other factors such as ignition sources, weather, fire suppression efforts, and topography.

Ecosystem processes: projected insect and disease activity and hazard ratings

Insects and disease will also play a role in vegetation change over the next five decades. The amount of insect and disease disturbance is closely tied to the abundance of the host species, vegetative succession, and warmer climates.

The estimated mean levels of Douglas-fir beetle are within the NRV. Mountain pine beetle would also generally be within its NRV, except on cold broad PVTs where the model predicts infestations above the historic amount. This indicates continued impacts to whitebark pine from this insect. The projected levels of western spruce budworm are above the NRV on cool moist and cold broad PVTs, but are declining through time and within the natural range for warm dry PVTs.

Hazard to bark beetles (mountain pine beetle and Douglas-fir beetle) and defoliators (primarily western spruce budworm) was also estimated. In all alternatives, the hazard to bark beetles is expected to increase over time; this partly reflects the re-growth of pine forests that were killed in the recent mountain pine beetle outbreak. It is also likely a function of the anticipated increases in large trees and large forest size classes. Alternatives A, B/C, and D are generally similar with respect to bark beetle hazard, while alternative E has a higher hazard from decades 3 to 5.

Similarly, the amount of the forest at high hazard to defoliators would decrease through time under all alternatives, to a relatively similar degree although alternative E would result in slightly more acres of high hazard as compared to the other alternatives. This trend is likely due to vegetation management and wildfires that result in a reduction or removal of forests with dense understories of susceptible hosts.

Effects from forest plan components associated with:

Timber management

Timber harvest is one of the tools available to change vegetation for purposes of maintaining or moving towards desired vegetation conditions. Forest plan direction guiding timber harvest is provided in all alternatives. The Spectrum model was used to generate the best solution for applying future timber harvest to move towards desired conditions while considering resource constraints and management guidance for each alternative. The acres influenced by timber harvest are a relatively small proportion compared to natural disturbance processes such as wildfire.

Alternative E has the most land determined to be suitable for timber production, while alternative D contains the least. These are lands where harvest would be used to the greatest extent, although the alternatives also include lands that are unsuitable for timber production where harvest can occur for other purposes. However, the difference between alternatives in terms of timber suitability is minor. Alternative E treats the fewest acres in the early decades, although it generates the most timber volume by virtue of where and how the harvest is conducted. Alternatives A, B/C, and D would harvest similar amounts.

In the first decade, all alternatives would treat more of the landscape with even-aged regeneration harvest than with other types of harvest (intermediate or uneven-aged systems). This proportion changes over time, with more intermediate and uneven-aged harvests occurring in decades 2 through 4. The proportion of even-aged regeneration harvest increases again in decade 5. These trends are based on the model finding the optimum solution to move the landscape towards desired conditions. Even-aged regeneration harvest are likely driven by the desired condition to alter species composition (most notably, the desired condition to increase the ponderosa pine cover type); whereas other types of harvest may be more related to altering forest structures (most notably, the desired condition to increase large size classes).

In alternatives A, B/C, and D the Spectrum model generally selected warm dry forests for harvest treatment to best meet the desired conditions as defined by cover type, density class, and size class distributions, while alternative E selected to treat cool moist forests as well (lodgepole pine and spruce/fir) in order to achieve more timber volume production. Generally speaking, alternatives A, B/C, and D would generally do more to move warm dry forests toward more open densities and ponderosa pine dominance than alternative E.

Average patch sizes are projected to decrease over time, which specifically in the cool moist broad PVT may result in average patch sizes that trend below the NRV and desired condition. The revised forest plan (alternatives B/C, D, and E) include standards for maximum even-aged harvest openings based on the NRV. For the warm dry and cold types, the standard is 40 acres, which is consistent with both the existing and desired condition ranges as well as the broad-scale average patch size projected through time. For the cool moist type, the standard is 125 acres, which is larger than the current and projected average size but aligned with the NRV. Therefore, to the extent that timber harvest affects the landscape, larger patch sizes may be promoted to offset the reduction in patch size to the limited degree possible under FS control. Patch size was not a variable included in the desired conditions for timber modeling (Spectrum), but would be a consideration during implementation of the plan. Alternative A would result in a maximum opening size of 40 acres for all PVTs (with exceptions as provided by law).

Regeneration harvest would alter forest size class, primarily resulting in seedling/sapling forests. Reforestation (planting or natural regeneration) would occur in these stands, and can be used to achieve desired conversions in composition. Other harvests include intermediate treatments, or thinning. These treatments primarily reduce tree density, but may also increase size class (when smaller trees are removed) and can change forest composition. Uneven-aged harvest tends to maintain or increase the shade tolerant tree species as compared to shade intolerant species, because of the small openings and denser forest canopy conditions, but can also be used to promote uneven-aged stands of intolerant species such as ponderosa pine. The projected harvest acres and subsequent vegetation changes produced by the Spectrum model are incorporated into the SIMPPLLE model, and therefore their influence on the indicators for terrestrial vegetation are reflected in the results described in this section.

Salvage harvest - Under any alternative, salvage harvest may occur in burned areas or those infested with insects or disease, removing some of the dead trees for their economic value; the potential for this activity is not modeled. In practice the term salvage is technically only applied as an intermediate harvest; as described in the affected environment section. However, the term “salvage” is used here more broadly to indicate any post-disturbance harvesting. The majority of the HLC NF is in designated wilderness, RWAs, or IRAs where salvage would be prohibited or limited and natural disturbances would be predominant, including fire that creates abundant burned forest conditions. Salvage would most commonly occur in lands suitable for timber production. The impacts of salvage would generally be consistent with a “green” harvest in terms of trees removed and reforestation, because the full suite of plan components that guide timber harvest would apply. Salvage cutting following fire is a controversial management approach. The ecological effects of post-fire logging are influenced by various combinations and intensities of the fire itself and management activities that affect (1) ground disturbance by equipment and road use; (2) number of living and dead trees and their spatial pattern following harvest; (3) postharvest fuel treatment; and (4) in some cases, grass seeding and placement of various structures and materials to mitigate the effects of fire and logging (Peterson et al., 2009). Post-fire harvest may fit into an effective restoration strategy if management pathways for attaining desired combinations of species, forest structure, and ecological functions are specified (ibid).

Fire and fuels management

Fire and fuels management provide tools to help achieve vegetation desired conditions, and therefore generally result in positive impacts to terrestrial vegetation.

Prescribed fire can be the only feasible management option in landscapes where mechanical treatments are not allowed or are infeasible. The objectives for fuel reduction are usually complementary to other desired vegetation conditions, especially related to forest resiliency. Plan components that allow for prescribed fire and other fuel reduction activities exist in all alternatives. Management direction for the action alternatives emphasizes and provides greater flexibility in the use of prescribed and natural, unplanned ignitions to improve vegetative conditions. The revised plan components are designed to recognize the natural role of fire on the landscape and its importance in shaping the ecosystem, while also protecting values at risk.

The Spectrum model was used to generate the best solution for applying future prescribed fire to move towards desired conditions while considering resource constraints and management guidance for each alternative. These treatments were only applied in forested lands, because that is the focus of Spectrum modeling. In reality, additional prescribed burning in nonforested vegetation types would also occur. In the model, prescribed burning treatments were applied both as maintenance treatments within harvested stands, as well as stand-alone prescriptions. The model projects that alternatives A, B/C, and D would apply similar levels of prescribed burning, with the greatest treatment acres occurring in decades 1 and 5. Alternative E would apply the least amount of fire to the forested landscape. Alternative E differs in this way because it emphasizes timber production in addition to achievement of desired conditions.

In lands within the WUI and near communities, there would likely be a continued emphasis on fire suppression, although the action alternatives would allow for managing wildland fires on all areas when appropriate. Although both prescribed fire and other fuels treatments may occur across the landscape to achieve desired conditions, in these areas in particular, it is likely that mechanical treatment methods would be needed to reduce hazardous fuels and create conditions conducive to more safe and effective suppression efforts. To achieve desired fuel conditions, there may be areas where forest conditions are created and maintained over the long term at lower densities, i.e., very open and park-like conditions. This would be consistent with the natural disturbance regime found on many sites, such as in the warm dry potential vegetation group. However, in cases where cool moist forest types are found in the WUI the site specific conditions could be more open than what would occur under natural disturbance regimes. This effect is common to all alternatives.

ROS settings

Recreation opportunity settings are defined for the action alternatives but do not apply to the no-action alternative. The array of ROS settings vary by each action alternative and influence both the potential access and type of vegetation treatments that can occur, particularly timber harvest. Alternative D is most limiting to harvest in this regard, as it includes the most primitive and semi-primitive nonmotorized settings. Alternative E is the least limiting, as it includes the most semi-primitive motorized and roaded natural settings, which are compatible with timber harvest and lands suitable for timber production.

Scenery

Under all alternatives, plan components associated with scenery may affect terrestrial vegetation through their influence on allowable vegetation treatments that could help move vegetation towards desired conditions. The magnitude and type of vegetation treatment (particularly timber harvest) in areas with higher scenic values may be limited. Effects to scenery are typically localized and would be determined in project-level analysis; in some landscapes scenery plan components may align perfectly with terrestrial vegetation desired conditions, while in other landscapes these components may inhibit or delay achievement of desired vegetation conditions. However, because both vegetation and scenery objectives emphasize retaining or mimicking conditions that are consistent with natural processes, at the broad scale plan components related to scenery and visual quality would not likely preclude the achievement of desired conditions for terrestrial vegetation.

Alternative A uses visual quality objectives to define scenery management, whereas the action alternatives utilize SIOs. SIOs offer greater flexibility and recognition of natural disturbance regimes and vegetation conditions. Alternative D is most potentially limiting to vegetation management activities, as it has the most high and very high SIOs as a result of having the most RWAs and primitive recreation opportunities. Alternative E is the least limiting.

General wildlife management

Wildlife plan components under all alternatives would influence terrestrial vegetation. In the existing forest plans, many of these elements are blended into management area guidance, and some complement terrestrial vegetation desired conditions. For the most part, plan components for wildlife under the action alternatives are complementary to those of terrestrial vegetation. By design, the desired vegetation would benefit and provide for the wildlife habitat conditions that support the full suite of native species. This is the coarse-filter approach to providing ecological integrity.

Elk (and other ungulates) management

Under all alternatives, terrestrial vegetation may be influenced by the management of elk and other ungulates through components that limit the location, access, timing and/or duration of vegetation management, and in some cases require certain vegetation conditions (such as hiding and thermal cover). These plan components vary by alternative as well as by GA. The potential influences of these components cannot be quantified with Spectrum or SIMPPLLE, and are therefore addressed qualitatively.

Plan components related to elk are detailed and specific to alternative A. The requirements for the maintenance of certain vegetation conditions, such as hiding or thermal cover as defined by tree canopy density, would not necessarily be consistent with desired vegetation conditions depending on the vegetation type and location. In some areas the standards may not be achievable given disturbances and climate. The effect of these plan components would be to limit vegetation management and preclude the achievement of desired conditions in some areas. Other components, such as open road densities and elk security standards, may limit the potential feasibility of some vegetation projects.

Under the action alternatives, plan components related to disturbance to ungulates (specifically on winter range) would also influence the potential timing and duration of vegetation management activities. Hiding and thermal cover would also be considerations for determining desired vegetation conditions at the project scale. Elk security requirements may limit the potential for vegetation treatments and achievement of desired vegetation conditions, and are found in alternatives B and E but not C or D. For all of these aspects of elk management, the potential constraints to management or influence on vegetation conditions would be based on the best available science to provide for the needs of elk, determined on a project-specific basis. In contrast to alternative A, the required conditions are not quantified in the revised plan and flexibility is provided to increase the potential that conditions necessary for elk would be consistent desired vegetation conditions.

The Elkhorns GA has unique plan components under all alternatives, based on its designation as a wildlife management unit. These components are similar across all alternatives, and would result in any vegetation management activities that occur being designed to benefit desired wildlife and vegetation conditions, hazardous fuel reduction, or protection of values at risk. This would not preclude, and in fact should complement, the achievement of desired conditions as defined for terrestrial vegetation, especially nonforested plant communities.

Canada lynx management

All alternatives would incorporate the NRLMD (USDA, 2007a), which would influence vegetation management and how desired conditions are applied in potential lynx habitat (roughly 44% of the HLC

NF). Refer to appendix H of the revised forest plan for the lynx plan components. Although the management direction applies to mapped occupied lynx habitat, the guidance should be considered on all mapped habitat on the Forest, including habitat that is currently considered unoccupied. Occupied lynx habitat was identified in the 2006 Amended Canada Lynx Conservation Agreement by the USFS and U.S. Fish & Wildlife Service, and currently includes only the Upper Blackfoot and Rocky Mountain Range GAs. However, because the guidance should be considered on all lands, and there is potential for occupied habitat to change, lynx management direction is applied and analyzed across the entire HLC NF for forest planning purposes.

Several of the objectives of the lynx direction complement the terrestrial vegetation plan components, by describing a desired condition to management vegetation to approximate natural succession and disturbance processes (#1), and provide a mosaic of habitat conditions through time (#2). Further, objective #4 specifically points to the opportunity to utilize vegetation management to promote the development of desirable habitat characteristics.

Several standards and guidelines may potentially impact the management of terrestrial vegetation (VEG-S1, S2, S5, and S6). These standards include an exemption for fuel reduction treatments within the WUI, and exceptions to these standards may also occur for pre-commercial thinning to benefit other resources. The acres affected for S1, S2, S5, and S6 cumulatively must occur on no more than 6% of mapped lynx habitat. The number of acres that may be treated in the WUI by exemption and/or pre-commercially thinned by exception are determined in consultation between the FS and the U.S. Fish & Wildlife Service; maximum acres that may be affected are defined for the Helena and Lewis and Clark portions of the HLC NF separately as part of an Incidental Take Statement. Treatments that are conducted under the exemptions and exceptions are monitored. To date, over the 10 years since the adoption of the final lynx direction, the exemption/exceptions have been applied to less than 3,000 acres of mapped occupied habitat across the HLC NF, which represents a small percentage of the allowable threshold.

The limitations of the lynx management direction were incorporated into the Spectrum model, and therefore their influence is incorporated into the results displayed in this section. The effects tied to each standard individually are assessed in the following subsections.

NRLMD Standard VEG-S1 and S2

Standards VEG S1 and S2 would potentially limit the amount of regeneration harvest that may occur. Standard VEG S1 requires that if more than 30% of the lynx habitat in a lynx analysis unit (LAU) is currently in a stand initiation structural stage that does not yet provide hare habitat during winter, no additional habitat may be regenerated by vegetation management. Standard VEG S2 requires that timber management shall not regenerate more than 15% of lynx habitat on NFS lands in a LAU in a ten-year period. These standards may limit potential vegetation treatments in some areas where seedling/sapling forests are abundant, particularly after a stand replacing disturbance. However, in those instances it is likely that the desired vegetation conditions would be consistent with not creating additional regenerating forest patches. Therefore, these standards should be complementary, or at least not preclude, the potential future achievement of terrestrial vegetation desired conditions.

NRLMD Standard VEG-S5

Standard VEG S5 does not allow pre-commercial thinning that reduces snowshoe hare habitat in seedling/sapling size stands except in very limited situations. In addition to the exemption/exceptions allowed in the WUI previously described, other exceptions are provided for pre-commercial thinning within 200’ of administrative buildings (#1); thinning for research studies or genetic tests (#2); thinning associated with aspen (#4); or whitebark restoration (#6). Finally, an additional exception (#3) is provided to allow for thinning based on new information that is peer reviewed and accepted at the Regional level; however this analysis and documentation does not yet exist.

This standard may reduce the effectiveness of achieving desired vegetation conditions across portions of the forest. Although dense forests may be desired in some stands, in many others pre-commercial thinning can be used to trend forests towards desired composition, densities, size classes, and improved resilience over time, especially in lands suitable for timber production. Early thinning can be more cost effective at achieving these goals than waiting until the trees are larger and more difficult to dispose of. Table 46 provides a depiction of the magnitude of the effect of standard VEG S5 on potential pre-commercial thinning opportunities.

Table 46. Seedling/sapling forests in potential lynx habitat (both occupied and unoccupied), in lands suitable for timber production

	Acres Within the WUI	Acres Outside the WUI	Total Acres
Alternative A	12,611	15,502	28,113
Alternative B/C	9,977	12,312	22,289
Alternative D	10,102	12,002	22,104
Alternative E	10,452	12,564	23,016

The proportion of the lands suitable for timber production in a seedling/sapling size class, within potential lynx habitat and outside WUI represent lands where pre-commercial thinning would most commonly be desired, and conversely that action would be delayed by lynx management direction. Precommercial thinning could not occur until the stands no longer provide habitat for snowshoe hare, i.e. after the trees self-prune and no longer include green limbs that touch the snow surface in the winter. Hand thinning is generally most feasible and cost-effective when the trees in the stand are small, and therefore delaying treatment may render the action infeasible, and the opportunity to improve stand growth and quality could be foregone in some areas. The amount of acres in this condition is highest in alternative A, and slightly less in alternatives B/C and E. Such areas that still provide snowshoe hare habitat could only be pre-commercially thinned if exception #3 can be met in the future through new peer-reviewed written documentation.

Pre-commercial thinning would not be feasible or needed in all of these young stands, depending on the site specific existing and desired conditions, nor would current or anticipated budget levels support thinning all these acres.

NRLMD Standard VEG-S6

Except for the exemption for fuels treatments in the WUI (as described above), standard VEG S6 does not allow vegetation management that reduces winter snowshoe hare habitat in mature multi-story forests. This habitat condition most commonly develops on the cool moist and cold broad PVTs. Other exceptions are provided for treatments within 200’ of administrative buildings, dwellings, outbuildings, recreation sites, and special use permits including ski areas (#1); treatments for research studies or genetic tests (#2); or for incidental removal during salvage harvest (#3). VEG S6 also notes that timber harvest could be used to create openings to improve hare habitat in stands with poorly developed understories.

Mature multi-storied hare habitat is fairly uncommon, currently comprising less than 2% of the potential lynx habitat area across the HLC NF. This amount will fluctuate over time as the condition is removed by disturbance and develops in other stands. Under all alternatives, the SIMPPLLE model predicts the amount of multistory habitat to increase for the first few decades (to nearly 10% of the potential lynx habitat area forestwide) and then decrease again to about 7% of the potential lynx habitat area forestwide by decade 5. Therefore, this standard is likely to be more limiting in the future than in the current condition, with any alternative.

Adhering to VEG S6 would result in harvest and prescribed fire treatments rarely being feasible in multi-story mature forests in potential lynx habitat, due to the likely damage to understory trees. This limitation would limit vegetation management to the greatest extent in potential lynx habitat outside of the WUI, which represents roughly 38% of the HLC NF in all alternatives. Much of this area is located in IRAs, RWAs, or designated wilderness areas where the only vegetation treatments that could occur would be prescribed fire.

VEG S6 would potentially reduce or delay the ability to achieve desired vegetation conditions in some areas, such as where increasing the abundance and resilience of whitebark pine is desired. The inability to apply vegetation management in whitebark pine forests where fire exclusion has allowed spruce/fir canopy layers to develop would result in foregoing some whitebark restoration opportunities; refer also to the Plants at Risk section. In addition, achieving resiliency through management in other stands by promoting early seral species (such as lodgepole pine) or more open tree canopies would not occur in mature multi-storied stands.

Mature multi-story hare habitat is likely to be susceptible to high severity fire as well as to damage and mortality from western spruce budworm, bark beetles, and other agents. Therefore, vegetation management to promote the development of future mature multi-storied hare habitat, as allowed in VEG S6, may be warranted in some areas. This guidance would influence the types of prescriptions selected in some projects (i.e., selecting uneven-aged management to promote the development of spruce/fir multi-storied stands, rather than another vegetation treatment that would promote other structures or species).

At the broad scale the promotion of mature multi-storied forest is an important piece of the desired vegetation mosaic. VEG S6 would not necessarily preclude a trend towards other terrestrial vegetation desired conditions, in large part because vegetation treatments are predicted to influence a relatively minor proportion of the landscape. Still, this standard may have some impact on the potential to achieve specific desired conditions related to lodgepole pine and whitebark pine forests. The vegetation modeling included parameters that did not allow timber harvest or prescribed fire within existing mature multi-storied stands in potential lynx habitat. While this condition currently represents only about 20% of the forests on the cool moist and cold broad PVTs, the amount is predicted to increase over time. The model also predicted a decrease in the lodgepole pine cover type and a fairly static trend for whitebark pine, along with increases in spruce/fir on the cool moist and cold broad PVTs. Therefore, VEG S6 may become increasingly limiting in the future and represent some tradeoffs with the potential to achieve other desired conditions through active management.

Under any alternative, the achievement of desired vegetation conditions and lynx habitat would require integration of the full suite of desired conditions for a given landscape, and appropriately assigning vegetation management in time and space.

Watershed and conservation watershed network management

Watershed plan components exist for all alternatives, but are more specific in the action alternatives (B, C, D, and E) than in alternative A. One way that watershed plan components would influence terrestrial vegetation is through their influence on potential timber harvest; refer to the Timber section. Watershed plan components may also either limit or encourage other forms of vegetation management, such as prescribed fire and tree planting, to maintain the appropriate level and types of vegetation cover that reduce erosion potential as well as the risk of catastrophic fire effects. These components are built on the concepts of the NRV, and therefore would generally either complement or at least not preclude the achievement of the vegetation desired conditions as described in this section. The management direction found in the action alternatives recognize more flexibility in potential scenarios related to vegetation and natural disturbances than the no-action alternative.

Soils

Under all alternatives, plan components related to soils would generally benefit terrestrial vegetation by ensuring that soil productivity is maintained in the long term. Standards and guidelines related to soils may limit vegetation management activities, such as timber harvest and prescribed fire, by restricting activities or conditions that may be detrimental to soils. The action alternatives provide greater specificity in the standards and guides for soils than alternative A, particularly with respect to allowable detrimental disturbance and post-treatment ground cover requirements.

Aquatic habitat and riparian areas

Measures to protect aquatic habitat and riparian areas would apply under all alternatives near streams, water bodies, and wetlands. RMZs are defined differently depending on the alternative, as described in the RMZ section. Plan components would limit and guide the type, amount and location of vegetation treatments that have the potential to impact riparian resources, as well as requiring retention of trees and other forest components, as discussed in the Timber section.

RMZs are narrow, linear features on the landscape that help provide for wildlife habitat connectivity, late successional forest features, and refugia for seed sources; therefore, plan components that encourage the retention of these features would generally complement terrestrial vegetation desired conditions. All action alternatives recognize that vegetation treatments, including prescribed fire, within RMZs may be beneficial and needed to achieve desired conditions and provides direction to increase efficiency and flexibility for managing in certain areas within RMZ, as determined through site-specific analysis. Though vegetation treatments in RMZs are not prohibited in the existing forest plan, alternative A does not provide as clear direction and flexibility, and thus could be more limiting on the ability to trend forest towards desired conditions.

West of the Continental Divide, alternative A is very similar to the action alternatives with respect to the sizes and management direction applied to riparian areas, although guidance for vegetation management in the outer RMZs is more flexible with the action alternatives. East of the Continental Divide (the majority of the HLC NF), the action alternatives would establish larger RMZs than alternative A.

Recommended wilderness areas

The alternatives vary in the quantity and location of RWAs, ranging from none in alternative E, to 16 areas in alternative D. Within these areas, all action alternatives would have the same level of ability to achieve desired vegetation conditions within RWAs through the use of vegetation treatments. All have forest plan direction that allow restoration activities to occur as long as the ecological and social characteristics that provide the basis for wilderness recommendation are maintained and protected. Anticipated vegetation treatment activities would largely be associated with the restoration of high elevation ecosystems, and whitebark pine forest communities in particular. There may be other treatments occurring to achieve restoration objectives outlined in the plan components. The most likely treatment would be prescribed burning (planned ignition), in some cases followed by limited planting of conifer seedlings. Objectives would include restoration of desired forest structure and compositions, and to restore desired landscape patterns.

Future wilderness designation of RWAs could be anticipated. Designation as wilderness would likely result in reduced flexibility and options for vegetation management to achieve desired conditions. Use of prescribed fire is typically restricted within designated wilderness areas, and the ability to use unplanned ignitions (wildfire) as a tool would be limited within some of the RWAs. This is because of the small size and/or in locations of the areas and most wildfires would likely have to be aggressively suppressed to protect identified values (i.e., private lands). Reduced ability to use prescribed fire treatments may limit ability to achieve desired vegetation conditions across portions of the landscape.

Cumulative Effects

The effects that past activities have had on all of the components of forest vegetation are reflected in the current condition of the forest vegetation. In addition, the section above that discusses consequences to vegetation from forest plan components associated with other resource programs or topic is a form of cumulative effects analysis.

Changing human populations

Additional stressors that may increase in the future are increasing population levels, both locally and nationally, with resulting increasing demands and pressures on public lands. Locally, at present populations are increasing in the counties on the west side of the plan area, but are declining or stable in other areas. These changes may lead to increased demands for commercial and non-commercial forest products, elevated importance of public lands in providing for habitat needs of wildlife species, and changing societal desires related to the mix of uses public lands should provide.

Management of adjacent lands

Portions of the HLC NF adjoin other NFs, each having its own forest plan. The HLC NF is also intermixed with lands of other ownerships, including private lands, other federal lands, and state lands. Some GAs contain inholdings of such lands, while others are more unfragmented in terms of ownership. The GAs which are island mountain ranges are surrounded by private lands.

Harvesting or conversion of forests on adjacent lands would affect vegetation conditions at the landscape level, changing forest composition and structures. State law applies to all harvest activities regardless of ownership; therefore, basic resource protections would be consistent. However, harvest practices on other lands would not necessarily be conducted to meet the same desired conditions as those outlined in the HLC NF Draft Plan. Forest pattern (patch sizes, shapes) would potentially be affected by treatments on non-NFS lands immediately adjacent to NFS lands. Forest conditions on adjacent lands may influence pattern, extent or intensity of natural disturbances within forests on NFS lands, for example fuel conditions/fire hazard or potential spread of insect/pathogen populations. Forest conditions on NFS lands will be important for their contribution to maintaining desired biodiversity at the broad landscape scale.

Some adjacent lands are subject to their own resource management plans. The cumulative effects of these plans in conjunction with the HLC NF draft plan are summarized in Table 47, for those plans applicable to terrestrial vegetation.

Table 47. Summary of cumulative effects to terrestrial vegetation from other resource management plans

Resource plan	Description and Summary of effects
Adjacent National Forest Plans	The forest plans for NFS lands adjacent to the HLC NF include the Custer-Gallatin, Lolo, Flathead, and Beaverhead-Deerlodge NFs. All plans address terrestrial vegetation. Generally speaking, management of vegetation is consistent across all NFs due to law, regulation, and policy. The cumulative effect would be that the management of vegetation would be generally complementary. This includes specific adjacent landscapes that cross Forest boundaries, such as the Upper Blackfoot, Divide, Elkhorns, Crazies, and the Rocky Mountain Range.
Montana Statewide Forest Resource Strategy (2010)	This plan guides forest management on state lands. It includes many concepts that are complementary to draft plan components, for example promoting forest resilience, providing wildlife habitat, and reducing hazardous fuels. While specific desired conditions are not stated in the same terms as the HLC NF, it is likely that some elements such as increasing large trees, early seral species, and open forests would be similar. State forest lands may be actively managed to a greater degree than NFS lands, and would likely contribute to achievement of desired vegetation conditions across the landscape.

Resource plan	Description and Summary of effects
BLM Resource Management Plans (RMP)	BLM lands near the HLC NF are managed by the Butte, Missoula, and Lewistown field offices. The Butte plan was recently revised (2009) while the existing plans for the Missoula and Lewistown areas are under revision. These plans contain components related to resilient terrestrial vegetation, and would therefore be complementary to the plan components for the HLC NF.
National Park Service - Glacier National Park General Management Plan 1999	The general management plan for Glacier National Park calls for preserving natural vegetation, landscapes, and disturbance processes. Broadly, the terrestrial vegetation characteristics in this area are therefore similar to the wilderness areas in the adjacent Rocky Mountain Range GA and would likely complement these conditions.
Montana Army National Guard – Integrated Natural Resources Management Plan for the Limestone Hills Training Area 2014	This plan is relevant to an area adjacent to NFS lands in the Elkhorns GA. The Limestone Hills area is primarily non-forested, and calls for managing for fire-resilient vegetation as well as restoration of native vegetation including mountain mahogany specifically. This plan would be generally complementary to the HLC NF most especially in promoting the health of native vegetation.
Montana State Parks and Recreation Strategic Plan 2015-2020	These plans guide the management of state parks, some of which lie nearby or adjacent to NFS lands. Terrestrial vegetation is a component of these parks, although not always the primary feature. Specific vegetation conditions would not necessarily contribute to the desired conditions as described for the HLC NF.
Montana's State Wildlife Action Plan	This plan describes a variety of vegetation conditions related to habitat for specific wildlife species. This plan would likely result in the preservation of these habitats on state lands, specifically wildlife management areas. This plan would interact with the Montana Statewide Forest Resource Strategy (above). The vegetation conditions described would be complementary to the conditions being managed for with the HLC NF plan.
County wildfire protection plans	Some county wildfire protection plans map and/or define the WUI. The HLC NF notes that these areas may be a focus for hazardous fuels reduction, and other plan components (such as NRLMD) have guidance specific to these areas. Managing for open forests and fire adapted species may be particularly emphasized in these areas. Overall, the effect of the county plans would be to influence where treatments occur to contribute to desired vegetation conditions.
City of Helena Montana Parks, Recreation and Open Space Plan (2010)	This plan is relevant to an area that lies adjacent to NFS lands in the Divide GA, in proximity to the City of Helena. The plan emphases forest management and wildfire mitigation. This would be complementary to management on some HLC NF lands, specifically the South Hills Special Recreation area (alternatives B, C, and D).

Conclusions

Broadly, the suite of desired conditions are characterized by increases in large trees and large forest size classes; more open forest densities and vigorous nonforested plant communities; and increasing early-seral shade tolerant species as compared to the existing condition while maintaining the full range of biodiversity on the landscape. These conditions are consistent with the modeled NRV and most likely to be resilient in the future given expected drivers such as climate change, drought, vegetation succession, wildfire, insects and disease, and the demands of people.

To an extent, all alternatives would help move the forest toward some desired conditions by allowing for active management and having similar types and extent of expected natural disturbances. The action alternatives provide more plan components specifically designed to ensure achievement of these conditions, than the no-action alternative. Expected trends for terrestrial vegetation show little to no variance across alternatives, due to the limited scope and impact of vegetation management treatments at that scale which are masked by the effects of natural disturbances. Table 48 summarizes the comparison of alternatives for the vegetation characteristics.

In all alternatives, the hazard to stand replacing fire decreases over time. The expected future hazard to bark beetles increases based on forest re-growth and increases in large trees. Alternative E has the highest hazard to bark beetles over time as compared to the other alternatives. The expected future hazard to defoliators decreases through time, likely due to decreases in forest density and/or susceptible hosts.

Table 48. Comparison of alternatives for terrestrial vegetation indicators

Key ecosystem characteristic	Relative contribution to desired condition			Discussion
	Highest		Lowest	
Role of wildfire	ABCDE			The expected acres burned by wildfire are similar for all alternatives, and within the NRV.
Role of insects and diseases	ABCD	E		Expected levels of insect infestation are within the NRV for all alternatives. Hazard to bark beetles increases as forests impacted by the recent outbreak regrow, and the large size class increases. Alternative E results in the highest hazard to bark beetles. Hazard to western spruce budworm decreases.
Vegetation composition and tree species presence		BCDE	A	Ponderosa pine would increase while Douglas-fir decreases, trending toward or within desired ranges. Limber pine, whitebark pine, and aspen remain stable. Lodgepole pine decreases while spruce and subalpine fir increase, trending away from their desired ranges.
Forest size	BCDE	A		The modeling predicts increases in the large tree size class, with decreases in the small and medium classes at most scales; these trends move towards or maintain desired ranges.
Large and very large trees	BCDE	A		Large tree concentrations are expected to increase. The very large tree size class and concentrations would remain rare. Trees per acre of large and very large trees would increase.
Forest density and vertical structure	BCDE	A		Increase in the low/medium forest density class is anticipated, along with decreases in the high density class, which trends towards or meets the desired condition range. The abundance of single-storied forests is expected to decline with increases in multistoried forests, trending towards desired conditions.
Landscape pattern: early successional forest		BCDE	A	Patch sizes of early successional forests are expected to decrease. This is within the desired range forestwide and in the warm dry and cold broad potential vegetation groups. However, this trend moves to the lower bound of the desired range for cool moist types.
Overall movement toward desired conditions of terrestrial vegetation	BCDE	A		All alternatives have the potential to move towards desired vegetation conditions to a similar degree based on modeling. Alternative A is ranked below the action alternatives because it does not include plan components that explicitly include desired conditions based on the NRV.

3.9 Old Growth

3.9.1 Introduction

Old growth is a structural condition that may develop during the late successional stage of forest development. Old growth is of particular value to many wildlife species, is an important component of biological diversity, and provides functions such as carbon storage. It also contains biological legacies and seed sources that contribute to landscape resilience. The concept of old growth involves not only the age of a forest but also characteristics such as large trees, size and spacing variation, large dead standing and fallen trees, broken and deformed tops, bole and root rot, multiple canopy layers, canopy gaps and understory patchiness, cessation in height growth of oldest trees, near zero net productivity, and biochemistry of secondary metabolic products in old trees (Johnson, Miyanishi, & Weir, 1995). This late-stage state of succession is not static and as old growth dies it is replaced by younger forests that age. The proportion and distribution of old growth across the landscape changes naturally over time.

The indicator and measure for the existing condition of old growth is the estimated abundance (acres or percent of the area) of this condition on the landscape. However, old growth cannot be explicitly modeled into the future with current analysis tools. Therefore, other attributes which have some correlation to old growth are used to compare the effects of the alternatives through time. These attributes are:

- Abundance of large and very large tree concentrations, estimated by the SIMPPLLE model; and
- Abundance of old forest as estimated by the Spectrum model.

The abundance, location, condition, and potential management of old growth were raised as issues during the scoping period for the revised forest plan.

3.9.2 Regulatory framework

USDA FS Position Statement on National Forest Old-Growth Values 1989 (Green et al., 1992) recognizes the many values associated with old growth forests, such as biological diversity, wildlife and fisheries habitat, recreation, aesthetics, soil productivity, water quality, and industrial raw material. Old growth on the NFs will be managed to provide the foregoing values for present and future generations. Decisions on managing existing old growth forest to provide these values will be made in the development and implementation of forest plans. These plans shall also provide for a succession of young forests into old growth forests in light of their depletion due to natural events or harvest.

3.9.3 Assumptions

Ecosystems are dynamic, and natural processes such as succession result in a proportion of mid to late successional forests becoming old growth over time.

Old growth is not static; stands are killed by insects, disease, windthrow, and wildfire, and are replaced by younger stands as they age.

With expected warm and dry climate, old growth will be subject to increased disturbances and therefore represents important areas for the retention of biological legacies, seed sources, late successional forest habitat features, and carbon storage.

For the action alternatives, the strategies described in appendix C of the revised forest plan would be followed.

3.9.4 Best available scientific information used

Though all old growth is late successional forest, not all late successional forest is old growth. Old growth, as currently defined, must contain specific attributes. The HLC NF has adopted definitions of old growth developed by the Regional Old Growth Task Force and documented by Green and others (1992) as the BASI. This work contains measurable criteria to consistently define old growth. These criteria were developed based on a national definition that old growth forests are ecosystems distinguished by old trees and related structural attributes (Green et al., 1992). The old growth definitions are specific to forest type and habitat type group. Key attributes of old growth include age, numbers and diameter of the old tree component within the stand, and the overall stand density. Minimum thresholds have been established for these attributes. Associated characteristics are also defined for each old growth type such as probabilities of downed woody material, number of canopy layers, and number of snags over 9 inches diameter at breast height.

For this analysis, old growth is estimated with Forest Inventory Analysis (FIA) and FIA intensified grid plots using an algorithm based on the definitions found in Green et al (1992). Please refer to appendix B for a more detailed description of these datasets.

Incomplete and unavailable information

The criteria specified in Green et al (1992) are the best available information that can be applied to plot data to provide estimates of old growth for the purposes of broad-scale analysis. However, the authors state, “because of the great variation in old growth stand structures, no set of numbers can be relied upon to correctly classify every stand…do not accept or reject a stand as old growth based on the numbers alone; use the numbers as a guide.” Therefore, as the forest plan is implemented, the determination of old growth patches at the project level may not match estimates made using plot data alone.

There is no forestwide map of old growth. Because the plots used to estimate old growth at the broad scale are designed to represent areas on a grid basis, polygons (or stands) of old growth cannot be delineated. Field inventories are necessary to accurately identify old growth stands. However, it is infeasible to maintain a stand examination inventory that covers every acre in a large analysis area. This type of inventory may occur at the project level, where site specific identification of old growth may be necessary. Some of the old growth on the Forest has been mapped during project level analysis, but much has not.

There is no quantitative estimate of the NRV of the abundance and distribution of old growth. It is difficult if not impossible to determine quantitatively the natural range in variation of old growth as currently defined across the landscape because the specific stand characteristics required to classify as old growth cannot be estimated with the model used (SIMPPLLE).

The data used for analysis represents the latest available, which includes FIA plots with the most recent measurements in 2011; and FIA intensified grid plots the most recent measurements in 2016. The effects of more recent disturbances, including the fires of 2017, are not portrayed by this data. However, the analysis of alternatives includes the potential for future fire and therefore the relative comparisons at the programmatic scale remain valid.

3.9.5 Affected environment

Currently about 11% of the HLC NF is estimated to be old growth (roughly 315,000 acres). Figure 6 shows the abundance of old growth at the forestwide scale and by broad PVT (see the Terrestrial Vegetation section for a description of these groups).

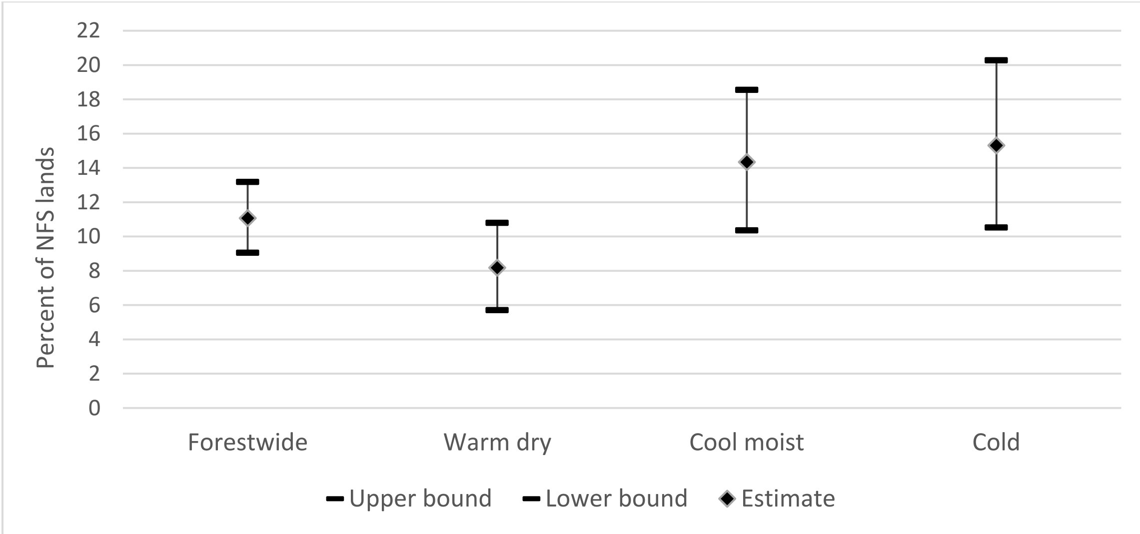

Figure 6. Old growth forestwide and by R1 broad PVT

Topography can influence the probability of old growth development; areas protected from wildfire (such as riparian areas or sites near rock features) may support vegetation legacy components which are more likely to be retained in the event of a disturbance. Even so, in fire prone landscapes the historic amount of old growth was probably not very high. In high elevation forests, the majority of the landscape would not have been very old at a given time due to fire cycles (Johnson et al., 1995).

From an early successional seedling stage, on sites typical of the HLC NF, it would take at least 150 years for a forest to become old growth, depending on the type. Periodic fire is a major disturbance process that influences old growth development. The likelihood of a particular forest stand to experience wildfire within 100 to 150 years would be high across many parts of the forest. Therefore, long-lived, early successional, fire tolerant tree species play a critical role in the successional process and development of old growth. These trees have a chance of surviving moderate and even high severity fires, and/or have adaptations that enable them to regenerate and grow rapidly post-fire. These species include ponderosa pine, Douglas-fir, and whitebark pine. Individual trees of these species can persist on some sites well into the late successional stages. They become the large diameter, old trees that are key features of the old growth forest condition. Old growth dominated by shade tolerant trees such as Engelmann spruce also occur particularly in riparian areas or other sites protected from disturbance by topographical features.

The existing old growth across the HLC NF represents an array of cover types, with those dominated by Douglas-fir (dry Douglas-fir and mixed mesic conifer) being the most common. Lodgepole pine dominated old growth is the next most abundant. Lodgepole pine is not as often thought of as old growth, as it would normally be replaced by fire or insects prior to reaching the required age. However, some stands do withstand low intensity fire and support large, old trees. Many plots used to estimate old growth forestwide have not been re-measured since the mountain pine beetle outbreak. Therefore, the amount of lodgepole pine and ponderosa pine old growth may be less. The lodgepole old growth remains vulnerable to mortality from insects and fire, more so than the other cover types, and losses may be inevitable in the near future.

The mosaic of structures available on some GAs to provide a stable quantity of old growth is limited because factors such as climate, fire history, and human intervention have resulted in homogeneity. For example, the Highwoods is dominated by young tree classes because the entire GA burned at the beginning the previous century. In the short term few older forests exist to become old growth. However, in the long term, a high proportion of forests could become old growth all at once (barring disturbance).

Conversely, GAs with a greater heterogeneity in age class, species composition, and structure, such as the Upper Blackfoot, may provide a more constant mix of old growth.

The abundance and distribution of old growth is influenced by the unique disturbance history of each GA. With the exception of the Highwoods, all of the GAs on the HLC NF contain old growth, with the means between 5 and 15% of the GA area. The Little Belts has a notably high proportion (17%). The Castles and Elkhorns also have relatively high estimates, but the lower bounds of the confidence intervals are not substantially different than other areas.

The total acres of old growth in the GAs is shown in Figure 7. Not surprisingly, the largest GAs (Rocky Mountain Range and Little Belts) support the most old growth acres. All other GAs have less than 25,000 acres of old growth each.

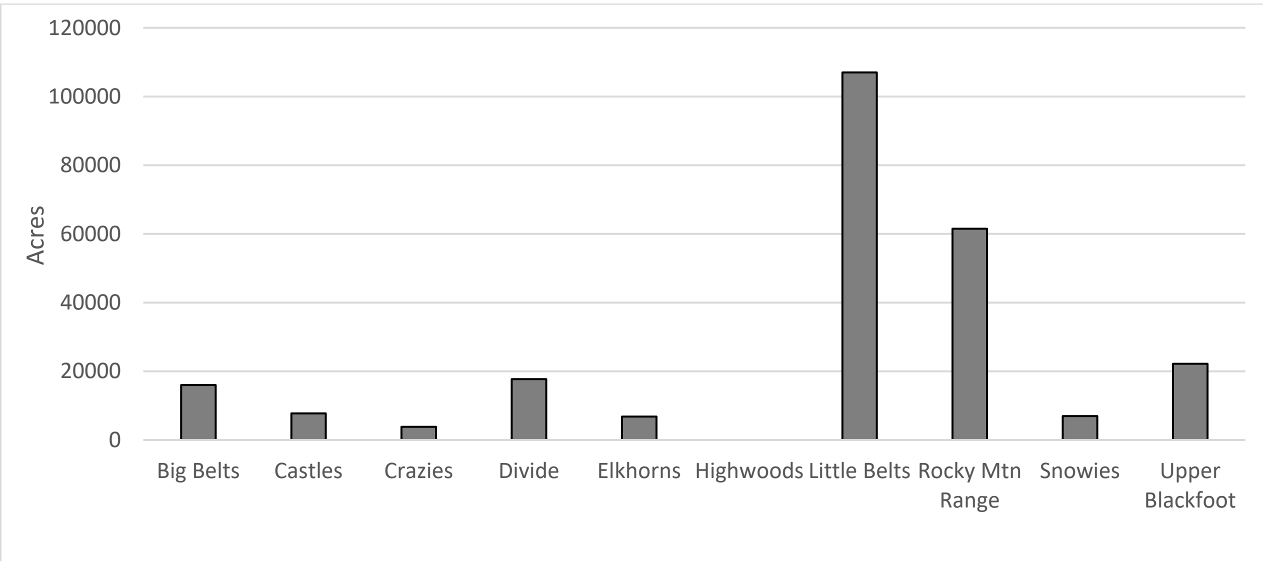

Figure 7. Estimated acres of old growth by GA[1]

1. Source: R1 Summary Database, F12_F15_Partial_IntGrid_4X_Hybrid_2016 and Hybrid 2011. Upper and lower bounds 90% confidence interval.

The abundance and distribution of old growth is influenced by the unique disturbance history of each GA. The recent mountain pine beetle outbreak has had an effect on pine-dominated old growth. The lack of old growth in some GAs, such as the Highwoods, is due to their small size and extensive fire history. Small island ranges such as these are susceptible to fires that spread from the surrounding prairie. In contrast, old growth in the Little Belts is abundant; this GA has experienced few wildfires recently. A substantial proportion of the old growth in this GA is the lodgepole pine type which may be susceptible to insect or fire mortality. The Upper Blackfoot, Divide, and Big Belts GAs are similar in old growth abundance. These GAs may have supported more old growth prior to recent large disturbances.

Old growth NRV and desired conditions

There is no means to determine a statistically sound, quantifiable estimate of NRV for old growth because the characteristics can be determined only through site specific inventory. However, other information provides historic context. Because old growth definitions are based in part on the presence of large trees, a partial correlation can be drawn with the presence of large and very large tree concentrations.

The NRV analysis estimated a mean of about 40% (range 35 to 43%) of the landscape had large tree concentrations, and 11% (range 9 to 14%) had very large tree concentrations. Not all of these areas would actually have been old growth. About 44% of the FIA plots that currently have large/very large tree concentrations on the HLC NF plan area also classify as old growth. If this proportion were applied to the NRV estimates for areas with large/very large tree concentrations, then it can be postulated that a natural range of old growth forestwide may have been 20-25%. This range would indicate that past amounts of old growth were likely higher than the existing condition. This conclusion is supported by the finding that the existing abundance of large and very large tree concentrations and size classes are lower than the NRV, especially in the warm dry broad PVT.

To the extent that desired conditions call for an increase in the large and very large size classes and tree concentrations, the old growth resource should increase as well on a proportion of those areas. This information was used to develop the desired condition for old growth as described in the draft revised forest plan. The desired conditions within old growth stands are based on the descriptions found in the BASI; these conditions are summarized in appendix B.

Another important feature of old-growth, particularly in regard to its importance to wildlife habitat and connectivity, is its spatial arrangement and patch size. Because there is no data to spatially map old-growth, the pattern is not quantified. However, the pattern of old growth is likely to vary as influenced by human and natural disturbances. Old growth that may have existed on non-NFS lands within the planning area has probably been removed over the past 100 to 120 years or so more through harvest or conversion of lands to other uses, such as agriculture. The average size of remaining old growth patches on all land ownerships are likely less than they were in the more recent past, particularly in areas where large patches were fragmented by harvest or development patterns.

Existing old growth is vulnerable to moderate or high severity fire, as well as insects and disease. Fire exclusion, particularly in low elevation warmer sites, has altered vegetation structure and composition in some old growth forests. Increasing tree densities, canopy layers, and proportions of Douglas-fir have increased tree stress and vulnerability to mortality from insects, disease, and fire. In addition, mountain pine beetle has recently affected many lodgepole pine old growth stands, and some ponderosa pine.

Benefits to People

Old growth is not specifically identified as a key ecosystem service of the HLC NF. However, this forest condition does provide benefits to people. Indirectly, these forests contribute to wildlife habitat and therefore contribute to the continued presence and possible wildlife interaction opportunities that people value. In some cases, these forests represent historic forest remnants that are valued by people, and where people enjoy hiking or other recreational activities, due to the large tree trees that provide shade and other aesthetic qualities. These forests also contribute to vegetative cover that helps provide for clean air, water, and other broad scale ecosystem services.

3.9.6 Environmental consequences

Effects common to all alternatives

All alternatives have forest plan direction for old growth that focuses on the maintenance of existing old growth across the landscape and managing for desired old growth amounts and patterns into the future.

In all alternatives, fire and other natural disturbances would continue to influence vegetation substantially more so than vegetation treatments, and would remain the main reason by far for loss of old growth. Similarly, succession would continue to be the primary means by which old growth is formed. This is in large part due to the expanses of land such as designated wilderness, RWAs, and IRAs where vegetation management is precluded or limited. Vegetation treatments that promote the long-term development of old growth (such as thinning in young stands to promote tree growth and resilience) are management tools that are available over a relatively small portion of the Forest in all alternatives. Old growth amounts and distribution would be dynamic and variable over time.

Predictions for warmer springs and warm, dry summers suggest that forests of the northern Rockies and the western U.S. will experience longer fire seasons, with larger and potentially more severe fires in the future. Therefore, existing old growth would be vulnerable to loss due to fire, as well as insects and disease, especially in wilderness and un-roaded areas. Fire exclusion and suppression in areas where a low or mixed severity historical fire regime occurred can alter vegetation structure and composition in old growth, and may make these stands more vulnerable to fire. Particularly on the warm dry broad PVT, increasing tree densities, canopy layers, and proportions of Douglas-fir have increased tree stress and vulnerability to mortality from insects, pathogens, and high intensity crown fires.

Old growth abundance

The expected effects to old growth abundance and distribution on the landscape cannot be quantitatively estimated with available modeling tools. Therefore, several proxy indicators are used. The expected trend in these characteristics is likely indicative of the trend of old growth. These values do not predict actual old growth conditions in the future, but are used to compare differences between alternatives. The results of the modeling for these indicators shows that it is likely that old growth may increase in abundance during the life of the plan, to a similar degree under all alternatives.

The SIMPPLLE model was used to estimate the abundance of large and very large tree concentrations, which show some correlation to areas that are most likely to be old growth. Figures in appendix B show the anticipated trend over time. All alternatives are nearly identical with respect to this metric. Forestwide, all alternatives appear to result in an increase in the abundance of this condition over time. This trend is most apparent in the warm dry broad PVT.

The SIMPPLLE model was also used to estimate the large and very large tree concentrations into the future for each GA. For most GAs, all alternatives are nearly identical, except in the Big Belts where alternative E indicates a slightly higher amount of large and very large tree concentrations as compared to the other alternatives. In all GAs, the modeling estimates an increase in these landscape components, with the exception of the Snowies. The slight loss of large/very large tree concentrations in the Snowies may occur based on susceptibility to disturbances such as bark beetles.

Another complementary source of information are the old forests that are tracked in the Spectrum model. Old forests are identified by age alone, and therefore would not necessarily always be old growth because other characteristics may be lacking. As shown in appendix B, all alternatives support an increasing trend in old forests through time, with the greatest acreage achieved with alternative A compared to the least achieved with alternative E. However, the magnitude of difference across alternatives is negligible.

Climate change

Climate is integrated into the SIMPPLLE model and a major driver of vegetation change and effects of the alternatives over time. There is a great deal of uncertainty surrounding climate change and its potential effect on vegetation, and therefore on old growth. Recent research suggests that climate change will likely exacerbate stressors and “stress complexes” will continue to manifest themselves (Halofsky and Peterson 2016). Increased disturbances may remove old growth from the landscape, and an increased focus on the resilience of old growth stands and development of old growth would likely be increasingly crucial to retain these habitat features on the landscape.

Effects from forest plan components associated with:

Vegetation management in old growth

All alternatives provide some flexibility to allow vegetation management within existing old growth stands. The degree to which this may occur, and how management would be guided, is compared across alternatives in subsequent sections.

Applying vegetation treatments in old growth is a controversial approach; however, some recent literature has concluded that carefully designed silvicultural treatments may be a valid approach in specific situations where needed to restore forest composition and structure so that fire can play its characteristic role (Noss, Franklin, Baker, Schoennagel, & Moyle, 2006; Salwasser, 2009)). Often it is the drier forest types that need treatment most, because fire exclusion has often created uncharacteristically high tree density and risk of high severity fire. These types of old growth would occur primarily in the warm dry PVT. Treatments to restore resilience could include reducing density with thinning in mid and understory tree layers, selective removal of overstory shade tolerant species, and retaining large, old fire-tolerant species such as ponderosa pine. These activities could reduce risk of high severity fire, provide for growth of smaller, younger trees into larger old overstory trees, and create gaps in canopy that allow establishment of new seedlings of fire-resistant species (Agee & Skinner, 2005; Fiedler, 2002; Franklin, Mitchell, & Palik, 2007; T. E. Kolb et al., 2007; Spies, Hemstrom, Youngblood, & Hummel, 2006).

A number of other studies also suggest that forest resilience can be improved through a variety of silvicultural treatments, while retaining diversity of plant and animal species (Fule, Crouse, Roccaforte, & Kalies, 2012; Lindh & Muir, 2004; Metlen & Fiedler, 2006; Ritchie, Wing, & Hamilton, 2008; Scott Lewis Stephens, 1998; S. L. Stephens & Moghaddas, 2005; Youngblood, Metlen, & Coe, 2006; Zhang, Ritchie, & Oliver, 2008). Further, treatments can maintain sufficient stand structure in old forests to provide habitat requirements for cavity nester species and a diversity of birds and small mammals, as well as maintain or improve understory plant diversity (Metlen & Fiedler, 2006; Steeger & Quesnel, 2003; Steventon, MacKenzie, & Mahon, 1998). Nevertheless, uncertainty associated with treatment of old growth for the purpose of improving forest conditions and resilience is also documented (Baker & Ehle, 2003; DellaSala et al., 2013).

Monitoring of treatments in old growth in the Region have indicated old growth characteristics can be maintained while achieving an increase in the proportion of desired fire-resistant species, an increase in average diameter of the stand, a decrease in stand density, maintaining or decreasing insect hazard ratings, and an overall reduction in fire hazard.

Fire and fuels management

Fire and fuels management plan components provide tools to help achieve vegetation desired conditions, and therefore generally result in positive impacts to old growth. It is possible that fires can destroy old growth, and many old growth stands are at risk to this disturbance based on their stand characteristics.

The degree to which wildfire has the potential to impact old growth would be similar for all alternatives. Prescribed fire is an important tool that can emulate natural disturbances and can be the only feasible management option in landscapes where mechanical treatments are not allowed or are infeasible. All alternatives provide plan components that allow a relatively high degree of flexibility in applying prescribed fire to the landscape. The plan components in the action alternatives in particular are designed to recognize the natural role of fire on the landscape and its importance in shaping the ecosystem. Old growth plan components in all action alternatives would ensure that prescribed fires are conducted in ways that do not remove existing old growth from the landscape.

Access and infrastructure

All alternatives are similar in terms of road access and infrastructure. In addition, all alternatives would apply access and road use limitations in areas identified as grizzly bear secure core, in the Rocky Mountain Range and Upper Blackfoot GAs. Where access is permitted along roads that are adjacent to or bisect old growth stands, some impacts to old growth could occur, primarily related to firewood cutting, which could remove old growth characteristics near the roadway. New road or temporary road construction could remove strips of old growth, if it occurs within old growth stands. Old growth that occurs in areas with limited access would not be subject to these impacts. However, limited access to conduct desired vegetation treatments would affect the ability to utilize vegetation treatments to enhance or promote future old growth.

Livestock grazing

Livestock grazing and old growth are not generally closely associated, as old growth stands would usually not provide the abundant forage, and where present in livestock allotments these forests are likely to provide only transitory range at best due to tree density. However, old growth and livestock uses may be juxtaposed in some areas, particularly riparian areas or in very dry, open old growth patches. Plan components in all alternatives for livestock grazing are designed to protect desired vegetation, with specific consideration given to riparian areas. Therefore, livestock grazing plan components would generally complement and not preclude movement towards the desired conditions for old growth.

Wildlife management

For the most part, under all alternatives the desired conditions and associated standards and guidelines for wildlife habitat would benefit old growth and vice versa. Plan components that may have the greatest influence on old growth are those that would influence terrestrial vegetation and vegetation management. These would generally include components related to big game, Canada lynx, and grizzly bear.

The direction for all of these species would result in limitations to the amount, type, and/or duration of vegetation management in specific areas, and/or would require the retention of a certain amount of mature or dense forests (such as components for hiding cover), as discussed in the Timber and Terrestrial Vegetation sections. To the extent that vegetation management is limited, the potential to retain existing old growth and allow natural old growth development to occur may be enhanced in some locations and vegetation types (such as spruce/fir). In other areas, limiting vegetation management may reduce the potential to increase forest resilience to maintain existing old growth, especially in dry forest types, and reduce the potential to treat younger stands in a manner that could help them develop old growth characteristics more rapidly.

With all alternatives, there are potential impacts in all alternatives resulting from forest plan standards associated with the NRLMD. The following standards have the greatest potential influence on old growth:

- Standard VEG S5 does not allow pre-commercial thinning projects that reduce snowshoe hare habitat in seedling/sapling size stands (outside the WUI) except in very limited situations. This may limit the amount of area where early thinning is done to promote the development of old growth.
- Standard VEG S6 does not allow vegetation management to reduce winter snowshoe hare habitat in “mature multi-story forests” (outside the WUI) except in very limited situations. This may complement the standard for retaining existing old growth, as some of these forests may also be old growth. However, it would also limit the potential to increase the resiliency of these stands with vegetation treatments.

Mining and mineral extraction

Mining undergoes site-specific analysis to determine effects and required mitigation. Effects to vegetation from mining is determined at the project level. Generally, the impacts to old growth from mineral extraction on the forest would be localized, and at the forestwide scale they would be minor.

Effects common to all action alternatives

All action alternatives include the same old growth desired conditions, guidelines, standards, and monitoring. Table 49 summarizes the expected effects of each plan component related to old growth.

Table 49. Summary of revised plan components for old growth

Plan component	Expected effects
FW-VEGF-DC, OBJ, and GDLs	As a coarse filter, the full suite of forested vegetation components provide for a natural diversity of forest conditions that should support the development of an appropriate array of old growth across the landscape. This direction would indirectly contribute to the development of old growth structures by providing for the appropriate array of species compositions, size classes, density classes, and other components on the landscape.
FW-VEGF-DC-07	This desired condition is specific to old growth. The component recognizes the dynamic nature of old growth forest over time, and the desire to increase resilience of old growth, and the size and shape of old growth patches. Qualitative descriptions of desired old growth conditions are provided, including species mixes and structures desired for old growth forest within the different broad potential vegetation groups. The effect of this desired condition is that management decisions would result in increasing the amount of old growth on the landscape.
FW-VEGF-GDL-04	This guideline would ensure that vegetation management activities would not modify the characteristics of old growth such that the stand would no longer meet the definition for old growth, unless specific exceptions apply. Therefore, no loss of old growth should occur under the action alternatives due to vegetation management activities. This component emphasizes several purposes for which treatment could occur in old growth, including promoting the resilience of old growth stands.
FW-VEGF-GDL-05	This guideline would ensure that vegetation management projects would promote the long-term development of future old growth, and recognizes that active management can help develop old growth. This management could include thinning in young stands to develop future species composition, size classes, and stand structures characteristic of late successional and old growth forests. It could also include treatment in small or medium forest size class stands to retain larger or more rapidly growing overstory trees, patches of younger trees, and other stand components and structures that could contribute to future old growth. The component also addresses actions near old growth that may help protect existing old growth from disturbances.
FW-VEGF-DC-05, 06; FW-VEGF-GDL-01	The desired conditions for large/very large live trees and concentrations complement the old growth plan components by providing for desired levels of large trees across the landscape. These are one important characteristic of old growth stands. The large/very large live tree guideline ensures that retention of these trees would occur within vegetation treatment units, which may help contribute to future old growth development.
FW-VEGF-DC-08, 09; FW-VEGF-GDL-02; 06	These plan components specify the desired conditions for snags and coarse woody debris, as well as provide guidance for minimum retention of these elements when vegetation treatments occur. This would contribute to future old growth development in some areas.

Alternative A, no action

Under the no-action alternative, the existing Forest Plan old growth standards would apply for the Helena and Lewis and Clark NFs respectively, as described in Table 50. The plans adopted the Green et al (1992) definition of old growth.

Table 50. Alternative A summary of forest plan standards for old growth (1986 plans)

Plan component	Expected effects
Helena NF forestwide standards II/20: An old growth stand is generally characterized by a high level of standing and down, dead and rotting woody material; two or more levels of tree canopies and a high degree of decadence indicated by heart rot, mistletoe, dead or broken tree tops, and moss. Five percent of each third order drainage should be managed for old growth. The priority for old growth in each drainage is: first, land below 6,000 feet in elevation; second, riparian zones and mesic drainage heads; and third, management areas emphasizing wildlife habitat. These areas will normally be managed on a 240	These plan components would result in a static amount of land being designated for management of old growth in each third order boundary or timber compartment. This does not necessarily reflect natural conditions; for example, in drainages or compartments dominated by nonforested plant communities this amount may be unachievable, and conversely in other landscapes the amount may be too low. The Helena NF plan does

Plan component	Expected effects
year rotation and will range from 10 acres to several hundred acres. Management areas other than T-1 through T-5 will be the primary source for old growth. However, if adequate old growth area cannot be achieved then the T management areas will be considered to meet old growth objectives.	not necessarily require that the stands selected actually are or are capable of becoming old growth, although the Forest has consistently chosen stands that are old growth or the "next best thing." It is unknown whether the quantity (5%) or scale (in every third order drainage or timber compartment) is representative of the natural range of conditions or necessary wildlife habitat amount and distribution. These plans would also result in only stands of a certain minimum size being selected for old growth (10 acres or 20 acres). These plans do not address a desire to increase the amount of old growth, nor do they reflect the varying capabilities of different landscapes and site capabilities. The amount of old growth prescribed does not have a clear tie to an understanding of the NRV or landscape resilience.
Lewis and Clark NF 2-16 Forest-wide management direction: Old growth forest inventory – there is currently no inventory of timber stands on the Forest which meet the old growth forest definition. These stands will be identified as a part of resource program and project level wildlife inventories and evaluations…2-44 Forest Wide management direction, management standard E-4 (9): A minimum of 5% of the commercial forest land within a timber compartment should be maintained in an old growth condition. A minimum stand size of 20 acres is recommended for old growth management. In management areas included in the regulated timber harvest base…a rotation of at least 200 years is recommended on the 5% of the commercial forest land to be maintained in an old growth condition. Appendix A: Silvicultural treatment recommendations for old growth.	

Effects that vary by alternative

Effects from forest plan components associated with:

Vegetation management

All alternatives include plan components that allow for vegetation management to occur within existing old growth stands, including timber harvest, prescribed fire, and other stand tending activities. In all alternatives, the majority of the HLC NF is in wilderness, RWAs, or IRAs, where harvest, including salvage would be prohibited or greatly limited, and natural disturbances would be predominant.

Alternative A requires that a certain proportion of the landscape be managed as old growth, and therefore old growth in excess of this amount could be removed from the landscape with vegetation management.

In contrast, the plan components in all action alternatives would ensure that timber harvest is conducted in a way that does not remove existing old growth from the landscape. Vegetation management would be limited to actions that do not result in the stand no longer qualifying as old growth, based on quantifiable characteristics. These characteristics are currently defined by Green and others (1992), although in the future newer science could be used if it becomes available. Because of these restrictions, no loss of old growth would occur under the action alternatives.

All action alternatives acknowledge the naturally dynamic nature of old growth over time, and that natural disturbances, such as fire, insects and disease, would impact it. Recognizing that old growth losses may be exacerbated by climate change, all action alternatives emphasize managing for resilience at the landscape and stand level. If fire or disturbance impacts an old growth patch, a more resilient forest may have the capability to restore previous composition and structure over time.

All alternatives would have a similar potential for vegetation management to be used in younger stands to promote future old growth, although only the action alternatives describe this in detail.

ROS settings and scenic integrity objectives

Alternative D is most limiting to vegetation treatments in this regard, as it includes the most primitive and semi-primitive nonmotorized settings. To a small extent, this could limit the amount of treatments that occur to promote the development of future old growth. Alternative E is the least limiting, as it includes the most semi-primitive motorized and roaded natural settings. In areas where vegetation treatment is precluded, natural processes would be the primary drivers of old growth impacts.

The effects from the various SIOs would have little impact on old growth, as the treatment limitations within old growth would generally meet all but the very high category. Effect to scenery is typically localized and would be determined in project-level analysis. Generally speaking, Alternative D has the most high and very high SIOs as a result of having the most RWAs and primitive recreation opportunities. This may to a small extent limit the amount of treatments that occur to promote the development of future old growth. Alternative E is the least limiting.

Watershed, soil, riparian, and aquatic habitat management

All alternatives contain direction that protects watershed integrity, soil productivity, riparian values, and aquatic habitat management. This direction limits and guides the type, amount, and location of vegetation treatment activities that have the potential to impact these resources, as well as the roads needed to access treatment areas. All action alternatives recognize that vegetation treatments, including prescribed fire, within RMZs may be beneficial and needed to achieve desired conditions. Alternative A does not provide as clear direction and flexibility as the action alternatives, and thus could be more limiting in the ability to trend forest towards desired conditions. In all alternatives, the limitations on treatments within RMZs would complement the old growth standards and guidelines for old growth stands that are found in these areas, by emphasizing retention of forest structure and downed wood.

Recommended wilderness areas

The alternatives vary in the quantity and location of RWAs, ranging from none in alternative E, to 16 areas in alternative D. Within these areas, all action alternatives would have the same level of ability to achieve desired vegetation conditions through the use of vegetation treatments. All have forest plan direction that allow restoration activities to occur, and the most likely treatment would be prescribed burning (planned ignition). Generally speaking, however, natural processes would be the primary driver of old growth impacts in these areas.

Cumulative Effects

Portions of the HLC NF adjoin other NFs, each having its own forest plan. All of the forest plans contain plan direction regarding old growth. In addition, The HLC NF is intermixed with lands of other ownerships, including private lands, other federal lands such as the BLM and Bureau of Reclamation, and state lands. Some GAs contain inholdings of such lands, while others are more unfragmented in terms of ownership. The GAs which are island mountain ranges in particular are typically surrounded by private lands. Harvesting or conversion of forests on adjacent private and state lands will affect vegetation conditions at the landscape level, changing forest composition and structures. Old growth forest or very large trees may be removed on non-NFS lands, increasing the importance of retention on NFS lands.

Some adjacent lands are subject to their own resource management plans. The cumulative effects of these plans in conjunction with the draft plan are summarized in Table 51, for plans applicable to old growth.

Table 51. Summary of cumulative effects to old growth from other resource management plans

Resource plan	Description and Summary of effects
Adjacent National Forest Plans	The forest plans for NFS lands adjacent to the HLC NF include the Custer-Gallatin, Lolo, Flathead, and Beaverhead-Deerlodge NFs. All of these forests have adopted the Green et al. 1992 definition for old growth. While specific old growth plan components vary, all plans address having old growth on the landscape. The cumulative effect would be that old growth is present across NFS lands at a scale broader than the HLC NF, and old growth management would be complementary. This includes specific adjacent

Resource plan	Description and Summary of effects
	landscapes that cross forest boundaries, such as the Upper Blackfoot, Divide, Elkhorns, Crazies, and the Rocky Mountain Range.
Montana Statewide Forest Resource Strategy (2010)	This plan guides forest management on state lands. It includes many concepts that are complementary to the plan components for the HLC NF, for example promoting forest resilience, providing wildlife habitat, and reducing hazardous fuels. This plan does not call out old growth as a desired condition. It is possible that old growth would not be a focus on these lands, thereby increasing the importance of old growth found on NFS lands.
BLM Resource Management Plans (RMP)	BLM lands near the HLC NF are managed by the Butte, Missoula, and Lewistown field offices. The Butte plan was recently revised (2009) and includes management goals for old forest. The existing plan for the Missoula area, the Garnet RMP, includes requirements to manage for a certain amount of old growth on non-commercial lands. This plan is under revision. The Lewistown area is managed with several plans (Judith-Valley-Phillips and Headwaters), and is also currently under revision. It is uncertain the degree to which old growth is specifically addressed in these plans, but it is likely that they would be complementary to that of the HLC NF.
National Park Service - Glacier National Park General Management Plan 1999	The management plan for Glacier National Park does not mention old growth explicitly, but calls for preserving natural vegetation, landscapes, and disturbance processes. Old growth is likely present in this area to a similar degree, and subject to similar ecosystem processes, as the wilderness areas in the adjacent Rocky Mountain Range GA and would likely complement this habitat condition found on NFS lands.
Montana Army National Guard – Integrated Natural Resources Management Plan for the Limestone Hills Training Area 2014	This plan is relevant to an area adjacent to NFS lands in the Elkhorns GA. The Limestone Hills area is primarily nonforested, although the plan does call for managing for fire-resilient vegetation. The plan does not have provisions related to old growth, and it is not expected that any old growth would occur or be maintained on these lands. These lands would not contribute to a landscape abundance and distribution of old growth associated with the Elkhorns GA.
Montana State Parks and Recreation Strategic Plan 2015-2020	These plans guide the management of state parks, some of which lie nearby or adjacent to NFS lands. It is unlikely that the vegetation in these areas would support old growth, and old growth management is not a focus of these plans. These lands would not contribute to a landscape abundance and distribution of old growth.
Montana's State Wildlife Action Plan	This plan describes old growth habitat where important for specific wildlife species. This plan would likely result in the preservation of these habitats on state lands, specifically wildlife management areas. This plan would interact with the Montana Statewide Forest Resource Strategy and should help ensure that old growth forest exists in some amount on state-owned lands and therefore would be complementary to the HLC NF forest plan.
County wildfire protection plans	Some county wildfire protection plans map and/or define the WUI for that county. The HLC NF notes that these areas may be a focus for hazardous fuels reduction, and other plan components (such as NRLMD) have guidance specific to these areas. Old growth that is found in the WUI, as defined by the counties, may be more likely to have treatments conducted to improve resiliency to fire. In addition, old growth may be more likely to be protected from wildfire as fire suppression is more aggressively applied in these areas.
City of Helena Montana Parks, Recreation and Open Space Plan (2010)	This plan is relevant to an area that lies adjacent to NFS lands in the Divide GA, in proximity to the City of Helena. The plan does not mention old growth, and emphases forest management and wildfire mitigation. While it is possible that old growth may occur, old growth would not necessarily be specifically maintained on these lands and should not be expected to contribute to the landscape abundance and distribution of old growth for the Divide GA.

Conclusions

Old growth takes hundreds of years to develop. A viable old growth strategy includes retention of existing old growth (to the extent practicable with natural disturbance regimes), as well as providing for an array of younger forests that may develop into old growth in the future.

The revised forest plan contains several plan components related specifically to old growth, including a desired condition as well guidelines designed to increase and enhance old growth on the landscape. All action alternatives are the same in terms of this guidance. These components would ensure management actions would not remove old growth, and that the development of future old growth would be promoted. The existing forest plans (no-action alternative) also contain standards related to old growth which do not specifically preclude the removal of some old growth, but provide for quantitative levels of old growth at specified scales (third order drainages or timber compartments).

The alternatives vary in terms of land allocations and expected vegetation treatments through time. While old growth cannot be explicitly modeled, several modeled attributes are used to provide indicators of the potential amounts of old growth through time. Under all alternatives, the amount of large and very large tree concentrations and old forests are expected to increase over time. A subset of these areas could be expected to be old growth, and therefore it is anticipated that old growth would at a minimum be maintained or increased as compared to existing levels under all alternatives.

The following conclusions were reached based on the old growth analysis:

- Old growth is an important habitat feature and component of vegetation diversity on the landscape. Old growth is likely less abundant today than it was historically.
- The desired condition is to maintain and increase the abundance and patch size of old growth, well-distributed across the landscape and representative of natural vegetation types.
- Existing plan components (alternative A) would provide for specific minimum amounts of old growth within certain boundaries (third order drainages or timber compartments). The minimum amounts and scale are not known to be consistent with the best available science.
- Revised plan components (alternatives B, C, D, and E) would provide for increasing the amount and patch size of old growth; ensure that vegetation management treatments would not remove old growth from the landscape; and ensures that vegetation management encourages the development of future old growth.
- In all alternatives, fire and other natural disturbances would continue to influence vegetation more so than vegetation treatments, and would remain the main reason for loss of old growth forest. Succession would continue to be the primary means by which old growth forest is formed. Old growth amounts and distribution would remain dynamic and variable over time.
- Based on modeling of future large/very large tree concentrations and old forests, all alternatives would likely result in an increase in the abundance of old growth forestwide, to a similar degree. By GA, expected trends are similar except in the Big Belts, where alternative E is modeled to result in slightly more large/very large tree concentrations; and in the Snowies, where all alternatives are expected to result in a slight decrease in these components.

3.10 Snags and Downed Wood

3.10.1 Introduction

Dead wood in the forest occurs as standing dead trees (snags) and as fallen trees or other woody material that lies on the ground (downed wood). These attributes have been identified as key ecosystem characteristics for the HLC NF plan revision.

Snags and dead wood contribute to biodiversity by providing habitat for wildlife feeding, reproduction and shelter, and play an important role in protecting the soil, enhancing soil development, and maintaining soil productivity over the long term. Although all dead wood has value, large snags and downed wood (or “coarse woody debris”) are of particular importance. Medium and larger-sized snags and downed wood greater than 3” in diameter are included in this programmatic analysis. Snags are created at broad scales, ranging from single-tree mortality to high-quantity pulses that result from wildfires or insect infestations. Recent disturbances on the HLC NF include the mountain pine beetle outbreak as well as large wildfires. Still, while smaller diameter snags are abundant, larger snags are relatively rare in part due to the growing conditions on the HLC NF.

The scale of the analysis and plan components related to snags and coarse woody debris is forestwide by snag analysis group or broad PVTs. Snag analysis groups are similar to broad PVTs, with the exception that lodgepole pine cover types are split out due to their unique ecological characteristics related to snags and downed wood.

The key indicators used in this analysis are:

- Snags per acre, by size class (medium, 10-14.9”, large 15-19.9”, and very large 20”+)
- Snag distribution (percent of area that has snags, by size class)
- Tons per acre coarse woody debris greater than 3” diameter

Snags and coarse woody debris, in terms of their importance to the ecosystem as well as concerns over plan components guiding their management, were raised as issues during scoping.

3.10.2 Regulatory framework

Please refer to the introductory regulatory framework section of this chapter (3.3).

3.10.3 Assumptions

A primary assumption used in the development of desired conditions for snags is that the best indication of the NRV is the abundance of snags found in wilderness and IRAs, where natural processes have by in large been allowed to occur (Bollenbacher, Bush, Hahn, & Lundberg, 2008).

Future climate will be warm and dry, and therefore increases in disturbances that create snags, such as wildfire and insect outbreaks, are expected to occur and possibly increase in frequency, extent, and/or severity across the landscape.

For the action alternatives, the suggested management approaches described in appendix C of the revised forest plan would generally be followed.

3.10.4 Best available scientific information used

The source of data for existing snags and woody debris are statistically based measurements collected on spatially balanced FIA plots. Refer appendix B for more information.

The work of Bollenbacher and others (2008) is the best available science for describing the conditions of snags in Region 1. This work provides snag quantity and distribution estimates for all NFs in eastern Montana by snag analysis groups and size classes. Updated data were queried in 2017 to augment this publication with the most current information available.

The data used for analysis represents the latest available. The effects of more recent disturbances, including the fires of 2017, are not portrayed by this data. However, the analysis of alternatives includes the potential for future fire and therefore the relative comparisons at the programmatic scale remain valid.

The best available science for coarse woody debris on the HLC NF is found in two publications. Brown et al (2003) was used to inform our understanding of the NRV and development of the desired conditions found in the revised forest plan, while Graham et al (1994) was used to inform the development of a guideline for coarse woody debris retention in vegetation management areas.

3.10.5 Affected environment

Snags

Snags are created over time by disturbances that kill trees (such as fire, insect, and disease), and as a by-product of succession, as trees die due to crowding out by the more dominant trees. Snag densities, sizes and distribution are influenced by the disturbance history and on pre-existing forest conditions. Snag longevity varies by factors such as tree size, species, cause of death, age of tree at death, rate of decay, and site conditions (L. J. Lyon, 1977; Mitchell & Preisler, 1998; Russell, Saab, Dudley, & Rotella, 2006; Michael J. Wisdom & Bate, 2008); Hansen et al 2015; USDA 2000).

A report on snag conditions in eastern Montana forests was completed by Bollenbacher and others (2008) using FIA data. Updated data tables were produced in 2017. Medium snags are the most prevalent; relatively few large or very large are present. Large snags tend to occur in the cool moist broad PVT. In areas dominated by lodgepole pine, early seral stands have the most snags due to a greater proportion of stand-replacing fires and species intolerance to fire. The warm dry broad PVT has a more even distribution of snags into later seral stages because of a more frequent, less severe fire regime. All broad PVTs show fewer mid-seral stage snags as snags transition to downed wood. Snags occur in a clumpy manner, and in all groups the larger the snag the less common it is.

Most of the existing large and very large snags on the HLC NF are Douglas-fir; this is the most common long-lived species. Less common large and very large snags are ponderosa pine, subalpine fir, whitebark pine, and Engelmann spruce. Ponderosa pine and Douglas-fir snags have the longest longevity due to their deep roots. Medium-sized snags are often lodgepole pine, which is the most common tree species on the HLC NF and one that does not tend to reach a large size. The lodgepole pine cover type has the highest density of snags largely due to the recent mountain pine beetle outbreak.

Snags are naturally unevenly distributed across the landscape. This variability applies at a temporal scale as well. Snag recruitment is dependent on the pattern and frequency of fire, insects and other disturbances. High snag densities, or “pulses”, are often the result of high severity wildfires or insect outbreaks which vary widely in time and space. Low densities of snags occur where low severity fires occur frequently, areas where fire has been excluded, and in areas with greater human access where snags can be removed through activities such as firewood cutting. Because of the naturally wide variation in snag conditions spatially and temporally, snags are analyzed at broad scales.

Desired conditions for snags are shown in appendix B, and are designed to reflect the conditions that would be expected to occur under natural disturbance regimes. Snags currently present in wilderness and roadless areas provide the basis for the desired condition because they reflect a more natural condition because human management is limited, although fire suppression has occurred.

Overall, existing mean snag quantities are within or just slightly higher than the desired ranges. Snag distribution of medium snags is higher than the desired condition, but within or close to the desired distribution for large and very large. Snag conditions at a forestwide scale are similar to what might occur under natural regimes, and are generally within the NRV. At smaller scales of analysis (such as project level), timber harvest and human access can have substantial impacts on snag density, distribution and longevity (Michael J. Wisdom & Bate, 2008). Presence of localized disturbances could also have substantial influence on snag conditions at smaller scales.

The existing condition of snags, both forestwide and for each GA, is shown in Figure 8 and Figure 9. Conditions at the GA scale vary due to the unique topography, site potential, and disturbance history of each area. All GAs have fewer average snags per acre, but more widely distributed snags, than the overall forestwide average; this is in part due to different datasets that represent each scale of analysis.

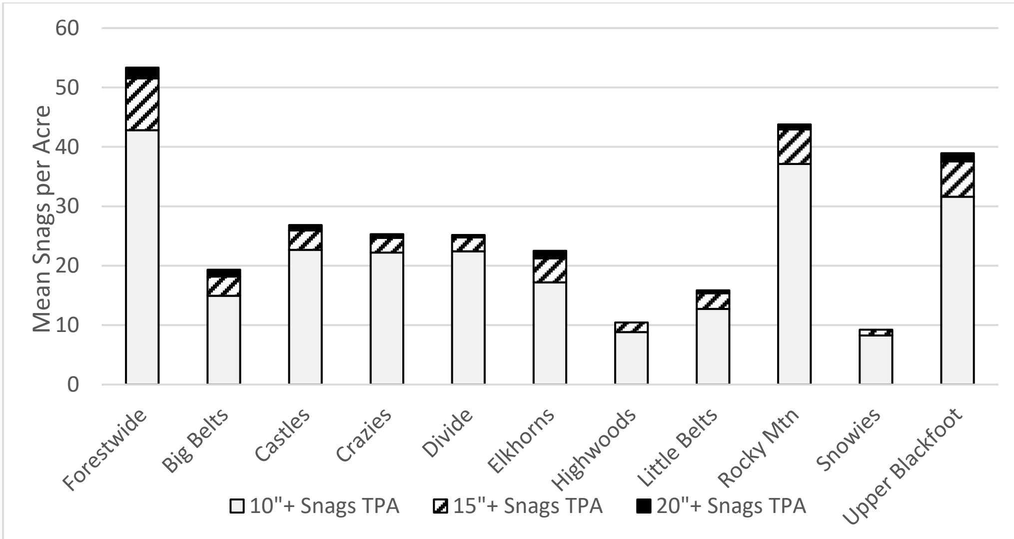

Figure 8. Snags per acre across all snag analysis groups, forestwide and by GA[1]

1. Source: R1 Summary Database: Hybrid 2011 (forestwide and Rocky Mountain Range GA); 4x 2016.

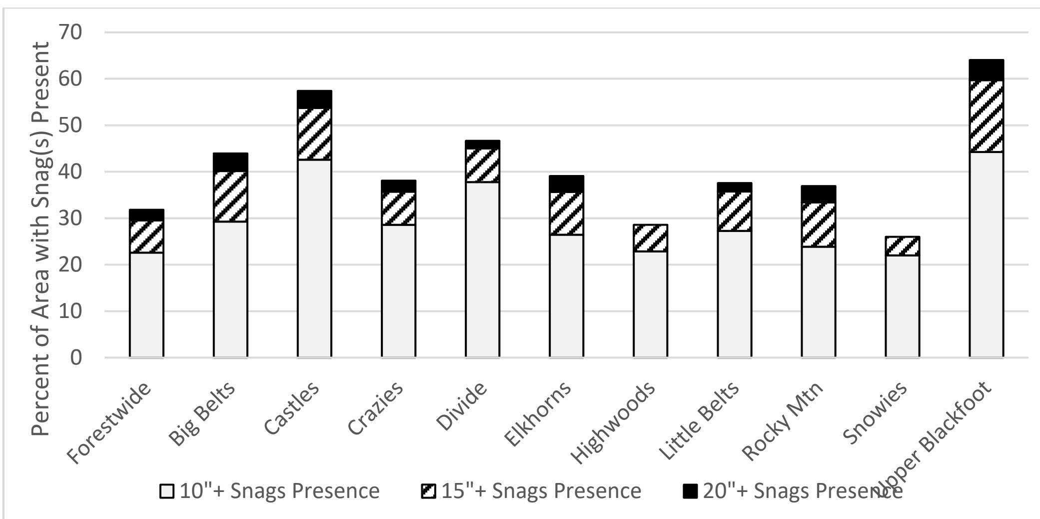

Figure 9. Snags distribution across all snag analysis groups, forestwide and by GA[1]

1. Source: R1 Summary Database: Hybrid 2011 (forestwide & Rocky Mountain Range GA); 4x 2016.

The Rocky Mountain Range and Upper Blackfoot GAs contain the most abundant snags per acre and snag distribution, due to their active recent disturbance history. GAs that have experienced little recent disturbance, such as the Highwoods and Snowies, contain fewer snags. The Big Belts, Castles, Elkhorns, and Upper Blackfoot contain the most very large snags, whereas these snags are essentially absent from the Highwoods and Snowies.

Quantitative desired conditions for snags were not developed for the GA scale for several reasons. First, there is a lack of data available to represent the NRV with confidence at that scale (i.e., fewer data points in roadless and wilderness areas). In addition, the appropriateness and application of GA-level desired conditions could be problematic in small GAs that may be subject to periodic disturbances that create a boom-and-bust situation for snags (i.e., the scale is too small to encompass the natural temporal variability of snag conditions). However, it may be appropriate to consider GA-level snag trends when designing projects (for example, focus on promoting large tree growth for future snag recruitment in the Highwoods and Snowies), as described in appendix C of the draft revised forest plan.

Downed wood

Downed wood is derived from snags, as well as from live trees or parts of trees, that fall to the ground. Recent fires and the mountain pine beetle have increased the amount of snags in many areas. As these snags fall, there will be a period of time when downed wood is elevated in these areas. Decomposition will reduce this component over time.

The desired condition for downed wood is to maintain amounts that contribute to forest structural diversity, soil ecological function, and habitat, focusing on coarse woody debris because larger downed wood is more valuable to ecosystem function than smaller debris. Appendix B displays the current and desired conditions for coarse woody debris across HLC NF. The desired conditions are based on the BASI (Brown et al., 2003). The ecosystem conditions described in the paper are relevant but are based on data west of the Continental Divide and therefore some adjustments using local data are needed.

The desired average tons/acre are not applicable to every forest stand, but rather as broad scale averages. There is no desired condition for nonforested potential vegetation groups, as there is generally no source of downed wood (i.e. trees) in those areas. At all scales, the current estimated amount of coarse woody debris is within the desired condition.

Conditions at the GA scale vary due to the unique topography, site potential, and disturbance history of each area as shown in Figure 10. In all cases the average tons/acre of coarse woody debris is less than 15 tons/acre. The Elkhorns and Upper Blackfoot GAs contain the most average coarse woody debris per acre. GAs that have experienced little recent disturbance, such as the Highwoods, have less coarse woody debris.

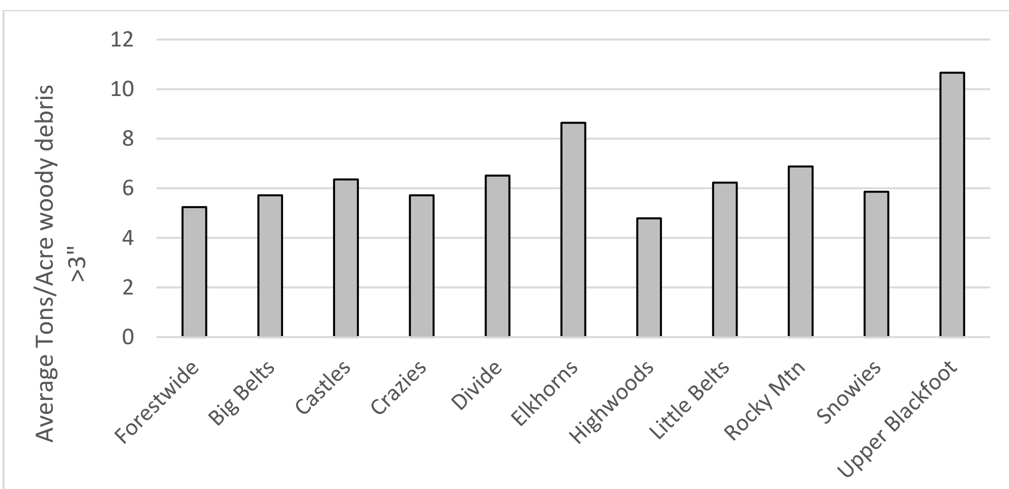

Figure 10. Coarse woody debris average tons/acre across, forestwide and by GA[1]

1. Source: R1 Summary Database: Hybrid 2011 (forestwide & Rocky Mountain Range GA); 4x 2016.

Benefits to people

Some snags provide a direct economic benefit to people when they are utilized with commercial timber sales and salvage projects, or when dead trees are removed as wood for fuel under firewood permits. Dead wood also indirectly provides benefits to people, such as, but not limited to: providing habitat (creating opportunities for wildlife viewing, fishing, and hunting); contributing to watershed function; and contributing to site productivity, which supports desired vegetation that may be used for timber products. In addition, plan components that describe the appropriate levels of dead wood are also of importance to fire risk and potential impacts of fires to values at risk, which include private property as well as other values that people have, such as a desire to recreate in green forests.

3.10.6 Environmental consequences

Effects common to all alternatives

Under all alternatives, snag and downed wood conditions would be dynamic, highly variable and unevenly distributed across time and space. Dead wood would be created by fire, insect, disease, and successional processes. Decomposition and fire are the primary ecological processes that remove dead wood from the ecosystem. In all alternatives, the majority of forest lands are in areas where human management is limited and natural ecological processes and disturbances would be the primary ecosystem drivers affecting snag and downed wood.

Natural disturbances such as wildfire are projected to occur at a similar degree in all alternatives because the impact of forest management has a relatively small influence. These disturbances influence the abundance, distribution, and condition of snags and coarse woody debris. The highest amounts of dead wood would be present where fire or insect/disease outbreaks occur. Snags would fall to the ground to become part of the downed wood component, where they decompose and eventually become part of the soil. Wildfires can have a wide range of effects, both creating snags (especially of smaller size classes) while causing some to fall and be consumed. Similarly, the effects to coarse woody debris can be variable, as fires may consume material on the forest floor, and also create snags and thus future downed wood. Meanwhile, insect infestations create snags, often of large size classes, and thus contribute to future large woody debris.

Recent fire and insect outbreaks on the HLC NF have created snag pulses, which are converting to downed woody material at the writing of this plan. Regardless of the selected alternative, in the short term medium snags, especially lodgepole pine, would be abundant. In the long term, this pulse of snags will be lost to natural attrition, and the material will accumulate on the forest floor as woody debris.

To some degree, fire exclusion would continue to affect the landscape under all alternatives, due in part to continued fire suppression activities. Fire exclusion can limit snag creation in areas that would otherwise have burned. Conversely, over the long term, fire exclusion can increase fuel loadings and stand densities that predispose areas to large stand-replacing events that create snag pulses. The creation of large and very large snags is dependent upon the development of large live trees. Large snags are not abundant because tree growth is moisture-limited on the HLC NF. Further, high stand densities that may develop due to fire suppression or other factors limits the potential for individual large tree growth. Homogenous landscapes yield snag pulses followed by periods with few snags. Because of pulse events, snags may not always be well-distributed spatially or temporally.

Lands where active vegetation management would occur (for example, lands suitable for timber production) cover a minority of the Forest under all alternatives. Many of the forests in areas suitable for timber production and within WUI areas would be managed to maintain vigorous trees and limit losses due to insects, disease and fire where possible. This would tend to result in less tree mortality, and a potentially lower density of snags and downed woody over time as compared to areas less influenced by human actions. On the other hand, active vegetation management provides the opportunity to manage for species and larger size classes that would contribute to larger snags and downed wood. Lower amounts of snags and downed wood would tend to occur in developed sites, areas where concern for fire hazard is elevated and in areas closer to communities and accessible to firewood cutting.

All alternatives have standards and guidelines that direct management of snags and downed wood in timber harvest units. These are designed to address the unequal distribution of snags and downed wood across the forest that may be the result of timber management, and supports the active role that is more likely to be needed to achieve desired conditions within actively managed landscapes.

Effects from plan components associated with:

Climate change

Climate change is anticipated to increase tree mortality on the landscape, either directly through drought and moisture stress on trees, or indirectly by increasing the frequency and severity of natural disturbances such as wildfire and insect outbreaks. Therefore, it will cumulatively impact both snags and downed wood, generally by creating more dead wood but also potentially reducing it in some areas, such as where fire burns repeatedly. Climate is integrated into the SIMPPLLE model and is a major driver of vegetation change and effects of the alternatives over time.

Access and infrastructure

In all alternatives, access on existing roads as well as construction of new roads (both permanent and temporary) could have an impact on the presence of snags and woody debris adjacent to roads, primarily as a function of firewood gathering. All alternatives are similar in terms of road access.

Mining and mineral extraction

Mining undergoes site-specific analysis to determine effects and required mitigation, and effects to vegetation from mining is determined at the project level. The impacts to snags and downed wood from mineral extraction on the forest would be localized, and at the forestwide scale they would be minor.

IRAs

IRAs do not vary by alternative, and timber harvest would be limited in these areas under the Roadless Area Conservation Rule (2001). RWAs, which vary by alternative, tend to overlap with IRAs, and no harvest would be allowed in those areas. Therefore, to the extent that RWAs vary by alternative, so too does the amount of IRAs where harvest could conceivably occur as shown in the Timber section. Prescribed fire may occur in IRAs, and would generally result in increases to the snag and downed wood components, although in some cases some dead wood could be consumed. Natural processes would dominate these areas under all alternatives. Given expected climate, more wildfire and insect activity are likely to occur in the future, and IRAs are likely to contain ample snags and downed wood regardless of whether prescribed fire or timber harvest occurs.

Wildlife management

Management for grizzly bears and lynx affects the amount of vegetation management that occurs on the landscape, as described in the timber and terrestrial vegetation sections. With regards to snags and downed wood, the influence of grizzly bear and lynx management guidance is related to the limitations placed on vegetation management that could reduce these components. For example, timber harvest would not occur in lynx multistory habitat, and these forest patches may provide ample snag and downed wood components. In general, under any alternative grizzly bear and lynx management would contribute to the retention of snags and downed wood on the landscape, because they would result in some limitations to vegetation management activities that could reduce snags or downed wood.

The NRLMD includes a guideline (Veg G11) specifies that denning habitat should be distributed in each LAU in the form of pockets of large amounts of large woody debris. This would apply in potential lynx habitat. This direction may result in project design features that retain concentrations of downed wood in some areas.

Effects common to all action alternatives

All action alternatives include the same snag and woody debris desired conditions, guidelines, standards, and monitoring. Table 52 summarizes the expected effects of these plan components.

Table 52. Summary of revised plan components for snags and coarse woody debris

Plan component	Intent and Expected effects
FW-VEGF-DC-05, 06; FW-VEGF-GDL-01	These desired conditions describe the desired levels of large and very large live trees and concentrations, which represent future large and very large snags and eventually woody debris. The guideline ensures retention of these trees during vegetation management. These components would ensure that future snags and downed wood are available in managed areas.
FW-VEGF-DC-07	This desired condition describes the structural components of old growth, including snags and woody debris. This component would help ensure that in these site-specific areas, snags and downed woody debris would be present and contribute to habitat.
FW-VEGF-DC-08; FW-VEGF-GDL-02	The Forestwide quantitative desired condition for snags describes appropriate numbers and distribution of snags. The guideline specifies the retention of snags during vegetation management. The desired condition would provide for adequate snags at the broad scale, which may be achieved with a combination of natural disturbances and management. The guideline would ensure that snags are retained in managed areas to contribute to the desired condition.
FW-VEGF-DC-09; FW-VEGF-GDL-06	The Forestwide quantitative desired condition for coarse woody debris describes its appropriate abundance and distribution. The guideline specifies woody debris retention during vegetation management. The desired condition would provide for adequate coarse wood at the broad scale, which may be achieved with a combination of natural disturbances and management. The guideline would ensure that sufficient coarse woody debris is retained in managed areas to contribute to the desired condition.
FW-VEGF-DC-11	This desired condition recognizes the role of insects and diseases in creating snags and downed wood to meet FW-VEGF-DC 08 and 09.
FW-POLL-DC-01	This desired condition addresses snags and coarse woody debris as components of pollinator habitat. It would complement FW-VEGF-DC-09.
FW-WTR-DC-12; FW-FAH-DC-02; FW-FAH-OBJ-01; FW-RMZ-GDL-01	These components address woody debris as important features for riparian and aquatic habitat and stream channels and would complement the quantitative desired condition FW-VEGF-DC-09.
FW-SOIL-DC-01; FW-SOIL-GDL-05	This desired condition and guideline reference woody material needed to provide nutrient cycling for soil productivity, and would complement the quantitative desired condition FW-VEGF-DC-09.

Alternative A, no action

Under the no-action alternative, the existing forest plan snag standards would apply for the HLC NFs respectively, as described in Table 53.

Table 53. Alternative A summary of forest plan standards for snags and coarse woody debris

Summary of plan standards	Expected effects
Helena NF Forestwide standard II/21: In summary, this standard requires minimum retention of an average level of snags across each third order drainage (2/acre). The primary areas where snags would be retained are those where timber management is not an emphasis. The standard specifies minimum snags or replacement trees by size class that should be left in cutting units if the average cannot be met otherwise, with the	The standard would result in retaining a minimum average number of snags per acre across each third order drainage; snags would not necessarily be left within treatment units. Not all of the Forest is delineated as a third order drainage, and therefore this standard would not necessarily be applied to all NFS lands. This plan component does not recognize the variability in snag distribution (clumpiness) nor the unique qualities and disturbance regimes of PVTs (or snag groups). It is not

Summary of plan standards	Expected effects
exception of units that are pure lodgepole pine. The plan does not include any quantitative guidance for coarse woody debris.	consistent with best available science for the natural condition of snags on the landscape. The management of coarse woody debris would be guided by other law, regulation, or policy.
Lewis & Clark NF Forestwide standard C-4: In summary, this standard includes both snags and down trees as wildlife trees, defining hard versus soft. All soft trees are to be retained. Recommended sizes and numbers of hard snags to retain across varying scales are specified by vegetation type and wildlife species. The desired distribution of these trees is described as is leaving live deformed trees for snag recruitment. *Standard E-1* also mentions informing the public on the importance of snags.	The standard would result in retention of minimum numbers of hard snags in the sizes and vegetation types described, which are not necessarily consistent with the best available science. The management of coarse woody debris would be further guided by other law, regulation, or policy.

Effects that vary by alternative

Snags can be created through management actions such as prescribed burning, and reduced by management practices such as timber harvest. The increases and decreases in snags are followed by subsequent increases and decreases in woody debris. These influences are at play under all alternatives, and to a small degree the magnitude of these events varies slightly.

The differences across alternatives are caused primarily by the land allocations that influence the type and amount of vegetation management that can occur. These allocations include suitability for timber production, RWAs, and ROS settings. It is impossible to model the nuances of meeting the snag and downed wood plan components across the landscape through time, because it is not possible to model at the broad scale the variations of site-specific treatments. The Spectrum model reports numbers of snags and downed wood; however, snags and downed wood are not well accounted for in new “regeneration” stands that are modeled after a disturbance occurs.

This analysis therefore relies on the expected magnitude of processes that influence snags and downed woody debris to compare alternatives. Figure 11 shows the four primary influences on snags and downed wood that vary by alternative: wildfire, bark beetles, prescribed burning, and timber harvest. Wildfire and prescribed burning would generally create snags in the short term, most often of the smaller size classes, although some snags and downed wood could be consumed. Bark beetles would tend to create large or very large snags and not consume any existing snags or downed wood. After these events, the longevity of the snags would vary depending on site-specific conditions, and as they fall the downed wood component would increase. For this comparison, it is assumed that timber harvest would reduce snags and downed wood, although appropriate levels of snags and downed wood would be retained.

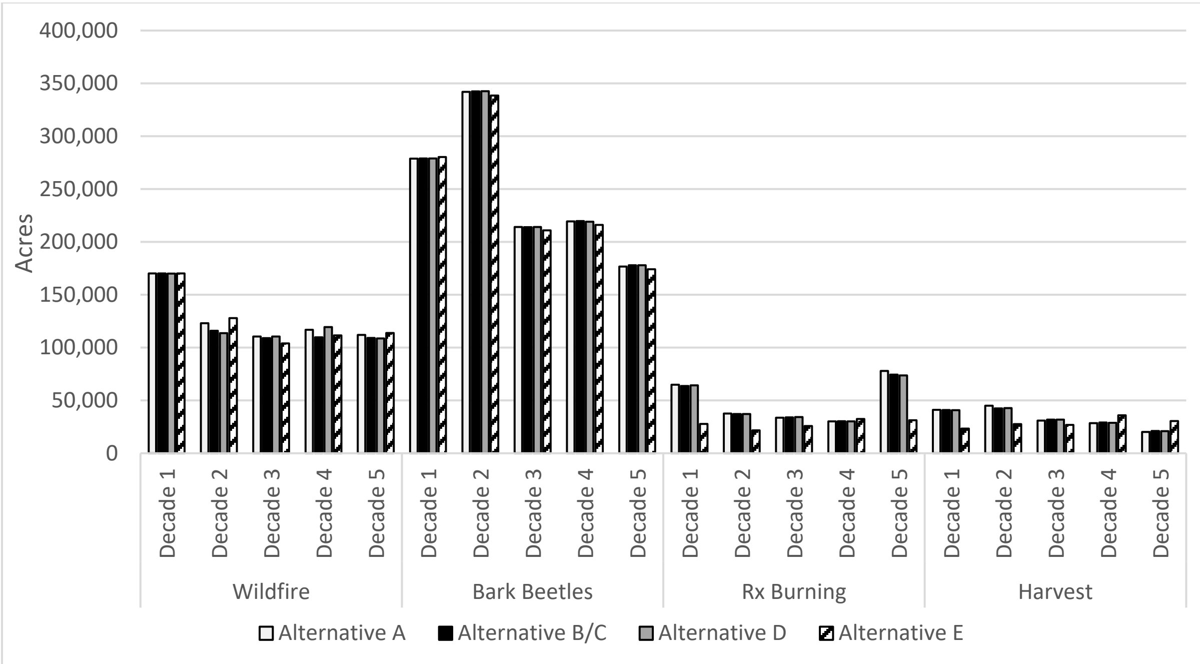

Figure 11. Processes and activities that influence snags and downed wood by alternative[1, 2, 3]

1. Source: Wildfire and bark beetle acres are from the SIMPPLLE model.
2. Prescribed burning is modeled by Spectrum for forested lands only, and does not reflect the entire burn program expected on the HLC NF, which would include nonforested lands as well. Actual accomplishment of burning would vary depending on operational considerations such as weather.
3. Harvest is modeled with Spectrum; see also the Timber specialist report.

While the alternatives vary slightly, at the programmatic level these differences are slight. Natural processes, primarily bark beetles, would influence snags more so than management activities under all alternatives. The potential loss of snags in timber harvest areas is far less than the potential creation of snags from natural disturbances and prescribed fire. It is likely that snags and downed wood would be within, or possibly higher, than the desired ranges for most periods in the future. Given that bark beetle activity is likely to be the most widespread disturbance, this may likely include creation of snags in the largest size classes available.

Effects from forest plan components associated with:

Vegetation management

Vegetation management (such as prescribed fire, timber harvest, and other stand tending) may occur for many purposes, including projects where coarse woody debris and snags are deliberately removed and others which maintain or increase these features. The influence of factors that drive how much vegetation management occurs is expressed by the projected acres of treatments that would occur by alternative, as shown in the terrestrial vegetation and timber sections.

The removal of snags and downed wood can also occur with salvage harvest, which is not predicted with the Spectrum model. The Forest salvage harvested approximately 2 percent of acres of lands that burned from 1986 to 2017. Although the amount is unknown, salvage harvest may occur in the future. If salvage is conducted under the action alternatives, plan components for snag and downed wood would ensure that at least the minimum levels of dead wood material would be retained, and FW-TIM-GDL-04 further would ensure that clusters of burned trees would be retained to provide habitat for wildlife species associated with burned habitats. Under alternative A, snag management standards would also result in at least minimum retention of snags. More information on the potential for salvage and the ecological effects is provided in the terrestrial vegetation and timber sections.

RWAs

Natural processes dominate these areas in terms of the influence on downed wood and snags. It is expected that snags and downed wood may be abundant in these areas given expected future disturbance and limited human influence, although the quantity and distribution may be cyclic in nature especially where stand-replacing disturbance regimes occur. Alternative D has the greatest acres of RWA, while alternative E has the least.

Aquatic habitat, riparian area, and watershed

Plan components that protect aquatic habitat, riparian areas, and watersheds generally contribute to the retention of snags and downed wood. The most specific plan direction for these resources related to dead wood are those for RMZs.

Under alternative A, the areas of the HLC NF west of the Continental Divide would be guided by riparian habitat conservation area direction found in the INFISH (USDA, 1995c); these areas are limited to portions of the Divide GA and most of the Upper Blackfoot. The remainder of the forest would be subject to state streamside management law and BMPs. This direction would generally ensure the retention of dead wood, snags, and a proportion of live trees immediately adjacent streams. The SMZs vary in size based on the type of stream but are generally smaller than the zones defined for the action alternatives.

With alternatives B/C, D, and E, all areas of the HLC NF would be subject to guidance for RMZs, which are defined based on the size and type of stream and include inner and outer boundaries. It is expected that greater amounts of snags and downed wood would be present in these areas, and vegetation management less common than in other areas on the landscape.

Cumulative effects

Portions of the HLC NF adjoin other NFs, each having its own forest plan. Generally speaking, management of vegetation is similar across all NFs due to law, regulation, and policy. In addition, the HLC NF is intermixed with lands of other ownerships, including private lands, other federal lands, and state lands. Some GAs contain inholdings of such lands, while others are more unfragmented. The GAs which are island mountain ranges are typically surrounded by private lands. Harvesting or conversion of forests on adjacent private and state lands will affect vegetation conditions at the landscape level, changing forest composition and structures. Snags and large and very large trees (future snags) may be removed on non-NFS lands, increasing the importance of retention on NFS lands. Snags on adjacent private and other non-NFS lands are likely to be less abundant.

Some adjacent lands are subject to their own resource management plans. The cumulative effects of these plans to snags and downed wood, in conjunction with the draft plan, are summarized in Table 54.

Table 54. Summary of cumulative effects to snags and downed wood from other resource management plans

Resource plan	Description and Summary of effects
Adjacent National Forest Plans	The forest plans for NFS lands adjacent to the HLC NF include the Custer-Gallatin, Lolo, Flathead, and Beaverhead-Deerlodge NFs. While specific snag and downed wood components vary, all plans address these attributes to some extent. The cumulative effect would be that snags and downed wood are present across NFS lands at a scale broader than the HLC NF, and the management of these resources would be generally complementary. This includes specific adjacent landscapes that cross forest boundaries, such as the Upper Blackfoot, Divide, Elkhorns, Crazies, and the Rocky Mountain Range.

Resource plan	Description and Summary of effects
Montana Statewide Forest Resource Strategy (2010)	This plan guides forest management on state lands. It includes many concepts that are complementary to the plan components for the HLC NF, for example promoting forest resilience, providing wildlife habitat, and reducing hazardous fuels. This plan does not explicitly mention snags or downed wood. It is possible that these attributes would not be a focus on these lands, thereby increasing the importance of snags and downed wood found on nearby NFS lands.
BLM Resource Management Plans (RMP)	BLM lands near the HLC NF are managed by the Butte, Missoula, and Lewistown field offices. The Butte plan was recently revised (2009) and includes components specific to snags and downed wood. The existing plans for the Missoula and Lewistown areas are under revision. It is likely that they would contain components similar to the Butte plan, and that to some extent snags and downed wood would be managed for on these lands in a fashion complementary to the HLC NF.
National Park Service - Glacier National Park General Management Plan 1999	The general management plan for Glacier National Park does not mention snags or downed wood, but calls for preserving natural vegetation, landscapes, and disturbance processes. Snags and downed wood are likely present in this area to a similar degree, and subject to similar ecosystem processes, as the wilderness areas in the adjacent Rocky Mountain Range GA and would likely complement these habitat conditions.
Montana Army National Guard – Integrated Natural Resources Management Plan for the Limestone Hills Training Area 2014	This plan is relevant to an area adjacent to NFS lands in the Elkhorns GA. The Limestone Hills area is primarily nonforested, although the plan does call for managing for fire-resilient vegetation. The plan does not have provisions related to specifically to snags or downed wood; therefore, it should be assumed that these lands would not contribute to a landscape abundance and distribution of these components associated with the Elkhorns GA.
Montana State Parks and Recreation Strategic Plan 2015-2020	These plans guide the management of state parks, some of which lie nearby or adjacent to NFS lands. Snags and downed wood are not specifically mentioned. While they may be present, it is unlikely that snags or downed wood would be a focus in these areas. These lands may not contribute to a landscape abundance and distribution of snags and downed woody debris.
Montana's State Wildlife Action Plan	This plan describes snag and downed wood habitat where important for specific wildlife species. This plan would likely result in the preservation of these habitats on state lands, specifically wildlife management areas. This plan would interact with the Montana Statewide Forest Resource Strategy. This plan should help ensure that snags and downed wood exists in some amount on state-owned lands and therefore would be complementary to the HLC NF Forest Plan.
County wildfire protection plans	Some county wildfire protection plans map and/or define the WUI for that county. The HLC NF notes that these areas may be a focus for hazardous fuels reduction, and other plan components (such as NRLMD) have guidance specific to these areas. The snag and downed wood plan components in the revised forest plan specifically allows that these areas would have fewer snags and downed wood.
City of Helena Montana Parks, Recreation and Open Space Plan (2010)	This plan is relevant to an area that lies adjacent to NFS lands in the Divide GA, in proximity to the City of Helena. The plan emphases forest management and wildfire mitigation. It is likely that there would be relatively few snags and downed wood in this area due to its recreation emphasis, thereby increasing the importance of these components in other areas of the Divide GA.

Conclusions

Natural processes such as wildfire, insects, disease, and vegetative succession would be the primary drivers of snag and downed wood creation and attrition over time under all alternatives because of the vast areas of the HLC NF that have minimal human influence. Along open roadways, firewood cutting and other activities may reduce the dead wood components; this would occur to a similar extent under all alternatives. Vegetation management would also influence these components. It is in this regard that the alternatives vary slightly due to different land allocations and expected harvest and prescribed burning.

Medium snags are currently abundant on many landscapes due to the recent mountain pine beetle outbreak; it is expected that these snags will decrease over time as they fall to the forest floor, with a corresponding increase in downed wood – this trend would be most evident in lodgepole pine stands. Future wildfire and bark beetle outbreaks are expected to continue to create snags, along with prescribed fire. Decreases in snags that may be caused by timber harvest would generally be minor in comparison to these other factors. All alternatives are similar with regards to snags and downed wood.

The following key points summarize the conclusions for the snag and downed woody debris resources:

- Natural disturbances are the primary factors affecting snags and downed woody debris.
- The existing conditions of medium, large, and very large snag quantity is generally within or slightly above the desired ranges; the distribution of medium snags specifically is above the desired condition while the distribution of the other size classes is close to or only slightly above.
- The existing conditions of coarse woody debris are within the desired ranges.
- The anticipated effects to snags and downed wood are similar for all alternatives.
- The action alternatives contain desired conditions and standards that would ensure that snags 10" and greater in diameter and coarse woody debris are present in quantities and distributions consistent with our best understanding of natural conditions. The no-action alternative also contains specific quantitative snag standards that would provide for minimum numbers of snags within certain scales, but have no components related to down woody debris.

3.11 Plant Species at Risk

3.11.1 Introduction

The geographic scope of the analysis for effects to at-risk plant species in the planning area is the lands administered by the HLC NF. The specific range of each at-risk species may extend beyond the forest boundary, however the lands administered by the Forest represent the area where changes may occur to these species or their habitats from activities that might be allowed under the alternatives. In some cases, the BASI for at-risk species' ecological relationships originated outside the analysis area. The full range of each species was considered to evaluate the viability and importance of each species' habitat within the plan area, but only indicator measurements from within the analysis area was used in making conclusions.

3.11.2 Regulatory framework

Please refer to the introductory regulatory framework section of this chapter (3.3).

3.11.3 Assumptions

Assumptions in this analysis are based on the ESA (that applies to all alternatives) and the FS manual direction (that applies to alternative A). The revised FS manual policy regarding SCC is forthcoming and the changes and impacts are not known. The current management direction is to evaluate proposed management activities and project areas for the presence of occupied or suitable habitat for any plant species listed under the ESA or on the Regional Forester Sensitive Species (RFSS) list (alternative A). FS policy is expected to include similar policy to maintain the viability of SCC (alternatives B-E) in the plan area. Additional information regarding SCC policy is expected following the release of this plan.

Relevant considerations to the analysis that are common to all alternatives include (1) designated wilderness would continue to be managed as such, (2) there would be a general increase in recreational demand as the human population size increases, (3) weeds and weed seeds would continue to be deposited and spread onto and within the planning area, and (4) climate change trends would continue as projected, with warming temperatures and variable precipitation.

The general strategies in appendix C would be followed for all action alternatives.

At-risk species occupy specific habitats on the landscape. There is limited data regarding trends for many at-risk plant species, so monitoring would be essential to determine the impacts of project activities and management direction.

3.11.4 Best available scientific information used

Primary information sources for at-risk plant species and their occurrences on the Forest are the FS Natural Resource Manager, Montana Natural Heritage Program Element Occurrence databases and online Montana Field Guide, NatureServe database, and the Consortium of Pacific Northwest Herbaria. The majority of at-risk plant species that are not federally listed do not have the same level of scientific data available as federally listed species. Though there may be uncertainties and gaps in data and knowledge about rare plant species, the best available information is utilized in this analysis to assess the designated condition and determining potential effects between alternatives.

The HLC NF botany program maintains a forestwide inventory of known sensitive species occurrences. This inventory includes information on population size, viability and potential threats known to populations collected by trained botanists. Most information on these plants are derived from expert opinion and/or panel consensus, specifically at biannual meetings held by the Montana Native Plant Society in conjunction with the Montana Natural Heritage Program. There is little published information about most rare plant species concerning their viability, biology, habitat, population dynamics, and occurrences. Information gaps relevant to at-risk species may be filled in through future inventories, plan monitoring program results, or research, and this information would be integrated into the databases as it becomes available.

3.11.5 Affected environment

A total of 31 at-risk plant species were identified on the HLC NF, including one candidate species (see appendix D). Although some hotspots of diversity can be identified on the NF (like the high alpine species found on the Rocky Mountain Front GA, or the east side of the Little Belts range GA), at-risk plant species and/or habitat can be found in all floristic geographic subdivisions, and in all ecosystem types.

Threatened, endangered, and candidate species

While no federally listed species are currently known to occur on the HLC NF, there is one candidate species: whitebark pine (*Pinus albicaulis*). The USFWS determined in 2011 that whitebark pine is a candidate species, with listing as threatened or endangered warranted but precluded by higher priority actions (FR 76(138): 42631-42654). As a result, Region 1 added whitebark pine to the RFSS list in 2011. The USFWS initially assigned whitebark pine a listing priority number of 2, indicating the threats were imminent and of high magnitude. The listing priority number was changed to 8 (threats imminent but of moderate magnitude) in 2015 (FR 80(247): 80584-80614).

Whitebark pine is a key ecosystem component growing at the highest forested elevations in cold, windy, snowy, and generally moist climatic zones (Arno & Hoff, 1989) that are difficult areas for plants and animals to inhabit. These areas are naturally limited in species diversity, and whitebark pine is an important component of this diversity.

According to FIA data, whitebark pine is present on roughly 12% of the HLC NF, or about 333,350 acres. It is dominant on far fewer acres; the whitebark pine cover type occurs on only 4%. This is because in some areas whitebark is a minor component in areas dominated by other species such as subalpine fir. Whitebark pine primarily occurs on the cold broad PVT. Whitebark pine is present on most GAs except the Highwoods. There are 47,125 mapped acres of whitebark pine on the HLC NF that was used to analyze the effects of the draft plan based on differences in alternatives. Though whitebark pine occurs on a greater number of acres in the plan area, this number of mapped acres is used because it is the best available spatial data available. This mapping is based on remotely sensed imagery and best available field data, but does not necessarily represent the abundance statistically represented by FIA estimates.

The interrelated threats to whitebark on the HLC NF that raise concerns about the long term viability of whitebark ecosystems include fire suppression, white pine blister rust, mountain pine beetle, and climate change.

Plant species of conservation concern

Table 55 below lists the plant species that are currently determined to be SCC by the Regional Forester on the HLC NF. Additional information on these species can be found in appendix D. In addition, information regarding the rationale for identifying these species as SCC can be found on the Region 1 SCC web page at: http://bit.ly/NorthernRegion-SCC.

Table 55. Plant SCC

SCC	Conservation Categories[1]	Distribution and Abundance in the Plan Area
Musk-root (*Adoxa moschatellina)*	SCC, RFSS, SOC, G3	One occurrence along the Smith River in the Smith River Wild and Scenic byway.
Round-leaved orchis (*Amerorchis rotundifolia*)	SCC, RFSS, SOC, Adjacent SCC	20 mapped areas in the Rocky Mountain Front GA, outside of wilderness; occurrences clustered near center of GA
Short-styled columbine (*Aquilegia brevistyla*)	SCC, RFSS, SOC, S2	43 occurrences occur on the east side of the Little Belts GA, in the Judith RD
Lesser rushy milkvetch (*Astragalus convallarius*)	SCC, SOC	Much of the species' range occurs in the valley near Helena, between the Big Belt, Elkhorns and the Divide GA's. Two occurrences are mapped in the Big Belts GA. More are likely.
Lackschewitz's milkvetch (*Astragalus lackschewitzii*)	SCC, SOC, RFSS, S2, G2	12 mapped occurrences in 4 areas of the Rocky Mountain GA; species is endemic to the Rocky Mountain GA
Dainty moonwort (*Botrychium crenulatum*)	SCC, RFSS, SOC, G3	Two occurrences known on the Divide GA.
Peculiar moonwort (*Botrychium paradoxum*)	SCC, RFSS, SOC, G3, Adjacent SCC	Four occurrences in the Plan Area; one in the Divide GA and three in the Rocky Mountain GA.
Low northern rockcress (*Braya humilis* or (*Neotorularia humilis*)	SCC, SOC, S2 (S1 Nature Serve)	Big Snowies (2 mapped occurrences), Rocky Mountain GA (1 occurrence)
Kerry's paintbrush (Castilleja kerryana)	SCC, SOC, G3	Newly described species, endemic to MT on Scapegoat Plateau in the Straight Creek and South Fork of the Sun River.
Small yellow lady's slipper (*Cypripedium parviflorum*)	SCC, RFSS, S3	Occurs in one drainage on Rocky Mountain GA; one additional occurrence is adjacent to Divide GA
Sparrowleg lady's slipper (*Cypripedium passerinum*)	SCC, RFSS, SOC,S2, Adjacent SCC	Rocky Mountain Front - 10 mapped occurrences.
Limestone larkspur (*Delphinium bicolor ssp. Calcicola*)	SCC, T3 (variety equivalent to G3)	One occurrence in the Big Belt GA.
Denseleaf draba (*Draba densifolia*)	SCC, SOC, S2	Five occurrence in the Blackfoot and Rocky Mountain GAs.
English sundew (*Drosera anglica*)	SCC, RFSS, SOC	Two occurrences in the Indian Meadows RNA in the Upper Blackfoot GA. Habitat is limited in Plan Area.

SCC	Conservation Categories[1]	Distribution and Abundance in the Plan Area
Slenderleaf sundew (*Drosera linearis*)	SCC, RFSS, SOC, S2, Adjacent SCC	Known from two occurrences in the Indian Meadows RNA in the Upper Blackfoot GA. Habitat is limited in Plan Area.
Beaked spikerush (*Eleocharis rostellata*)	SCC, RFSS, SOC, Adjacent SCC	Little Belts GA, two occurrences mapped
Northern wildrye (*Elymus innovates*)	SCC, RFSS, SOC, S2	Known from four mapped occurrences at two locations in the Rocky Mountain and Little Belts GAs.
Giant helleborine (*Epipactis gigantean*)	SCC, RFSS, SOC, S2, Adjacent SCC	Rocky Mountain GA, one occurrence.
Fan-leaved fleabane (*Erigeron flabellifolius*)	SCC, SOC, G3	Crazies GA.
Macoun's fringed gentian (*Gentianopsis macounii*)	SCC, RFSS, SOC, S2	One mapped occurrence in the Rocky Mountain GA
Lesser rattlesnake plantain (*Goodyera repens*)	SCC, RFSS, SOC	Little Belts and Snowies GA. 94 mapped occurrences.
Howell's gumweed (*Grindelia howellii*)	SCC, SOC, RFSS, G3, S2, Adjacent SCC	One large occurrence mapped in the Divide GA.
Treelike clubmoss (*Lycopodium dendroideum*)	SCC, RFSS, SOC, S2	One occurrence is mapped in the Blackfoot GA.
Missoula phlox (*Phlox kelseyi var. missoulensis*)	SCC, RFSS, SOC, G3	53 mapped occurrences across the Little Belts, Big Belts, Divide, and Blackfoot Gas.
Austin's knotweed (*Polygonum austiniae or Polygonum douglasii var. austiniae*)	SCC, RFSS, SOC	35 mapped occurrences in the Big Belts, Rocky Mountain, and Little Belts Gas.
Bluntleaf pondweed (*Potamogeton obtusifolius*)	SCC, RFSS, SOC	Three occurrences in Rocky Mountain GA.
Northern buttercup (*Ranunculus pedatifidus*)	SCC, SOC	Two known occurrences in the Rocky Mountain GA; historical collection from Little Belts.
Water bulrush (*Schoenoplectus subterminalis*)	SCC, RFSS, SOC	One occurrence on the Upper Blackfoot GA, Indian Meadows RNA
Scorpidum moss (*Scorpidium scorpioides*)	SCC, RFSS, SOC, S2, Adjacent SCC	Rocky Mountain GA, one occurrence.
Sphagnum (*Sphagnum fimbriatum*)	SCC, SOC, S1	Upper Blackfoot GA, one occurrence.
Letterman's needlegrass (*Stipa lettermanii*)	SCC, SOC, S1	One occurrence in the Crazies GA.

1. RFSS = Regional Forester Sensitive Species; SCC = species of conservation concern; SOC = species of concern; S1 = state ranking 1; S2 = state ranking 2; G3 = global ranking 3.

Species guilds

Plant species have been grouped for purposes of analysis, based on broad similarity of habitat they occupy. Though there may be variation in specific habitat needs for species within a guild, the potential stressors and associated conservation strategies for the species in the habitat guild would be very similar, allowing for more efficient analysis and identification of relevant information pertaining to the species.

The list of plant species previously identified as sensitive and known to occur on the HLC NF, and their associated habitats, is in appendix D. There are a total of 34 species previously identified as sensitive. 14 species from the RFSS list would not be designated by the Regional Forester as SCC and 9 additional species would be added that were not previously identified as at-risk species. Of the 14 plant species previously identified as sensitive, 7 are not currently known to occur within the plan area or occur only historically. These species are 'suspected, but not known' and thus do not meet the criteria for SCC. This group includes *Botrychium ascendens*, *Carex chordorrhiza, Micranthes tempestiva, Salix barrattiana, Thalictrum alpinum, Trichophorum cespitosum*, and *Veratrum californicum*. These suspected species will not be considered further in this document. Also, *Pinus albicaulis* is not a SCC because it is addressed as a candidate threatened and endangered species under the ESA. The remaining 5 species, which are known to occur within the plan area, fall within habitat groups that are also associated with the identified plant SCC. This group includes *Carex rostrata, Erigeron lackschewitzii, Juncus hallii, Oxytropis podocarpa,* and *Potentilla nivea var. pentaphylla*. Stressors and effects to these species would be similar to those disclosed for the SCC in their respective habitat guilds.

SCC found on the HLC were placed in one or more of the following guilds:

- Peatlands
- Wetland-riparian
- Alpine
- Grasslands
- Mesic-Montane-Disturbance-Talus
- Aquatic

Benefits to people

Rare plants contribute to diversity on the landscape and recreation opportunities for rare plant enthusiasts. Please refer to the ecosystem services section for more information about multiple uses, key ecosystem services, and benefits to people.

3.11.6 Environmental consequences

Effects common to all alternatives

At the scale of the entire HLC NF, it is difficult to assess the impacts of Plan direction to 31 SCC, 1 candidate species, and 12 RFSS. Plant species may be rare due to evolutionary history, changes in climate, basic population ecology, historic or current human activities, or more likely, a complex combination of these factors. Human activities may or may not be responsible for the current distribution and abundance of the rare plant species. An important assumption in this analysis is that certain management actions may contribute or detract from the availability or quality of habitats that support rare plant species.

Threatened, endangered, proposed, or candidate species have special management requirements for all FS management activities. The ESA section 7 guidelines and recovery objectives would be followed if potential habitat for any threatened or endangered plant species were to occur on the Forest. For RFSS, policy to ensure the diversity of rare plant communities or their habitat are already in place and would continue under the No-action alternative. This policy would not continue under the new 2012 Planning Rule, but current and future policy for SCC would be followed.

In addition, all of the alternatives (including alternative A) retain Montana Statewide riparian area protection and riparian management objectives for habitat conservation areas and a comprehensive set of standards and guidelines related to what kind of activities may or may not occur within the riparian areas. Although they were not specifically designed to do so, many of the standards and guidelines serve as protection measures for rare plants that are associated with aquatic and/or riparian habitats.

Climate change

Anthropogenic caused increases in temperatures and changes in precipitation are likely to impact both ecosystem structure and ecosystem processes (IPCC, 2007). Climate controls many ecosystem processes including species distribution and abundance, regeneration, vegetation productivity and growth, and disturbance all of which could affect at-risk species on the HLC NF. While there is some uncertainty regarding the scale, rate, and direction of future climatic conditions in the western United States and Montana some general observation regarding past changes and expected future changes, the majority of published science suggests that climate changes may strongly influence the frequency, intensity, and size of disturbances (such as fire and extensive insect outbreaks) in coming decades on areas of the HLC NF. Changes in disturbance prompted by climate change are likely as important as incremental changes in temperature and precipitation for affecting ecosystem productivity and species composition. Recent research indicates that these risks may be particularly acute for forests of the Northern Rockies. Conservative future climate scenario models predict that the effects of climate change result in a growing season lengthened, the number of days with snow on the ground decreased, peak snow occurred earlier, and water stress increased for all sites in the study, which represent temperature and precipitation spectrum in the forests of the Rocky Mountain region (Boisvenue & Running, 2010).

All habitat guilds for at-risk species are expected to be impacted by climate change. Peatland, aquatic, wetland-riparian, grasslands, and montane-mesic-disturbance-talus guilds may increase the rate of desiccation due to increased and prolonged summer temperatures and/or drought conditions, although due to uncertainty, the opposite could be true and all guilds could see an increase in precipitation. Available habitat in the alpine habitat guild for sensitive species may decrease as a result of climate change and an upward shift of lower alpine habitats. Increased fire severity or frequency may also affect all habitat guilds except the aquatic guild, especially those found outside of rocky areas, either favorably or detrimentally depending upon their habitat requirements.

Increases in the severity of disturbances, combined with projected climatic changes, may limit habitat for at-risk species. Rare and uncommon species, disjunct populations and species at the edge of their known range are expected to experience a number of barriers when adjusting to a rapidly changing climate because of the combination of a small number of occurrences, narrow elevation ranges, and requirements of specific soils types. Some sensitive species with potential habitat in project area are known to occur on restricted and/or limited areas within the forest. Plants confined to outcrops of special soils are generally expected to have a far lower chance of successful migration to new suitable sites and thus far greater risks of extinction in the face of climate change, than plants that are soil generalists (Harrison 2009). Because of the uncertainty in scale, direction, and rate of climate change, management of sensitive species on the HLC NF focuses on maintaining viable populations throughout the species known range in the plan area.

Whitebark pine population trend

Based on a preponderance of data, the USFWS has concluded that there is an ongoing pattern of substantial decline of whitebark pine on the majority of its range (U.S. Department of the Interior, Fish and Wildlife Services, 2011). They predict whitebark pine forests may become extirpated and its ecosystem functions rendered obsolete in the foreseeable future. As discussed in the forest plan assessment, analysis at the Regional scale indicates that the abundance of live whitebark pine has decreased. The abundance of the whitebark pine cover type on the HLC NF is below the NRV, and SIMPPLLE modeling indicates that the cover type would generally remain static over time. In contrast, the overall distribution (presence) of whitebark pine is within the NRV, and at the forestwide scale slightly declines but remains within the natural range over a 50-year modeling period. Whitebark pine presence increases in some GAs, and decreases in others, as influenced by factors such as climate, disturbances, succession, and vegetation management.

The loss of whitebark has dramatically altered the structure, composition and pattern of high-elevation ecosystems, and threatened their long-term stability and integrity. This impacts hydrological processes and wildlife habitat values. Restoration activities are needed to address the threats to whitebark pine (USDI 2011). The percentage of whitebark that are resistant may increase slowly through the process of natural selection, if 5-needled pines are given a chance to regenerate (Tomback et al 2001).

The current Forest Plans do not contain specific standards or guidelines related to maintaining whitebark pine. The revised plan components include specific targets for treatments acres of whitebark pine. The current and revised plans have opportunities to restore whitebark pine and are expected to contribute to this species persistence in the plan area despite the current population trend.

Current stressors in habitat guilds

Peatlands

Threats to peatlands include land uses surrounding fens that can potentially alter the hydrology, water quality or nutrient inputs of these systems, thus changing their underlying processes (i.e. diversion, draining, development, road construction, and heavy grazing). Increased land use within 100 meters has been found to be correlated with increased nutrient levels in peatlands in Montana, suggesting that setbacks should be 100 meters or more for adequate protection (Jones 2003). Draining, heavy cattle use, and irrigation practices can also alter hydrology and result in the loss of species diversity. Localized peat mining may occur on private lands.

Wetland-riparian

Threats to wetland-riparian habitats include heavy grazing, invasive species, drought, alteration of the original hydrology or hydric soils (i.e. diversion, draining, development, road construction, and heavy grazing). Management activities that have the potential to disturb soils and vegetation within riparian areas or adjacent to wetlands, such as road construction, reconstruction, and maintenance; livestock use; disturbances/exclusion as they change vegetation conditions in riparian areas and vegetation adjacent to wetlands, invasive plant treatments, recreation use, trails, visitor trampling, camping in riparian areas.

Alpine

Alpine habitats are often fragile systems due to limited growing season and soil development. Although recreation and road construction are threats to rocky habitats, disturbance is often limited due to inaccessibility. Radio structures, mining, trail construction and recreation and are the main management related disturbance. Changes in fire patterns and severities, and associated effects on vegetation succession may be a stressor in some environments. Grazing has the potential to negatively impact these habitats, but this activities rarely occurs in these habitats due to low forage cover.

Grasslands

Threats to grasslands include fire suppression, agricultural conversion, heavy grazing, noxious species invasion, conifer encroachment, off-trail recreation (e.g. all-terrain vehicles, bicycles) and human development. In the absence of natural fire, periodic prescribed burns and appropriate grazing management practices can be used to maintain this system. The spread of nonnative grasses species has reduces native species diversity in all GAs in the plan area.

Mesic-montane-disturbance-talus

Stressors and ecological processes that influence upland forested habitats apply to all species to varying degrees. These include vegetation treatments (such as logging and prescribed fire), fire disturbances and fire exclusion/suppression, natural succession, cattle grazing, trampling, construction of roads and other developments, mining activities, recreational activities, such as trails, camping and off road vehicle use, that could disturb or trample plants, and invasive plant species and treatment of infestations.

Aquatic

Stressors to these species would be similar to those associated with fens and wetlands, including changes in hydrology or water quality that might occur either from natural or human caused sources. Threats include alteration of the original hydrology or hydric soils (such as diversion, draining, development, road construction, and heavy grazing). Invasive species also pose a threat to wetland plant communities.

Effects from forest plan components associated with:

Recommended wilderness

The alternatives vary in the quantity and location of RWAs, ranging from none in alternative E, to 16 areas in alternative D. RWAs would protect at-risk plant habitat from ground disturbing threats and development, and these areas would be managed allowing natural fire regimes to contribute to a mosaic of different seral stages and diversity habitats as much as possible. An increase in RWAs decreases threats to at-risk plants overall from ground disturbing activities (i.e. vegetation projects, some motorized/mechanized access) while promoting a naturally managed system that has the potential to improve the mosaic pattern on the landscape for approximately 15 years. Since the guidelines for RWAs are similar to IRAs, and the bulk of each RWA overlaps with IRAs, the decrease in threats overall are minimal in these areas. Areas proposed as RWAs that were not previously identified as IRA would see a more substantial decrease in threats. See the administratively and congressionally designated areas sections for more details on the management differences between RWAs and IRAs.

All action alternatives would have the same level of ability to achieve desired vegetation conditions within RWAs through the use of vegetation treatments within RWAs. All have forest plan direction that allow restoration activities to occur as long as the ecological and social characteristics that provide the basis for wilderness recommendation are maintained and protected. Anticipated vegetation treatment activities would largely be associated with the restoration of high elevation ecosystems, and whitebark pine forest communities in particular. There may be other treatments occurring to achieve restoration objectives outlined in the plan components. The most likely treatment would be prescribed burning (planned ignition), in some cases followed by limited planting of conifer seedlings. Objectives would include restoration of desired forest structure and compositions, and to restore desired landscape patterns.

Lands suitable for timber production

Timber harvest is most likely to occur on lands identified as suitable for timber production. Harvest increases some threats to at-risk species but also can create a mosaic pattern on a landscape and promote early successional stands with some treatments, such as regeneration harvest. Typically known at-risk species would receive site-specific protection following botanical surveys (FS Manual 2670) and negative effects would be minimized. This would continue to occur with the revised plan components for at-risk species and the management strategies in appendix C of the revised plan. Without these components and strategies, it is likely that several at-risk species would decline in the plan area. Vegetation treatments can also increase forest resiliency by treating insect and disease and reducing fuel loads, improving for health in the long term. Individual occurrences and suitable habitat could be impacted in the short term by mechanized equipment and incidental damage from felling trees. Site disturbance and increased weeds could also negatively impact habitat requirements. Long term habitat improvements include habitat heterogeneity, increased diversity and increased available forage.

Habitat connectivity

Habitat connectivity would be improved under three of the alternatives by the prioritization of certain areas of wilderness which creates uninterrupted habitat corridors. These areas would receive minimal disturbance and increase habitat quality. The focus on habitat connectivity improves the selection of wilderness areas to increase effectiveness of the naturally managed areas to support diverse natural ecosystems.

Motorized and mechanical means of transport

Motorized and mechanical means of transport impact sensitive plant occurrences within road prisms and parking areas and remove habitat in these areas. Vehicles that travel off-road can crush at-risk plant occurrences and compress soil, eliminating habitat along designated travel routes and roads open to motorized use. Reduced motorized and mechanized means of travel use correspond to reduce threats to at-risk species. Each alternative would use designated travel plans, which is considered a part of the designated condition of at-risk plant species. The no-action alternative currently allows mechanized means of transport and limited motorized use in RWAs. Alternatives C and E would continue to allow motorized use in RWAs, while alternatives B and D restrict motorized use in these areas. There are additional differences between alternatives for motorized and mechanized use, but no at-risk plant viability or habitat quality for at-risk plants is expected to be impacted outside of wilderness areas, which would be addressed separately under each alternative.

Elk security guidelines

The elk security desired condition states that ‘elk and other big game species are present and potentially available to hunters on NFS lands during both the archery and rifle hunting seasons. Habitat on NFS lands provides hunting opportunities that support MTDFWP population and harvest objectives.’ Additional plan components state that elk security areas should be maintained or increased to influence elk distribution. The elk security areas would be defined and applied at various scales dependent on best available science, and these areas should be centered on known elk habitat. These components are included in alternatives A, B and E, and are *not* included in alternatives C and D. A number of at-risk species suitable habitat overlap partially with elk security habitat, but no at-risk species are known to specifically rely on elk hiding cover or forest characteristics determined by elk security. Elk security guidelines are not expected to influence sensitive plant populations in the plan area for any alternative.

Canada lynx management

All alternatives would incorporate the NRLMD (USDA, 2007a), which would influence vegetation management and how desired conditions are applied in potential lynx habitat (49% of the HLC NF). Refer to appendix H of the revised forest plan for the lynx plan components. Although the management constraints are only required in occupied lynx habitat, the NRLMD specifies that its guidance should be considered on all lands. Occupied lynx habitat has been identified by the U.S. Fish & Wildlife Service, and currently includes only the Upper Blackfoot and Rocky Mountain Range GAs. However, because the guidance should be considered on all lands, and there is potential for occupied habitat to change, lynx constraints are applied and analyzed across the entire HLC NF for forest planning purposes.

Several of the objectives of the lynx direction complement the at-risk plant plan components, by describing a desired condition to management vegetation to approximate natural succession and disturbance processes (#1), and provide a mosaic of habitat conditions through time (#2). These components would contribute to the maintenance of habitat for at-risk species in the grasslands, wetland-riparian and mesic-montane-disturbance-talus habitat guilds. Standard VEG-S6 may potentially impact the management of terrestrial vegetation and could affect whitebark pine by limiting the opportunity for some restoration activities. Standard VEG S6 does not allow vegetation management that reduces winter snowshoe hare habitat in mature multi-story forests. This habitat condition most commonly develops on the cool moist and cold broad PVTs and overlaps with areas of whitebark pine that are being impacted by competition from other conifer species. VEG S6 does not include an exception for whitebark pine restoration treatments similar to the exception that is listed in VEG-5. An estimated 25,507 acres of mapped whitebark pine overlaps with lynx habitat, which equates to 56% of mapped stands in the plan area. This amount would fluctuate over time, as the condition is removed by disturbance and develops in other stands. Much of this area is located in IRAs, RWAs, or designated wilderness areas where the majority or all of vegetation treatments that could occur would be prescribed fire. VEG S6 would potentially reduce or delay the ability to achieve desired vegetation conditions in some areas. The inability to apply vegetation management in whitebark pine forests where fire exclusion has allowed spruce/fir canopy layers to develop would result in foregoing some whitebark restoration opportunities.

Effects common to all action alternatives

All action alternatives contain revised forest plan components that explicitly state the desired conditions for each aspect of forest condition, such as vegetation composition, structure, and pattern, livestock grazing, and timber harvest. The components that are likely to have an effect on at-risk plants species habitat guilds are summarized in the following sections. Individual species are not addressed for forestwide plan components – see supplemental botany report in the project file for more information.

Effects from forest plan components associated with:

At-risk plant species

Draft Plan components that are relevant to at-risk plants are the same for each action alternative (Table 56). The management direction recognizes the need to maintain or improve occurrences and habitats of plant SCC. Appendix C of the draft plan describes possible strategies for achieving desired conditions and objectives for at-risk plants, and also provides strategies for gathering data and including additional species that warrant inclusion, such as previous RFSS. These strategies include evaluating areas proposed for vegetation management activities for the presence of occupied or suitable habitat for at-risk species, focusing botanical surveys on increasing known information about other plant species (such as Montana state species of concern and newly discovered species), and monitoring known occurrences of at-risk species. More details are provided in appendix C of the draft plan.

Table 56. Draft plan components for at-risk plant species

At-Risk Plant Plan Components	Component Language and Summary of expected effects for at-risk plants
FW-PRISK-DC-01	This desired condition would maintain or restore at-risk plant species occurrence viability, habitat quality and provide opportunities to reduce threats in habitat guilds.
FW-PRISK-DC-02	This DC would promote rust-resistance populations of whitebark pine in the plan area, which is one of the recommendations by Keane at al (2012).
FW-VEGT-DC-02	This DC would maintain or restore at-risk plant species occurrence viability, habitat quality and provide opportunities to reduce threats in all habitat guilds.
FW-PRISK-GO-01	This goal would maintain or restore at-risk plant species occurrence viability, habitat quality and provide opportunities to reduce threats in all habitat guilds.
FW-PRISK-OBJ-01	This objective would improve whitebark pine population viability, habitat quality and reduce threats in all habitat guilds.
SCC	There are unknowns about future SCC policy; RFSS had defined policy but FS handbook policy is not yet available for SCC. An interim management policy is expected to become available prior to the revised handbook. Nothing is available currently except the above plan components.

As a result of these plan components, at-risk plant populations in all habitat guilds are expected to be maintained and continue supporting at-risk plant species with opportunities to restore sites if conditions warrant. RFSS that are not currently on the proposed SCC list would no longer be specifically protected once the new plan is implemented. The dropped RFSS occur in habitats with either infrequent project activity (e.g. alpine habitat guild) or in sensitive habitats protected by current plan standards (e.g. peatlands, wetland-riparian habitat guilds). The strategies in appendix C of the draft revised plan include recommended actions to review additional information as it becomes available and gather data during field work. If new pertinent information becomes available indicating a potential threat to loss of viable populations in the plan area these species would be reconsidered and the SCC list may be adjusted.

The revised plan components include components specific to whitebark pine that are expected to enhance restoration efforts. Due to wide spread decline of this species, these plan components focus on restoration of healthy populations for this species. Appendix C of the draft revised plan describes possible strategies for whitebark pine treatment.

Population viability for SCC is expected to remain stable for all species in the plan area because the plan components will maintain and restore habitat for these species. Habitat quality would improve for whitebark pine under the action alternatives at a faster rate than the no-action alternative, though both provide benefits and support long term persistence in the plan area. The action alternatives include additional opportunities for restoration activities; however the no action and action alternatives result in similar outcomes for at-risk plants. Habitat quality is expected to improve under these alternatives at a faster rate for all at-risk plant species than the no-action alternative. Threats remain similar between the no action and action alternatives for at-risk plant plan components.

Aquatic ecosystems

Four habitat guilds containing 30 at-risk species, including 2 RFSS and 22 SCC, are impacted by aquatic ecosystems. The threats to these species include changes to hydrologic and nutrient alternations. Mechanical vegetation treatments, off-road vehicles, roads and trails, livestock grazing, and catastrophic wildfires are some of the actions that affect the hydrologic regimes or nutrient inputs. Subwatersheds provide the distribution, diversity, and complexity of landscape-scale features including natural disturbance regimes and the aquatic, wetland, and riparian ecosystems to which native species, populations, and communities are uniquely adapted within those watersheds, such as at-risk plant species. The action alternatives include desired conditions that would specifically support sensitive plant habitat in the four previously mentioned guilds that overlap with aquatic ecosystems. The revised plan components have additional protection measures and an increased emphasis on the restoration and maintenance of riparian and aquatic resources when compared with the existing plans reflected in alternative A.

As a result of these plan components, wetland-riparian, peatland, aquatic and some areas in the mesic-montane-disturbance-talus and grasslands guilds are expected to be maintained and continue supporting all at-risk plant species that occur in these habitats. The revised plan is more explicit on aquatic ecosystems protections, connectivity in riparian habitats, and groundwater-dependent systems, and specifically expands the RMZs east of the Continental Divide, in addition to following state guidelines and BMPs in the previous plans.

These plan components are expected to contribute to stable populations for all at-risk species in peatlands, wetland-riparian, and aquatic habitats, and also for at-risk species that overlap with aquatic habitats in the mesic-montane-disturbance-talus habitat guild by preserving required habitat characteristics for these species. Habitat quality would improve for all at-risk species in the peatlands, wetland-riparian, mesic-montane-disturbance-talus, and aquatic habitat guilds under the plan components in the action alternatives. Threats would be reduced for at-risk plants in these four wetland guilds in the action alternatives.

Soil

All habitat guilds depend on soil quality and productivity within their respective habitats. FS activities that lead to soil compaction or soil contamination with toxic materials have the potential to negatively impact sensitive plant habitat. Some activities that can threaten soil quality include mechanized vegetation treatments, roads and trails, recreation, grazing and off-road vehicles.

As a result of these plan components, all habitat guilds are expected to be maintain soil quality and productivity, which would contribute to stable at-risk plant populations in the plan area. This plan provides similar protections and guidelines for soil productivity which would support sensitive plant habitats and populations, and includes a desired condition that supports biological soil crusts that is not in the no-action alternative. This component is expected to provide additional protection for bryophytes, lichens, and other flora that could exist in the plan area. Habitat quality would improve for all habitat guilds in the action alternatives. Threats would remain similar to the no-action alternative.

Fire and fuels management

All alternatives use fire as a tool to accomplish management goals and objectives. The objectives for fuel reduction are usually complementary to the other desired vegetation conditions, including those beneficial to at-risk species, and especially as related to forest resiliency. There are several factors that are important to consider with regard to at-risk plants. One factor that is important to some rare plants is the timing and placement of prescribed burns. For example, the use of prescribed fire in the spring has potential to impact to some rare plants that are not adapted to fire at this time of year and spring burning can interfere with flowering, fruiting, pollinator availability, and other physiological impacts. Other at-risk species prefer spring burning event due to a lower rate of litter build-up which reduced fire intensity and increases survival. Considering sensitive species during the planning process (FSM 2670) should ensure that the timing and placement of prescribed burns is used to maintain at-risk plant populations as much as possible by timing when phenologically appropriate and avoiding populations of species adverse to fire.

Another factor is the risk of high intensity wildfire as a result of high fuels. The current condition is overall a high risk of high intensity burns in many areas within the plan area due to high fuels load, which has resulted from various causes, such as fire suppression and the recent outbreak of bark beetle infestation. Without some prescribed fire introduced to mitigate the threat of high intensity fire, at-risk species populations are susceptible to being eliminated in areas on the landscape in all habitat guilds. Many species tolerate and in fact require frequent fire to maintain populations on the landscape. Frequent fire is has historically been low intensity or varied intensity in the plan area, depending on vegetation type. Stand-replacing fires have the potential to kill at-risk plants and reduce or eliminate seed banks, making reestablishment difficult or even impossible without additional seed sources brought in.

A third factor to consider is that some at-risk species require regular fire to maintain early successional conditions that supports known occurrences. This includes species in the wetland-riparian, grassland, mesic-montane-disturbance-talus guilds, and could potentially incorporate additional habitat guilds in the future depending on species specific requirements, which can change depending on new best available science and adjustments to the SCC list. These species require fire, typically low intensity fire to maintain sensitive habitats. The lack of fire has reduced the amount of available habitat. In general, most plant species would benefit by the restoration of more historical fire regimes. For those rare plants that thrive in open areas created by fires, using fire to help restore a more natural fire regime could benefit those species in the long-term. There are also impacts to plants associated with wildfire suppression activities, such as fire line construction and other mechanical activities, reforestation following fire, and the increased potential for the spread of noxious weeds.

Sensitive plants have various reactions to fire. As a result of these plan components, all habitat guilds are generally expected to be maintained and continue supporting at-risk plant species, including the species that are currently on the RFSS list but that would not be specifically protected as a SCC once the new plan is implemented. Analysis prior to implementation would omit populations and habitat that could be detrimentally impacted, and overall habitats on the HLC NF benefit from fire occurring on the landscape similar to historic fire regime conditions. Emphasis in the new plan to allow natural fire to function in its ecological role would likely benefit native plant species as a whole, with few exceptions.

As a result the plan components that encourage natural fire on the landscape, habitat for multiple habitat guilds is expected to maintained and re-established. This would contribute in the long-term to stable at-risk plant populations in the plan area, though increased short-term risk would likely occur. Habitat quality would improve for all at-risk species habitat guilds that require frequent fire to maintain desired seral stage under the plan components in the action alternatives by allowing natural fire to play a larger role in the plan area. Threats currently exist from large, high intensity fire and also from fire suppression tactics. The minimum impact strategy for fire suppression in some locations would reduce threats to at-risk plant species in those habitats. Threats from suppression in location where minimum impact strategies are not used and threats from catastrophic fire events would remain.

Terrestrial vegetation

All habitat guilds are impacted and supported by the action alternative vegetation desired conditions. Broadly, the desired conditions for terrestrial vegetation on the HLC NF are characterized by increases in large trees and large forest size classes; more open forest densities; vigorous nonforested plant communities; increasing early-seral shade tolerant species; and maintaining the full suite of native biodiversity on the landscape. More information is available in the terrestrial vegetation section. The desired conditions are consistent with our understanding of the NRV and are most likely to be resilient in the future given expected drivers such as climate change, drought, vegetation succession, wildfire, insects and disease, and the demands of people. Desired conditions for vegetation support native species and habitats within their NRV, including at-risk species.

Ground disturbing activities and changes in site conditions that could impact at-risk species are likely to result from the terrestrial vegetation plan components. As discussed above, the restoration of historical fire regimes and restoration of conditions towards historical range of variation with a range of seral stages for different potential vegetation groups may benefit some at-risk species in the long-term.

These revised vegetation plan components are expected to maintain and continue supporting at-risk plant species in the plan area. Habitat quality would improve for at-risk species in all habitat guilds under the plan components in the action alternatives. Threats would be remain similar for at-risk plants in regards to vegetation plan components.

Invasive species

Invasive species have a major impact on at-risk species in the plan area. Introduced, invasive plant species can displace at-risk species through competitive displacement. Impacts include herbicide spraying and mechanical ground disturbance to control noxious weeds once they gain a foothold. Competition from invasive non-native species and noxious weeds can result in the loss of habitat, loss of native pollinators, and decreased rare plant species viability. Roads, trails, livestock, and canopy reduction can provide ideal pathways for the introduction of exotic and non-native species. Regarding the risk of weed invasions and/or expansion of populations, the alternatives would vary in some ways. In general, increased ground disturbance corresponds with increased weed spread.

As a result of these plan components, all habitat guilds are expected to benefit from the reduction of invasive species, particularly the wetland-riparian, grasslands, and mesic-montane-disturbance-talus guilds. This would contribute to stable at-risk plant populations in the plan area. This plan provides similar protections and guidelines for invasive species treatment as the existing plans, however additional plan components specify treatment of weeds in at-risk plant habitats. This is expected to increase the opportunities for at-risk plant restoration in the plan area. Habitat quality would improve for all habitat guilds in the action alternatives. Threats would remain similar to the no-action alternative. The revised plan includes language specifically to target at-risk plant species and would likely provide additional protection to sensitive native plant populations when compared to the two older plans. Habitat quality would improve for at-risk species in all habitat guilds under the plan components in the action alternatives. Threats would be reduced for at-risk plants by the action alternatives plan components for invasive species.

Recreation setting, designated areas and infrastructure

Recreation impacts can include trampling, both by hikers and off-road vehicle use. Road building and the development of campgrounds and other facilities used by recreationists also contribute to plant impacts, as these developments make more areas accessible and concentrate use. Dispersed camping and recreation have similar impacts, which are more difficult to monitor. Parking areas, particularly undesignated areas, pose similar impacts to plants. In addition, there can be long-term impacts of bisecting a rare plant population with a road or similar feature and affecting the reproduction and/or plant dispersal. Other recreational impacts include off-road vehicle use, which can also disturb soil, affecting both habitat and potential habitat. Roads and trails for recreational use can contribute to the spread of noxious weeds and increase the accessibility of areas to livestock as well as native ungulates, which in turn can increase the impacts of trampling, herbivory, and congregation.

Increased access to transportation can increase the amount of the plan area that is available for restoration, fire or timber treatments. These treatments can provide opportunities to improve habitat, or the lack of access can remove opportunities and lead to habitat degradation overtime. Infrastructure can also provide vectors to weeds and cause unintentional erosion, which can negatively impact at-risk species over time.

These plan components are expected to contribute to the maintenance of viable at-risk populations in the plan areas by including additional ecosystem protections associated with recreation opportunities. Threats are reduced for at species in all habitat guilds by multiple plan components. Aquatic guilds are protected from recreational related damages by other components, reducing risk for species that occur in with these habitats. There is additional resource protection language and components allowing restoration activities to be completed in wilderness areas. Wilderness areas and WSRs are still protected under national guidance and would continue from the old plans. Habitat quality would remain similar between the action and no-action alternatives for at-risk species in all habitat guilds under the recreation plan components. Threats would be reduced for at-risk plants by the action alternatives plan components for recreation.

Livestock grazing

Livestock grazing can greatly impact riparian habitats and at-risk plant habitat. All habitat guilds except alpine have the potential to be impacted by livestock grazing, which can cause hydrologic conditions to change, trampling to individual species, and habitat degradation through invasive species introduction.

As a result of these plan components, grasslands, peatlands, wetland-riparian, aquatic and mesic-montane-disturbance-talus habitat guilds are expected to be maintained and to continue supporting at-risk plant species in livestock allotment. There would be opportunities in the future to restore habitats that have become degraded over time. The language in the new plan is more explicit than the other plans, but management direction to preserve habitat quality is generally similar. Habitat quality would improve with the action alternatives for at-risk species in all habitat guilds under the livestock grazing plan components due to increased monitoring and active management. Threats would be reduced for at-risk plants by the action alternatives plan components for livestock grazing.

Timber

All alternatives have varying amounts of land suitable for timber production, but the impact of timber plan components on at-risk species is consistent between action alternatives. All habitat guilds can be impacted by timber production, even if habitats guilds, such as aquatic, alpine or grassland, or not directly harvested for timber. Mechanical activities include vegetation management treatments, whether for restoration or to meet timber production objectives. Activities, such as logging, can have impacts to plants and plant habitat through canopy removal, soil disturbance and erosion, and stream sedimentation. In addition, mechanical activities for vegetation treatment may require road building. Roads increase access to sensitive habitats and can fragment habitat, thus, providing an avenue for invasive plant species. Reconstruction and maintenance of designated roads can directly or indirectly affect plant populations by introducing competitive weeds and altering availability of light, nutrients, and moisture. Sudden changes in seral stage, or an abundance of early seral stages, also reduce the available habitats for those plants that require mid-to-late seral stages. However, those species that prefer openings, early-seral stages, or some ground disturbance, could benefit from moderate levels of mechanical activities. The restoration of historical fire regimes and conditions within the NRV (with a range of seral stages for different potential vegetation groups) may benefit some at-risk species in the long-term.

As a result of these plan components, at-risk species and their respective habitats would be considered during vegetation projects and grasslands, peatlands, wetland-riparian, aquatic and mesic-montane-disturbance-talus habitat guilds are expected to be maintained and continue supporting at-risk plant species despite the potential for impacts in areas used for timber production. The new plan is more explicit regarding resource protections, though similar guidelines applied under the old plans. Habitat quality would remain similar between the no action and action alternatives for at-risk species in all habitat guilds under the timber plan components. Threats would be reduced for at-risk plants by the action alternatives plan components by including additional language to protect sensitive habitats.

Alternative A, no action

Effects from forest plan management direction

The no-action alternative is represented by the designated 1986 Forest Plans, as amended. Law and regulation that have been adopted since the 1986 plans would be analyzed as part of the No-action alternative (for example, the designation of IRAs). The designated forest plans (1986) were developed over 30 years ago under a different planning rule and paradigm, a direct comparison to the revised plans is difficult. The plan content in the designated forest plans relevant to at-risk plants are summarized in Table 57.

Table 57. Helena NF and Lewis and Clark NF 1986 Plans' at risk plants plan components

Resource	Lewis and Clark Forest-Wide Standards	Helena Forest-Wide Standards
Threatened and Endangered Plants	• Standard C-2 (1): Comply with law, regulation, and policy regarding threatened and endangered. • Standard C-2 (2): This evaluation would determine whether or not informal or formal consultation with the USFWS on T&E species is appropriate.	The Forest Plan refers to Section 7 of the ESA
Sensitive Plants	• Standard C-2 (2): This evaluation would determine whether or not informal or formal consultation with the USFWS on T&E species is appropriate. • Standard C-2 (3): This evaluation may result in specific management recommendations in addition to those above. • Standard C-2 (13): Assessments of suitable habitats for sensitive plants would be conducted before surface disturbing activities are permitted.	Species of Special Concern There are habitats on the Forest where species of special concern may be found. If any of these species are verified on the Helena Forest, appropriate measures, pursuant to Section 7 of the Endanger(ed) Species Act, would be taken."

The FS manual and ESA policy is followed under both plans. No threatened and endangered species are currently known to occur in the plan area. The combination of FS handbook policy for RFSS and the existing two plans provide protections that are similar to the revised plan's components. The 1986 plans differ from each other and the revised plan: the Helena NF Plan calls out species that are not based on current BASI and relies on FS handbook policy to support RFSS plant species in the plan area; the Lewis and Clark NF plan did includes direction in a 1995 amendment with explicit direction that repeats FS handbook direction.

The separate 1986 Helena and the Lewis and Clark Forest plan standards have led to the current condition of the affected environment for sensitive plants. These plans have specifically called out at-risk species in a number of cases; northern rattle snake plantain in the minerals section of the Lewis and Clark NF Plan, and the sensitive species listed in the threatened and endangered species section in the Helena NF Plan, though additional information has removed several of the Helena Plan species from protected status. Whitebark pine is not specifically mentioned. These plans would ensure that at-risk species persist in the plan area. These plans have fewer opportunities for restoration and less of a focus on native vegetation improvements than the new plan components.

Population viability is expected to remain stable for all at-risk species in the plan area with these plan components. Habitat quality has the potential to improve, however there are fewer plan components promoting restoration and there are inconsistencies between the two forest plans. The no-action alternative is expected to maintain similar habitat quality for at-risk plant species in all habitat guilds. Threats would be remain similar to current conditions for at-risk plants.

Effects of plan components associated with:

Recommended wilderness and undeveloped areas

There are 34,226 acres proposed as RWAs under this alternative. Mechanized means of transport and limited motorized uses are allowed in RWAs. Undeveloped areas are provided by designated wilderness, IRAs, and RNAs. Designated wilderness does not change between alternatives, however this analysis considers all occurrences for each species that are within either designated or recommended wilderness to assess and quantify what percentage of occurrences occur in areas with reduced threats and the relative value of including more in proposed recommended wilderness. Frequently, occurrences that are known within RWAs currently overlap with IRAs. Threats only minimally decrease in these areas; threats decrease to a greater degree in areas that were not previously designated as IRAs.

There are 15 at-risk species with known occurrences in designated or RWAs. There are 82 plants occurrences in designated wilderness areas and 6 additional at-risk plant occurrences in RWAs. *Amerorchis rotundifolia, Astragalus lackschewitzii, Castilleja kerryana, Cypripedium passerinum, Erigeron lackschewitzii, Oxytropis podocarpa* and *Ranunculus pedatifidus* do not have additional occurrences in RWAs but much of their known occurrences and habitat exist in currently established wilderness areas in the Rocky Mountain Range GA with decreased threats from motorized and mechanized access.

The RWAs include suitable habitat in all habitat guilds. The at-risk species that have suitable habitat within the RWAs include *Astragalus convallarius, Botrychium spp*, *Delphinium bicolor ssp. calcicola, Juncus hallii,* and *Phlox kelseyi var. missoulensis.* Habitat for RFSS that would not be carried forward with the SCC designation that have known occurrences in designated wilderness or RWAs include *Erigeron lackschewitzii, Juncus hallii,* and *Oxytropis podocarpa.* Some suitable habitat occurs for *Carex rostrata*. More suitable habitat for these species, and additional species, are present under the RWAs under alternatives B, C and D and less suitable habitat under alternative E. Threats to at-risk species and habitats in RWAs are would remain consistent with the old Forest Plans and there would be no additional protections (e.g. permissible restoration activity, limited access to motorized vehicles) for at-risk plant occurrences. Habitat quality and threats would remain consistent with current plans.

Land suitable for timber production and habitat connectivity

There are 430,489 acres proposed as suitable for timber production in the current forest plans. The emphasis on timber production in these areas increases threats to sensitive species from timber related activity. There are 1,151,728 acres unsuitable for timber production where harvest may occur for other reasons, but these areas do not have a management emphasis on timber production and are therefore not considered in as much detail. These areas would be subject to the plan components listed above, and since there is no specific emphasis on timber production, these areas were not considered separately in this analysis. There are 224 known sensitive plant populations in areas suitable for timber production. This number is inflated due to the greater number of surveys that occur in project areas, such as vegetation projects. There is suitable habitat for at-risk species outside of lands suitable for timber production.

Species that do not occur in lands suitable for timber production include *Amerorchis rotundifolia, Astragalus convallarius, Astragalus lackschewitzii, Botrychium crenulatum, Braya humilis, Castilleja kerryana, Cypripedium passerinum, C. parviflorum, Delphinium bicolor ssp calcicola, Draba desifolia, Drosera anglica, D. linearis, Epipactis gigante, Erigeron flabellifolius, E. lackschewitzii, Gentianopsis macounii, Lycopodium dendroideum, Oxytropis podocarpa, Potamogeton obtusifolius, Potentilla nivea var pentaphylla, Ranunculus pedatifidus, Schoenoplectus subterminalis, Scorpidium scorpioides, Sphagnum fimbriatum,* and *Stipa lettermanii.* These species populations and suitable habitat may still occur within forest projects, including vegetation projects, and subject to potential direct and indirect effects. The RFSS species would be protected by the FS manual guidelines and current forest standards during vegetation project work to prevent listing, as listed above. SCC not included on the current 2011 RFSS list would not be protected under this alternative.

Alternatives B and C

Effects of forest plan components associated with:

Recommended wilderness and undeveloped areas

These alternatives recommend nine RWAs totaling 213,076 acres. There are 21 at-risk species with known populations in designated or RWAs. There are 82 occurrences in designated wilderness areas and 24 additional at-risk plant occurrences in RWAs. *Amerorchis rotundifolia, Astragalus lackschewitzii, Castilleja kerryana, Cypripedium passerinum, Erigeron lackschewitzii, Oxytropis podocarpa* and *Ranunculus pedatifidus* do not have additional occurrences in RWAs but much of their known occurrences and habitat exist in currently established wilderness areas in the Rocky Mountain Range and Blackfoot GA’s with decreased threats to populations as a result of reduced motorized and mechanized access. Habitat for *Erigeron lackschewitzii* and *Oxytropis podocarpa* is especially valuable because these species would not be carried forward on the species of conservation list.

The RWAs include suitable habitat in all habitat guilds. The species with suitable habitat within the recommended wilderness include *Astragalus convallarius, Botrychium spp, Braya humilis, Delphinium bicolor ssp. calcicola, Draba densifolia, Drosera anglica and D. linearis, Goodyera repens, Juncus hallii, Phlox kelseyi var. missoulensis,* and *Schoenoplectus subterminalis*. More suitable habitat for these species, and additional species, are present under the RWAs under alternative D. Habitat for RFSS that would not be carried forward with the species of conservation designation that have known populations in designated wilderness or RWAs include *Juncus hallii* and *Carex rostrata*. Threats to at-risk species and habitats in RWAs are reduced due to the reduction of ground disturbing activities, restriction of motorized and mechanized travel in some cases, and the authorization of restoration activities.

Land suitable for timber production and habitat connectivity

There are 442,601 acres of land suitable for timber production in these alternatives. Habitat connectivity was addressed as several areas identified as being narrow fragments of remaining connectivity in the Upper Blackfoot GA were excluded from lands identified as suitable for timber production. Some harvest may occur in these areas for purposes other than timber production, where consistent with other plan components. There are 1,573,374 acres unsuitable for timber production where harvest may occur for other reasons. These areas would be subject to the plan components listed above, and since there is no specific emphasis on timber production, these areas were not considered separately in this analysis. There are 244 known sensitive plant populations in areas suitable for timber. This number is inflated due to the greater number of surveys that occur in project areas, such as vegetation projects. There is suitable habitat for at-risk species outside of lands suitable for timber production.

Species that do not occur in lands suitable for timber production under these alternatives include *Amerorchis rotundifolia, Astragalus lackschewitzii, Botrychium crenulatum, Braya humilis, Castilleja kerryana, Cypripedium passerinum, C. parviflorum, Delphinium bicolor ssp. calcicola, Drosera anglica, D. linearis, Epipactis gigantea, Erigeron flabellifolius, E. lackschewitzii, Gentianopsis macounii, Oxytropis podocarpa, Potamogeton obtusifolius, Ranunculus pedatifidus, Schoenoplectus subterminalis, Scorpidium scorpioides,* and *Stipa lettermanii.* These species populations and suitable habitat may still occur within forest projects, including vegetation projects, and subject to potential direct and indirect effects. These species would be protected by the revised plan components during vegetation project work to prevent listing.

Alternative D

Effects of forest plan components associated with:

Recommended wilderness and undeveloped areas

There are sixteen RWAs totaling 474,589 acres. These include the nine from the alternatives B and C, plus seven additional areas. There are four additional areas recommended as undeveloped areas outside of recommended wilderness for this alternative. Motorized and mechanized use would no longer be allowed in RWAs.

There are 25 at-risk species have known populations in designated or RWAs. There are 82 plant occurrences in designated wilderness areas, 81 additional at-risk plant occurrences in RWAs, and 19 occurrences in the undeveloped areas proposed for primitive recreation. *Amerorchis rotundifolia, Astragalus lackschewitzii, Castilleja kerryana, Oxytropis podocarpa* and *Ranunculus pedatifidus* do not have additional populations in RWAs or undeveloped recreation areas but much of their known populations and habitat exist in currently established wilderness areas in the Rocky Mountain Range GA. Additional suitable habitat for these species occurs in the undeveloped recreation area in the Rocky Mountain Front GA. *Cypripedium passerinum* and *Erigeron lackschewitzii* have additional populations and suitable habitat that occurs in undeveloped recreation area under this alternative. These species in designated wilderness would experience fewer threats to populations as a result of reduced motorized and mechanized access. The undeveloped recreation would receive less ground disturbing activity than developed areas and another layer of protection for suitable habitat and populations of the above species. Habitat for *Erigeron lackschewitzii* and *Oxytropis podocarpa* is especially valuable because these species would not be carried forward on the SCC list.

The additional RWAs include suitable habitat in all habitat guilds. The species with suitable habitat within the RWAs include *Aquilegia brevistyla, Astragalus convallarius, Botrychium spp, Braya humilis, Cypripedium passerinum, Delphinium bicolor ssp. calcicola, Draba densifolia, Drosera anglica and D. linearis, Elymus innovatus, Erigeron flabellifolius, Goodyera repens, Juncus hallii, Phlox kelseyi var. missoulensis, Polygonum austiniae* and *Schoenoplectus subterminalis.* This alternative includes additional suitable habitat and a greater number of at-risk species than all other alternatives. More suitable habitat for these species, and additional species, are present under the RWAs under alternative D. Habitat for RFSS that would not be carried forward with the SCC designation that have known populations in designated wilderness or RWAs include *Juncus hallii* and *Carex rostrata*. The undeveloped recreation areas include 18 populations of 9 at-risk species, including *Astragalus convallarius, Cypripedium passerinum, Delphinium bicolor ssp. calcicola, Draba densifolia, Elymus innovatus, Erigeron lackschewitzii, Juncus hallii, Phlox kelseyi var. Missoulensis,* and *Polygonum austiniae.* Threats to at-risk species and habitats in RWAs are reduced due to the reduction of ground disturbing activities, restriction of motorized and mechanized travel in some cases, and the authorization of restoration activities.

Land suitable for timber production and habitat connectivity

There are 435,730 acres suitable for timber production in this alternative. Habitat connectivity was addressed as additional recommended wilderness, and primitive and semi-primitive non-motorized ROS areas. There are 1,195,455 acres unsuitable for timber production where harvest may occur for other reasons. These areas would be subject to the plan components listed above, and since there is no specific emphasis on timber production, these areas were not considered separately in this analysis. There are 236 known sensitive plant populations in areas suitable for timber. This number is inflated due to the greater number of surveys that occur in project areas, such as vegetation projects. There is suitable habitat for at-risk species outside of lands suitable for timber production.

Species that do not occur in lands suitable for timber production include *Amerorchis rotundifolia, Astragalus convallarius, Astragalus lackschewitzii, Botrychium crenulatum, Braya humilis, Castilleja kerryana, Cypripedium passerinum, C. parviflorum, Delphinium bicolor ssp calcicola, Drosera anglica, D. linearis, Epipactis gigantea, Erigeron flabellifolius, E. lackschewitzii, Gentianopsis macounii, Oxytropis podocarpa, Potentilla nvea var pentaphylla, Ranunculus pedatifidus, Schoenoplectus subterminalis, Scorpidium scorpioides,* and *Stipa lettermanii.* These species populations and suitable habitat may still occur within forest projects, including vegetation projects, and subject to potential direct and indirect effects. These species would be protected by the revised plan components during vegetation project work to prevent listing, as listed above.

Alternative E

Effects of forest plan components associated with:

Recommended wilderness and undeveloped areas

There are no RWAs in this alternative. There are 9 at-risk species have known populations in designated wilderness. There are 82 plant populations in designated wilderness areas. Much of their known populations and habitat exist in established wilderness areas in the Rocky Mountain Range or Blackfoot GAs for *Amerorchis rotundifolia, Astragalus lackschewitzii, Botrychium spp, Castilleja kerryana, Cypripedium passerinum, Erigeron lackschewitzii, Oxytropis podocarpa* and *Ranunculus pedatifidus.* These species in designated wilderness would experience fewer threats to populations as a result of reduced motorized and mechanized access. Habitat for *Erigeron lackschewitzii* and *Oxytropis podocarpa* is especially valuable because these species would not be carried forward on the SCC list.

More at-risk plant occurrences and suitable habitat for these species are present under the RWAs under alternatives A, B, C and D. This alternative would not include additional suitable habitat for RFSS that are not being carried forward on the SCC list in wilderness areas.

Land suitable for timber production and habitat connectivity

There are 474,184 acres suitable for timber production. Habitat connectivity was addressed as a part of this alternative. There are 1,664,257 acres unsuitable for timber production where harvest may occur for other reasons. These areas would be subject to the plan components listed above, and since there is no specific emphasis on timber production, these areas were not considered separately in this analysis. There are 248 known sensitive plant populations in areas suitable for timber. This number is inflated due to the greater number of surveys that occur in project areas, such as vegetation projects. There is suitable habitat for at-risk species outside of lands suitable for timber production.

Species that do not occur in lands suitable for timber production include *Amerorchis rotundifolia, Astragalus convallarius, Astragalus lackschewitzii, Botrychium crenulatum, Braya humilis, Castilleja kerryana, Cypripedium passerinum, C. parviflorum, Delphinium bicolor ssp calcicola, Drosera anglica, D. linearis, Epipactis gigantea, Erigeron flabellifolius, E. lackschewitzii, Gentianopsis macounii, Oxytropis podocarpa, Potamogeton obtusifolius, Ranunculus pedatifidus, Schoenoplectus subterminalis,* *Scorpidium scorpioides*, and *Stipa lettermanii.* These species populations and suitable habitat may still occur in forest projects, including vegetation projects, and subject to potential effects. These species would be protected by the draft plan components during vegetation project work to prevent listing, as listed above. *Trichophorum cespitosum* would no longer be protected by forest plan standards. These species are not known to occur in the plan area, but if found would be reconsidered for SCC protection.

Cumulative effects

Increasing human populations

Additional stressors that may increase in the future are increasing population levels, both locally and nationally, with resulting increasing demands and pressures on public lands. At present, local populations are increasing in the counties on the west side of the plan area, but are declining or stable in other areas. As related to forest and vegetation conditions, these changes may lead to increased demands for commercial and non-commercial forest products, elevated importance of public lands in providing for habitat needs of wildlife species, and changing societal desires related to the mix of uses public lands should provide. The plan components are adequate to support viable at-risk plant populations and habitat in the plan area as human populations and demands increase. Activities known to be threats to at-risk plant habitat guilds as described in the effects common to all alternatives section above that occur or originate on other ownership land can impact populations and habitat in the plan area.

Adjacent lands and other management plans

Portions of the HLC NF adjoin other NFs, each having its own forest plan. The HLC NF is also intermixed with lands of other ownerships, including private lands, other federal lands, and state lands. Some adjacent lands are subject to their own resource management plans. The cumulative effects of these plans in conjunction with the HLC NF revised forest plan are summarized in Table 58 below, for those plans applicable to at-risk plants. Activities known to be threats to at-risk plant habitat guilds as described in the effects common to all alternatives section above that occur or originate on other ownership land can impact populations and habitat in the plan area.

Table 58. Summary of cumulative effects to at-risk plant species from other resource management plans

Resource plan	Description and Summary of effects
Adjacent National Forest Plans	The forest plans for NFS lands adjacent to the HLC NF include the Custer-Gallatin, Lolo, Flathead, and Beaverhead-Deerlodge NFs. All plans address at-risk plant species. Generally speaking, management of vegetation is consistent across all NFs due to law, regulation, and policy. The cumulative effect would be that the management of at-risk plants and habitats would be relatively consistent and provide adequate protection to prevent species from decline. This includes specific adjacent landscapes that cross Forest boundaries, such as the Upper Blackfoot, Divide, Elkhorns, Crazies, and the Rocky Mountain Range.
Montana Statewide Forest Resource Strategy (2010)	MT conducted a Statewide assessment of forest resources and identified issue-based focus areas with implementation strategies and deliverables for each including Focus area 1: Forest Biodiversity and Resiliency. Strategies include managing ecosystem and biotic composition to achieve ecological integrity through recovery of species diversity, water quality and quantity, soil quality and function by implementing best available science and adaptive management; and increasing terrestrial carbon sequestration and soil carbon sinks. The maintenance of native vegetation and emphasis on diversity is expected to benefit at-risk plant species that often occur in rare or sensitive habitats. This management is complementary, though some impacts to populations could occur.
BLM Resource Management Plans (RMP)	BLM lands near the HLC NF are managed by the Butte, Missoula, and Lewistown field offices. The Butte plan was recently revised (2009) while the designated plans for the Missoula and Lewistown areas are under revision. These resource management plans equivalent to a forest plan. The primary issues included special status and priority plant and animal species and are complementary to the HLC NF revised plan in terms of

Resource plan	Description and Summary of effects
	managing for multiple uses and sustaining healthy and functional ecosystems. Broadly speaking the plan would likely contribute toward similar desired conditions as the HLC NF and much of the management guidance has similar intent with respect to resource protections and monitoring.
National Park Service - Glacier National Park General Management Plan 1999	The general management plan for Glacier National Park calls for preserving natural vegetation, landscapes, and disturbance processes. Broadly, the terrestrial vegetation characteristics in this area and guidance toward at-risk plant species are therefore likely similar to the wilderness areas in the adjacent Rocky Mountain Range GA and would likely complement these conditions.
Montana Army National Guard – Integrated Natural Resources Management Plan for the Limestone Hills Training Area 2014	This plan is relevant to an area adjacent to NFS lands in the Elkhorns GA. The Limestone Hills area is primarily non-forested, and calls for managing for fire-resilient vegetation, restoration of native vegetation including mountain mahogany specifically, identify special plants, and survey and manage for weeds including bio control. This plan would be generally complementary to the HLC NF most especially in promoting the health of native vegetation.
County wildfire protection plans	Some county wildfire protection plans map and/or define the WUI. The HLC NF notes that these areas may be a focus for hazardous fuels reduction, and other plan components (such as NRLMD) have guidance specific to these areas. Managing for open forests and fire adapted species may be particularly emphasized in these areas. Overall, the effect of the county plans would be to influence where treatments occur to contribute to desired vegetation conditions. Species in the grasslands guild in these areas would likely benefit from open forest habitat.
City of Helena Montana Parks, Recreation and Open Space Plan (2010)	This plan is relevant to an area that lies adjacent to NFS lands in the Divide GA, in proximity to the City of Helena. The Mount Helena City Park is being managed as a “natural park”, which ensures its natural character in perpetuity. The plan emphases forest management, wildfire mitigation and noxious weed management. This would be complementary and additive to management on some HLC NF lands, specifically the South Hills Special Recreation area (alternatives B, C, and D) and maintain the native vegetation composition. Heavy recreation use and high noxious weed density could impact sensitive plant populations in these areas, but in general this management plan supports at-risk populations by reducing threats and maintaining quality habitat.
Bureau of Reclamation Canyon Ferry Shoreline Management Plan 2012; Canyon Ferry Reservoir Resource Management Plan 2003	These plans cover the management of the Canyon Ferry Reservoir, which lies between the Big Belts and Elkhorns GAs. The shoreline plan includes resource considerations such as (but not limited to) recreation access, erosion control, hunting and fishing, off road vehicle use and weed management. The Canyon Ferry Wildlife Management Area was transferred to MT Fish Wildlife & Parks for management. The plan includes direction for campgrounds, weed control, fire rehabilitation, fisheries, habitat improvement on the wildlife management area; heritage resources; integrated pest management; and water quality monitoring. Habitats for a few at-risk plants would be maintained in these areas.
Natural Resources Conservation Service – Montana Soil Health Strategy 2015	Plan briefly outlines goals related to promoting soil health and conservation, primarily on agricultural lands. Soil quality is expected to good, but these areas not likely to support at-risk plant populations on agricultural lands. These areas are considered to put sensitive plants in the grasslands habitat guild at greater risk for impacts with little to no suitable habitat available compared to historic conditions.
County Growth plans (Broadwater, Cascade, Choteau, Jefferson, Judith, Lewis and Clark, Meagher, Ponderosa, Powell, Teton counties)	No at-risk plant protection provided as a part of these plans. Would work with FS to enhance communities. At-risk plant on private lands are considered to be at greater risk of local extirpation due to lack of protections. The county plan generally aim to maintain native vegetation communities and reduce noxious weeds. The reservation of native habitats would maintain habitat for at-risk species where they occur.
Blackfeet Integrated Resource Management Plan	In general Integrated Resource Management Plans there are guidelines for rangeland management to maintain or improve ecological functions in rangeland habitats and eradicate noxious weeds when feasible. They comply with the ESA on tribal lands. There is no information available on at-risk species management, though there is information on

Resource plan	Description and Summary of effects
	preserving native plant communities. In areas managed at natural systems it is likely that at-risk plant species would persist and receive some level of protection; in developed areas there is a high likelihood of eradication of at-risk species.

Conclusions

All action alternatives include language to ensure that SCC and federally listed species are considered during ground-disturbing project activities. The RFSS that would no longer be covered under a protected designation with the draft plan have been individually evaluated and determined not to be at risk of declining in the plan area.

Federally listed plants

Due to the lack of federally listed plant species within the plan area, and on the Forest in general, implementation of any of the proposed alternatives would have no impacts on listed plants.

Candidate for listing: whitebark Pine (Pinus albicaulis)

Indirect and cumulative effects for all alternatives were considered. Whitebark pine is currently trending downwards range wide due to stressors not under NFS control (e.g. disease, climate change) and stressors under NFS control (e.g. fire suppression). This species is expected to benefit from each alternatives by restoration treatments designed to improve habitat. Threats exist in the plan area and would persist under all alternatives. Changes in proposed management designations, such as proposed recommended wilderness acres and lands suitable for timber production, adjust the benefits for whitebark pine by the acres of area feasible for restoration treatments and incidental negative impacts resulting from project activities. The comparison between alternatives is largely qualitative and each subsequent decision would evaluate impacts to this species.

The no-action alternative (alternative A) provides the least direction to treat whitebark pine stands with the intention to improve population health in the plan area. All action alternatives include plan components specifically targeting whitebark pine for 1,500 - 10,000 acres treated during the life of the plan, though restorative whitebark pine treatments are expected under all alternatives. Alternative D has the greatest number of mapped acres with reduced potential for restoration treatment by mechanical methods at 53%, alternatives B and C have the moderate restricted acreage with 41%, and alternatives A and E have the fewest limited acres with 24%. Threats are similar for each alternatives.

Species of conservation concern

Indirect and cumulative effects for plant SCC were analyzed using habitat guilds to compare plan components and impacts of habitat management. There are 6 habitat guilds: peatlands with 7 species, wetland-riparian with 8 species, alpine with 3 species, grassland with 5 species, mesic-montane-disturbance-talus with 6 species, and aquatic with 2 species. Alternative A provides the least direction to protect habitats for SCC, though the at-risk plant species plan components are adequate to maintain viable populations of all SCC in the plan are in conjunction with FS manual guidance. All action alternatives (alternatives B-E) include additional plan components to maintain at-risk plant habitat in the plan and are expected to provide additional beneficial impacts to habitat quality for at-risk plant species in the plan area. The comparison between alternatives is largely qualitative and subsequent project decisions would evaluate impacts to these species while they are designated as SCC.

These species were also considered individually between alternatives to determine the impacts of wilderness designation and lands suitable for timber production. The threats are similar for all alternatives in regards to proposed lands suitable for timber production due to consistent proposed acres and overarching FS manual and at-risk plant components protecting these species during project activities. Threats to SCC are reduced in alternative D due to the highest number of RWA acres. Alternatives B and

C provide the second highest acreage and alternative E provides the least. All action alternatives provide additional opportunities for at-risk plant restoration. Alternatives A, C and E allow motorized and mechanized means of travel in RWAs, which increases threats to at-risk plant species. Alternatives B and D do not allow motorized and mechanized transportation and therefore threats are reduced in these areas.

Regional Forester's sensitive plants species

Indirect and cumulative effects for RFSS were analyzed using habitat guilds to compare plan components and impacts of habitat management. *Carex chordorrhiza, Micranthes tempestiva, Salix barrattiana, Thalictrum alpinum, Trichophorum cespitosum* and *Veratrum californicum* are not known to occur in the plan area, therefore no indirect or cumulative impacts are expected. The remaining species occur within 4 habitat guilds: peatlands with 3 species, wetland-riparian with 3 species, alpine with 5 species, and mesic-montane-disturbance-talus with 2 species. All species that are being removed from the list that overlap with lands suitable for timber production occur in habitats that would be omitted during project activities (e.g. peatlands and wetland-riparian habitats). Habitat would be maintained in the plan area for all species and threats are not considered to pose a risk to decreased viability in the plan area for these species based on BASI and revised plan components that protect specific habitat requirements. As new information becomes available or additional threats become known, these species would be reconsidered for the SCC designation. The comparison between alternatives is qualitative. Additional information on species-specific responses to threats is available in the project record.

3.12 Pollinators

Invertebrate pollinators are crucial components of functioning ecosystems. There is evidence that many species may be in decline due to a variety of factors. Broadly, the desired conditions in the action alternatives increase habitat quality for invertebrate pollinator species and decrease threats with the revised plan components. All alternatives provide habitat for pollinator species in the plan area with native plant species, a variety of habitats, and large areas without the habitat fragmentation that has become characteristic of agricultural and developed land. All action alternatives include plan components specific to pollinators. Those components coupled with the plan components for other resources that improve habitat for pollinators in the plan area contribute more to increases in habitat quality under the action alternatives. Please see the project record for the full specialists report.

3.13 Invasive Plants

3.13.1 Introduction

While invasive plants are often adapted to habitats where they are not native, they lack the natural controls (insects, disease) they may have evolved within their native ranges. As a result, they tend to spread aggressively and reduce overall native community diversity, and generally disrupt the natural processes of the environment. They displace native plants or reduce forage for some animal species, degrade natural communities, change hydrology, change microclimatic features, increase soil erosion, alter wildfire intensity and frequency, and cost millions of dollars in treatments and fire suppression to land management agencies and governments (USDA APHIS 2001). Invasive plants are capable of successfully expanding their populations into new ecosystems beyond their natural range and can create lasting impacts to native plants.

The geographic scope of the analysis for non-native invasive plants are the NFS lands of the HLC NF. This area represents the lands where changes may occur to vegetation as a result of management activities or natural events. For cumulative effects, the analysis area also includes the non-NFS lands within and adjacent to the administrative boundary of the HLC NF.

Measurement Indicators

The following are indicators used for the analysis of invasive species:

- Acres of timber harvest, measured as a qualitative correlation between acres treated or harvested and the potential for ground disturbance at risk for week invasion.
- Miles of open motorized roads and trails, measured as miles of open roads and motorized trails that could serve as weed vectors.
- Acres affected by management changes to livestock grazing, measured as a qualitative assessment of potential changes in disturbance from livestock grazing projects and practices.
- Acres disturbed by fire activity, measured as acres burned by prescribed or wildfire events.

3.13.2 Regulatory framework

Federal law

The Federal Noxious Weed Act of 1974 states that each federal agency shall establish and adequately fund an undesirable plant management program; complete and implement cooperative agreements with state agencies regarding the management of undesirable plant species on federal lands under the agency's jurisdiction; and establish an integrated management system to control or contain undesirable plant species targeted under cooperative agreements.

The Federal Insecticide Fungicide and Rodenticide Act (Public Law 92-516) requires all pesticides to be registered with the Environmental Protection Agency. It also states that it is unlawful to use any registered pesticide in a manner inconsistent with its labeling.

The Carlson-Foley Act of 1968 (Public Law 90-583) authorizes and directs heads of Federal Departments and Agencies to permit control of noxious plants by State and local governments on a reimbursement basis in connection with similar and acceptable weed control programs being carried out on adjacent non-federal land. In other words, this act permits county and state officials to manage noxious weeds with herbicides on Federal lands and to be reimbursed for that management, given that other applicable laws such as the National Environmental Policy Act are also met.

Executive orders

Executive Order 13112 directs federal agencies to prevent the introduction of invasive species; detect and respond rapidly to and control populations of such species in a cost-effective and environmentally-sound manner; to monitor invasive species populations accurately and reliably; to provide for restoration of native species and habitat conditions in ecosystems that have been invaded; to conduct research on invasive species and develop technologies to prevent introduction; to provide for environmentally sound control of invasive species; and to promote public education on invasive species and the means to address them. Federal agencies are also called to collaborate with Federal, State, and local partners to address invasive species that can spread from adjacent lands. All of these actions are subject to the availability of appropriations. The desired condition inferred from Executive Order 13112, FSM 2900 and the national strategy is the prevention of new infestations (within the area where activities would occur or from the use of travel routes associated with those activities) and to manage the infestations currently established on the forest through control measures. For all forests, management goals for invaders are to:

- Potential invaders—prevent establishment, and if found, promptly eradicate
- New invaders—for small infestations, eradicate, and for larger infestations, reduce
- Widespread invaders—contain areas that are already infested and reduce plant populations.

State and local law

The State of Montana County Noxious Weed Management Act states that it is unlawful for any person to permit any noxious weed to propagate or go to seed on the person's land, except that any person who adheres to the noxious weed management program of the person's weed management district or who has entered into and is in compliance with a noxious weed management agreement is considered to be in compliance with this section.

Other regulation, policy, and guidance

The FS National Strategic Framework for Invasive Species Management (2013) provides broad and consistent strategic direction on the prevention, detection, and control of invasive species and incorporates the Invasive Species Systems Approach to respond to threats over the next 5 to 10 years. This policy directs the FS to: 1) Determine the factors that favor establishment and spread of invasive plants; 2) Analyze invasive species risks in resource management projects; and 3) Design management practices that reduce these risks.

3.13.3 Assumptions

It is assumed that the establishment of new, undocumented weed infestations has likely occurred, and are not reflected in the existing condition description for invasive plant infestations.

3.13.4 Best available scientific information used

The HLC NF utilizes the Montana Noxious Weed List (2017) to identify which invasive species to manage across the forest, as well as project specific invasive plant risk assessments (risk assessments). Risk assessments help identify threats to native vegetation as a result of project related ground disturbance and invasive species within or near the project area. They also prescribe mitigation measures to reduce these threats. As project areas are surveyed, new infestations are inventoried. These data are entered into the Natural Resource Manager’s Threatened, Endangered, and Sensitive Plants, and Invasive Species database, a system of database tools for managing Agency data across the forest. Invasive plant infestation data (spatial and tabular) is stored and can be retrieved for later reference and analyses. This database has been continually updated with inventoried infestations with a special emphasis on correcting geospatial data.

Invasive plant treatments are also recorded and entered into the Natural Resource Manager system, which allows the HLC NF to track invasive plant treatment accomplishments.

3.13.5 Affected environment

Land use and land-cover change has undoubtedly been the underpinning for the successful establishment of invasive plant species (Parks et al., 2005). Locally, the rate of establishment and spread has been influenced by timber harvest, road building, grazing, and recreation. Most of these activities began on a large scale in the 1950s and 1960s on the HLC NF.

Current invasive plant infestations

As of December 23, 2014, 142,052 acres (5%) of the HLC NF had been inventoried as having invasive species present. The number of currently recorded invasive plant species is 26. A majority of recoded infestations on the HLC NF are associated with past disturbances. Approximately 98 percent of the current inventoried invasive plant infestations occur within ½ mile of major transportation routes (system roads and trails). 15 percent of the inventoried infestations on the HLC NF are within 30 feet of major system roads and trails. The main vectors for spread are road maintenance equipment, logging vehicles, all-terrain or off-highway vehicles, and passenger cars and trucks. Seeds of many species are also wind or animal dispersed (wildlife and livestock). Many roadless areas remain relatively weed free because of healthy undisturbed native plant communities where few mechanisms exist to spread invasive species.

The most abundant invasive plant species on the HLC NF are spotted knapweed (*Centaurea maculosa*), oxeye daisy (*Leucanthemum vulgare*), dalmation toadflax *(Linaria dalmatica*), musk thistle (*Carduus nutans*) Canada thistle (*Cirsium arvense*), houndstongue (*Cynoglossum officinale*), and leafy spurge (*Euphorbia esula*). The species of highest priority for treatment are spotted knapweed, leafy spurge, toadflax (yellow and dalmatian), orange and meadow hawkweed (*Hieracium spp.*) and those species that are on the state noxious list but not currently present on the HLC NF (e.g., yellow starthistle). These species are known to be highly aggressive (e.g., spotted knapweed) or are not currently established on the HLC NF (e.g., yellow starthistle). Reduction of particular aggressive species is critical for the protection of intact plant communities and associated habitats. Avoiding the establishment of additional species is equally important in the maintenance of healthy landscapes within the HLC NF. Eradication is likely not feasible for many of the invasive species on the HLC NF. Although there are large infestations of species such as Canada thistle and houndstongue, these species are not considered high priority due to their abundance, both on the forest, in the state, and in the West at large. They are still considered a priority to treat but due to the level of infestation of these species on NFS lands, they are targeted for control instead of eradication (some exceptions may apply to specific project areas depending on local conditions).

Disturbance and invasive plant species

Disturbance is widely recognized as a primary influence on plant community composition and is frequently implicated in the spread of invasive exotic plants (Hobbs & Humphries, 1995). Disturbance is defined as “any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment” (Pickett and White 1985). Parks et al. (2005) examined the patterns of invasive plant diversity in northwest mountain ecoregions and found an overwhelming importance of disturbance in facilitating the establishment of non-native plants. Disturbances can occur as a result of natural events such as floods, wind events and animals disturbances. Disturbance can also result from human activities such as construction of roads and trails, livestock grazing, features common to logging activities such as skid-trails and landings, and off-road vehicle use. Fire suppression efforts can also result in disturbances. Fire-line disturbances create suitable conditions for many non-native species to become established (Parks et al., 2005).

Fire and invasive plant species

Even as fire is considered a factor in modifying sites and leading to suitable conditions for weeds, it can also be used to control weeds to an extent (DiTomaso et al., 2006). Considering the fire-prone nature of the HLC NF during the time when these plants would need to be burned (mid- to late-summer), fire is not a practical control tactic. It is useful, however, to remove thatch left behind by dead plants to allow herbicide access to fresh shoots at ground level. This burning approach could be conducted during the fall or spring burning windows.

Treatments such as manual, mechanical, biological, and chemical methods are used to treat infestations and are typically focused on those species included on the Montana state noxious weed list. Containment tactics are employed when eradication is not feasible. Containment tactics combine prevention and treatment actions with the objective of limiting the spread of an existing infestation, reducing the acres of existing infestations by treating around the perimeter of the infestation and increasing the resiliency of threatened ecosystems to mitigate the impacts of the invading species.

Treatment of identified infestations is accomplished through herbicide applications and biological control, from this point forward referred to as “treatments.” The HLC NF has a strong commitment to weed control efforts and cooperates with a variety of partners (such as non-governmental organizations, counties, and state agencies) to accomplish these treatments.

Over the past 5 years, a total of 56,842 acres of invasive plants have been treated on NFS lands on the HLC NF. The average acres treated per year is approximately 9,473 acres. A typical year would result in the treatment of six to seven thousand acres as large aerial projects on the Helena NF have increased the average. Specific treatment levels vary depending on funding levels and project priorities. Treatments include both herbicide and biological control methods and are accomplished by FS employees, counties (through agreements), volunteers (cooperative spray days) and other partners.

Criteria for determining order of treatment priority are influenced by the species to be controlled, its rate of spread, infestation size, habitat, and location. Species vary in their reproduction methods, and weeds that reproduce vegetatively require different treatment methods than species that only reproduce by seed.

Areas of high public use, such as roads, trails, campgrounds, trailheads and other recreation sites are a high priority since these areas receive a lot of visitor use and are typically at greater risk of invasion and/or function as vectors into less infested areas. Other areas that are remote and/or are less disturbed and considered natural areas (e.g., wilderness and RNAs) and areas considered to be weed free are also a high priority for treatment. These areas are a high priority due to the effort needed to access and treat the areas as well as the fact that they are presumably not yet heavily infested or are weed free. There is a far greater chance for eradication and equally lower costs associated with management when infestations are detected and treated early.

Removal of roads and trails can lead to an increased risk of invasion or expansion of existing infestations. The HLC NF has implemented mitigation measures such as seeding of temporary roads to improve desirable species cover and reduce invasive species infestations. Desirable non-native mixes of grasses and forbs have primarily been used in the past. Native grasses and forbs have been used only recently. Observations of some of the temporary roads constructed in the last 30 to 40 years indicate some success in the prevention of invasive plant invasion within the road corridors. Sun-loving species, such as knapweed, are not as abundant as the native and non-native grass and forb seed mixes on these old roads. However, shade-tolerant species, such as Canada thistle, hounds tongue and musk thistle are often abundant along these legacy roads. There is no information on the design and construction of these legacy roads or subsequent early rehabilitated efforts. As such, it is difficult to infer specifics of how invasive species became established along the legacy road beds. Observations of historic roads (built over 50 years ago) indicate that plant communities on some roads may naturally recover as the road prism is filled in by forest vegetation. A majority of legacy roads were constructed to support harvest operations. Prevention measures were most likely not implemented during these older harvest operations.

The HLC NF now implements an integrated invasive species management process for all approved management actions. Methods used to prevent invasive species from being introduced and spreading into new areas include closing infested areas to travel, washing vehicles and equipment upon entering an area, requiring use of weed-free hay for pack animals, and using weed-free seed and straw mulch for re-vegetation. Treatments such as manual, mechanical, biological, and chemical methods are generally limited to localized areas and those species on the Montana state list. Containment combines prevention and treatment with the objective of limiting spread of an existing infestation and reducing the acres of existing infestations by treating around the perimeter of the infestation. Invasive weed management in cooperation with private and agency partners, county weed districts and others is important in all of these treatment activities. Seeding of temporary roads as a conservation measure to reduce invasive species infestations has been occurring on NFs for many years. Desirable non-native mixes of grasses and forbs have primarily been used in the past. Native grasses and forbs have been used more in recent years.

Infestations in some sites have been reduced by these measures. However, in spite of these control efforts, existing infestations continue to invade disturbed areas and intact plant communities. Changes to the landscape with warmer temperatures, associated drier conditions, and more severe or frequent droughts, may lead to more frequent fires and may increase the ability of invasive plants to out-compete native plants in the future.

3.13.6 Environmental consequences

Effects common to all alternatives

Invasive species will continue to have a presence on the HLC NF landscape, with existing infestations and continual introductions of new invaders. Some invasive species have become almost “naturalized” to vegetation communities on the HLC NF, and some level of their presence will persist in all alternatives. Other invasive species have become well-established and continue to increase in dominance within native plant communities. Canada thistle, cheatgrass, houndstongue, Kentucky bluegrass, smooth brome, and timothy are all examples of invasive species that have spread to many herbaceous plant communities across the Forest. Management under alternatives would attempt to slow the spread and introductions of new invaders as well as prevent existing weed species from establishing to new non-infested areas. The HLC NF will continue to conduct weed treatments with the most effective options (chemical, mechanical, and biological) as they become available and to implement mitigations such as the weed-free forage program, and vehicle washing/inspections for contract work.

Development of additional management direction for noxious weeds has occurred under the existing Forest Plans and implementation may continue based on this direction under all alternatives. In 1994, the Lewis and Clark NF signed a ROD for the Noxious Weed Control FEIS, which implemented an integrated pest management approach to treat 1,787 acres of NFS lands, as well as providing the ability to apply herbicide in wilderness areas. The analysis also evaluated the use of new herbicides and imposed new environmental safeguards. However, the analysis (1994) underestimated future invasive species problems and limits weed managers on available tools.

The Helena NF issued a ROD for Noxious Weed Treatment in May of 2006. The document authorized a more aggressive noxious weed control approach by permitting additional types of herbicides, adopting adaptive management, and broadening herbicide application methods to include aerial treatment options. Existing and newly approved biological agents could also be introduced to infestations where appropriate. The selected alternative contained environmental protection measures to reduce non-target species exposure to herbicides caused by spray drift through wind speed restrictions during application, buffering of sensitive areas, weather monitoring, boundary marking, and restrictions on areas to be sprayed, and use of drift reduction agents.

Under all alternatives, management of invasive species would continue following Noxious Weed Control EIS documents (1994, 2006). Both Noxious Weed analysis documents provide acceptable invasive species management options while being flexible to budget constraints, but are not quickly adaptable to adopt new technology and treatment options.

All alternatives contain multiple use resource management objectives, with varying degrees of forest vegetation management. Timber production, livestock grazing, and farming activities continue to provide endpoints for introduction and subsequent seed dispersal, as well as the environmental disturbance that enhances germination and establishment of non-native plants (Toney et al. 1998).

Invasive species have significantly increased across the HLC NF, with a present infestation level of approximately 142,000 acres. Assuming that the national average annual rate of spread of 8 to 12 percent applies, the HLC NF can expect to encounter an increase in invasive plant infestations at a rate of up to approximately 11,000 to 17,000 acres per year (when applying the range of 8% to 12% rate of spread to the current combined inventory of 142,052 acres). Initial data review suggests that the rate of spreads is greater on the western portions of the HLC NF (Helena NF) and less rapid on the Eastern portion (Lewis and Clark NF) due to differences in precipitation and habitat types.

Of equal importance is the current and predicted continuation of globalization, or the free movement of goods, capital, services, people, technology, and information. Globalization processes will most likely significantly affect the State of Montana, especially as the human population continues to grow. Globalization facilitates and intensifies the spread of invasive alien species (Meyerson & Mooney, 2007). As a result, the extent and density of invasive plant infestations as well as the number of invasive plant species has the potential to increase on NFS lands within the plan area.

Climate change

Climate change is likely to result in differing responses among invasive plant species, due to differences in their ecological and life history characteristics. Climate change could result in either range expansion or contraction of an invasive species (Halofsky et al., in press-b). For example, modeling indicates that leafy spurge is likely to contract and spotted knapweed is likely to shift in range. Invasive species are generally adaptable, capable of relatively rapid genetic change, and many have life history strategies (e.g., prolific seed production, extensive deep roots) which can enhance their ability to invade new areas in response to changes in ecosystem conditions. Warmer temperatures, and associated drier conditions, more severe or frequent droughts, and more favorable conditions for wildland fire may increase the ability of invasive plants to establish and out-compete native plants. These changes may provide more opportunities for invasive plants to gain an advantage over native species, and spread within and beyond the HLC NF's boundaries. This potential effect is common to all alternatives.

Studies have shown that elevated carbon dioxide levels can lead to a reduction in herbicide efficacy (Archambault 2007, (Ziska & R., 2000). Reduced treatment effectiveness coupled with the potential for increased opportunities for growth and vigor has the potential for invasive plants to gain an even greater advantage over native species.

The effects of climate change on species' distributions are likely to be complex given the potentially differing climatic controls over upper and lower distribution limits (Harsch & Ris Lambers, 2015). Some studies predict a movement in some invasive plant species range closer to the poles or upward in elevation (Chen, Hill, Ohlemuller, Roy, & Thomas, 2011). Pauchard et al. (2009) suggest that the threat posed to high-elevation biodiversity by invasive plant species is likely to increase because of globalization and climate change. Other studies, such as Harsch and Lambers (2015) suggest that distribution shifts in response to recent climate change could occur in either direction (upward or downward).

Fire is another factor affected by climate change. When combined with climate change, fire/invasive plant relationships may be exacerbated leading to greater invasive species populations and spread. Other disturbances or shifts in historical patterns may be affected by climate change and in turn affect the spread of invasive species. As the agency responds to climate change by new, different, or more land and vegetation management actions, those disturbances could provide suitable conditions for invasive plants.

Effects from plan components associated with:

Infrastructure

In all alternatives, inadvertent seed spread could decrease areas that are either closed to motorized access or are more difficult to access. During road closure/decommissioning activities that require short-term ground disturbance, there could be short-term invasive plant establishment until invasive weed treatments are applied to the disturbed area. Additionally, road closures and/or decommissioning make administrative access more difficult to treat invasive species in some areas of the forest. Many of the roads and trails previously closed to motorized vehicles have invasive species present within the trail corridor. These infestations, known and yet to be discovered, are a concern for weed managers under all alternatives.

Road obliteration projects for travel management purposes also can create ideal conditions for invasive species to establish. Road obliteration would occur under all alternatives.

Road maintenance, reconstruction and construction can contribute to the establishment and spread of invasive plants. Gravel pits can oftentimes become infested with weeds if not routinely checked and treated. Weed seeds can be spread onto lands far from the gravel pit when gravel is used for road surfacing or other purposes. This potential for this effect would be the same under all alternatives; however plan components are in place to mitigate this. Management direction to address invasive plant species is in place for all alternatives and would continue to be followed. Gravel pits and main road corridors would be a priorities to consider for weed management and treatments.

Fire

Fire can result in an increase in non-native species diversity and cover, whether it is a prescribed burn or a wildfire (Zouhar, Kapler Smith, Sutherland, & Brooks, 2008). Invasive species such as cheatgrass may alter fire regimes in drier forests, shrublands and grasslands which comprise much of the HLC.

Wildfires would occur in the future under all alternatives, although uncertainty exists as to extent and location. Weather and climatic factors along with fuels conditions would affect intensity and spread of a fire event. Effects of wildfire on invasive species spread potential is the same across alternatives. Generally, prescribed fire implementation would be similar under all alternatives as well. There is potential for establishment and spread of invasive plant species within burned areas, depending largely upon site-specific conditions, such as fire location, vegetation types that were burned, presence of weed infestations pre-fire, potential vectors, and fire characteristics. Weed infestations within burned areas would be addressed following forest plan management direction, which is similar for all alternatives.

Recreation

Recreational activities, including non-motorized, are vectors for potential seed establishment and dispersal. Recreation activities and areas receive concentrated and frequent use and continual ground disturbance. Generally, wilderness areas and large un-roaded lands are less likely to contain invasive weeds due to less widespread public access, especially via motorized means. However, these large un-roaded areas are vulnerable to weed infestation and spread from recreational uses. Seed transport happens inadvertently, by humans, dogs, and pack stock. Trails that receive high uses, including those in wilderness areas, are vulnerable to invasive weed infestation. Mountain bike, horse, and motorized trails may be at higher risk of introduction, spread and establishment of weeds compared to hiking trails. Areas of high use and ground disturbance occur within wilderness areas and are as vulnerable to weed infestation as developed sites outside wilderness. Frequently, infestations are found around trailheads, trails, campgrounds, and other developed recreation sites. These seed sources pose a risk of further spread into wilderness and undeveloped lands. Areas located immediately adjacent to and surrounding developments tend to experience the most disturbance, while the peripheries of these areas are less disturbed and less likely to be favorable for invasive species establishment and persistence.

Methods used to help prevent invasive species from being introduced and spreading into recreation areas include public education and requirements for use of weed-free hay for pack stock. Public education efforts, such as the Play Clean Go campaign, have helped raise invasive species awareness for many recreational activities. Lack of public knowledge, combined with limited enforcement and/or monitoring options for recreational activities is a concern for weed introductions, and would be similar for all alternatives.

Wildlife

Invasive species expansion is most likely occurring to some degree with transport of seed from wildlife. Several satellite patches of noxious weeds are located on the HLC NF that are far from roads and trails, have no possible livestock or pack animal access, and are far from any know infestation. Native ungulates can move seeds from infested areas and relocate them in remote or off-the-grid areas. Hounds tongue has been and will continue to be on the move throughout the forest, but other species such as spotted knapweed and toadflax species are showing up in unexplainable places. Birds could be a major transporter of Dalmatian toadflax on the Helena and Townsend Ranger Districts. These transport issues from wildlife will continue under all alternatives.

All alternatives would incorporate standards and guidelines of the Grizzly Bear Conservation Strategy. This strategy is not expected to create un-due hardship to noxious weed control efforts for the Forest as treatments are already limited in time and space within the primary conservation area, as weed infestations are generally lower as compared to other areas of the HLC NF. Budget constraints, topography, and lack of personnel also already hinder weed treatment options within the primary conservation area. Weed treatments generally occur as opportunities allow in the backcountry.

Effects common to all action alternatives

A primary difference the action alternatives have compared to the no-action alternative is their targeted management direction, including treatment objectives and more clarity regarding treatment strategies, priorities and methods. Management direction under all the action alternatives for non-native invasive plants includes a guideline and treatment objective to obtain desired conditions of invasive species control and maintenance of natural ecological functions. Targeted objectives for non-invasive plant control are an administrative change that promotes measurable objectives and accountability to the program toward reaching desired conditions. The objective was chosen to be responsive toward desirable conditions while also being flexible to uncertain yearly budgets, which is the program's primary operating constraint.

While preference for use of low-leaching chemical treatments is currently exercised under the no-action alternative, the action alternatives formalize this practice, and promote effective long-term treatments that are compatible with other resources. Consideration of technological advances in weed treatments is emphasized, if they are shown equivalent to, or more effective than, existing treatments. Preference is stated regarding the use of low-leaching chemical treatments and application methods to minimize ground and subsurface drift effects. Additionally, the ability to evaluate and incorporate new chemical treatments, if equivalent or more effective than existing treatments, to the integrated pest management program is also current program practice. Thus, the action alternatives update the 1986 forest plans by formalizing current invasive species management practices that prevent or decrease the spread or densities of noxious weeds and invasive plans and enhance native plant communities.

Alternative A, no action

The current Helena and Lewis and Clark forest plans, as amended, are the existing management direction being used by the HLC NF to address non-native invasive plants. This direction represents the no-action alternative. However, because the no-action alternative is the baseline to which the action alternatives are compared, it is important to understand what actions would continue under the no-action alternative.

The existing Helena NF Plan (1986) and Lewis and Clark NF Plan (1986b) include forestwide objectives that emphasized the need to control noxious weeds through an integrated pest management approach utilizing chemical, biological, and mechanical methods. The Helena NF Plan specifically called for spot herbicide treatment of identified weeds and considering biological control as it became available (1986 HNF Plan, II-22). The Lewis and Clark NF Plan (1986) discussed in even lesser detail the need to control noxious weeds through an integrated pest management strategy. At the time of these forest plans' publication, the extent and magnitude of ecological issues invasive species would create for the HLC NF was unforeseeable.

The 1986 forest plans lack specificity in plan direction for noxious and invasive species management. The no-action alternative as amended with Noxious Weed Control FEIS documents (1994, 2006) encompasses current management practices on the Helena NF, but is outdated and limits managers on Lewis and Clark NF.

Effects that vary by alternative

Effects of plan components associated with:

Watershed, aquatic habitat, riparian areas, and soils

Plan components and activities related to watershed, soil, riparian, and aquatic habitat would have effects on invasive plant management. The plan components that would have the greatest influence are those associated with RMZs. With the action alternatives, east of the Continental Divide (the majority of the HLC NF), RMZs would be adopted and result in more acres being subject to riparian area plan components as compared to the no-action alternative, in which SMZs would be used. West of the Continental Divide, the area influenced by riparian plan components is the same across all alternatives because RMZs would be defined the same way as riparian habitat conservation zones are in the no-action alternative. Please refer to the RMZ section.

With the action alternatives, the use of herbicide treatments within RMZs would be limited to instances where they are needed to maintain, protect, or enhance aquatic and riparian resources or to restore native plant communities (FW-RMZ-STD-05). Further, peatlands, fens, and other groundwater dependent ecosystems would be buffered 100 feet from management activities that alter water chemistry, unless site-specific information supports a smaller or larger buffer (FW-RMZ-GDL-03). These components may limit the treatment methods for some invasive plants in riparian areas and near groundwater dependent ecosystems; for example, hand pulling may be required instead of herbicide use. The herbicides selected for use in these areas would be those that would not alter water chemistry.

Timber and vegetation management

Ground-disturbing activities, equipment transport and use associated with management activities such as timber harvesting, fire treatments and fire suppression, or other authorized uses are a common vector influencing the expansion of noxious weeds. Most of these risks are minimized with localized site restoration and rehabilitation, as well as the use of weed control measures during implementation (e.g., contract clauses to wash equipment).

Vegetation management activities such as timber harvest, the use of skidders and mechanical harvest techniques and equipment have contributed to the introduction, spread, establishment and persistence on the landscape. Contract specifications help prevent introduction of weed seed to units from outside NFS lands by requiring cleaning of equipment. Other weed BMPs include pre- and post-implementation spraying of haul routes, as well as seeding disturbed areas after implementation to prevent establishment of infestations.

Lands suitable for timber production are where the vast majority of timber harvest activities and associated road access could be expected to occur. It could be assumed that a larger amount of area suitable for timber production may result in more areas where timber harvest or active management could occur. In actuality, acres harvested are not necessarily directly tied to the amount of suitable lands, but also to the treatment type that may be applied. Timber harvest may also occur on lands unsuitable for timber production. For analysis of potential of invasive species spread, projected harvest acres were used to assume the amount of ground disturbance expected to occur. The direct correlation between ground disturbance and potential of invasive species to establish in those areas was used to differentiate effects between alternatives. Table 59 provides a comparison of lands suitable for timber production and the projected harvest by alternative.

Table 59. Acres of lands suitable for timber production and projected harvest by alternative

	A	B	C	D	E
Acres of land suitable for timber production	430,489	442,601	442,601	431730	474,184

	A	B	C	D	E
Projected average annual harvest acres (decade 1 constrained by budget)	4,108	4,091	4,091	4,075	2,336

The potential ground disturbing activities associated with timber harvest would be similar for alternatives A, B, C, and D, and therefore, potential weed spread would be similar. Alternative E would be the most favorable for restricting weed spread as the alternative would have the fewest acres harvested under a constrained budget. Alternative E would also harvest timber on more productive forest lands, which generally receive more moisture. These sites, in general, would be more resilient with quicker re-establishment of native vegetation and thus more resistant to invasive species.

Based on projected harvest levels, no single alternative presents weed managers with an unmanageable level of monitoring or treatment workload as it relates to timber management activities.

Motorized use and recreation settings

A main vector for seed spread is vehicle use (Taylor, Brummer, Taper, Wing, & Rew, 2012). Many existing infestations can be found along, or have originated from, roadsides because vehicle traffic provides ideal means for noxious weed spread. Primitive two-track roads also provide opportunity for noxious weeds to become established on areas of bare soil and disturbance. Once invasive species establish on road or trailside prism, the threat of spreading into adjacent native plant communities has a high likelihood if vigilant monitoring and treatments do not occur. An even greater threat for spread of invasive species is from unauthorized cross-country travel. Infestations can go undetected for years, resulting in a well-established population that oftentimes are difficult to access.

Transportation of weed seed by contractor or special use vehicles, or equipment, on NFS roads is managed to a degree. Contract stipulations are used to require specific actions, e.g., vehicle and equipment washing, to lessen the possibility of weed transport to reduce the risk of new infestations. Recreational use of roads and motorized trails as well as unauthorized cross-country travel by the general public presents a greater risk, because of the lack of control measures and the lack of knowledge about invasive species spread.

Alternatives vary in the amount of motorized access opportunities for recreational use, both on roads and trails, based on ROS settings. Summer motorized uses pose the greatest risk of invasive weed transport. Because of the small differences and site-specific localized nature of weed infestation and spread, changes in weed infestations estimated at the programmatic level would be subtle and may not be noticeable on the ground. In general, the potential for weed infestation threats would be heavily correlated to the amount of open motorized routes and area of summer motorized travel (Table 60).

Table 60. Miles of open roads, trails and percent of desired ROS settings pertaining to summer use

Alternative	Miles of open Roads and Trails	Acres of Primitive/semi-primitive (summer)	Acres of semi-primitive motorized (summer)	Roaded natural (summer)	Percent of total forest open to motorized (roaded natural and semi-primitive)
A	4462	1,789,460	365,953	700,160	37
B	4448	1,801,888	367,377	686,186	37
C	4462	1,802,251	367,323	685,877	37
D	4383	1,849,039	341,327	666,817	35
E	4462	1,782,174	244,040	830,397	37

Alternative D would be the most favorable to limit the spread of invasive species from motorized use because it has the least about of open roads and trails and acreage identified in motorized ROS classes. Alternatives A and E would be similar for having a higher potential to increase the spread of invasive species through motorized transportation since the alternatives have the most miles of open motorized routes and less acres of primitive/semi-primitive settings. Alternatives B and C would be have similar effects to weed spread, with alternative B being more favorable as motorized trails are slightly less.

Although alternative D would be the most favorable for slowing the spread of invasive species by motorized means, the alternative could also create issues for existing weed infestations to go undetected and untreated in new RWAs. Alternative D would eliminate the most miles of open routes and possible weed vectors of any alternative, but could also increase treatment difficulty or detection of existing weed populations in recommended wilderness. As long as resources continued to be devoted to monitoring and treatment of weeds on closed motorized routes, minimal negative effects would result from all action alternatives with a reduction in road and trail mileage.

Livestock grazing

Invasive species expansion may also occur with the transport of seed by livestock from infested areas. Seeds can be spread through livestock feces, fleeces, and hooves, and many can pass through an animal's digestive system and retain the ability to germinate (A. Joy Belsky & Gelbard, 2000). Native grazers such as mule deer, bighorn sheep and elk, and some birds such as mourning doves and starlings (Carr 1993), can also perform this same method of seed spread. Conversely, domestic livestock grazing (in a process known as prescribed grazing) has also been shown to be an effective method in managing some large invasive plant infestations while assisting the ecological succession process (Jacobs, 2007).

Localized areas where congregation can occur, such as water developments and supplement locations, contribute to reduced ground cover and can become potentially susceptible to invasive plant establishment. All alternatives could have equal impacts from domestic livestock grazing relating to invasive species establishment on acres where disturbance results in reduced native plant vigor and cover. Action alternatives include plan components that should enhance rangeland vegetation communities, which would be more resistant to invasive species. Options to adjust livestock grazing management in the future may involve more range improvement infrastructure, thus increasing acres disturbed by construction activities in the short run. Some initial ground disturbance from new off-site water development and fencing may cause some ground disturbance, and therefore, provide a niche for invasive plants to establish. In the long term, action alternatives would improve livestock grazing management, which in turn promotes the enhancement of desirable native plant communities. Action alternatives provide plan components to increase the resistance and resilience of native plant communities and pursue the best available invasive species management options while maintaining multiple uses like livestock grazing.

Fire and fuels

Site-specific projects are evaluated under the NEPA for the impact of invasive species and generally projects have requirements to prevent their spread as mitigations for project implementation. For fire treatments, both wildfire, and planned ignitions, invasive species introduction, spread, establishment and persistence has a potential for occurrence. These circumstances result in a change of treatment priorities for the invasive species management program, under all alternatives.

Projected prescribed burning acres are similar for alternatives A, B, C, and D, and less with alternative E. Therefore alternative E would have slightly less potential to encourage the spread of invasive species through vegetation management activities than the other alternatives. However, for all alternatives plan components are in place that would limit or mitigate this potential.

Cumulative Effects

Invasive species spread without regard to administrative boundaries. As such, the cumulative effects of the HLC NF invasive species management under any alternative, including the no-action alternative, may negatively or beneficially impact adjacent federal, state and private lands depending upon the specific site treatment or lack thereof. Adjacent or nearby landowners specific site conditions and weed treatment efforts also would affect weed conditions and treatments on NFS lands. Over 327,895 acres of individual and other private entity lands lie within the boundaries of the plan areas of the Forest, though not all these lands are directly adjacent to NFS lands. Under all of the alternatives, coordination with state and local agencies and communication with the public would continue to combat the spread of undesirable non-native invasive species.

Portions of the HLC NF adjoin other NFs, each having its own forest plan. The HLC NF is also intermixed with lands of other ownerships, including private lands, other federal lands, and state lands. Some adjacent lands are subject to their own resource management plans. The cumulative effects of these plans in conjunction with the HLC NF revised forest plan are summarized in Table 61, for those plans applicable to invasive species management.

Table 61. Summary of cumulative effects to invasive species from other resource management plans

Resource plan	Description and Summary of effects
Adjacent National Forest Plans	The forest plans for NFS lands adjacent to the HLC NF include the Custer-Gallatin, Lolo, Flathead, and Beaverhead-Deerlodge NFs. All plans address invasive species management. Generally speaking, management of invasive species is consistent across all NFs due to law, regulation, and policy. The cumulative effect would be that the management of invasive plants would be generally complementary. This includes specific adjacent landscapes that cross Forest boundaries, such as the Upper Blackfoot, Divide, Elkhorns, Crazies, and the Rocky Mountain Range.
BLM Resource Management Plans (RMP)	BLM lands near the HLC NF are managed by the Butte, Missoula, and Lewistown field offices. The Butte plan was recently revised (2009) while the existing plans for the Missoula and Lewistown areas are under revision. These plans contain components related to invasive species, and would therefore be complementary to the plan components for the HLC NF. Weed control efforts on BLM lands have great potential to influence spread on invasives to Forest lands.
National Park Service - Glacier National Park General Management Plan 1999	The general management plan for Glacier National Park calls for preserving natural vegetation, landscapes, and disturbance processes. Broadly, the plan shares common goals and desired conditions to reduce invasive species in this area, which is similar to the wilderness areas in the adjacent Rocky Mountain Range GA. This plan would be complementary to the goals of the HLC NF concerning invasive species.
Montana Army National Guard – Integrated Natural Resources Management Plan for the Limestone Hills Training Area 2014	This plan is relevant to an area adjacent to NFS lands in the Elkhorns GA. The Limestone Hills area is primarily nonforested, and calls for managing invasive species that is generally complementary to efforts on the HLC NF.
Montana State Parks and Recreation Strategic Plan 2015-2020	These plans guide the management of state parks, some of which lie nearby or adjacent to NFS lands. Invasive species management is a component of these parks, although not always the primary feature. Management of invasive species in these areas would help control the spread to other areas, as visitors to these parks would most likely visit the HLC NF at some point. Goals for invasive species management would be largely complimentary to the goals of the HLC NF.
Montana's State Wildlife Action Plan	This plan describes a variety of vegetation conditions related to habitat for specific wildlife species. This plan would likely result in the preservation of these habitats on state lands, specifically wildlife management areas. This plan would interact Forest Plans and be complementary to the efforts to manage invasive weeds.

Resource plan	Description and Summary of effects
County noxious weed control agreements	Most counties within the plan area have agreements with the HLC NF which coordinate noxious weed treatment areas and roads as well as provide a mechanism for the in which the Forest can financially fund county weed control efforts on NFS lands and other priority areas in order to help preserve native plant communities at the landscape level. These weed agreements are consistent with goals and objectives of the HLC NF.

Conclusions

Alternatives B, C, D, and E update the 1986 Forest Plans for management of non-native invasive plants by formalizing current, effective invasive species management practices. Plan components in action alternatives should have a positive effects to slow the spread of invasive plants as well as manage existing infestations by moving towards adopting best tools and practices available in the future. These practices are administrative in nature and result in no adverse effects to the invasive species management program.

Plan components regarding livestock grazing should generally have positive effects on rangeland vegetation condition. In turn, acres within grazing allotments should have more resilient and resistant plant communities that can compete with invasive species to a certain degree. Small, localized areas of disturbance relating to range improvement construction may be vulnerable to weed infestation and will need monitoring and treatment actions built into project design. However, these improvements should help improve vegetation condition and grazing management that will benefit rangeland vegetation in the future.

All alternatives have potential to create similar amounts of disturbance relating to timber harvest. Alternative E may be the most favorable as far as limiting the total harvest footprint on the Forest. Vegetation management projects will have plan components that prescribe BMPs that should limit the introduction of invasive species as well as implement treatment options if they are found.

Alternative D, with more RWAs, would have 65 less miles of open road and trail mileage than the next lowest alternative. In terms of trail mileage as a weed vector, alternative D would be move favorable to limit the spread of invasive species. All alternatives have options to treat weeds on open motorized routes.

Ultimately, consequences to non-native invasive plants from forest plan components associated with other resource programs or revision topics are similar under both the no-action and action alternatives. An aggressive integrated pest management approach must be implemented in order to keep invasive species from expanding beyond existing infestation levels.

3.14 Terrestrial Wildlife Diversity

3.14.1 Introduction

The 2012 Planning Rule (U.S. Department of Agriculture, Forest Service, 2012) provides direction to maintain diversity of animal communities and the persistence of native species through emphasis on a coarse filter approach (FSH 1909.12 23.11 (1) (c)) (USDA, 2015). As described in the Rule and in the Directives, plan components developed for ecosystem integrity and ecosystem diversity are expected to provide for ecological conditions necessary to maintain the persistence or contribute to the recovery of native species within the plan area (FSH 1909.12, sec 23.11).

By design, this section relies on the coarse-filter information in the terrestrial vegetation section. Plant communities discussed in the terrestrial vegetation section are discussed here as vegetation groups or as plant communities that generally provide for the needs of a number of wildlife species.

The Rule recognizes that for some at-risk species (i.e. threatened, endangered, proposed, or candidate species or those identified as SCC), coarse-filter plan components may not be sufficient to ensure recovery or persistence of those species within the plan area. Where that is the case, species-specific plan components that would contribute to the recovery of listed species or maintain the viability of SCC within the plan area (219.9 (b) (1)) (U.S. Department of Agriculture, Forest Service, 2012) are included in the plan.

Terrestrial wildlife species are important as contributors to biological diversity and ecosystem integrity, as well as providing benefits to humans.

Organization of the terrestrial wildlife section

This section is organized by key ecosystems or groupings of vegetation systems or their characteristics, such as size or structural class, that provide habitat for associated wildlife species. Although all wildlife species ultimately rely on vegetation, various aspects of that vegetation are the key components of habitat. Some species are associated with a particular cover type or group of cover types, whereas others may be associated with a structural stage (e.g. early seral openings, large dead trees, etc.), or with a combination of type and structure. Some species are more strongly associated with certain landscape features, such as cliffs, streams, or caves. For the purposes of analyzing how the alternatives provide for the ecological conditions required by terrestrial wildlife species, this section discusses wildlife species in the context of the vegetation group, structural stage, or landscape feature most often associated with their requirements or that contributes to a key or critical part of their life history. That discussion provides an analysis of the ecological conditions (coarse filter) expected to maintain the diversity of native wildlife species.

Most native wildlife species' needs are evaluated in the context of the habitat groupings as described in the above paragraph, so most wildlife species are not discussed individually. For some species, however, species-specific or habitat-specific plan components were considered necessary to mitigate potentially negative impacts of management actions or activities occurring on NFS lands. The effects of those plan components are described within the section where the species is discussed, even where that section may not relate to the species-specific components. For example, bighorn sheep are discussed under the section "Species Associated with Grass and Shrub Habitats", because that vegetation type is critical for bighorn sheep foraging and movement. The revised plan includes components for separation of bighorn sheep from domestic sheep; those components are not related to the vegetation group, but the consequences of those components are discussed within the section "Species Associated with Grass and Shrub Habitats" because that is where bighorn sheep are otherwise addressed. Similarly, species currently designated by the Regional Forester as sensitive (RFSS) are discussed briefly in the section for the vegetation or landscape feature group with which they are associated. A detailed analysis of potential effects to species currently listed as sensitive will be provided in a separate BE to be prepared when a preferred alternative is selected. The BE will be completed concurrent with the FEIS.

The sections that address species associated with specific vegetation groups, structural stages, or landscape features are followed by a discussion about the potential effects of plan components guiding management of specific resources or broad programs (e.g., livestock grazing, recreation, minerals and energy development, etc.).

3.14.2 Regulatory framework

Please refer to the introductory regulatory framework section of this chapter (3.3).

3.14.3 Assumptions

The primary assumption underlying the analysis in this section is based on the 2012 Planning rule and the directives for implementing the rule: that plan components developed for ecosystem integrity and ecosystem diversity would provide for ecological conditions necessary to maintain the persistence or contribute to the recovery of native species within the plan area (FHS 1909.12, 23.13). Therefore, we assume that effects to vegetation systems and characteristics as described in the terrestrial vegetation