Helena and Lewis & Clark National Forests

Forest Plan Assessment

Chapter 2, Terrestrial Ecosystems

2015

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Terrestrial Ecosystems

Introduction

This section addresses the terrestrial (land-based) ecosystems of the Helena and Lewis & Clark National Forests (hereafter referred to as the plan area or HLC NFs). The HLC NFs straddle the Continental Divide in central Montana, and are characterized by the topographical transition between western mountainous terrains and eastern prairie grasslands. Bisected by the Missouri River, the area supports a wide diversity of vegetation due to its geographic extent, topography, and climate. Vegetation ranges from grassland prairie, to dense coniferous forests on foothills and mountain slopes, to sparse vegetation on cold, steep, high-elevation sites. Elevation ranges from about 3,000 feet along the Missouri River to over 9,000 feet on mountain peaks. Landforms include flat grassland, rolling foothills, and steep mountains. The HLC NFs stretch over 150 miles north to south and 200 miles east to west. The plan area is made up of a series of distinctive landscapes and "island" mountain ranges, identified as geographic areas (GAs). Detailed descriptions of each GA are provided in chapter 1, Introduction. The dissected nature of the area has unique implications for ecosystem function.

The 2012 planning rule directs the USFS to use a coarse filter/fine filter approach for assessing the needs of terrestrial wildlife and plant species. Modern designs for conservation of biological diversity combine managing for broad ecosystem characteristics (coarse-filter) with species-specific management (fine-filter) (Cushman et al. 2008; Haufler 1999; Hunter et al. 1988; and others). Coarse-filter strategies are based on:

- Understanding past, current, and projected future conditions (Haufler 1999).
- Providing a mix of ecological communities across a plan area.
- Providing for ecological integrity/biological diversity at an appropriate landscape scale (Kaufmann et al. 1994).
- Identifying how to maintain or restore composition, structure, function, diversity, and connectivity of ecosystems.
- Providing for a range of species habitat conditions at a variety of spatial scales over the long term while maintaining biological diversity for the vast majority of species (Hunter 1990, Lindenmayer and Franklin 2002).

Most species will be maintained by coarse filter plan components that provide for broad ecosystem integrity and diversity. With a coarse-filter approach in place, fine-filter strategies can be focused on the species whose requirements are not captured by coarse-filter attributes (Seymour and Hunter 1999). After completing the coarse filter, the next step is to assess species that may require fine-filter components. We use a step-down approach to identify and assess ecosystems starting at a coarse landscape scale to summarize vegetation types and key ecosystem characteristics geographically. We then refine our ecosystem classification, estimating key ecosystem characteristics for meaningful vegetation type groups. This allows us to assess conditions and trends of vegetation, which provides a basis for wildlife habitat discussions. Terrestrial vegetation is described first, followed by terrestrial wildlife.

Terrestrial Vegetation

Introduction

This section addresses the terrestrial vegetation relevant to the HLC NFs and provides the basis for terrestrial wildlife discussions. Vegetation is complex and subject to an array of interacting ecosystem processes. The extent, type, and condition of vegetation is dependent upon relatively fixed site capability features on the landscape, such as soils, combined with the influences of system drivers such as climate, disturbances, and human activities.

Key concepts related to terrestrial vegetation include *resilience*, *sustainability,* and *adaptive capacity*. *Resilience* refers to the ability of an ecosystem and its component parts to absorb or recover from the effects of disturbance through preservation, restoration, or improvement of its essential structures and functions and redundancy of ecological patterns across the landscape (FSH 1909.12). *Sustainability* is the capability to meet the needs of the present generation without compromising the ability of future generations to meet their needs (FSH 1909.12). Adaptive capacity refers to the ability of ecosystems to respond, cope, or adapt to disturbances and stressors to maintain options for future generations. *Adaptive capacity* is determined by genetic diversity, biodiversity, and the heterogeneity and integrity of ecosystems occurring as mosaics within broader-scale landscapes (FSH 1909.12). A landscape mosaic of components or conditions, which may be referred to as *spatial heterogeneity*, in part through its contributions to resilience may allow adaptation to future environmental change and help to sustain ecosystem services, but humans often rescale or reshape natural heterogeneity (Turner et al 2012). Spatial heterogeneity is important for sustaining forest regeneration, primary production, carbon storage, natural hazard regulation, insect and pathogen regulation, timber production, and wildlife habitat (Turner et al 2012).

The Terrestrial Vegetation section covers the following topics which contribute to an understanding of these concepts for the HLC NFs.

- Vegetation drivers
- Potential vegetation types
- Vegetation composition
- Vegetation structure and function (including connectivity)
- Threatened, endangered, proposed and candidate species and potential species of conservation concern
- Special ecosystem components
- Ecosystem diversity

Scale and Methods

A framework of spatial extents is used depending on the analysis element, in order of broadest to finest:

- *Ecoregion* (USDA 1994): Ecoregions are broad ecological zones covering millions of acres.
- *Administrative Region*: The USFS Northern Region 1 encompasses Montana and Northern Idaho.
- *Helena and Lewis & Clark National Forests (HLC NFs or plan area)*: The administrative plan area covers approximately 3.2 million acres including private land inholdings. The HLC NFs includes the entire Helena and Lewis & Clark National Forests, in addition to a small portion of the Beaverhead-Deerlodge National Forest (Elkhorns GA). The Helena National Forest manages this area per a Memorandum of Understanding for the Elkhorn Wildlife Management Unit. Modeling is done across the private lands separating the administrative Forest areas.
- *Helena National Forest (HNF) or Lewis and Clark National Forest (LCNF)*: Individually, the national forests encompass about 1.2 and 2.0 million acres within their administrative boundaries respectively, including private land inholdings.
- *Geographic areas (GAs)* – The HLC NFs are broken into ten unique GAs ranging from roughly 45,000 acres to 900,000 acres, including private land inholdings. These GAs are described in chapter 1. The Elkhorns GA includes the portion of the mountain range on the Beaverhead-Deerlodge National Forest. The label “Elkhorns HNF” is applied to data that only covers the Helena National Forest. The label “Elkhorns All” is applied to data that covers the entire Elkhorns GA.

Some attributes are summarized at large scales to provide context and incorporate representative trends (e.g. climate, wildfire, and insects). Most of the analysis occurs at the HLC NFs or GA scales. However, some ecosystem components, such as species of special interest, are described at a more localized scale due to their ecological importance and/or limited distribution.

The temporal scale of analysis varies. Current condition analyses typically depict data collected within the last 5 years. Information currently available for historical vegetation describes conditions approximately 500 years ago. New analyses of the natural range of variation, which are not yet complete, will depict conditions as long as 1,000 years ago. Assessments of trend include both short term (within several decades) and longer term predictions.

A variety of methods were utilized to analyze terrestrial vegetation. Please refer to appendix B.

- Summarization of existing Geospatial Information Systems (GIS) data
- Summarization of forest inventory and analysis (FIA) and grid intensification data
- Literature review of the best available science
- Vegetation modeling to characterize the natural or historic range of variability is done with a stochastic model called SIMPPLLE (SIMulating Patterns and Processes at Landscape scaLEs) (Chew 2012)
- Consultation with regional experts and partners

Broad Scale Context

An ecoregion is a scale of planning and analysis in the National Hierarchical Framework (USDA 1994) that distinguishes common climatic and vegetation characteristics. Based on continental weather patterns, most of the plan area is in the *Middle Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow* province. Within this province, *sections* are identified as subdivisions with similar geomorphic processes, stratigraphy, geologic origin, drainage networks, topography, and regional climate. Sections are drawn at a coarse scale and designed to be modified as needed. The sections for the HLC NFs area have been refined into three areas (see map 1 in appendix A, Modified Ecoregion Sections) which are summarized as follows (USDA 1994).

- *Belt Mountains*: This section encompasses most of the plan area east of the Continental Divide. It is characterized by high mountains, gravel-capped benches, and intermontane valleys bordered by terraces and fans. Plains and rolling hills surround the isolated mountain ranges. The climate is cold continental, with temperature extremes common in the winter months; strong winds are common. Precipitation ranges from 10-40", with maximum occurring in the spring and early fall. Winter precipitation is snow. Much of the area is foothills prairie and dry conifer forest.
- *Bitterroot Valley*: This section covers some portions of the Upper Blackfoot and Divide GAs west of the Continental Divide, and is characterized by high, glaciated mountains with alpine ridges and cirques at higher elevations and glacial and lacustrine basins at lower elevations. Climate is cool-temperate with some maritime influence. Precipitation ranges from 14-80"+, and most of the precipitation in fall, winter, and spring is snow. The section supports substantial conifer forest and foothills prairie.
- *Rocky Mountain Front*: This section covers the Rocky Mountain Range GA. It is characterized by glaciated mountains with limestone scarps and ridges interspersed with glacial and lacustrine intermontane basins. The climate is cold continental, with severe chinook winds and dramatic fluctuations of winter temperatures. Precipitation ranges from 18-100"+, with maximum precipitation occurring from spring through early summer. Winter precipitation is snow. Foothills prairies make up an extensive proportion on lower elevation foothills, with conifer forests and aspen above 4000'.

Ecosystems and Key Ecosystem Components

An *ecosystem* is defined as a spatially explicit, relatively homogeneous unit of the earth that includes all interacting organisms and elements of the abiotic environment within its boundaries (FSH 1909.12). *Ecosystem integrity* is the condition where natural ecological composition, structure and processes are essentially intact and self-sustaining. This indicates that the ecosystem is able to evolve naturally with its capacity for self-renewal and biodiversity maintained. Ecosystems are described in terms of *structure, composition, function,* and *connectivity* (CFR 219.8). *Composition* refers to the types and variety of living things. *Structure* is the physical distribution and character of components of the ecosystem. *Function* is the processes or interactions that occur between the living elements of the ecosystem; and *connectivity* as the spatial linkage between them.

Key ecosystem characteristics are identified based on the dominant ecological characteristics that describe ecosystems. Indicators and measures are identified for each. Some key characteristics are agents of change and may be referred to as *drivers*. Some characteristics may be carried forward to inform Forest Plan components and/or long term monitoring plans depending on their relevancy to coarse and fine filter ecosystem diversity.

Table 2.1 Key terrestrial vegetation characteristics of ecosystems on the HLC NFs

Key Ecosystem Characteristic		Indicator(s)	Measure(s)
Composition	Cover Type	Proportion of existing dominant vegetation groups	% Area
	Tree Distribution/Density	Presence of individual tree species by size classes (+/- 5" diameter); and trees per acre of each species.	% Area, TPA
	Plant Distribution	Presence of individual plant species of interest.	% Area
Structure	Forested Size Class	Proportions of (5) forested size classes: 0-5"/Seedling/Transitional; 5-9.9" Small Tree; 10-14.9" Medium Tree; 15-19.9" Large Tree; >20" Very Large Tree.	% Area
	Large Live Trees	Densities of Very Large Trees >20" dbh; and Presence of Large Trees	TPA, BA/ac[1], % Plots
	Forested Vertical Structure	Proportions by vertical structure classes: 1-storied, 2-storied; 3-storied, Continuous	% Area
	Forested Canopy Density Class	Proportions by canopy cover classes: 0-9% (nonforested); 10-24.9% (low cover); 25-39.9% (tree cover); 40-59.9% (mod-high cover); 60%+ (high cover)	% Area
	Forest Age Class	Proportions by forested age classes: <20; 20-99; 100-199 ; 200+	% Area
	Dead Trees	Snag quantity by size classes: 10-14.9"(medium); 15-19.9"(large); 20"+(very large)	TPA[1]
	Large Woody Debris	Quantity of large Downed Wood >3" diameter, estimated overall and by potential vegetation type	Tons/acre
	Old Growth	Amount of old growth per Green et al. (1992) definitions.	% Area
Function	Wildfires	Proportion of fire regime severity (low/mixed/high)	% Area
		Wildfire areas burned	Acres
		Fire Frequency (mean fire return interval)	MFI[2]
	Insects & Disease	Extent of existing/modeled infestation	Acres
		Proportions of (4) hazard ratings for mountain pine beetle; Douglas-fir beetle; and western spruce budworm. (0 = no host; 1 = low; 2 = moderate; 3 = high)	% Area
	Rangeland Health	*Refer to the Multiple Use Ecosystem Services Chapter 6 – Range Section*	N/A
	Soil Indicators	*Please refer to the Watershed, Aquatic, Soil, and Air Chapter 3 – Soils Section.*	N/A
Connectivity	Stand-replacing Disturbance Pattern	Forest Openings: Abundance, Average and Range of Patch Size of Transitional/seedling/sapling size classes	Acres
	Forested Horizontal Structure	Large Multi-Storied Patches: Amount/extent of 3000+ acre patches 2-3-C storied	#, acres
		Ecosystem Connectivity: By cover type, average and range of patch size; patch frequency/density; and perimeter to assess coarse filter.	Acres, #, meters/feet

[1] TPA = Trees per Acre; BA/ac is square feet of basal area per acre
[2] MFI = Mean Fire Return Interval

Key ecosystem characteristics, concepts and other relevant attributes are first described at geographic scales. Then, characteristics are summarized for individual ecosystems as defined by potential vegetation type groups.

Existing Information

Terrestrial ecosystems are complex and dynamic across space and time. Our ability to fully understand and describe processes and inter-relationships of ecosystems is limited. This assessment utilizes the best available science, integrated with professional experience. Because of the enormous number of factors that interact with each other in unpredictable ways, we have gaps in our information of ecosystem function and the means to measure it; this gap may lessen over time. Vegetation data and information will continue to be updated.

There are a series of tables that display numbers and percentages. All raw numbers can be found in the project file. The values are rounded; as a result sometimes the total is slightly less or more than the actual total.

Information sources are described in detail in appendix B and include published, peer-reviewed literature, Forest Service internal reports, statistically-based vegetation inventory data, and geospatial datasets. In brief, the primary data sources used for this assessment include:

- *Region 1 Vegetation Map (VMap)*: Mapping of vegetation is based on the Region 1 Vegetation Map (VMap). VMap is a geospatial dataset developed using the Region 1 Existing Vegetation Classification System (Barber et al. 2011). It is a remotely sensed product that is derived from satellite imagery, airborne acquired imagery, field sampling and verification.
- *Forest Inventory Analysis (FIA), FIA Intensified Grid, and the R1 Summary Database*: This analysis draws upon measurements collected on spatially balanced FIA and FIA intensified grid plots. The FIA grid is a nationwide grid which includes 444 plots on the HLC NFs. This dataset is used to display estimates for the plan area because it spatially represents all National Forest System lands; however, most plots have not been re-measured since the recent mountain pine beetle outbreak and therefore conclusions are tempered with an understanding that conditions have changed in many areas. In addition, the FIA base grid is intensified by four times (4x) on the HLC NFs. Intensified grid plots are not available for the Rocky Mountain Range or Snowies GAs, or the proportion of the Elkhorns GA on the Beaverhead-Deerlodge NF. Where the intensified sample is completed, 4x plots are added to the base FIA to create an analysis dataset of 1,772 plots. Intensified grid plots affected by the mountain pine beetle outbreak have been re-measured, and therefore where it is complete it represents a more current and intensive sample. FIA and FIA intensification plot data is summarized in the R1 Summary Database, which includes statistical reporting functions and derived attributes (Bush 2006; Barber et al. 2009).
- *Natural Range of Variation* (NRV): Determination of the natural (historical) range of variation for vegetation components utilizes an analysis using the SIMPPLLE model. This assessment draws upon work and data done for the Eastside of Region 1 in 2003 until a new NRV analysis can be completed. The analysis areas used in 2003 are not identical to the GAs currently delineated. The data in the 2003 analysis were generated by running SIMPPLLE for 500 years; the modeling included calibrations for historic climate and natural disturbances. The historic range of variation for each variable is represented by a maximum, minimum, and average percent of the acres of forested habitat types (USDA 2003).
- *Aerial Detection Survey (ADS)*: Survey data and condition reports that estimate levels of tree mortality and defoliation resulting from insects and diseases.
- *Fire history and fire ignition* data found in Forest GIS libraries.
- *Forest Activity Tracking System (FACTS)* is a corporate database that records management activities.
- *Potential Vegetation Mapping (Jones PVT 2005)*: This Region 1 layer was developed to map groups of potential vegetation types (based on habitat types), and incorporated into the HLC NFs vegetation layer (VMap). The assessment utilizes an initial calibration of this layer which included adjustments to resolve illogical combinations with VMap attributes. Additional calibrations are ongoing and will be included in additional modeling associated with Forest Plan revision.
- *LANDFIRE 2010 Fire Regime Groups*: This National data layer was used to depict fire regimes.

- *Threatened, Endangered and Sensitive Plants and Invasive Species (TESP-IS) Database*: The extent of weeds and TES plants is reported in this corporate database and mapped through a Geospatial Interface.
- *Forest Service Natural Resource Manager TESP Database* and the *Montana Natural Heritage Program (MTNHP) Database* were used to determine which plant species to consider for potential plants of conservation concern. NatureServe and the MTNHP's Montana Field Guide were also used.

Vegetation Drivers

Figure 2.1 Mountain pine beetle infestation in the Divide GA, 2009

Introduction

The natural world is in a constant state of change. Ecosystem "drivers" are the dominant ecological or human-influenced processes that shape the ecosystem. "Stressors" are related and interconnected with drivers; they are agents that strain the ecosystem and can cause imbalances. For simplicity, henceforth drivers and stressors are collectively referred to as *drivers*. Some drivers, such as wildfire, occur quickly and cause rapid visible changes, while others such as succession result in slow, incremental change. Drivers interact in time and space. Changes in key drivers may affect the sustainability of forest landscapes and set the stage for increased tension among competing ecosystem services; the interaction of drivers may be the greatest source of complexity and uncertainty regarding the degree to which landscape patterns can be managed to sustain multiple ecosystem services in the face of change (Turner et al 2012).

The following drivers are considered primary on the HLC NFs. Other processes such as flooding, decay and nutrient cycling, and windthrow also occur.

- Climate and climate change
- Vegetative succession
- Fire
- Forest Insects and Diseases
- Vegetation Treatments
- Invasive Species

Climate

Existing Condition

Climate strongly influences vegetation and ecosystem processes. Periodic variation in precipitation can initiate events such as droughts and flooding which alter vegetation directly, such as through mortality of trees, or indirectly, such as by increasing the probability and/or severity of disturbances. This section contains brief comments relative to climate's influence on vegetation. Please refer to chapter 4, Climate Change and Baseline

Assessment of Carbon Stocks for information on climate change. Over geologic time, changes in climate and disturbance regimes are a natural part of ecosystems; 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).

The climate of the plan area is dominated by cold continental, cold-dry continental, and cool temperate with maritime influence (USDA 1994). Summers are generally dry, and the precipitation in winter is primarily snow. In some areas, spring and fall precipitation is also snow. Precipitation is generally 10-50" per year, although it can be higher in areas west of the Continental Divide. The current condition is considered to be warm and dry. Winter temperatures can fluctuate widely and foehn winds, known locally as chinook winds, commonly occur.

Climate influences vegetation directly and indirectly. Vegetation requires sunlight (energy) and moisture in addition to nutrients found in the soil. Systems on the HLC NFs are generally moisture-limited as opposed to energy-limited. That is, there is plenty of sunlight, but growth is limited by moisture. Warm/dry climatic periods generally result in slower growth and lower *site capability* (the ability of a site to support vegetation based on available resources) than cool/moist periods. Competition-based mortality increases during dry periods because there is less moisture available. Species extent and distribution are consequently impacted. For example, species such as ponderosa pine are adapted to dry conditions and can out-compete associates during droughts. In future phases of the Forest Plan revision process, it may be possible to map water movement through soil and identify where water deficits may increase due to climate change.

Trend

Historically, the climate of the Northern Region has fluctuated between cool and warm periods. Climate is affected by multiple factors, including sea surface temperatures tracked by indices such as the *Pacific Decadal Oscillation* (PDO), *El Niño Southern Oscillation* (ENSO), and the *Atlantic Multidecadal Oscillation* (AMO). The PDO tracks variations in sea surface temperature in the northern Pacific which tend to cycle approximately every 20 years (Zhang et al. 1997). PDO can help explain the cycles of some drivers such as wildfire. Severe fire years tend to occur when warm weather spikes follow cool wet weather cycles (USDA 2013c). Figure 2.2 depicts PDO periods along with the acres impacted by wildfire and mountain pine beetle activity in Region 1 of the Forest Service from 1889 to 2007. From 1905 to 1945, the PDO was warm and the Region experienced high fire and insect activity. Conversely, the period from 1950-1980 was cool with low activity. Many acres in the Region have been impacted by fires and mountain pine beetle in the warm PDO since 1980. Uncertainties exist regarding the acres affected by fires and insects, especially in earlier periods prior to consistent record keeping.

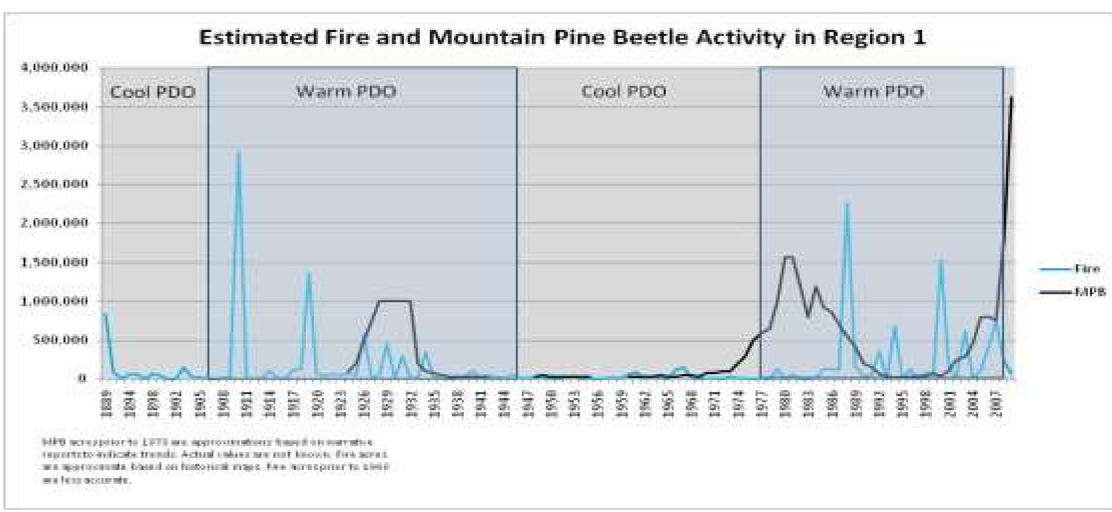

Figure 2.2 Region 1 fire and beetle disturbance (acres affected) related to PDO (from USDA 2013c)

Wildfire chronologies assembled from fire scars on tree rings and reconstructions of sea surface temperatures indicate the PDO may explain the decadal variation of fire activity in the Pacific Northwest whereas ENSO is thought to be linked to shorter term variation of fire activity in a single year or between years (Kitzberger et al. 2007). The combination of positive warm phases of both the PDO and AMO seems to have a broad geographic influence as this may be responsible for drier conditions across the entire western U.S. (Kitzberger et al. 2007). In the northern Rockies, the combination of a positive PDO during El Niño (combined warm phase) was significantly correlated with large-fire years based on data from 1700 to 1975 (Schoennagel et al. 2005). A multi-year positive El Niño index combined with a slightly above-average PDO may set the stage for large fire growth years in the northern Rockies as well (Schoennagel et al. 2005). Morgan and others (2008) isolated eleven years from 1900 to 2003 that exceeded the 90th percentile in annual acres burned based on fire atlas data that included the northern Rockies; these fire years occurred when the PDO was positive and suggest there is a connection between spring and summer weather and climate with fire activity and acres burned. However, it is acknowledged that there have been conflicting findings of the effects of El Nino and PDO on regional fire years (Kipfmueller et al. 2012; Heyerdahl et al. 2008).

Considerable natural variation in climate occurred historically and will continue. Different climate models project differing rates of change in temperature and precipitation because they operate at different scales, have different climate sensitivities, and incorporate feedbacks differently. However, climate models are unanimous in projecting increasing average annual temperatures over the coming decades. Continued and/or increasing drought will likely further limit the carrying capacity of sites, resulting in altered composition, structure, or even lifeform (grass/shrub versus forest vegetation) especially on low elevation sites. Further, drought will likely also exacerbate vegetation drivers such as fire, insects, disease, and invasive species.

Information Needs

Please refer to chapter4, Climate Change and Carbon Baseline Stocks.

Vegetative Succession

Existing Condition

Succession is the progression of change in composition, structure, and processes of a plant community through time (Winthers et al. 2004). It is based on the concept that every species has a particular set of environmental conditions under which it will reproduce and grow. As long as these conditions remain fairly constant, the species will flourish. Plants impact their environments and each other, and this causes the community to change over time. The successional process follows a pathway with major steps referred to as a *seral or successional stage*. In a simplified model for a forest, *early successional stages* typically follow a stand-replacing disturbance (e.g. fire), which kills all or a portion of existing plants while leaving the physical environment intact. Trees and other plants start re-colonizing the site to fill up available growing space; this is also known as the establishment phase of stand development. Then, a series of intermediate successional stages follows, referred to as *mid* and *late successional stages*, where established species grow larger and denser based on site capability to make full use of resources. During these stages, new plants may be inhibited by high site occupancy or initiated in opening gaps as competition based mortality occurs. Changes in environmental conditions and competition for limited resources cause some species to decline and others to expand. 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 catastrophic disturbance. The concept also applies to non-forested communities which change based on the strategies of grasses, forbs, and shrubs to establish and compete over time.

Trend

Plant species are often distinguished as playing either an early or late/climax successional role. Species that have traits that enable rapid colonization and domination of a site after a disturbance are called *early successional*. They are typically less shade tolerant, able to flourish under full or nearly full sunlight, and have rapid early height growth. Ponderosa pine, lodgepole pine, aspen, whitebark pine, and western larch are the major early successional tree species on the HLC NFs. In nonforested communities, early seral plants include grasses, forbs, and shrubs that resprout quickly following fire such as bluebunch wheatgrass. Late successional tree species, or *climax species,* are typically shade tolerant, capable of reproducing and growing in dense shady conditions. Engelmann spruce and subalpine fir are the major climax tree species on the HLC NFs. Late seral nonforested species include woody shrubs that reseed more slowly following disturbance, such as mountain big sagebrush. To an extent most species can play multiple successional roles depending on site conditions and the other species present. This is particularly true of Douglas-fir on the HLC NFs, which functions as both an early and late successional species depending on the site.

Recognizing the potential successional pathways of plant communities is important; however, in disturbance-prone ecosystems the climax state may rarely if ever be achieved because succession is commonly interrupted by drivers such as wildfire. Fire influences succession in most vegetation types on the HLC NFs. An important feature is the influence of long-lived, fire tolerant early successional species such as ponderosa pine, whitebark pine, and Douglas-fir which are able to persist for centuries. In many areas, climax conditions are uncommon due to the long-term survival of these early successional species that tolerate low or moderate severity fire. They grow large and become prominent features of the overstory canopy, providing structural components of late successional and old growth forest. Because fire often maintains specific species or vegetation types adapted to fire, fire exclusion has altered successional trajectories in some locations and habitats.

Information Needs

No additional information is needed. The trend of successional trajectories is explored for ecosystem characteristics in subsequent sections.

Fire

Existing Condition

The Northern Rocky Mountain ecosystem is a fire-driven ecosystem, experiencing monsoonal disturbances that move up from the Great Basin causing intense summertime storms which can produce thousands of lightning strikes. Fire is a natural driver because natural ignition sources (lightning) exist.   Indigenous humans were also a source of fire for centuries. Many factors influence fire effects, including fuel loading, climate, weather, topography, vegetation structure and composition, elevation, seasonality, and interacting disturbances such as insect infestations. On the HLC NFs, fires generally move from west to east with prevailing winds, but dry cold fronts can produce northwest wind flows that move fires from northwest to southeast. Without wind as the driving mechanism, terrain and diurnal heating influence fire movement, causing fire to generally move uphill faster than downhill. Fire plays innumerable ecological functions, including species structure and composition, carbon and nutrient recycling, snag and tree cavity creation, and stimulating seeding and sprouting of vegetation.

Natural Fire Regimes

A *fire regime* represents the periodicity and pattern of naturally occurring fires, described in terms of frequency, biological severity, and aerial extent (Anderson 1982). Coarse-scale definitions for natural fire regimes were developed by Hardy and others (2000) and Schmidt and others (2002) with additional interpretations for fire and fuels management provided by Hann and Bunnell (2001). The *natural fire regime* is a classification of the role fire would play across a landscape in the absence of modern human intervention but including the influence of aboriginal fire use (Barrett et al. 2010). Five natural fire regimes are classified based on the average number of years between fires (fire frequency or *mean fire interval*) combined with *severity* (the amount of vegetation replacement) and its effects to the dominant vegetation (Barrett et al. 2010). The fire regimes on the HLC NFs are mapped using LANDFIRE data.

Table 2.2 Fire regimes on the HLC NFs - LANDFIRE

Fire Regime[3]	Definition[3]	Existing Vegetation Types[1, 3]	Approximate Acres[2]	Proportion (%)
I	0- to 35-year frequency; low / mixed severity	Mountain sagebrush; Ponderosa pine; Dry Douglas-fir; Wooded draws/ravines	1,214,264	38
II	0- to 35-year frequency; replacement (high severity)	Grasslands; Mixed-grass prairies; Great Plains shrubland	213,263	7
III	35- to 200-year frequency; mixed / low severity	Wyoming big sagebrush ; Low sagebrush; Riparian systems (cottonwood); Limber pine/Rocky Mtn juniper; Dry lodgepole pine; Moist Douglas-fir; Whitebark pine	686,748	21
IV	35- to 200-year frequency; replacement (high severity)	Aspen; Moist lodgepole pine; Subalpine fir Engelmann spruce	937,182	29
V	Greater than 200-year frequency; any severity	Poor-site lodgepole pine; Subalpine forbs and grasses	56,960	2
Sparsely Vegetated	National Land Cover Database (NLCD) class	N/A	15,441	<1
Barren	NLCD class	N/A	81,250	3
Snow/Ice	NLCD class	N/A	172	<1
Water	NLCD class	N/A	3,249	<1

[1]Vegetation types are not the same as existing vegetation types discussed elsewhere in this chapter.
[2] Acre summaries in this section may differ slightly due to the data source (raster versus vector GIS data).
[3]Table information is adapted from Barrett et al. 2010

All fire regimes are present on the HLC NFs, with I, III, and IV being the most common. Fire regimes by GA are shown in Figure 2.3. The Rocky Mountain Range is unique in its high proportion of nonburnable area (sparse vegetation, barren, snow/ice, and water). Fire regime V is rare, and occurs mostly in the Little Belts.

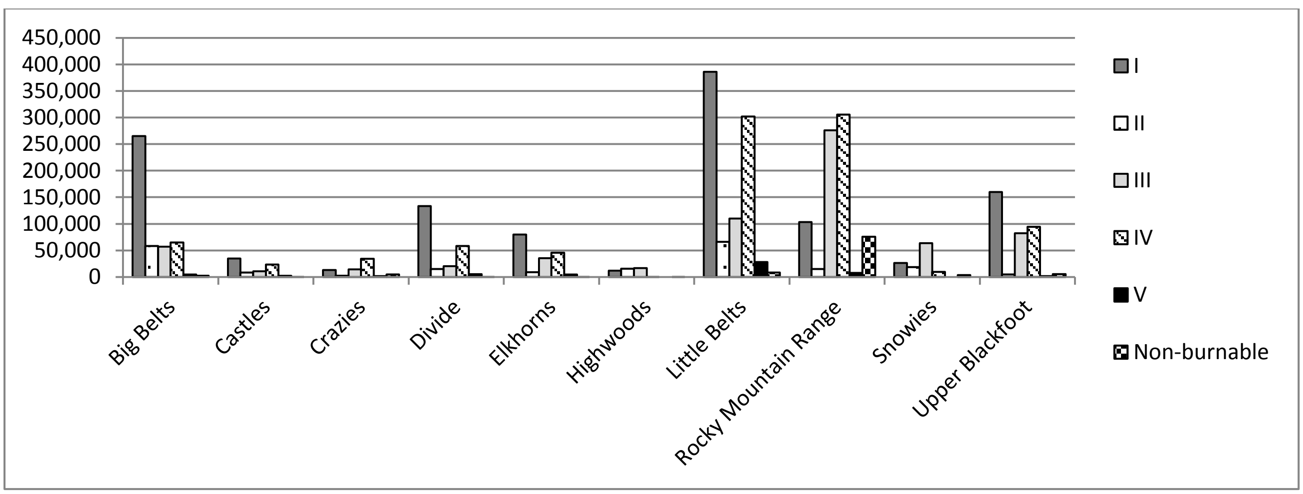

Figure 2.3 Acres per fire regime group by geographic area

Fire severity describes immediate fire effects as opposed to *burn severity* that depicts longer-term effects on vegetation and soils (Lentile et al. 2006). Fire severity can be described in a variety of ways. As it relates to the natural fire regimes, fire severity is generally classified as *low*, *mixed*, or *stand replacing* based on effects to above-ground vegetation.

- *Low severity* fires are common in low elevation dry forests, and result in minimal overstory mortality (<20% of the basal area), edge, and patch size (Agee 1998; Arno et al. 2000; Hessburg et al. 2005). These fires often consumed litter, herbaceous fuels, and foliage and small twigs with little heat travelling down through the duff (Fischer and Clayton 1983). Forests adapted to frequent, low severity fires were often dominated by fire-resistant, early seral species; frequent fire maintained their dominance and promoted open, sometimes uneven-aged structures. These species are adapted to reforest gaps via fire-resistant seed bearing trees. These fires also maintain grasslands, shrublands and a shifting distribution of limber pine/juniper ecotones. This type of fire would be common in fire regimes I and III, which are common in most GAs on the HLC NFs.
- *Mixed severity* fires kill a moderate amount of the overstory, burning with a mosaic of severities but replacing <75% of the overstory (Barrett et al. 2010). Overstory mortality is generally 20 to70% (Hessburg et al. 2005). Highly variable patch sizes would be created, with a mosaic of effects including stand replacement, low severity, and unburned areas (Agee 1998; Arno et al. 2000). This creates an irregular pattern with an abundant amount of edge. Fire tolerant species often survived many fire events, with large, old trees of these species becoming prominent overstory components. Mixed severity fires also allowed for patches of unburned refugia that could develop into climax conditions dominated by shade tolerant species. This type of fire would be common in fire regimes I and III.
- *Stand-replacing (high severity*) fires kill off most tree cover (>75%) over a substantial area, returning forests to early successional stages (Barrett et al. 2010) and creating an intermediate amount of edge (Agee 1998; Arno et al. 2000). The fire-adapted, shade-intolerant trees in these ecosystems commonly live 140 to 400+ years and maintain their dominance through reforestation strategies rather than individual tree resistance. For example, lodgepole pine, though shorter lived and much more vulnerable to fire injury, is well adapted to high severity fire because of its ability to regenerate large areas without a living seed source by storing serotinous cones on trees and in the soil that open under intense heat. This type of fire characterizes fire regime II (nonforested areas across the HLC NFs) and IV, which is one of the most common regimes characterizing most high elevation, moist forests.

Figure 2.4 shows examples of fire severities demonstrated on the HLC NFs. Classification of severity is complex and dependent upon the scale being considered. For example, a fire considered mixed-severity overall would contain patches of both stand replacing and low severity.

Low Severity, Prescribed Burn, 2013, Divide GA

Mixed Severity, Red Shale, 2013, Rocky Mountain Range

Stand Replacing, Snow Talon 2003, Upper Blackfoot

Figure 2.4 Examples of fire severity

Trend

Fire has been a fundamental part of the Northern Rockies ecosystems for thousands of years. Fire, fuels, and climate are closely interrelated. Natural long-term variations in temperature and precipitation have resulted in continuously changing fire regimes (Whitlock et al. 2008). Climatic variability and potential future changes in climate have major effects on the timing, frequency, intensity, severity, and extent of wildfires. This is due to direct climate-related effects, such as increased temperature and greater drying of fuels; or indirectly, related to changes in vegetation composition and structure. Climate-induced changes in fire regimes could have substantial impacts on ecosystems, with associated effects to communities and economies. In addition to climate, interactions with other drivers and fire suppression policies influence fire trends.

Historic Fire (Prior to 1940)

Fire history records prior to 1940 are variable. For the Helena National Forest, fire point data from the 1920's and 1930's indicates that over 12,000 acres burned during that period. On the Lewis and Clark National Forest, fire history data indicate that over 300,000 acres burned from 1800 to 1940. Additional information regarding historic fire is provided in landscape assessments, boundary reports, and fire history studies. These accounts and studies vary in purpose and methodology. Highlights from available sources include the following:

- Over half of the Upper Blackfoot GA burned between 1840 and 1888 (USDA 1995, USDA 1926).
- At least one large fire burned in the Divide Landscape in the late 1800's. "…the last season witnessed some very destructive [fires] along Ten Mile Creek, at Bullion [Divide GA]…" (Hatton 1904).
- Major fires burned in the Big Belts, with the last prior to suppression occurring in 1897 (Losensky 1993).
- In the Elkhorns, fires occurred in virtually every decade since 1700, with a precipitous decline in the late 1800's (Barrett 2005). Large stand-replacing fires were rare before 1900 and the forest mosaic was highly undifferentiated; a historic pattern of low to mixed severity fire was due to the extent of grass, forb, and shrub communities, Douglas-fir components resistant to fire, and diverse topography (ibid). An average of 2,400 acres per year would have burned on this landscape historically (ibid).
- "Fires have swept over the entire area", [proposed Helena and Elkhorn Forest Reserve] (Stickney 1907).
- Much of the Castle and Highwood Mountains burned at the turn of the last century (USDA 1986b).
- Vast areas in the Little Belt Mountains burned in the early 1900's (USDA 1986b).
- Historic fire was quantified for the Helena National Forest using a coarse-filter approach which analyzed the pattern of historic fire disturbance prior to settlement by European Americans; this analysis found that Forest-wide, historically 156,615 to 792,330 acres burned per decade (Hollingsworth 2004).
- The extent of fires in island mountain ranges could be due to protruding topography which may attract a greater frequency of lightning, or their adjacency to steppe from which grass fires spread (Murray 1998).

A SIMPPLLE analysis conducted in 2003, which modeled vegetation 500 years into the past, provides estimates of historic fire by depicting the percentage of the forested habitat types that would burn in a decade, by severity (USDA 2003). The geographic areas used do not match the GAs delineated for this assessment, and the simulation area includes all ownerships. Average values from this analysis are shown in 0; maximum and minimum values of the ranges are reported in the project file. It is estimated between about 12% and 35% of the forested habitat types on each geographic area would burn on average per decade. The analysis areas with the highest estimates are associated with the Upper Blackfoot, Big Belts, and Divide GAs. The landscapes with the least amount of natural fire expected include analysis areas associated with the Highwoods, Rocky Mountain Range, and Castles GAs. All severities would be expected, although the proportion between them varies. For example, high severity fire would be the most common type in the analysis area associated with the Divide GA, while light severity would be the most common in the Snowies GA.

Table 2.3 Historic wildfire processes – adapted from USDA 2003 data – average % landscape burned by decade

2003 HRV Analysis Area	Historic Average % Landscape Burned by Decade			
	Light Severity	Mixed Severity	Stand Replacing	Total, all Severities
1 - North part Little Belts GA; Most of Snowies GA	7.1	5.9	6.1	19.1
2 – West Little Belts GA, North Big Belts GA; Highwoods GA	4.6	0.6	7.5	12.7
3 – Northern part of Rocky Mountain Range GA	5.0	2.2	8.7	15.9
4 – Southern part of Rocky Mountain Range GA	5.3	3.9	9.0	18.1
5 – Upper Blackfoot GA, small Northwest part Divide GA	12.2	11.5	11.4	35.1
6 – Most Big Belts GA; eastern part of Elkhorns GA	12.8	11.0	9.2	33.1
7 – Western part of Elkhorns GA, most of Divide GA	7.8	5.8	10.8	24.4
16 – Crazies GA	5.4	4.7	7.8	17.9
17 – South Little Belts GA; Castles GA; South Snowies GA	5.5	4.0	6.3	15.9

Recent Fire History – Area Burned since 1940

Fire data in GIS shows wildfire areas burned since 1940. In this dataset, the earliest records may not be complete and often include only large fires or active fire years, creating the potential to underestimate the quantity and extent of older fires. The data is based on fire start records on National Forest System lands, and does not include ignitions that went out prior to being detected. Refer to map 2 in appendix A, Recent Wildfire History by Decade.

Large fires have occurred across the plan area since 1940. The decade that saw the most acres burned was 1980-1989, during which over 500,000 acres burned on the HLC NFs. Acres burned and the number of large fires appears to have increased since 1980, as shown in Figure 2.5. The increase in burned area may be in part due to 1) fuel buildup caused by fire exclusion (especially in low severity regimes), 2) climatic conditions, 3) the influence of a warm/dry climate on vegetation, fire behavior, and effectiveness of suppression, 4) recent fire policies that have allowed natural fires to burn, and 5) more complete record-keeping processes. The increase in acres burned is consistent with other observations in the northern Rockies. Westerling et al. (2006) attribute increase in wildland fire frequency over the last twenty years to alterations in fire regimes due to climate changes.

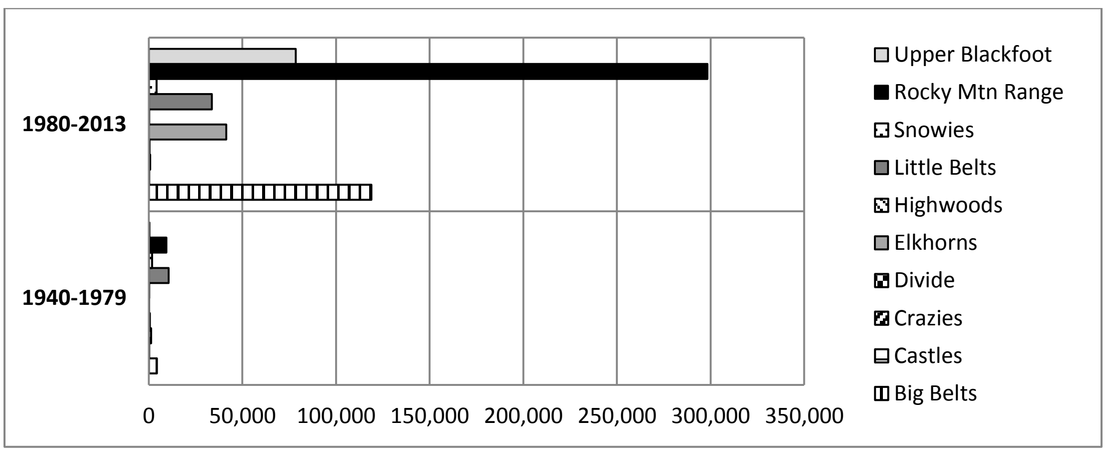

Figure 2.5 Wildfire acres burned by geographic area, pre and post-1980

From 1940 to 2013, about 18% of the HLC NFs administrative area has burned. The proportion of area burned by GA and decade are shown in Table 2.4. Data indicate that most GAs burned only a fraction of their area in any given decade since 1940. This information can be roughly compared to historic fire data derived from modeling

(Table 2.4). Caution against precise comparisons is advised because the datasets differ in fundamental ways. Despite this, the values show a trend that acres burned by decade in all GAs have likely been below historic levels. However, several GAs have had periods which approach historic levels: The Elkhorns in the 1980's, and the Rocky Mountain in the 1980's and 2000's appear to have met or exceeded historic levels of acres burned. The Upper Blackfoot has also had substantial proportions burned in the 1980's and 2000's. Local findings indicate fire exclusion and cool moist climate conditions resulted in acreage burned well below historic levels prior to 1970; however, recent decades are approaching historic levels of acreage (Hollingsworth 2004).

Table 2.4 Recent wildfire history – HLC NFs GIS data –% landscape burned by decade

Geographic Area (GA)	1940-1949	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2009	2010-2013*
Big Belts	1.21	0	0	0.14	5.91	1.89	29.53	0.21
Castles	0.01	0	0	0.05	0	0	0.02	0
Crazies	0	0	1.67	0.09	0.07	1.00	0.02	0
Divide	0	0	0	0.22	0.05	0.01	0	0
Elkhorns	0	0	0	0.02	41.02	0.05	0	0
Highwoods	0	0	0.07	0	0	0	0.24	0
Little Belts	0.35	0.08	0.09	0.92	1.74	1.21	1.41	0.20
Snowies	0.03	1.45	0	0.01	1.11	2.44	0.02	0
Rocky Mountain Range	2.31	0.04	0.09	0.05	28.32	0.65	37.83	11.44
Upper Blackfoot	0	0	0	0.17	12.47	0.10	13.67	2.72

*only 3 years included; not a full decade

In areas that have burned recently, future fires may be somewhat self-limiting in extent because of the variability in residual vegetation conditions. Along with many other factors, the fire history of each GA has influenced the quantity and pattern of recent fires and will influence the potential effects of future fires.

There are many ignitions across the HLC NFs every year and most are suppressed or are extinguished naturally. Over 5,000 detectable ignitions have been mapped on the HLC NFs since 1940, as shown in Table 2.5. The number of ignitions is not necessarily proportionate to burned area. For example, fire starts were not especially numerous in the 1980's but the fires that escaped suppression grew to large sizes. Most fires are caused by lightning, but some by human causes such as campfires, smoking, vehicle or railroad sparks, or arson. The Helena National Forest, in particular, has shown a slight trend of an increasing proportion of human-caused fires, commensurate with urban development and recreation. Lightning strikes appear to be concentrated in some areas due to weather patterns and topography. Refer to map 15 in appendix A, Wildfire Ignitions Recorded Since 1920.

Table 2.5 Fire starts by cause since 1940

Decade	Helena National Forest		Lewis & Clark National Forest	
	# Fire Starts	% Lightning Caused	# Fire Starts	% Lightning Caused
1940's	444	72%	231	79%
1950's	412	74%	273	76%
1960's	600	72%	332	80%
1970's	427	59%	278	70%
1980's	370	62%	276	78%
1990's	411	58%	246	64%
2000-2013	578	58%	401	79%
TOTALS	3,242	65%	2,037	75%

Departure from Historical Conditions and Future Trend

Multiple information sources indicate that wildfire area burned has diminished relative to the historical condition, although more large fires have been occurring in recent decades. The historical condition included the influence of aboriginal burning. Since European settlement, changes to historic fire regimes have occurred due to fire suppression, forest management, and climate change (Hessburg and Agee 2003; Hessburg et al. 2005; Westerling et al. 2006). Roads, railroads, grazing, urbanization, agriculture, and rural settlement all influenced fire exclusion (Hessburg et al. 2005). Grazing was one of the earliest and most extensive land uses on the HLC NFs, which reduced fine fuel loads and contributed to fire exclusion (Heyerdahl 2006). When forest reserves were first proposed, wildfires were viewed as destructive and fire suppression was considered to be necessary to protect resources. This sentiment was expressed in the reserve report prepared for the Helena area (Hatton 1904):

"There are few forest fires in this vicinity which taken in time may, with well-directed effort, be extinguished before serious harm results."

Climate exerts a strong influence on wildfire activity (Marlon et al. 2012, Littell et al. 2009), although weather conditions and ignition sources are also important. An apparent divergence in fire and climate since the mid-1800's has created a fire deficit in the West that is jointly attributable to human activities and climate change (Marlon et al. 2012). Because pervasive warming can lead to stress on trees, warming trends may also increase fire severity because trees may be more susceptible to fire-induced mortality (van Mantgem et al. 2013).

The consequences of a departure from historical wildfire regimes on the HLC NFs include but are not limited to:

- Fire in dry forests, often dominated by ponderosa pine, limber pine, and Douglas-fir, has shifted from low/moderate severity, high frequency to moderate/high severity regimes, with increases in uncharacteristic large-scale stand-replacing fires (Lehmkuhl et al. 2007). Because fires have been excluded in some areas, fuels have often built up to an uncharacteristic level. In some cases, numerous fire cycles have been missed.
- Higher elevation moist forests, which are often dominated by lodgepole pine and subalpine fir, naturally have a long fire interval with higher severity fires. Changes to the natural regime are less pronounced than in frequent interval fire regimes. However, while infrequent stand replacing fires play a definite role, the interval between fires in one area might be only a few years (Fischer and Clayton 1983). Fire suppression has had the effect of decreasing acreage burned in normal fire seasons, reducing natural variability in landscape patterns (USDA 1990). While fire suppression may not have had a substantial effect on succession at the stand level due to naturally long return intervals, at the landscape scale it may have induced homogeneity (Barrett 1993).
- Mixed severity fire regimes have experienced changes incorporated by both low severity and high severity regimes in a mosaic. Fire exclusion has reduced stand and landscape diversity in subalpine forests in that vegetation has aged more uniformly and become less diverse spatially and compositionally, resulting in stand replacing fires that regenerate extensive areas that were often a mosaic of varying age classes historically (Barrett 1997). While the adaptation of lodgepole pine to stand replacing events has long been acknowledged, some lodgepole forests also historically burned in low to mixed severity fire, often creating 2-aged stands and variable landscape patterns (Hardy et al. 2000).
- More fires are burning for extended periods of time compared to the fires lasting less than one week that were common prior to the mid-1980s (Westerling et al. 2006). Vegetation changes include higher tree density, more multi-storied stands and ladder fuels, and a greater homogeneity of structures across the landscape which results in a greater probability for disturbances to affect large contiguous areas (Hessburg et al. 2005).

- Non-forested regimes have also changed, in part due to conifer encroachment that has occurred because of the cessation of frequent fire, grazing, and climate (Heyerdahl 2006). In some areas that historically had a mosaic of sagebrush-grasslands with stable islands of Douglas-fir savanna, Douglas-fir cover has increased exponentially (Heyerdahl 2006). This is largely due to the lack of frequent fire that would have killed conifer seedlings. Fire exclusion occurred as a result of fire suppression, grazing (which reduced fine fuel loads), and the cooler/wetter climate prior to the 1980's. Climate conditions during this time would also have been conducive to the growth of Douglas-fir. Interestingly, an increasing frequency of dry summers can also enhance conifer encroachment because drought-tolerant sagebrush is favored over grasses; sagebrush in turn can create microsites suitable for Douglas-fir establishment (Heyerdahl 2006).

The forests of western Montana and the Northern Rockies have fire regimes strongly controlled by temperature and precipitation, making the forests highly vulnerable to increased temperatures (Peterson et al. 2012). In the future, fire intensity and severity may be higher due to more extreme fire weather (i.e. hotter) and higher fuel loadings (i.e. tree mortality, increased forest densities). In mixed severity regimes, shorter fire return intervals could convert lands to more of a low severity fire regime, as frequent fires promote more open stand conditions and species resistant to fire. Even in natural high severity fire regimes, fire intensity and severity could be exacerbated in the short term due to the combination of drought and the dead fuels created by the recent mountain pine beetle outbreak. These influences could cause soil damage and reduction of regeneration potential where fires occur. Researchers have indicated high confidence that in the future Fire Regime I will shift towards decreased fire frequency and increased fire severity, Fire Regime III will have a shorter fire interval, and Fire Regime IV will experience increases in fire frequency but fire severity will remain unchanged (Rocca et al. 2014).

Wildfire trends are interrelated with other drivers. Potential changes in the spatial heterogeneity of landscapes that result from changes in fire regimes may impact many ecosystem functions (Turner 2012). For example, forests impacted by insects experience changes in fuel distributions that alter the effects of fire, and conversely fires can alter the susceptibility of forests to insects and diseases. Wildfire is strongly influenced by landscape heterogeneity (e.g., the abundance and connectivity of fuel, and the presence of natural fire breaks and topographic variability) when fire weather is not extreme (ibid). Further, fire hazard depends, in part, on spatial patterns of human development and management activities. Vegetation management may decrease subsequent fire hazard under moderate burning conditions, depending on types and spatial patterns of treatment. A key element of ecosystem function and resilience is forest regeneration following wildfire. Spatial heterogeneity is important to forest regeneration in that the amount and configuration of undisturbed patches and individual legacy trees that survived prior disturbance will be important as seed sources for forest regeneration (Turner et al 2012). Fires burning with high severity in forests adapted to low or mixed regimes can disrupt the regeneration mechanisms of plants, resulting in shifts in composition.

Information Needs

A more current Natural Range of Variability analysis is needed with the SIMPPLLE model using new data sources to refine our understanding of the role of fire, particularly with future climate changes.

Forest Insects and Disease

Existing Condition

Insects and diseases are important ecosystem drivers because of their influence on vegetation on a local and landscape level. Most of the agents and pathogens on the HLC NFs are native, with the notable exception of white pine blister rust and balsam woolly adelgids. Existing conditions are described for the following agents. Refer to maps 4, 5, and 6 in appendix A for infestation maps for the insects of greatest importance.

- Bark beetles and secondary beetles
- Defoliators

- Dwarf mistletoe
- Root diseases
- White pine blister rust
- Other insects and diseases

Bark Beetles and Secondary Beetles

Bark beetles are the most significant biotic agent in terms of trees killed on the HLC NFs. The bark beetles of most importance in this area are mountain pine beetle and Douglas-fir beetle. Others such as spruce beetle, western pine beetle, western balsam bark beetle, fir engraver, as well as secondary beetles play a lesser role.

Mountain pine beetle

Mountain pine beetle (*Dendroctonus ponderosae*) is a native bark beetle which attacks all species of pine and is capable of causing widespread tree mortality. Each bark beetle species exhibits a preference for trees of a certain size (Fettig and Hilszcanski 2015). Mountain pine beetle is generally attracted to the largest trees available (Preisler and Mitchell 1993). Tree death is caused by the feeding of larvae which girdle the cambium, aided by blue-stain fungi (Amman and Logan 1998). Mountain pine beetle prefers dense, shady stands because the microclimate is conducive to survival and communication, and trees are less vigorous (Bartos and Amman 1989; Preisler and Mitchell 1993). Most bark beetle species have a preference for larger trees often with declining radial growth, growing in high density stands with a high percentage of host type (Fettig and Hilszcanski 2015). Typically an outbreak continues until the beetle runs out of host (food) or weather ceases to be conducive, although parasites and predators are also important regulating factors especially when populations are at endemic levels (Amman and Cole 1983). Weather that regulates mountain pine beetle includes extreme cold for extended periods in the winter, late spring or early fall frost, and wet springs/summers (Amman and Cole 1983). Abiotic factors including temperature, moisture, and physiographic site conditions such as soils and elevation may also influence tree vigor and stand susceptibility (Six and Bracewell 2015). Frequency of outbreaks generally ranges from 20-40 years (Cole and Amman 1980); however, outbreak periodicity is strongly influenced by forest stand conditions. Beetle infestation can result in more open canopies that provide regeneration opportunities for shade intolerant trees, and/or promote the growth of shade-tolerant understory trees.

Mountain pine beetle outbreaks have occurred in the Northern Rockies for thousands of years; bark beetles have been found in lake cores indicating their presence at least 8,000 years before present (Brunelle et al. 2008). Most recently a wide-scale outbreak occurred across the plan area from 2006 to 2011. At the peak of infestation extent in 2009, nearly a million acres were infested across the HLC NFs. Acres of infestation have greatly decreased since, attributable largely to host depletion and weather conditions. Several interrelated factors contributed to the conditions that fueled this outbreak:

1. The homogeneity and extent of susceptible forests created by several factors, including:
   - Natural fire (which would likely have created a more heterogeneous mosaic of age classes, species, and density) was largely suppressed since the early 1900's;
   - Harvest practices at the turn of the century and large stand-replacing fires in the late 1800's created an abundance of early seral forests that grew into susceptible even-aged mature forests; and
   - The small extent of modern harvest did little to break up the age class and density homogeneity.

2. The climate trends over the last century which included a cool and moist period conducive to the establishment and rapid growth of dense forests and fire exclusion, followed by a shift to warm and dry conditions in recent decades that stressed established forests and favored insect survival.

Infestation varied by GA based on composition and topographical isolation. GAs containing a higher proportion of mature, dense, pine forests sustained more infestation than those with more diversity. Although the recent outbreak is subsiding, mountain pine beetle has always been and will continue to be present on the HLC NFs causing some level of observable tree mortality.

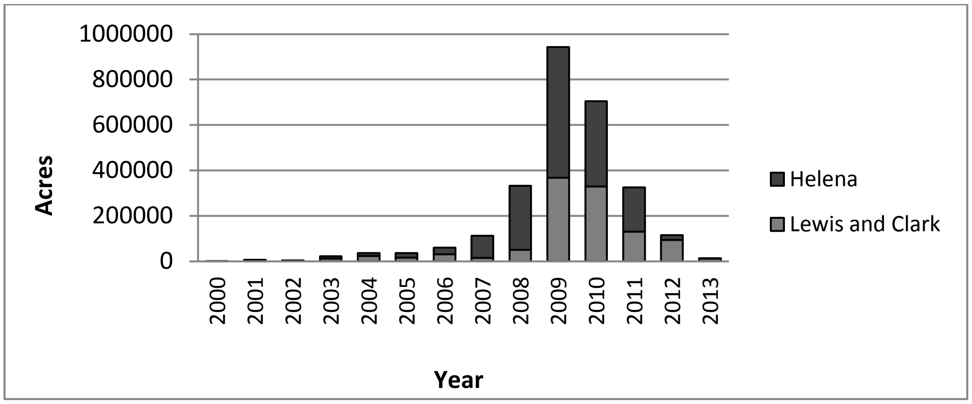

Figure 2.6 Mountain pine beetle infestation 2000-2013 - Federal lands on HLC NFs (USDA 2001-2013, R1-FHP)

The level of mortality on infested acres varies depending on host conditions; in some areas, only a few trees were killed, while in others over 90% of the stand was killed. In 2012, an analysis using FIA Intensified Grid plots was done on the Helena National Forest in an effort to understand the intensity of mortality (Olsen and Milburn 2012). This analysis utilized re-measured plot pairs with pine components. This analysis found that most plots with pine had experienced some canopy loss, as shown in Table 2.6. Mortality was generally higher in lodgepole pine areas than in ponderosa pine areas.

Table 2.6 % Canopy Loss due to Mountain Pine Beetle Infestation on 279 Re-measured Plot Pairs on the Helena National Forest (Olsen and Milburn 2012)

% Canopy Loss	% Re-Measured Plots
0%	19%
1-25%	38%
26-50%	18%
51-75%	10%
>75%	15%

Figure 2.7 shows the intensity of tree mortality on the Helena National Forest according to aerial detection surveys from 2006 to 2011 (Egan 2012). The Elkhorns, Divide, and Upper Blackfoot GAs had substantial areas of relatively high mortality (over 45 or 75 trees per acre killed). While the infestation was relatively widespread on the Lewis and Clark NF as well, as shown in appendix A, most areas appear to have experienced a lower intensity of mortality.

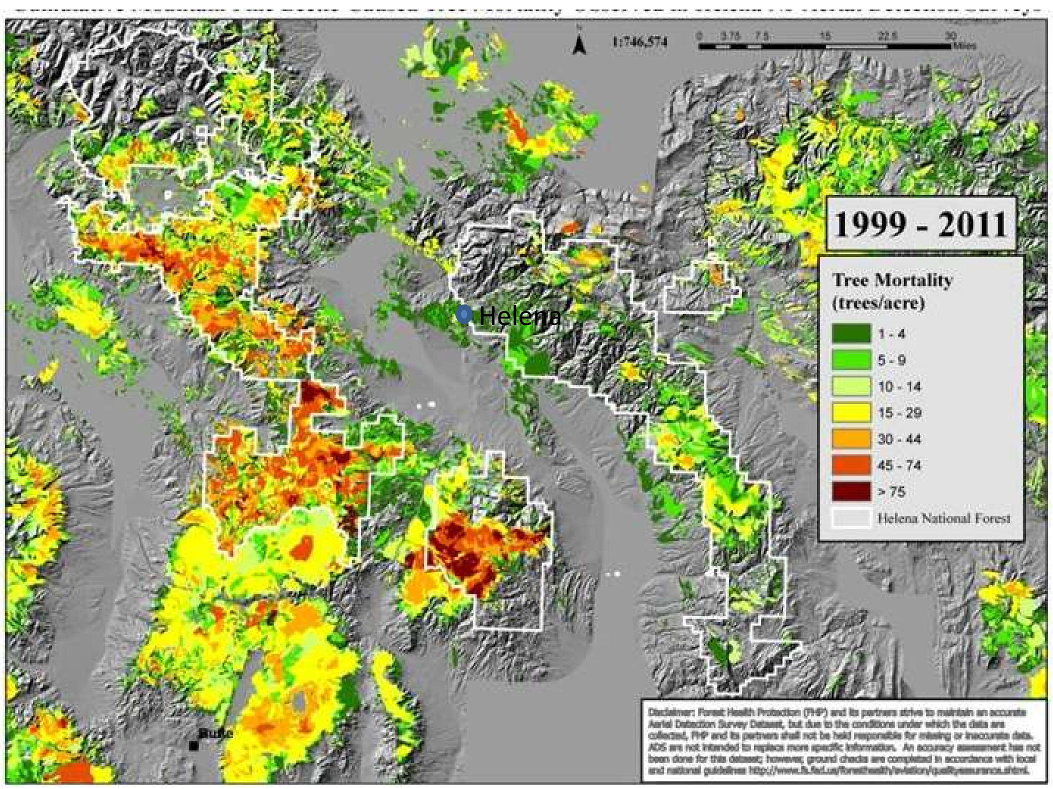

Figure 2.7 Cumulative mountain pine beetle caused tree mortality observed on Helena NF (Egan 2012)

At the local scale the outbreak was a natural disturbance influenced by anthropogenic factors. At the broader scale, this is part of an outbreak that has affected much of the western U.S. and Canada and studies have shown that some aspects have been unprecedented in terms of extent and elevations and latitudes impacted. The results may influence ecosystems and ecosystem services for decades to come, including impacts to ecosystem function as well as human uses such as recreation. The mountain pine beetle outbreak has impacted whitebark pine, a candidate species under the Endangered Species Act, by killing important seed producing trees. The influences of this are discussed in the Threatened, Endangered, Proposed and Candidate Species section.

Douglas-fir beetle

Douglas-fir beetle (*Dendroctonus pseudotsugae*) is a native bark beetle affecting Douglas-fir. At endemic levels, it infests scattered trees and groups, including blowdown and trees injured by fire, defoliation, or root disease (Schmitz and Gibson 1996). Disturbances can trigger outbreaks that cause widespread mortality, typically lasting two to four years (Negron et al. 2001). This beetle kills the tree through the same mechanisms as the mountain pine beetle, but it is less aggressive and outbreaks generally subside shortly after the beetles start to infest healthy green stands containing vigorous trees. It has a stronger preference for larger, older trees. Douglas-fir beetle has been endemic across the HLC NFs over the last decade, although a spike in infestation occurred following wildfires in 2000 and 2007 as the insect capitalized on fire-weakened trees. The most recent peak of infestation occurred in 2004 at just over 13,000 acres. This beetle remains active in some areas with large diameter Douglas-fir, and can be associated with stands that have been significantly impacted by western spruce budworm.

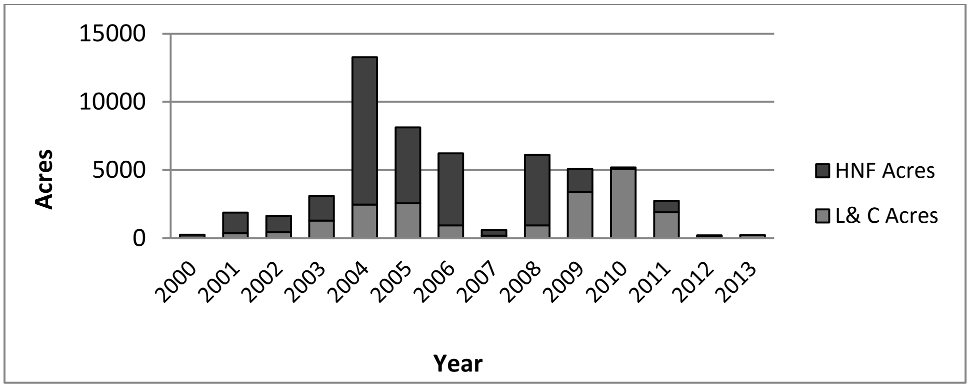

Figure 2.8 Douglas-fir beetle infestation 2000-2013 - Federal lands on HLC NFs (USDA 2001-2013, R1-FHP)

Other bark beetles

The other bark beetles present on the HLC NFs include pine engraver (*Ips spp*), red turpentine beetle (*Dendroctonus valens*), spruce beetle (*Dendroctonus rufipennis*), western balsam bark beetle (*Dryocoetes confusus*), and western pine beetle (*Dendroctonus brevicomis*). These insects are active at endemic levels, and have the potential to locally impact stands. From 2000 to 2013, these insects have collectively been mapped on less than 17,000 acres per year which is less than 1% of the reporting area associated with the HLC NFs.

- Pine engravers attack pines, especially ponderosa pine, and are commonly associated with logging slash, wind-thrown trees, or trees broken by wind or snow (Kegley et al. 1999), and can kill a few trees to groups of trees as large as 50 to 100 trees (Livingston 2004). Outbreaks are predicted in drier than normal years, typically in dense young stands, and seldom last more than one season (Kegley et al. 1999).
- Red turpentine beetle affects mainly ponderosa pine on the HLC NFs. It focuses on the largest and weakest trees, and is typically only noted in areas where the trees have been damaged. It seldom kills trees, but can cause scattered mortality when populations build up in areas damaged by low-intensify fire.
- Spruce beetle is limited to Engelmann spruce as a host in the plan area. Because of the limited extent of this host, this beetle generally only affects small groups of trees.
- Western balsam bark beetle affects subalpine fir on the HLC NFs, often "strip attacking" trees or killing small groups of trees. Of this category of pests, this is the most active in the plan area.
- Western pine beetle is only known to occur west of the Continental Divide. It attacks ponderosa pine, generally of large diameter, often in conjunction with other pests.

Bark beetle interactions with other drivers

Bark beetles interact with other ecosystem drivers, including climate and fire. These insects are highly sensitive to climate. Drought makes trees more vulnerable to insect attacks. In general, as temperature increases, development rate, initiation of and maintenance of dispersal flights, mating, and ovipositon rates are all influenced (Six and Bracewell 2015).

The interaction with fuels and fire is complex. The foliar moisture content of needles starts to decrease once a tree dies from bark beetles and has been measured as low 12 percent in red needles as compared to an average of 109 percent for green needles; there is also a corresponding change in the chemical composition of needles as starch, sugar, and fat content decreases (Jolly et al. 2012). These changes appear to influence needle flammability, as red needles ignited more quickly than green needles in a controlled environment (Jolly et al. 2012). Schmid et al. (2007) suggest that beetle-killed trees result in increases in dry fuel loads and thereby increase the potential for severe fires. Fire behavior varies in post-outbreak stands depending upon when they occur; the net result of bark beetle infestation is a substantial change in species composition and a highly altered fuels complex (Jenkins et al. 2008). Early in epidemics there is an increase in the amount of fine surface fuels, while in post-epidemic stands large, dead, woody fuels and live surface fuels dominate (Jenkins et al. 2008). Passive crown fires may be more likely in post-epidemic stands but active crown fires are less likely after dead needles have fallen due to decreased aerial fuel continuity (Jenkins et al. 2008). However, there have been local anecdotal accounts of severe wildfire behavior even in the “gray phase”, when dead trees are still standing, which may be in part due to the presence of a living understory beneath the canopy. Once dead trees fall to the forest floor, they create woody debris which can burn with high severity and long duration; the potential for crown fire during this stage would also be dependent upon the remnants of other species in the stand, including understory layers.

Secondary Beetles

A variety of secondary beetles are present in the forest, such as ambrosia beetles (families *Scolytidae* and *Playtpodidae*), and wood borers (families *Cerambycidae* and *Bupresdidae*). These insects do not target healthy trees, but feed on damaged or dying trees, or downed wood, providing nutrient cycling and a food source for other animals such as woodpeckers. Secondary beetles can reach outbreak status on a localized scale following disturbances such as fire.

Defoliators

Defoliators found on the HLC NFs feed on the foliage of trees in their larval stages and disperse as moths, and outbreaks occur in cycles driven by climate and host conditions.

Western spruce budworm

Western spruce budworm (*Choristoneura fremanni*) is the primary defoliator of concern on the HLC NFs. It affects mainly Douglas-fir, but also feeds on Engelmann spruce, subalpine fir, and even pines during outbreaks. Larvae mine buds and old needles prior to bud burst in May and June, consuming new foliage as buds flush. Feeding causes growth decrease, branch dieback, top kill, and in some cases mortality. Cones and seeds are destroyed, and terminal and lateral new larch shoots can be severed (USDA 2004). When the larvae become moths, they disperse to upper canopy layers to lay eggs. Good budworm habitat consists of dense, multiple layers of host species because the upper story provides a food source and refuge from predation and parasitism while the lower canopy layers intercept budworm spinning from above and provide sanctuary from predators on the forest floor (ibid). Development of outbreaks depends on suitable habitat, although budworm is also influenced by climate, weather, parasites, and predators. It does well in dry climates and on dry aspects (Carlson and Wulff 1989). Impacts are often short-term and vigorous trees can recover after populations subside. Mortality is usually limited to suppressed regeneration and pole-sized trees which collect falling larvae (Bulaon and Sturdevant 2006), but this insect has also killed stands of mature trees in combination with Douglas-fir beetle following periods of drought on the Helena National Forest (Sturdevant and Kegley 2006; Steed et al. 2007).

On the HLC NFs, western spruce budworm outbreaks are chronic in that they occur over large areas with relatively short periods between them. As forests become dense with a higher composition of Douglas-fir, budworm outbreaks become more frequent and severe (USDA 2004). Percent climax crown cover, stand density, and site index were the strongest indicators of stand susceptibility to budworm damage (Bulaon and Sturdevant 2008). Defoliation has been widespread over the last decade in large part due to warm, dry weather and a preponderance of dense, layered forests. Defoliation can also predispose trees to attack by Douglas-fir beetle, a phenomenon which is most evident currently on Flesher Pass in the Upper Blackfoot GA (USDA 2006; Steed et al. 2007). The acres infested have cycled due to wet springs and summers, but overall remains at elevated levels.

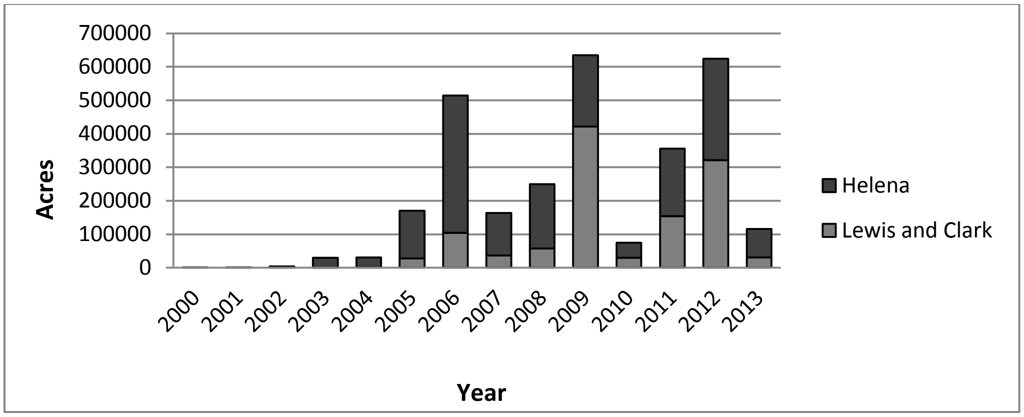

Figure 2.9 Western spruce budworm infestation 2000-2013, aerial detection survey GIS Data for HLC NFs reporting area

Balsam Woolly Adelgid

Balsam woolly adelgids, *Adelges piceae*, are nonnative and impact subalpine fir and grand fir in Montana. The insect feeds on branches, twigs, and the main boles of host trees and causes gouting on branches and can kill trees following several years of heavy feeding. It was recorded at low levels on the Helena NF during surveys in 2010-2013 (USDA 2014d).

Dwarf mistletoe

Dwarf mistletoes are a family of native parasitic plants that extract water and nutrients from living conifers. These plants cause reduced tree vigor, reduced diameter and height growth, and reduced cone and seed production as well as irregular branching, branch kill, and top kill. Premature death eventually follows, usually aided by secondary bark beetles (Hawksworth and Johnson 1989). The parasitic activity can also increase the predisposition to other pathogens and insects. Witches brooms and mortality also provide structural diversity and habitat for arboreal mammals and some bird species. In the long term, heavily infested stands decline and shift toward other tree species. Dwarf mistletoe is fairly common in lodgepole pine across the HLC NFs.

Root Diseases

Root diseases are pathogens that live in root systems and break down cellulose and lignin. They compromise the uptake of water and nutrients and eventually cause mortality. They are commonly endemic in areas with susceptible hosts and are persistent where present. Older trees and high density stands are at higher risk to some root and butt rots than younger, more open-grown stands. Tree species most susceptible to root disease on the HLC NFs are Douglas-fir and subalpine fir, with Engelmann spruce being moderately susceptible and pines generally less susceptible. Root diseases influence structure, composition, and successional trajectories. On sites with a root disease-susceptible forest type and climax species, high levels of disease may maintain early stand development because the stands experience waves of mortality as trees grow and healthy roots contact diseased roots allowing the disease to spread; this is not a common phenomenon on the HLC NFs. The common root diseases on the HLC NFs include Armillaria root disease (*Armillaria ostoyae*), Schweinitzii root and butt rot *(Phaeolus schweinitzii*), and tomentosus root disease (*Onnia tomentosa)*. Schweinitzii is common throughout the range of Douglas-fir (USDA 2003).

The most aggressive of the root diseases on the HLC NFs is Armillaria. While it is not particularly widespread or common in the plan area, it has caused mortality in portions of the Little Belts and Big Snowy Mountains as well as other eastside locations (USDA 2003). The most notable Armillaria infection occurs in Logging Creek in the Little Belts. Stress predisposes trees to armillaria by reducing host vigor and compromising defenses (Wargo and Harrington 1991). Armillaria carries over in roots, stumps, and snags from one generation to the next, surviving fire and harvest. Schweinitzii root and butt primarily affects mature and over-mature Douglas-fir and may pre-dispose affected trees to Armillaria or Douglas-fir beetle (Hoffman 2004). Determining an estimate of acres affected by root disease is difficult because their effect is not often obvious and they typically do not kill wide swaths in short periods of time. Aerial detection surveys underestimate its extent. Since 2000, root disease has been mapped on less than 2,500 acres yearly. It appears to be most prevalent in the Highwoods and Little Belts, with some representation in the Snowies, Big Belts, and minor occurrences in other GAs.

White pine blister rust

White pine blister rust (*Cronartium ribicola*) is a nonnative, introduced disease that entered the United States from Europe early in the 20th century. By the 1940s widespread infection was noted throughout the western United States. It infects all five-needled pines, specifically limber and whitebark pine on the HLC NFs. This disease has a complicated life cycle composed of five spore types alternating between two hosts. In addition to five needled pines, it requires an alternate host such as currant plants, *Ribes spp* (Tomback et al. 2001). The disease creates cankers on branches and the stem, usually eventually girdling and killing it although a small proportion of trees with resistance traits can survive indefinitely. Although mortality does result, it is a slow process. Of greater importance may be the mortality of cone-producing branches which reduces the reproductive potential of whitebark and limber pines, which is especially critical in areas that are disturbed by fire. Successional pathways have been altered because species not susceptible to the disease are favored. Many five-needled pine stands have become dominated by snags, with only a few seed-bearing survivors that possess one or more resistance traits. However, in many areas, there are abundant seedlings and saplings. Please refer to the Threatened and Endangered Species section for more information regarding whitebark pine, and the Species of Public Interest section for information regarding limber pine.

Other insects and diseases

A host of other insects and pathogens play a role in the ecosystem but are not identified as major drivers. Those that may be present include, but are not limited to red ring rot, western gall rust, Comandra and stalactiform blister rusts, Sequoia pitch moth, pine pitch mass borer, fire and spruce canker, wood wasps, broom rusts, pine shoot blight, gouty pitch midge, terminal weevils, western pine shoot borer, pine tip moths, aphids, Cooley spruce gall adelgid, rhabdocline needle cast, larch needle diseases and insects, pine needle miners, as well as a host of casts, and blights, and needle scales. In particular, there have been recent accounts of pine shoot blight, a canker-causing fungus in ponderosa pine, particularly on low-elevation ponderosa pine trees in the Helena area.

Trend

Historical Conditions

With the exception of white pine blister rust and balsam woolly adelgid, the insects and pathogens on the HLC NFs are native and have co-evolved with their hosts over millennia. Through selective killing or reducing growth of trees, they influence structure and composition which affects other processes such as fire. They benefit plants and animals that utilize dead or modified wood, or feed on insects or pathogens. These agents have a role in maintaining soil fertility. Climate and weather play a major role in controlling insects, as does availability and quality of food and breeding habitat. Historically, insect populations would periodically build to high levels under favorable climatic and host conditions. Frequency of epidemics varies by species and locality. Cool climate conditions, such as those that predominated from the 1940's through the 1970's, were not conducive to outbreaks. The current warm/dry cycle correlates with the increased extent of outbreaks since the 1980's. Human actions such as fire suppression, past logging practices, and land development in conjunction with succession influence vegetation which influences the population or intensity of insects and diseases. Higher stand densities increase stress and competition for resources, which renders trees less able to resist insect and diseases.

To depict historical trends, aerial detection survey data from 1962 to 1999 is summarized in Figure 2.10. Western spruce budworm has been present with regular outbreak cycles. Douglas-fir beetle had several outbreaks in the 1960's but has been at low levels since. Mountain pine beetle had several minor periods with elevated activity. All three of these pests were inactive in the 1990's compared to the activity that has occurred since 2000. These data depict a relatively recent time period. Historically, mountain pine beetle outbreaks have occurred somewhere in the Northern Region (Montana and northern Idaho) about every 10-15 years, most notably in the 1930's on the adjacent Beaverhead-Deerlodge National Forest and the 1980's in northwestern Montana. Large scale outbreaks of other bark beetles have been less common and dramatic. Western spruce budworm is known to have chronic outbreaks on the HLC NFs roughly every 20 years driven by climate and cyclic population dynamics, as evidenced by deformed "bottle-brush" shaped trees that survived the previous outbreaks.

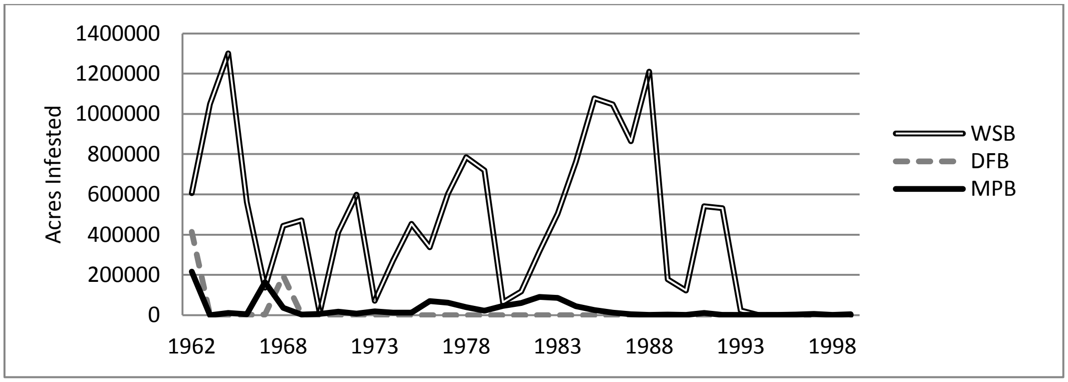

Figure 2.10 Major insect trends 1962-1999, ADS, HLC NFs reporting area including non-Federal lands

The SIMPPLLE analysis conducted in 2003, which modeled vegetation 500 years into the past, depicts the average percentage of forested habitat types on each landscape that would be infested by selected insects and diseases in a decade (USDA 2003). The geographic areas used do not match the GAs delineated for this assessment, and the runs include all ownerships. Average values are shown here; maximum and minimum values of the ranges are reported in the data in the project file.

Table 2.7 shows the estimates for mountain pine beetle by host. This analysis found that very little of each landscape would have been impacted by mountain pine beetle on average, ranging from about 1% to 10% per decade. Although caution is advised against a direct comparison with this analysis, it is reasonable to conclude that the current levels of mountain pine beetle are higher than what would have occurred historically; this is likely in part related to the current distribution of age and size class diversity which has been influenced by fire processes (or the lack thereof). The majority of multiple GAs were infested in the recent outbreak.

Table 2.7 Historic mountain pine beetle processes – adapted from USDA 2003 data

2003 HRV Analysis Area	Historic Average % Landscape Infested by MPB			
	Ponderosa	Lodgepole	Whitebark	Total
1 - North part Little Belts GA; Most of Snowies GA	0.6	0.4	0.0	1.0
2 – West Little Belts GA, North Big Belts GA; Highwoods	0.0	0.6	9.7	10.3
3 – Northern part of Rocky Mountain Range GA	0.0	0.3	0.0	0.3
4 – Southern part of Rocky Mountain Range GA	0.0	0.9	0.0	0.9
5 – Upper Blackfoot GA, Northwest Divide GA	0.2	0.4	0.0	0.6
6 – Most Big Belts GA; eastern Elkhorns GA	0.3	0.2	0.0	0.5
7 – Western part of Elkhorns GA, most of Divide GA	0.2	1.7	0.0	1.9
16 – Crazies GA	0.0	1.1	0.0	1.1
17 – South Little Belts; Castles GA; South Snowies GA	0.3	0.9	0.0	1.2

Results for the historic Douglas-fir beetle, western spruce budworm, and root disease were also assessed with SIMPPLLE in 2003. Western spruce budworm was estimated to impact between 2 and 6% of each landscape by decade; current conditions appear to exceed this. Douglas-fir beetle and root disease were estimated to impact small areas, less than 1% of all landscapes assessed per decade. Existing levels of these agents appear to be similar to historic estimates, although localized outbreaks of Douglas-fir beetle may have exceeded these levels.

Table 2.8 Historic insect and disease processes – adapted from USDA 2003 data

2003 HRV Analysis Area	Historic Average % Landscape Infested by Decade		
	WSB	DFB	Root Disease
1 - North part Little Belts GA; Most of Snowies GA	5.7	0.8	2.0
2 – West Little Belts GA, North Big Belts GA; Highwoods	3.2	0.0	1.0
3 – Northern part of Rocky Mountain Range GA	2.2	0.3	0.6
4 – Southern part of Rocky Mountain Range GA	2.4	0.3	0.7
5 – Upper Blackfoot GA, small Northwest part Divide GA	2.2	0.5	0.3
6 – Most Big Belts GA; eastern part of Elkhorns GA	3.1	0.6	0.4
7 – Western part of Elkhorns GA, most of Divide GA	3.0	0.5	0.6
16 – Crazies GA	2.2	0.3	0.6
17 – South Little Belts GA; Castles GA; South Snowies	2.7	0.4	0.6

Expected Future Trend: Hazard

Based on the current warm/dry period and anticipated climate trend, the future extent and damage of most insects and pathogens may increase. Specific trends will vary and be influenced by anthropogenic factors and availability of susceptible hosts. Trend can be in part predicted by estimating hazard. *Hazard* is synonymous with "susceptibility", and is defined by forest characteristics suitable for the insect of interest. Whether or not an outbreak occurs, and the severity of damage, also depends on *risk* – or the presence of the insect or pathogen where it can utilize susceptible forests. Hazard ratings that have been developed for several major insects in the Northern Region are applicable to the HLC NFs which can be applied to FIA and FIA intensified grid plots to estimate hazard (Randall and Bush 2010). High and moderate hazard areas are more likely to experience significant mortality if insect populations are present and the weather is favorable (Randall and Bush 2010).

Mountain pine beetle

Mountain pine beetle hazard is driven by species composition, tree size, and stand density. The quality of ponderosa pine as mountain pine beetle food is best characterized by stand density and phloem thickness (Randall and Bush 2010). A pure, well-stocked ponderosa pine stand will be more likely to support a large mountain pine beetle population than a mixed species and/or poorly stocked stand (ibid). Across the HLC NFs, plot estimates show that 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, moderate hazard is common. The base FIA used for this estimate have not been re-measured since the recent outbreak; some of these areas have been impacted by the recent outbreak. According FIA, just over 151,000 acres are at moderate to high hazard to mountain pine beetle in ponderosa pine across the HLC NFs.

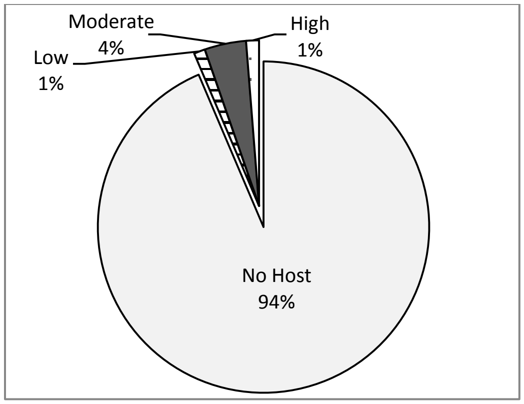

Figure 2.11 Mountain pine beetle hazard in ponderosa pine, HLC NFs, R1 summary database

Hazard to mountain pine beetle in ponderosa pine forests varies by GA as shown below; these estimates include the FIA intensified grid where available, which has been re-measured since the outbreak and therefore provides a better depiction of hazard. Moderate and high hazard areas exist on the Big Belts, Divide, Elkhorns, Little Belts, and Snowies GAs with trace amounts on the Upper Blackfoot. Of particular interest are the ponderosa pine forests on the Snowies GA, which have been largely untouched by the current outbreak but are at high hazard. Ponderosa pine forests on most other GAs have been recently impacted by the mountain pine beetle outbreak, and have lower hazard today than they did previously. While mortality was high in some stands, the infestation was somewhat patchy, and scattered individuals and groups of susceptible ponderosa pine survived the outbreak.

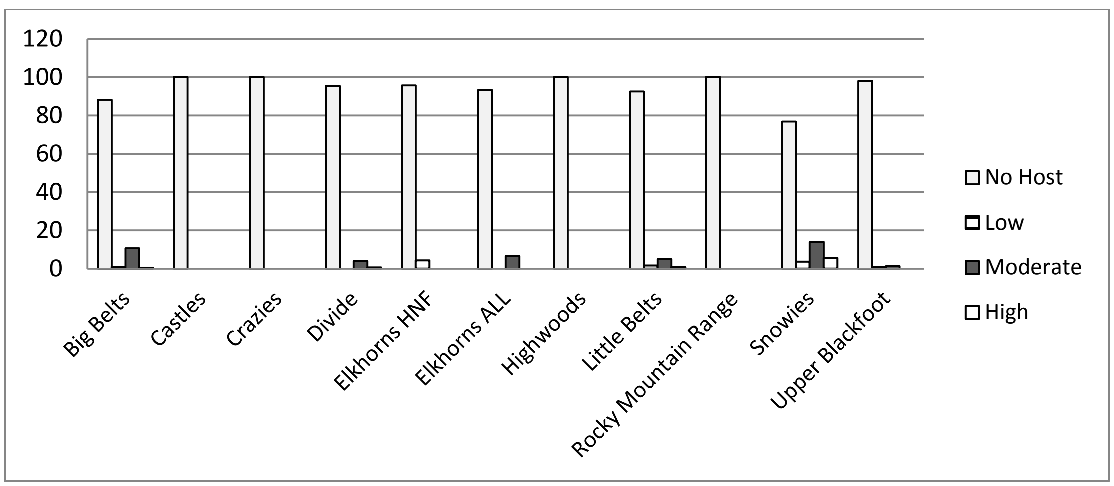

Figure 2.12 Mountain pine beetle hazard in ponderosa pine by GA, R1 summary database

Lodgepole pine areas are extensive on the HLC NFs. Epidemics develop in lodgepole pine stands with well-distributed, large-diameter trees; the hazard rating system uses criteria such as diameter, basal area, species composition, and elevation (Randall and Bush 2010). Susceptible stands are dense (at least 100 square feet of basal area per acre) and have a high composition (at least fifty percent of the basal area) of large diameter (at least eight inches diameter) lodgepole pine, although outbreaks may be limited once basal area becomes too high, such as in dense stands of small diameter trees, or if stands are at high elevations (ibid). Based on the summary database, most lodgepole pine forests on the HLC NFs are at moderate to high hazard; these categories represent roughly 833,000 acres. Substantial lodgepole forests, particularly on the Lewis and Clark National Forest, sustained light infestation during the recent outbreak and are still susceptible to mountain pine beetle outbreaks. However, many areas recently impacted by the outbreak have a lower hazard today because substantial susceptible hosts were killed. HLC NF-wide estimates are based on base FIA plots, most of which have not been re-measured since the recent outbreak. Hazard has likely sharply declined in the last several years.

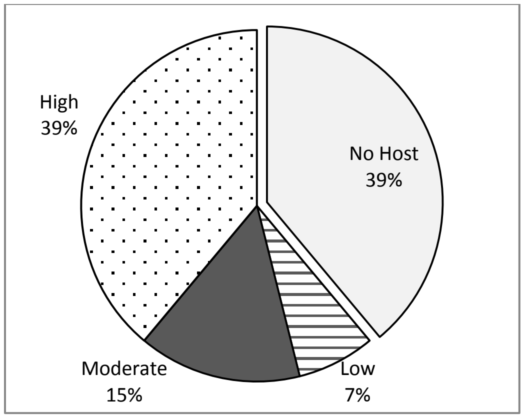

Figure 2.13 Mountain pine beetle hazard in lodgepole pine, HLC NFs, R1 summary database

GA-specific estimates using FIA intensification plots which have been recently re-measured are considered to be a more accurate depiction of existing hazard. By GA, hazard to mountain pine beetle in lodgepole pine varies as shown in Figure 2.14. The GAs that sustained high mortality in the recent outbreak, such as the Divide, Big Belts, and Upper Blackfoot GAs, now have small percentages of moderate or high hazard. It will be decades before these forests have grown into susceptible conditions again. Conversely, GAs that still support extensive areas of mature pines, such as the Castles, Highwoods, and Little Belts GAs, have higher proportions at moderate to high hazard. The Elkhorns HNF estimate is considered to be more representative of the Elkhorns GA than the Elkhorns All estimate because it is based on plots that have been re-measured since the outbreak.

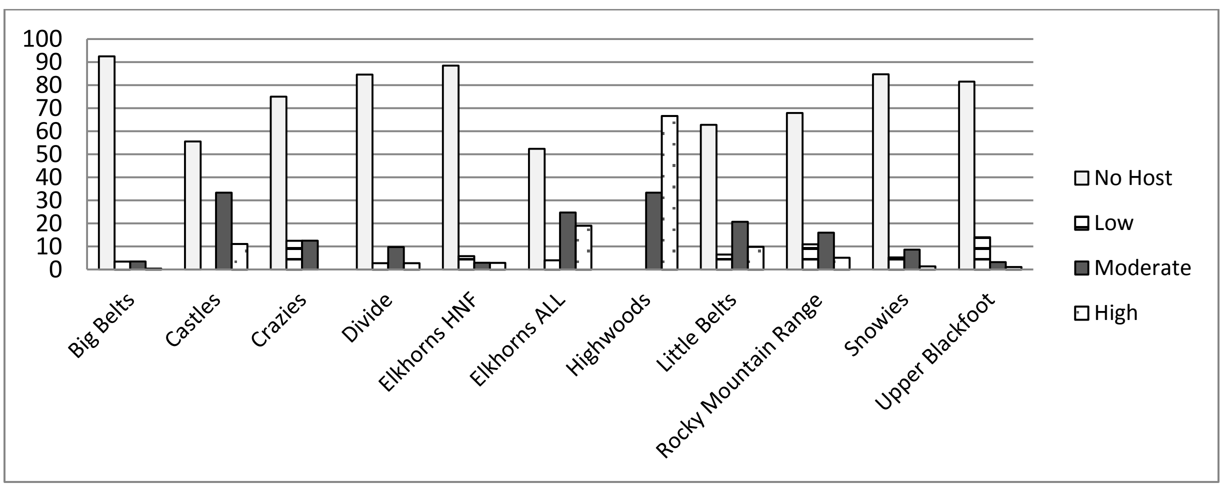

Figure 2.14 Mountain pine beetle hazard in lodgepole pine by GA on FIA and FIA intensification plots

In most GAs large-scale outbreaks are likely to be limited for the next few decades until mature lodgepole pine forests re-establish and grow to maturity. Some GAs, however, contain potential for mountain pine beetle outbreaks in the short term, most notably in the ponderosa pine on the Snowies GA, and in the lodgepole pine on the Castles, Highwoods, and Little Belts GAs. Mountain pine beetle hazard also exists in whitebark pine and limber pine forests, which are minor but important cover types on the HLC NFs.

Mountain pine beetle will always be an important part of ecosystem function; outbreaks will occur once large-scale areas of mature, continuous pines are available and favorable climatic influences coincide. Actions that mimic the past century's actions could result in future large outbreaks 80-100 years from now; allowing for management and natural events that promote heterogeneity in species and age class could reduce that likelihood. While the efficacy of management actions to directly suppress beetle outbreaks has been questioned (Six et al 2014), a viable long-term preventative solution to uncharacteristic outbreak levels may be to change forest structure and composition to increase resiliency by incorporating sound, appropriate forest management tools such as prescribed fire and timber harvest (Fettig et al. 2014).

Douglas-fir beetle

At broad scales, compared to historical conditions, Douglas-fir beetle outbreaks appear to occur for longer periods of time over entire landscapes (Hessburg et al. 1994). Western spruce budworm and Douglas-fir beetle will likely promote each other as they capitalize on hosts stressed by climate. The primary source of large, old trees on the HLC NFs is Douglas-fir; therefore, Douglas-fir beetle has potential to affect valuable habitat components. The likelihood of a Douglas-fir beetle infestation developing in a stand is related to the proportion of susceptible Douglas-fir and stand density; hazard ratings are based upon the average diameter of Douglas-fir, stand basal area, and percent composition of Douglas-fir (Randall and Bush 2010). The availability of large trees in addition to high densities increase the amount of Douglas-fir beetle-caused tree mortality sustained during an outbreak (Negron et al. 1999). Hazard ratings on the HLC NFs indicate that where susceptible Douglas-fir are available (roughly 50% of the area), hazard is primarily low and moderate with a small proportion of high. This may indicate a limited potential for a large scale outbreak; however, localized outbreaks are possible especially where other disturbances such as fire occur, and may impact high value stands such as old growth. The proportions equate to over 170,000 acres of high hazard and over 564,000 acres of moderate hazard across the HLC NFs.

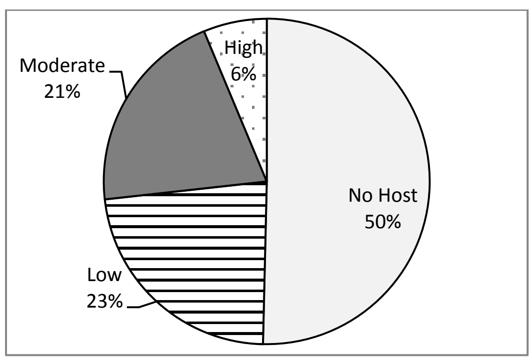

Figure 2.15 Douglas-fir beetle hazard, HLC NFs, R1 summary database

Figure 2.16 shows Douglas-fir beetle hazard rating by GA. Moderate to high hazard is present in most GAs based on the extent of mature Douglas-fir. Douglas-fir beetle may capitalize on trees damaged in future wildfires, which may increase in extent and severity, allowing populations to build and move into green, healthy forests.

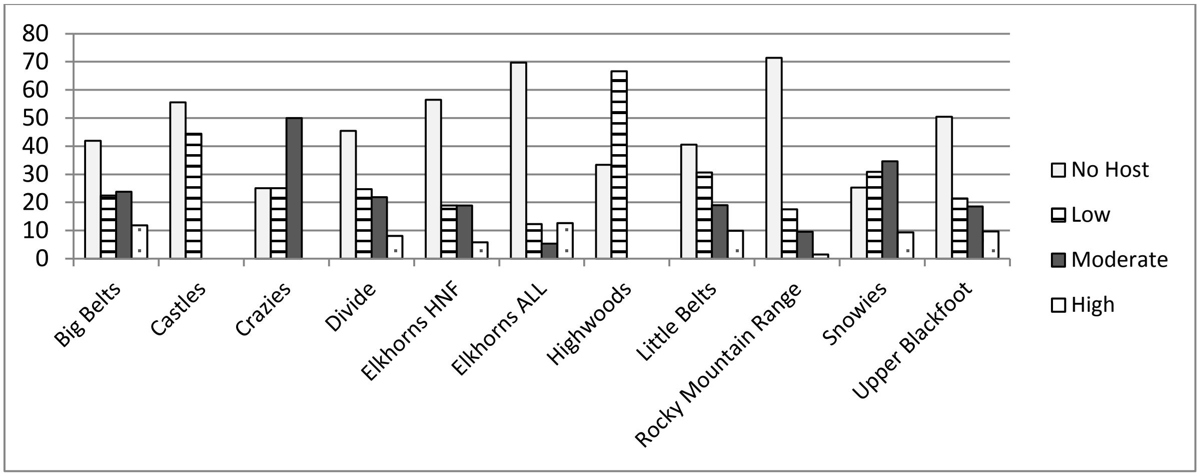

Figure 2.16 Douglas-fir beetle hazard by GA on FIA and FIA intensification plots

Western spruce budworm

Western spruce budworm outbreak cycles also appear to be increasing in duration because of warm/dry conditions and extent of susceptible host conditions (dense, multi-layered forests of Douglas-fir, subalpine fir and spruce). The hazard rating system for western spruce budworm also represents the hazard to Douglas-fir tussock moth, which is not known to occur on the HLC NFs (Randall and Bush 2010). The hazard rating for these defoliators is based upon basal area, percent composition of susceptible species, and trees per acre (ibid). Estimates for the HLC NFs show that 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. These proportions equate to over 761,000 acres of high hazard and over 782,000 acres of moderate hazard on the HLC NFs.

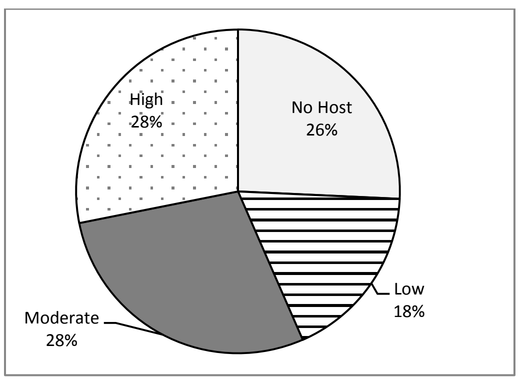

Figure 2.17 Western spruce budworm hazard, HLC NFs, R1 summary database

Due to the widespread distribution of Douglas-fir and dense stand conditions, defoliator hazard is prevalent on all GAs, as shown in Figure 2.18. The Castles GA contains the least hazard due to its species composition.

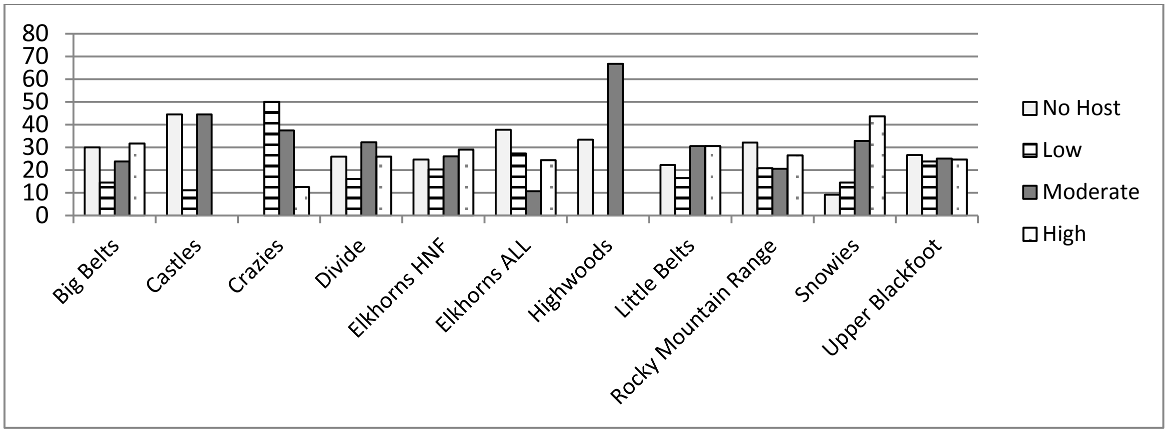

Figure 2.18 Western spruce budworm and Douglas-fir tussock moth hazard by GA on FIA & FIA intensification plots

Summary of Expected Future Trend

There is uncertainty in predictions of how climate and other drivers may cause changes in vegetation, thereby influencing feedbacks with insects and disease processes. Interactions between components are complex and change will most certainly occur in these dynamic ecosystems. In some cases changes may be within the natural range of variation and will not negatively impact ecosystem integrity, though they may not be desirable from a social perspective. In other cases the change may render ecosystems less resilient. In areas that experienced previous mountain pine beetle outbreaks, projected forest conditions will resemble pre-mountain pine beetle conditions without management. Temperature increases may predispose forests to stresses through increasingly negative water balances (McKenzie et al. 2007). Trees have natural defense mechanisms to insects and disease, such as using resin to push out invading beetles or re-growing needles after defoliation. Water stress limits the resources available for trees to utilize these survival mechanisms, thereby increasing their likelihood of damage.

Climate change may affect beetle populations in two ways: directly through insect physiological processes, and indirectly through the effects to host plants and natural enemies (Williams and Liebhold 2002). Climate influences over-winter survival, reproductive rate and success, dispersal ability, and timing of the life cycle of beetles. Expected increases in temperature are likely to affect beetle population growth, but effects may be positive or negative. The response of bark beetle community dynamics to climate change will be ecosystem and species-specific (Bentz et al. 2009). All bark beetles are freeze-intolerant, and undergo a cold-hardiness process which serves to lower the temperature at which body tissues freeze; the resulting level of cold tolerance depends on the temperature regime experienced by each individual (Bentz et al. 2009). Warmer temperatures, therefore, increase the likelihood of over-wintering beetle survival. As maximum temperatures increase, developmental rates can also increase to a point, and adult emergence and flight may occur earlier, although there is some risk of disrupting population synchrony and increased mortality in less cold hardy stages (Bentz et al. 2009). Given the rapid colonization by mountain pine beetles of former climatically unsuitable areas during the last several decades, continued warming in western North America associated with climate change will allow the beetle to further expand its range northward, eastward, and toward higher elevations (Carroll et al. 2003). Models of potential effect of climate change on mountain pine beetle population dynamics suggest an increase in probability of outbreak potential in higher elevation forests and a decrease in lower elevations for the period 2001-2030, compared to 1961-1990 (Bentz et al. 2009). Changes in climate may allow bark beetles to move into other ranges of their host species or the ranges of new potential hosts (Williams and Liebhold 2002).

The increased potential for fire extent and severity that may be associated with a warming climate may be exacerbated by increasing insect infestations which create an altered fuel complex; and conversely post-fire conditions will alter future insect activity. In some cases, fire-scorched trees are more susceptible to infestation, as in the case of Douglas-fir, and may give rise to outbreaks. Conversely, stand-replacing fires may reduce insect activity in lodgepole pine forests.

The diseases of interest on the HLC NFs will continue to be present in the future, and their trend is influenced by many of the same factors discussed for insects. Dwarf mistletoe is common in lodgepole pine and is likely to remain so, although increases in the extent and severity of fires could cause localized reductions in infections. Root diseases are generally considered permanent fixtures of the site, although it may be more active in areas where species shift toward tolerant species versus those that are dominated by shade intolerant species. The effect of the nonnative white pine blister rust is expected to continue and has no analog in the natural range of variation.

Spatial heterogeneity is important for insect and pathogen regulation; this is largely influenced by feedbacks between wildfire and insect and disease processes. The spatial heterogeneity in stand ages and structures following fire creates complex templates of suitable hosts for bark beetles, while spatial heterogeneity of bark beetle outbreaks creates complex patterns of fuel that influence behavior and severity of future fires (Turner et al. 2012). Spatial variability in post-fire stand density/structure may dampen subsequent bark beetle outbreaks because trees reach susceptible size at different times; intensive forest management with even-aged, even-sized trees may increase vulnerability of forests to certain insects and pathogens (Turner et al. 2012).

Information Needs

A more current Natural Range of Variability analysis is needed with the SIMPPLLE model using new data sources to refine our understanding of the role of insects and disease and feedbacks with other processes.

Vegetation Management

Existing Condition

Vegetation has been shaped by human intervention; various management activities have been conducted to meet a variety of objectives. Aboriginal burning occurred prior to European settlement; however, this is considered part of the historical condition. Vegetation management described in this section refers to manipulations that have occurred since European settlement. Early activities, generally prior to the 1940's, are addressed qualitatively due to the lack of available information. More modern activities can be addressed quantitatively.

Vegetation treatments can include a host of methods and activities that are implemented to achieve objectives. Ever since the National Forest Management Act (NFMA) of 1976, silviculture prescriptions written or reviewed by a certified silviculturist direct the implementation of treatments on forest lands. The many possible treatment types are grouped into three broad categories: harvest, stand improvement and reforestation, and fire and fuels. These types are interrelated and may all occur in the same stand as part of a prescription. Therefore, the acres reported in activity tracking databases are greater than the footprint of managed area. Treatments have been recorded since about the 1940's in corporate databases such as the Forest Activity Tracking System (FACTS).

Please refer to chapter 6, Ecosystem Services and Multiple Use – Timber section for detailed information related to timber harvest, wood products, the suitability of lands for timber production, and reforestation and stand improvement activities related to harvest. This section focuses on the impacts of treatments to vegetation.

Harvest

Timber harvest is the removal of trees for wood fiber use and other multiple-use purposes (FSH 1909.12). The term harvest usually indicates that trees were removed with mechanized equipment and harvested trees are typically, but not always, utilized commercially. Harvest has been used to achieve diverse ecosystem objectives in addition to extracting value and improving timber productivity. There are three main categories of harvest:

- *One or two-aged Regeneration Harvest*: One or two-aged regeneration harvests establish a new age class and include silvicultural systems such as clearcutting, shelterwood cutting, seed tree cutting, and coppice cutting. These treatments result in the establishment of early seral forest that is single (even) or two-aged depending on the quantity of remnant trees.

- *Uneven-aged Harvest*: An uneven-aged harvest is part of a planned treatment sequence designed to regenerate or maintain a stand with three or more age classes. This category includes silvicultural systems such as single tree selection and group tree selection.
- *Intermediate Harvest*: Intermediate harvest is designed to enhance growth, quality, vigor, and composition of a stand after establishment and prior to final harvest. Density, structure, and/or species composition may be altered. This category includes treatments such as commercial thinning, liberation harvest, sanitation/salvage, and improvement cutting.

Harvest activities occurred prior to the 1940's, primarily associated with early homesteading, mining, and railroad building that occurred during early settlement. These activities were generally concentrated in easily accessible and/or productive forest areas. Based on local knowledge and early boundary survey reports, it appears that in some cases forests were cleared of all trees for uses such as fuelwood, while in others only the selected removal of the largest and best trees, or "*highgrading*", occurred. The evidence (e.g. stumps) of these activities can still be seen in some areas. Based on early boundary survey reports, and likely in part due to the cool/moist climate at the time, most cut-over areas regenerated quite well regardless of whether rigorous reforestation planning was done. Some degradation in terms of genetic diversity or tree quality may have occurred in areas where the best trees were removed and the less vigorous trees were left to provide seed for the new forest. While no data are readily available to quantify early harvest activities, it undoubtedly shaped vegetation conditions.

A suite of resource management laws, such as NFMA, were enacted in the 1960's and 1970's that regulated vegetation management, and harvest cutting practices in particular, on federally managed lands. Modern harvests are prescribed based on a wide array objectives coupled with an understanding of site capability, existing and potential vegetation pathways, species ecology, and other resource considerations. For example, even-aged treatments are most often prescribed in lodgepole pine types on the HLC NFs, which are adapted to re-establishment after stand-replacing disturbances. The array of resource objectives can include, but are not limited to, considerations such as productivity, economic value, habitat, watershed function, forage, biodiversity, insect and disease hazard, and restoration of natural fire regimes.

According to FACTS, harvest has occurred on roughly 138,649 acres on the HLC NFs since about 1940. This includes about 110,066 acres of one or two-aged regeneration harvest, 6,605 acres of uneven-aged harvest, and 21,977 acres of intermediate harvest. The total acreage of harvest accomplished represents about 5% of the HLC NFs administrative landbase. Acre figures include potential duplicates, in the event that more than one harvest occurred in the same stand. These treatments resulted in creating age class diversity with regeneration harvests, along with changes in structure and composition with intermediate harvests (generally creating more open, larger diameter stands). Usually, early seral, shade intolerant species are favored.

Current Management Direction for Harvest

The current Forest Plans (USDA 1986a and 1986b) identify management areas that are tentatively suitable for timber management. Approximately 19% of the HLC NFs was identified as tentatively suitable in 1986. Harvest can occur in unsuitable areas when needed to meet resource objectives other than timber production. Since 1986, inventoried roadless areas have been designated which include additional restrictions and guidance for harvest activities that were not considered in the 1986 plans. The existing plans also include forest-wide standards relative to timber harvest. These included a limitation of maximum size openings created by even-aged management to be 40 acres, unless specific exceptions apply or regional forester approval for deviation is granted.

Stand Improvement and Reforestation

Reforestation and stand improvement are guided by the same resource management laws and regulations as harvesting; in particular, NFMA requires that timely and adequate reforestation be established following even-aged harvests. *Stand improvement* refers to intermediate treatment of trees not past the sapling stage made to improve the composition, structure, condition, health, and growth of even or uneven-aged stands. *Reforestation* is simply the establishment of reproduction. A variety of site preparation activities can be associated with reforestation, including burning, thinning, scarification, and chemical treatments. While in the past these treatments were primarily tied to harvesting, reforestation and improvement activities are increasingly conducted in areas impacted by wildfire and/or insects to meet an array of resource objectives. The maintenance of adequate stocking in all areas suitable for timber production is required by NFMA; therefore, post-fire reforestation is emphasized in these areas. In addition, reforestation or stand improvement may be desired in areas that are not suitable for timber production because of other resource objectives such as watershed health or wildlife habitat.

- *Stand Improvement*: This treatment category includes pre-commercial thinning, cleaning, and weeding of young stands. A young forested stand is retained and the tending results in altered composition, structure, health, and growth.
- *Reforestation*: Reforestation includes both artificial (tree planting) and natural regeneration. Artificial establishment of seedlings may be prescribed due to a lack of natural desirable seed, harsh site conditions, or a desire for species diversity. Locally adapted seedlings from local seed sources are used, and the species and density established vary by prescription. Certification of natural regeneration occurs when there is adequate seed source and site conditions that result in tree establishment that meets stand objectives. The type of reforestation desired is included in harvest prescriptions, including the determination of which trees are left to provide seed for the new stand.

According to FACTS, since 1940 about 182,945 acres of stand improvement and reforestation have occurred on the HLC NFs, which includes 39,705 acres of stand improvement and 143,240 acres of reforestation. Please refer to chapter 6, Ecosystem Services and Multiple Use – Timber section for a table of these activities by decade.

Fire and Fuels Treatments

In the past, prescribed fire and fuel treatments often occurred after harvest to reduce woody fuels and/or prepare the site for reforestation. Increasingly, prescriptions include fire and fuels activities that are implemented with or without harvest to restore ecosystem processes, improve resilience, promote certain wildlife habitats, and/or to modify or change fire behavior. There are three general categories of fire and fuel treatments.

- *Prescribed Burning* includes treatments that apply fire ignited by managers over most of a stand, such as underburning, broadcast burning, site preparation burning, and jackpot burning. Objectives are site specific and may include but are not limited to reduction of surface fuels or logging slash, eliminating ladder fuels, creating conditions suitable for regeneration, altering species composition, thinning overstory trees, and re-introducing fire as an ecosystem process. Prescribed fires are planned ignitions (USDA and DOI 2009).
- *Other Fuel Reduction Treatments* include activities such as chipping, slashing, piling, and pile burning which may be accomplished by hand or with equipment. These activities may be done in conjunction with harvest and/or prescribed burning, or may occur alone where prescribed burning is not feasible such as in areas with sensitive soil. Objectives may be similar to prescribed burning objectives.
- *Wildfires* are unplanned ignitions and prescribed fires that are declared wildfires (USDA and DOI 2009). Wildfires can be managed for one objective or multiple objectives and objectives can be modified over time as a fire burns across the landscape; incident objectives may address restoration, resiliency, or other resource benefits such to allow natural disturbance processes to occur within a defined prescription.

Since the 1940's, according to FACTS, approximately 177,965 acres of prescribed burning and 250,628 acres of other fuel reduction treatments have occurred on the HLC NFs. Many of these activities occurred in the same stands where harvest was conducted. Thus far the highest number of prescribed burning and other fuel reduction treatments occurred in the 1990's. Since 2000 an increasing proportion of prescribed fire and fuel activities have occurred without prior harvest, often on lands not considered suitable for timber production.

Table 2.9 Acres of Prescribed Burning and Other Fuel Reduction Treatments, FACTS

Decade	Acres of Prescribed Burning	Acres of Other Fuel Reduction	Total Acres
1940-1959	1,494	4,847	6,341
1960-1969	10,231	14,456	24,758
1970-1979	13,558	28,018	41,791
1980-1989	31,790	39,389	71,954
1990-1999	51,460	88,808	140,671
2000-2009	51,998	47,356	102,945
2010-2013[1]	17,433	27,755	45,188
Total	177,965	250,628	433,648

[1] Only includes 3 years; not a full decade

Wildfires that have been managed to meet objectives are also reported in FACTS; most have been reported since 2000. Across the HLC NFs approximately 33,673 wildfire acres have been reported that meet the desired conditions per management objectives. This has been particularly prevalent in the Rocky Mountain Range GA, where over 26,000 wildfire acres (nearly 80% of the HLC NFs total) met management objectives as of 2013.

Current Management Direction for Fire and Fuels

Fuel treatments were recognized in the 1986 HLC NFs forest plans, primarily as post-harvest treatments. Forest-wide standards and guidelines were developed that provided guidance for prescribed burning, and fire suppression was specified as a protection activity in most areas. Fire suppression has had far-reaching implications on disturbance regimes and vegetation. Since 1986, additional fire management policy and guidance has been developed. Increasingly, policy seeks to reflect an increased understanding of natural fire processes. The latest policy regarding wildfire management indicates that natural fire ignitions may be managed to achieve desired land and resource management plan objectives when risk is within acceptable limits (USDA & DOI 2009).

Wildland Urban Interface

Wildland Urban Interface (WUI) is the area where wildlands and human development meet. Residences, commercial properties, and infrastructure may be situated within, around, or adjacent to burnable vegetation and may themselves be burnable. Treatments are often focused in WUI areas with the objective of reducing the hazardous fuels that may pose a threat to communities. Also, treatments outside of the WUI may be designed to alter landscape-scale fire behavior to impact the type of wildfire that may burn into the WUI. Therefore, an understanding of the extent and condition of wildland urban interface areas is important to managers.

Lewis and Clark, Broadwater, Jefferson ("Tri-County"), Powell, Cascade, and Meagher Counties developed Community Wildfire Protection Plans (CWPPs) in the mid-2000s. These plans prioritized areas for fuels treatment and defined WUI areas. Maps of the WUI have been digitized for all except Powell County. The Tri-county Plan specifies zones of low, moderate, high, and very high risk; only moderate, high, and very high are shown in this summary which include National Forest System lands within two miles of communities. The Meagher County map does not specify zones and the Cascade plan includes two classes of WUI. For areas that are not covered by county CWPP's, WUI areas are defined based on a regional Forest Service map which delineates WUI areas within one mile of urban areas and structures. To estimate the extent of WUI, all WUI maps were consolidated. Where maps were available from CWPP's, those delineations were used; otherwise, the Region 1 Forest Service map was used. Some GAs include WUI from multiple maps. WUI areas are more closely assessed at the project level. Across the HLC NFs, over half a million acres are estimated to be in WUI areas, representing nearly 20% of the administrative area.

Table 2.10 WUI areas within administrative GA boundaries, including private land inholdings (2014)

Geographic Area	Approximate WUI Acres	% of GA in WUI
Big Belts	45,599	15%
Castles	20,140	29%
Crazies	1,321	2%
Divide	76,178	38%
Elkhorns	41,565	26%
Highwoods	4,790	11%
Little Belts	269,566	34%
Rocky Mountain Range	20,233	3%
Snowies	10,283	9%
Upper Blackfoot	32,589	10%
Total HLC NFs	522,254	18%

Fire Plans and Fire Management Units

Interagency federal fire policy requires that every area with burnable vegetation have a fire management plan. The plans for the HLC NFs compile guidance from the existing forest plans, national policy, and national and regional directives. Fire management strategies, including parameters for the management of naturally occurring wildfires for restoration, resiliency and other resource benefit objectives, are outlined. The plans identify fire management units which frame fire planning guidance. A *fire management unit* is a land management area defined by objectives, topographic features, values to be protected, political boundaries, fuel types, or major fire regimes (USDA 2014b and USDA 2014c). Each forest describes fire management units differently.

On the Helena National Forest, relatively small areas are identified as "high risk fire management units, located primarily on the Divide GA. The most common fire management unit identified is "moderate risk", where there is some potential to manage naturally occurring wildfires for restoration, resiliency and resource benefit objectives. The Elkhorns GA contains the highest amount of areas classified as "low risk".

Table 2.11 Fire management units on the Helena National Forest, Fire Plan (2014)

Fire management Unit	Description
1 – High Risk	Areas with high risk to human life, home, towns, private property, municipal watershed, and timber values. These areas are associated with WUI areas. Wildfires receive an immediate suppression response due to values at risk.
2 – Moderate Risk	These areas are considered moderate risk, and include active roaded, inventoried roadless, and un-roaded areas outside of wilderness. These make up the bulk of the administrative landbase. Some opportunities exist to manage naturally occurring wildfire for restoration, resiliency or other resource benefit objectives while minimizing risks and exposure to firefighters and publics.
3 – Low Risk	Low risk areas are identified in wilderness areas, proposed wilderness areas, research natural areas, and the Elkhorn wildlife management unit. The goal is to manage naturally occurring wildfires for restoration, resiliency and other resource benefit objectives while minimizing risk and exposure to firefighters and publics.

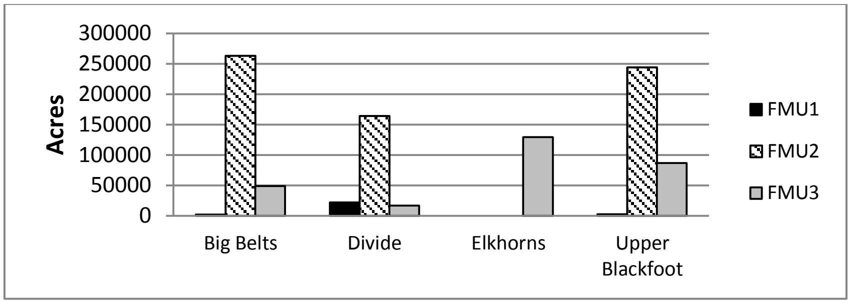

Figure 2.19 Fire management units by GA, Helena National Forest

On the Lewis and Clark National Forest, high risk fire management units are located primarily on the Little Belts and Rocky Mountain Range GAs. The most common fire management units are the "moderate" and "low/moderate risk". The Rocky Mountain Range GA is the only landscape that contains "low risk".

Table 2.12 Fire management units on the Lewis and Clark National Forest, Fire Plan (2014)

Fire management Unit	Description
1 – High Risk	Areas with a high percentage of private land and development, and contain high resource values for timber, recreation, visuals, the Tenderfoot experimental forest, locatable minerals, and municipal watershed protection. They are often associated with wildland urban interface areas. Wildfires are unwanted events and receive an immediate suppression response.
2 – Moderate Risk	These areas are highly valued for timber, range, and riparian values and are characterized as general forest and grasslands. Wildfires are unwanted events and receive a suppression response. There is more flexibility in tactics than high risk areas.
3 – Low/Mod Risk	These areas include those with timber, range, wildlife, semi-primitive recreation, or custodial management values and also include roadless areas, research natural areas, wilderness study areas, and recommended wilderness areas. Where values at risk allow, naturally occurring wildfires are likely to be managed for restoration, resiliency and other resource objectives.
4 - Low Risk	This fire management unit is assigned to wildlife, semi-primitive recreation, roadless, custodial management, research natural areas, wilderness study areas, recommended wilderness, and wilderness areas. Where values at risk allow, naturally occurring wildfires are likely to be managed for restoration, resiliency and other resource benefit objectives

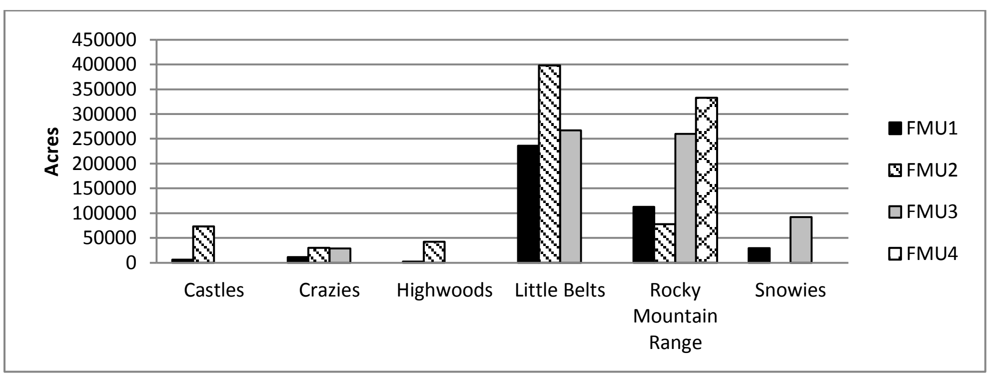

Figure 2.20 Fire management units by GA, Lewis and Clark National Forest

Trend

Treatment Activity Trends

Prior to the 1940's quantitative records of vegetation treatments are not readily available. Early accounts note that extensive tree clearing occurred in conjunction with mining and the railroad industries in the late 1800's (Stickney

1907, Hatton 1904). Early accounts indicate that the Lincoln area (in the Upper Blackfoot GA) was an exception; prior to 1926, due to accessibility, there was not much demand for timber cutting and at that time nearly 90% of the area was still covered by dense forest growth (USDA 1926). Indigenous prescribed burning occurred for centuries and is considered part of the natural fire regime.

Figure 2.21 shows the trend of modern vegetation treatment types by decade since 1940. Timber harvest reported from 1940 to 1959 may be low due to incomplete record keeping and/or the young age of forests in areas disturbed in the late 1800's. Harvest occurred on 20,000 to 30,000 acres per decade from 1960 to 1999 and has decreased by about 60% since 2000. The 1990's was the decade during which most total acres were treated, primarily based on an increase in fire/fuels treatments. The highest level of harvest occurred in the 1960's. Reforestation and stand improvement treatments were the highest in the 1980's and 1990's, in part as a response to a backlog from harvests in the 1960's. Treatments of all types decreased after 2000, and increasingly treatments are most often prescribed in response to disturbance events such as fire or insect-caused mortality. The reporting period since 2010 only reflects 3 years and therefore not a direct comparison to earlier decades.

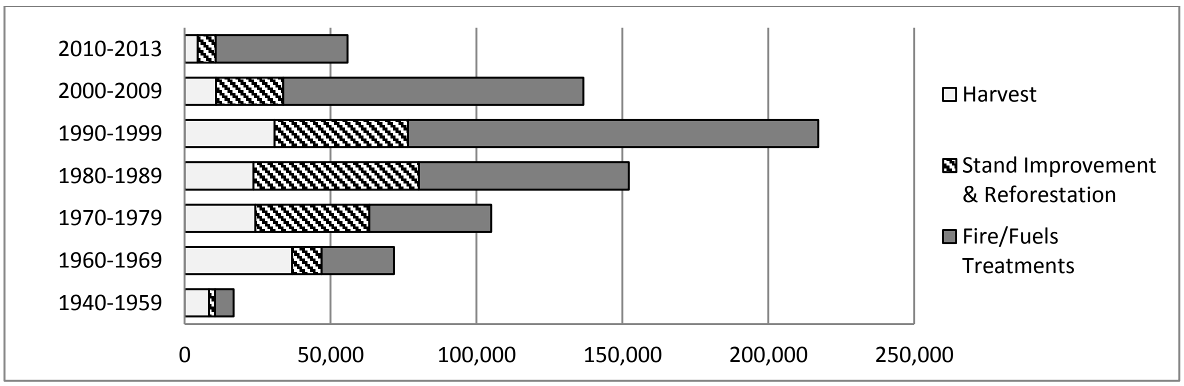

Figure 2.21 Vegetation treatment trends on the HLC NFs, FACTS

Harvest consisted mostly of even-aged regeneration treatments until 1990 (80-90%), when the proportion started to shift toward intermediate treatments. Regeneration harvests since 2000 were largely related to post-fire and insect salvage. Uneven-aged treatments have represented a small proportion. This is in part due to the ecology of tree species; harvest often occurred in lodgepole pine that regenerates better under even-aged conditions.

Stand improvement tended to mirror harvest, but dropped off after 2000 in part due to emerging information about the importance of regenerating moist forests to lynx habitat. These forest types were the focus of harvest, and therefore made up the bulk of stand improvement needs. Also, increasingly reforestation is conducted to establish stands that retain desired characteristics without stand tending. The overall trend of reforestation also mirrored harvest until about 2000; since then, reforestation exceeds harvest because of restoration efforts in wildfire areas. Reforestation may also exceed harvest because sometimes stands are planted more than once. In areas not managed for timber production, reforestation and stand improvement may occur to meet other resource needs such as watershed restoration and wildlife habitat. Reforestation can also be deferred or scheduled over a long time period in unsuitable areas ("natural recovery"); this type of reforestation is not summarized here.

Prescribed fire, fuel reduction, and wildfires managed to meet objectives have become increasingly common because managers recognize the importance of fire on the landscape. Since 2000, fire and fuels treatments have exceeded harvest acres as these activities are increasingly conducted without harvest. WUI areas may change, and in general are increasing as developed areas continue to push into the margins of wild areas. The current trend in private land ownership is further subdivision and development with subsequent increases in the number of structures in WUI areas. Although new policies and fire management plans are consistent with existing forest plans, the 1986 plans do not contain objectives for the use prescribed fire and wildfires to meet objectives.

Reforestation Success

Forest regeneration after natural or human disturbance underpins many ecosystem services and may well be a keystone process (Turner et. al 2012). Per NFMA, reforestation is required within five years after regeneration harvest. Adequate stocking must also be established after stand-replacing disturbances in areas suitable for timber production. In these areas, planted and naturally regenerated stands are monitored to ensure sites become restocked. Stands are not considered satisfactorily stocked until there is a sufficient quantity of well-established seedlings appropriately distributed. Reforestation success is summarized by reforestation indices reports from FACTS for the last 10 years. The HLC NFs show a high rate of reforestation success, with the lowest success associated with areas not harvested (i.e., wildfire areas) and natural regeneration.

Table 2.13 Recent reforestation success indicators (last 10 years), FACTS

Indicator	% of Stands	
	HNF	L&C
Plantation success after regeneration harvest in the last 10 years	98%	100%
Plantation success not associated with harvest in the last 10 years	96%	73%
Natural regeneration success after regeneration harvest in the last 10 years	100%	86%

Regeneration timeframes reports are also available that show reforestation success by year after regeneration harvest from 1976 to 2008. (Regeneration initiated after that time is still in the monitoring phase with less than 5 growing seasons at the writing of this report.) Since 1976, 2,116 stands have had a regeneration harvest on the HLC NFs. Of these, 89% were satisfactorily stocked within five years and an additional 10% were stocked after five years. The reason for the delays likely included failures followed by replanting, delayed germination, or site harshness resulting in slow growth. The 1% that remains unstocked may be due to a failure to adequately assess site suitability, reforestation remedies not yet occurring, or in some cases a recent disturbance.

Managed Area Footprint

Multiple treatments can occur in a stand – for example, a 30 acre stand with a harvest, burn, plant, and thin would be reported as 120 acres, but only a 30 acre "footprint" was actually impacted. To place treatments in context of landscape patch and pattern, it is useful to depict this footprint. Stand improvement and reforestation occur after ground disturbing activities such as harvest or fire and so are not included in the footprint. Wildfires that meet management objectives are also not included. The duplication in activity acres is eliminated by only including a stand in the summary once, although some minor duplication may remain because FACTS allows activity areas to overlap. The total footprint of treatment since 1940 is estimated to be just over 240,000 acres on the HLC NFs. The Little Belts is the largest GA and has by far had the most acres managed.

Table 2.14 Total harvest and fuel treatment footprint since 1940 by GA, FACTS

Geographic Area	Harvest & Fire/Fuel Footprint - Acres	Total GA Acres*	% GA[1]
Big Belt Mountains	34,010	451,948	8%
Castle Mountains	6,647	79,862	8%
Crazy Mountains	1,854	70,036	3%
Divide	22,687	233,813	10%
Elkhorns	14,279	141,752	10%
Highwood Mountains	7,651	44,495	17%
Little Belt Mountains	83,949	900,958	9%
Snowy Mountains	5,201	121,897	4%

Geographic Area	Harvest & Fire/Fuel Footprint - Acres	Total GA Acres*	% GA[1]
Rocky Mountain Range	31,419	783,209	4%
Upper Blackfoot	38,672	350,112	11%
Total for Planning Area	246,369	3,178,080	8%

1 Landscape acres used to calculate % include private inholdings within the admin boundary. Only activities on NFS are included in the footprint.

An examination of the percentage of each GA treated provides a view of how activities have impacted patch and pattern. While the Little Belts GA has had the most acres treated, this has affected less than 10% of the GA because of its large size. Conversely, the few acres treated in the Highwoods represent a high proportion of that small GA. The managed footprint represents about 8% of the HLC NFs overall.

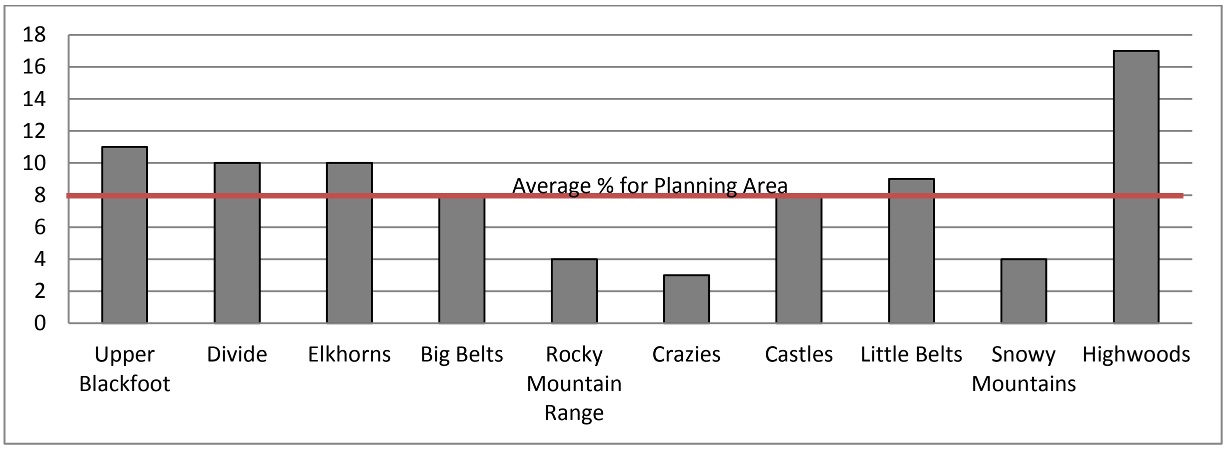

Figure 2.22 Footprint (% of GA) of harvest and fire/fuel treatments since 1940

On this footprint, vegetation treatments resulted in new age classes and/or manipulations of stand structure and composition. In some cases this may have mimicked natural disturbance, but in many instances harvest patch size is smaller than natural patterns. The current forest plans generally limit regeneration harvest openings sizes to 40 acres unless specific exceptions apply. Further, harvest openings are concentrated within the suitable landbase. Therefore, the distribution and size of harvest patches are different than those that would be produced by wildfires. Openings created by wildfire would range from less than 1/10th of an acre to tens of thousands of acres. Some fire and fuel treatments have been larger in size and more representative of natural disturbance patterns than harvest. Increasingly, landscape patch and pattern is a consideration for the design of all vegetation treatments.

The footprint of harvest and fire/fuel treatments can be found on map 7 in appendix A, Past Harvests and Fuel Treatments. Harvest treatments are symbolized on top, although this activity may have been followed by fuels activities. Past wildfires are shown separately in appendix A; desired conditions were met on a subset of these areas, primarily in the Rocky Mountain Range GA.

Restoration and Resiliency

Recently an emphasis has been placed on enhancing restoration and resiliency of vegetation; these concepts were not explicitly included in the 1986 HLC NFs forest plans although they are related to sustainability, which has long been a land management principle. Restoration of forest resiliency in an uncertain future climate will require adaptive management at various spatial and temporal scales. The Northern Regional Office has provided direction for the reporting of these concepts related to management activities; specific restoration goals include (USDA 2013d):

- Establish or maintain the proportion of shade-intolerant species. The focus species identified that are present on the HLC NFs include western larch, ponderosa pine, aspen, whitebark pine, spruce/fir lynx winter habitat, and dry Douglas-fir east of the Divide;
- Restore presence or dominance of native grasses and shrubs;
- Restore forest densities and structure to be more resilient to historical and projected disturbance processes in various size classes including wildlife habitats of concern; and
- Promote forest patterns with a range of patch sizes as informed by historical disturbance processes and projected future disturbances and a changing climate.

The methods to accomplish restoration can include artificial and natural regeneration, stand improvement, fuel treatments, prescribed burning, and invasive weed treatments. A complete restoration and resiliency report is currently only available for 2012 and 2013. The species promoted in the plan area have included ponderosa pine, dry Douglas-fir, and grass/shrub communities. The HLC NFs reported that a high proportion of vegetation treatments (60-100%) met the restoration/resiliency requirements. Restoration and resiliency objectives are expected to remain a high priority for the planning and implementation of vegetation treatments.

Reforestation is of particular interest because of its influence to future resiliency. Spatial heterogeneity is important to forest regeneration in that the amount and configuration of undisturbed patches and individual legacy trees that survived prior disturbance will be important seed sources (Turner et al. 2012). Through its effects to regeneration, spatial heterogeneity of the landscape therefore impacts primary production, carbon storage, timber production, and wildlife habitat (ibid). Specific reforestation trends will vary by potential vegetation type, and may include changes in the distribution of species due to drought and fire. To retain stand resiliency, managers should maintain as much species diversity as possible and prescriptions should evaluate a range of management options that are reasonable in light of changing site conditions, particularly the assumption of warmer, more arid conditions (Scott et al. 2013). Specific recommended strategies include, but are not limited to, planting to increase species diversity, favoring early seral species, limiting stand density, maintaining high genetic diversity of seed, following seed transfer guides, using seed from improved seed sources, conserving soil moisture, planting promptly after disturbance, being alert to “savannahfication”, and monitoring (Scott et al. 2013).

Information Needs

Vegetation and timber output modeling that includes disturbance processes such as fire, insects, and climate is needed to better understand how existing and forest management and treatments have and may continue to influence ecosystem resilience.

Invasive Plants

Introduction

Though the HLC NFs prioritize management of both aquatic and terrestrial invasive species (all taxa), this section addresses invasive plants. Please refer to chapter 3 for a discussion of aquatic invasive species. For the purposes of this assessment, invasive plants are considered to include Montana State designated noxious weeds, regulated plants, and other plant species considered to be invasive. A species is considered to be invasive if it meets two criteria: (1) it is nonnative to the ecosystem under consideration, and (2) its introduction causes, or is likely to cause, economic, or environmental harm or harm to human health (Executive Order 13112, 1999). A noxious weed is defined by Montana code annotated (MCA 7-22-2101, 2014) as, “any exotic plant species established or that may be introduced in the state that may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities”. Invasive plants are capable of successfully expanding their populations into new ecosystems beyond their natural range and can create lasting impacts to native plant communities. Adverse impacts from invasive species can be exacerbated by interactions with fire, native pests, weather events, human actions, and environmental change.

Executive Order (EO) 13112 directs federal agencies to respond to invasive species that threaten terrestrial and aquatic resources of the National Forest System (NFS) and to collaborate with federal, state, and local partners to address invasive species that can spread from adjacent lands. The Forest Service (forest) adopted new guidelines for invasive species management in 2011in the form of a new Forest Service Manual (FSM) 2900. FSM 2900 was issued in order to comply with EO 13112 and address adverse impacts from invasive species. FSM 2900 is also intended to ensure, as a matter of policy, that all forest management activities are designed to minimize or eliminate the possibility of establishment or spread of invasive species on NFS lands, or to adjacent areas. To accomplish this, FSM 2900 directs the forest to:

- Initiate, coordinate, and sustain actions to prevent, control, and eliminate priority infestations of invasive species in aquatic and terrestrial areas of the NFS.
- Incorporate invasive species management actions and standards into resource management plans at the forest level.
- Determine the vectors, environmental factors, and pathways that favor the establishment and spread of invasive species in aquatic and terrestrial areas of the NFS, and design management practices to reduce or mitigate the risk for introduction and spread of invasive species in those areas.
- Determine the risk of introducing, establishing, or spreading invasive species associated with any proposed action and where necessary provide for alternatives or mitigation measures to reduce or eliminate that risk prior to project approval.
- Develop and utilize site-based and species-based risk assessments to prioritize the management of invasive species infestations in aquatic and terrestrial areas of the NFS. Where appropriate, use a structure decision making process and adaptive management or similar strategies to help identify and prioritize invasive species management and actions.
- Ensure Forest Land and Resource Management Plans include objectives, desired conditions, guidelines, and specific elements and activities to address the management of aquatic and terrestrial invasive species.

There are two Environmental Impact Statements (EIS) that analyzed weed management alternatives on the HLC NFs. A Record of Decision (ROD) implementing the preferred alternative for each EIS in place on the HLC NFs have also been issued. The EIS's and subsequent RODs are (1) The 2006 Helena National Forest Weed Treatment Project EIS and RODs and, (2) the 1994 Lewis and Clark National Forest Noxious Weed EIS and ROD. The EIS's evaluated the effects of treating invasive plants and identified an adaptive and integrated pest management strategy to control and reduce the presence of invasive species on the HLC NFs. The purpose and need of those EIS's are consistent with the objectives and approach of EO 13112, FSM 2900 and the Forest Service National Strategic Framework for Invasive Species Management (FS-1017, 2013). The common weed management approach amongst the aforementioned documents can be summarized by the following four key elements:

- Prevention
- Detection
- Control and Management
- Restoration and rehabilitation

The goal of invasive species management is to prevent new infestations and manage (contain, reduce, and eradicate) infestations currently established on the forest through control measures. Methods to control the spread of invasive species include prevention, treatment, and containment. Methods used to prevent invasive species from being introduced and spreading into new areas include closing infested areas to travel, washing vehicles and equipment prior to entering or leaving an area, and using weed-free seed and straw mulch for re-vegetation and requiring weed seed free forage for stock use on NFS lands. Another key strategy for preventing further spread and/or introduction of invasive plants into weed free areas is the use of early detection and rapid response (EDRR) tactics. EDRR focuses on the discovery and early treatment of small isolated infestations. This results in greater control when the infestations are small and more easily managed and/or eradicated. 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.

Currently, inventory and treatment is prioritized by the invasive plants coordinator, district rangers, and project leads. 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. Some species have higher rates of spread than others; widespread species take more resources to control than new or potential invaders. Small infestations are possible to eradicate, while large infestations are more difficult to eradicate and are typically prioritized for management through containment. Habitat type influences the survival of an invasive plant and of native plants that need to compete for resources, and some habitat types are more vulnerable to invasive plants than others (especially drier, more open sites).

The location of infestations is important. 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 or, in cases where invasive plant species are already present, function as seed sources for introduction of those species into less infested areas. Other areas that are remote and/or are less disturbed and considered natural areas (e.g., wilderness and research natural areas [RNAs]) and areas considered to be weed free are also a high priority for treatment. Although these areas require effort to access and treat, they are considered a high priority because they are usually not yet heavily infested or are weed free. This leads to a greater chance of eradicating the existing infestations while they are still relatively small or maintaining areas as weed free. This leads to a greater chance of eradicating the existing infestations while they are still relatively small or maintaining areas as weed free. As a result, this approach can result in protection of larger landscapes from invasive plant introduction and spread. The most effective, economical, and ecologically sound approach to managing invasive plants is to prevent their invasion in the first place (Clark 2003). There is a far greater chance for eradication and lower costs associated with management when infestations are detected and treated early. Lack of early treatment typically leads to the development of major weed problems (Hobbs and Humphries 1995). Large infestations are often logistically and economically difficult to manage.

Transportation corridors (roads and trails) have a high likelihood of being invaded. The ground disturbance resulting from the removal of roads and trails can lead to an increased risk of invasion or expansion of existing infestations. The HLC NFs has implemented mitigation measures such as seeding of temporary roads to improve desirable species cover and reduce invasive species infestations. Mitigation measures have been occurring on the HLC NFs for the past 30 to 40 years. Desirable nonnative 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 nonnative 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 NFs now implement an integrated invasive species management process for all approved management actions. This includes prevention methods, such as equipment cleaning and spraying prior to operations to reduce the transport and introduction of noxious weed seed, and pre and post treatment of invasive plants within project areas, etc. Treatment of identified infestations is accomplished thru herbicide applications and biological control, from this point forward referred to as "treatments". The HLC NFs have a strong commitment to and work with a variety of partners (NGO's, counties, state agencies, etc.) to accomplish these treatments.

Scale and Methods

Spatial Scale

The spatial scale chosen to assess the current condition of invasive plants is the NFS lands within the HLC NFs administrative boundaries.

Temporal Scale

Two temporal scales were chosen to assess the current condition of invasive plants:

- Inventory data collected over the past 14 years (beginning in 2001) has been summarized to characterize current invasive plant infestations (in acres) on the HLC NFs.
- Treatment data collected during the past 5 year period (2010-2014) has been summarized to characterize invasive plant treatments (in acres) across the HLC NFs. This allows for the use of the most recent and relevant data in regards to invasive plant treatments.

Methods

The following methods and associated data were used to analyze the current condition of invasive species:

- Summarization of existing Geospatial Information Systems (GIS) data as entered through the NRM (Natural Resource Manager) Threatened, Endangered, and Sensitive Plants, and Invasive Species (TESP-IS) database and reported through the Geospatial Interface (GI);
- Summarization of existing Forest Service Activity Tracking System (FACTS) data;
- Literature review of the best available science.

Existing Information

Terrestrial invasive plants are aggressive and have the potential to spread rapidly across landscapes. A large portion of the HLC NFs has not been surveyed for invasive plants. This is largely due to funding and staffing levels as well as areas that are difficult to access as a result of steep and rugged terrain, distance from roads, etc.

The HLC NFs utilize the Montana Noxious Weed List (2013) 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 known to occur 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 NRM TESP-IS system, 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. NRM has been continually updated with inventoried infestations with a special emphasis on correcting geospatial data through the use of GPS units. For the purposes of this assessment invasive plant inventory data collected over the past 14 years has been summarized to characterize the current condition and trend of invasive plants on the HLC NFs.

Invasive plant treatments are also recorded and entered into the NRM system through TESP-IS and reported through the FACTS database. This allows the HLC NFs to track invasive plant treatment accomplishments. For the purposes of this assessment invasive plant treatment data over the past 5 years has been summarized to characterize treatment efforts and trends on the HLC NFs.

Existing condition

Current Invasive Plant Inventory

As of December 23, 2014, 142,052 acres (5%) of the HLC NFs are associated with invasive plant inventories. The number of currently recorded invasive plant species is 26 (Table 2.15). Approximately 98 percent of the current inventoried invasive plant infestations occur within ½ mile of major transportation routes (system roads and trails). Fifteen percent of the inventoried infestations on the HLC NFs are within 30 feet of major system roads and trails. The main vectors for spread are road maintenance equipment, logging vehicles, ATVs/OHVs, and passenger cars and trucks. Seeds of many species are also wind or animal dispersed (wildlife and livestock).

Table 2.15 Invasive plant species currently known and inventoried on the HLC NFs

Accepted Common Name	Accepted Scientific Name	Helena National Forest	Lewis and Clark National Forest	Grand Total
black henbane	*Hyoscyamus niger*	721.73		721.73
broadleaved pepperweed	*Lepidium latifolium*	0.14		0.14
Canada thistle	*Cirsium arvense*	11,988.27	5,164.03	17,152.29
cheatgrass	*Bromus tectorum*	43.20		43.20
common mullein	*Verbascum thapsus*	5,835.49	8.05	5,843.54
common St. Johnswort	*Hypericum perforatum*	12.77	2.80	15.57
common tansy	*Tanacetum vulgare*	132.93	0.49	133.42
dalmatian toadflax	*Linaria dalmatica*	23,492.90	62.25	23,555.15
diffuse knapweed	*Centaurea diffusa*	4.84	0.71	5.54
field bindweed	*Convolvulus arvensis*	2.14	5.00	7.14
greater burdock	*Arctium lappa*	6.93		6.93
hoary alyssum	*Berteroa incana*	623.04		623.04
houndstongue	*Cynoglossum officinale*	9,215.28	5,992.80	15,208.08
leafy spurge	*Euphorbia esula*	3,187.95	7,186.04	10,373.99
lesser burdock	*Arctium minus*	2.16		2.16
meadow hawkweed	*Hieracium caespitosum*		3.35	3.35
musk thistle	*Carduus nutans*	15,525.48	2,393.13	17,918.61
orange hawkweed	*Hieracium aurantiacum*	50.67	1.20	51.87
oxeye daisy	*Leucanthemum vulgare*	785.67	1,132.03	1,917.70
plantain	*Plantago*	2.26		2.26
spotted knapweed	*Centaurea stoebe ssp. micranthos*	33,410.82	12,006.56	45,417.39
sulphur cinquefoil	Potentilla recta	418.61	88.29	506.90
tall tumblemustard	Sisymbrium altissimum	0.04		0.04
whitetop	Cardaria draba	3.80	95.23	99.04
yellow mignonette	Reseda lutea		0.02	0.02
yellow toadflax	Linaria vulgaris	2,403.66	38.93	2,442.59
	Grand Total	**107,870.78**	**34,180.90**	**142,051.68**

The status of each invasive plant species relative to the Forest is considered when determining the appropriate management strategy and priority. The most abundant invasive plant species on the HLC NFs are spotted knapweed, dalmation toadflax, musk thistle, Canada thistle, houndstongue and leafy spurge. The species of highest priority for treatment and containment are spotted knapweed, leafy spurge, toadflax species (yellow and dalmation), orange and meadow hawkweed and those species that are on the state noxious list but not currently present on the HLC NFs (e.g., yellow starthistle). These species are known to be highly aggressive (e.g., spotted knapweed) or are not currently established on the HLC NFs (e.g., yellow starthistle). Reduction of particularly 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 NFs. Eradication is likely not feasible for many of the invasive species on the HLC NFs. Although there are large infestations of species such as Canada thistle and houndstongue, these species are not typically targeted for eradication due to their abundance, both on the forest, in the state, and in the West at large. They are categorized as priority 2B species on the Montana Noxious Weed List (2013) meaning that they are widespread. The management approach for these widespread species is typically focused on containment with eradication efforts and resources typically reserved for smaller isolated infestations and species with lower abundance across the HLC. Some exceptions may apply to specific project areas depending on local conditions.

Nonnative invasive plant species, also called noxious weeds, invasive plants, or invasive species, have disrupted natural processes on nearly 100 million acres in the United States and are spreading at an estimated rate of 14 percent per year (USDA 2001). On NFS lands in the United States, an estimated 6 to 7 million acres are currently infested and increasing at 8 to 12 percent per year (USDA 1998).

Invasive Plant Treatments

Over the past 5 years, a total of 56,842 acres of invasive plants have been treated on NFS lands within the HLC NFs. On average, approximately 9,473 acres are treated per year. A typical year would result in the treatment of 6 to 7 thousand acres on the HLC NFs and some years out of the past five included large projects (e.g., aerial treatments) which increased the five year average. Specific annual treatment levels will vary depending on funding levels and project priorities. Recorded treatment acres by fiscal year are shown in Table 2.16 below. Treatments include both herbicide and biological control methods and are accomplished by Forest Service employees, counties (through agreements), volunteers (cooperative spray days), and other partners.

Table 2.16 HLC NFs invasive plant treatments 2010 – 2014

Fiscal Year	Helena National Forest	Lewis and Clark National Forest	Combined Grand Total
2010	3,637.8	3,954	7,591.8
2011	8,634.7	4,458.5	13,093.2
2012	2,952.2	4,580.6	7,532.8
2013	5,957.2	10,383.4	16,340.6
2014	4,060	2,011	6,071
Grand Total	**29,742.5**	**27,099.8**	**56,842.3**

Consideration of system drivers

Role of 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 and 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 nonnative plants. Disturbances can occur as a result of natural events such as floods, wind events and animals. 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, off-road use of ATV/UTV's, etc. Fire suppression efforts can also result in disturbances. Fire-line disturbances create suitable conditions for many nonnative species to become established (Parks et al. 2005).

At local scales, nonnative invasive species richness and abundance are generally highest in and around disturbed patches, corridors, and edges such as riparian corridors, transportation corridors and fuel treatments (Benninger-Truax et al. 1992, Gelbard and Belnap 2003, Larson 2003). Buckley et al. (2003) found that features common in logged areas such as skid trails and haul roads are likely to support populations and propagules of nonnative plants. Their research also suggests that haul roads, skid trails and main forest routes serve as primary conduits for entry of introduced species into the interior of managed stands. At regional or landscape scales, richness and abundance of nonnative invasive plants tend to be lower in protected or undeveloped areas than in human-dominated landscapes or landscapes fragmented by human use (Barton et al. 2004). Though, natural disturbance can be a major contributor to increases in invasive species abundance, most of todays weed problems arise from past and present human activities (Hobbs and Humphries 1995).

Role of Fire and Invasive Plant Species

Although the HLC NFs are attempting to restore historical fire regimes to the landscape, fire can have a detrimental impact to the ecosystem post-fire, depending on the occurrence of invasive species infestations pre-fire. Generally speaking, if a fire occurs in a plant community where nonnative propagules are abundant and/or the native species are stressed, then nonnative species are likely to establish and/or spread in the post-fire environment (Zouhar et al. 2008). From studies conducted in closed-canopy forests in the West (mostly subalpine fir and spruce), it has been observed that nonnative species with easily dispersed seed can infest a burned area where there were no invasive plants pre-burn. Some species (e.g., St. John's wort) tend to die back when the canopy closes post-fire. Other species (e.g., Canada thistle) persist in partially closed canopy conditions. Fire size and burn severity also influence post burn susceptibility to invasion by nonnative plants. Ferguson and Craig (2010) suggest that invasive plant occurrences after fire generally increase with increasing burn severity.

Some studies suggest that the presence of invasive plants in the landscape changes fire regimes. The most notable is cheatgrass which has been shown to increase fire frequency and severity. Research is emerging that suggests other invasive species may impact fire regimes. For example, Zouhar and others (2008) suggest that dense knapweed infestations may alter fuel characteristics at a given site and thus affect fire regime characteristics such as return interval and severity due to that fact that knapweed does not carry fire as readily as grasses.

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). Timing in the plant's phenology is crucial and often cannot be met when considering prescribed burning windows. Annual and biennial species are easier to control than perennial species, and do not need as many fire treatments to impact the seed bank. Perennial species take more treatment and need more than just fire to control the infestation. The intent of controlling an infestation by fire is to kill the seeds as they are still immature on the plant or newly dropped on the ground. Considering the fire-prone nature of the HLC NFs 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.

Climate Change and Invasive Plant Species

Multiple studies support the hypothesis that climate change is occurring in one form or another. A local study by Pedersen et al. (2009) examined temperature observations in Montana over the past 100 years. The study found that, on average, very cold temperatures (≤-17.8°C) ended 20 days earlier in 2006 than in 1892, and very hot temperatures (≥32°C) had a three-fold increase in number of days and have extended, on average, 24 days longer in the season. Global warming describes much more than elevated temperatures across biomes. It accounts for an increase in both minimum and maximum temperatures, with daily minimum temperatures rising more rapidly than maximum temperatures (Vose et al. 2005).

The success of invasive plants in native plant communities is highly influenced by factors related to environment (e.g., temperature, precipitation, CO_2), disturbance or resource availability, propagule pressure (e.g., seeds), and biotic resistance (Pauchard et al. 2009, Poorter and Navas 2003, Eschtruth and Battles 2009). The kind of temperature changes observed, described and projected by several studies over the past decade may have notable effects on native vegetation and invasive plants. Although temperature shifts can alter invasive dynamics, the greatest effect of climate change in biotic communities arises from shifts in maximum and minimum temperatures rather than annual means (Stachowicz et al. 2002). These changes can give invasive species an early season start, resulting in increased growth and recruitment relative to native species (Traill et al. 2010). The increase in CO_2 in the atmosphere may also affect plant metabolism because CO_2 is the main requirement for photosynthesis and oxygen production. Studies have shown that elevated CO_2 levels can lead to a reduction in herbicide efficacy (Archambault 2007, Ziska and Teasdale 2000). Reduced treatment effectiveness coupled with the potential for increased opportunities for growth and vigor as a result of changes in precipitation levels, CO_2, temperature, etc., increases the potential for invasive plants to gain an even greater advantage over native species.

Other effects include shifts in distribution. 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 and Lambers 2014). Some studies predict a movement in some invasive plant species range closer to the poles or upward in elevation (Chen et al. 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 (2014), suggest that distribution shifts in response to recent climate change could occur in either direction (upward or downward).

Fire is another factor potentially 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. Conversely, appropriately planned and implemented restoration treatments following fire events could improve the resistance and resilience of plant communities to invasive plant invasion.

Trend

Historical conditions and trends

Many invasions of nonnative plants established in the Northwest between 1850 and 1920 during the regions great influx of agrarian settlers (Parks et al. 2005). Initial introductions were associated with early trade vessels which brought grain and livestock shipments contaminated with foreign seeds, as well as freighters that dumped ore deposits and ship ballasts containing foreign plant material onto shores and around docks at and near port cities (Kartesz, 1999). Invasive plants have continued to increase and spread since introduction. According to Westbrooks (1998) invasive plants have more than quadrupled their range between 1985 and 1995 and comprise from 8-47% of the total flora of most states. As of 1996, invasive nonnative species had invaded at least 17 million acres of federal lands in the West (USDA 1998). Similar increases in infested acres have been experienced at the local scale on the HLC NFs.

Topography has been shown to influence invasive plant spread. Mountains, in general, have fewer nonnative plant introductions relative to lowland areas, due in part to the large amount of public land and limited access to these areas. Nonetheless, plant invasions occur in the mountains, and 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 1950-60's on the HLC NFs. A majority of recoded infestations on the HLC NFs are associated with disturbances. According to current inventory data, approximately 98% of the current inventoried invasive plant infestations on the HLC NFs occur within ½ mile of major transportation routes (system roads and trails). Many roadless areas remain relatively weed free because of the presence of healthy undisturbed native plant communities where few vectors exist to spread invasive species.

Expected future trend

Timber production, livestock ranching, 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 nonnative plants (Toney et al. 1998). As of 1996, invasive plant species had invaded 6 to 7 million acres of NFS lands with an observed annual rate of spread of 8 to 12 percent (USDA 1998). It is predicted that climate change trends will continue into the reasonably foreseeable future. Of equal importance is the current and predicted continuation of globalization. Globalization facilitates and intensifies the spread of invasive alien species (Meyerson and 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. Assuming that the national average annual rate of spread of 8 to 12 percent applies, the HLC NFs can expect to encounter an increase in invasive plant infestations at a rate of up to approximately11,000 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). Additional data and monitoring is needed to determine the actual rate of spread on the HLC NFs. Initial data review suggests that the rate of spread is greater on the western portions of the HLC NFs (Helena National Forest) and less rapid on the eastern portion of the HLC NFs (Lewis and Clark National Forest). This is primarily due to annual precipitation and associated habitat types. Habitat characteristics are unquestionably important predictors of susceptibility to invasion by invasive plants. Stohlgren et al. (2002) found that areas with greater habitat heterogeneity and available resources are at greater risk of invasion by invasive plants. This is attributed to the fact that nonnative plant species thrive on the same resources (high light, nitrogen, and water) as native plant species. At the local scale, available resources for plant growth increase as you move toward the western portions of the HLC NFs. Some exceptions are present and are primarily associated with island mountain ranges in the eastern portions of the HLC NFs.

The rate of future trends will be dependent on land-use and land-cover changes and ultimately how land managers respond to those changes. The future potential trend for invasive plant infestations can be addressed through invasive plant management programs but may be inhibited by future budgetary and personnel constraints at the local, regional and national levels. Hobbs and Humphries (1995) suggest that much of the plant invasion problem stems from socioeconomic rather than ecological factors. Attempts to treat weed invasion will fail unless the underlying causes of the problem are identified and dealt with.

Information Needs

There are many areas that are suspected to have invasive plant infestations but have not yet been thoroughly surveyed and inventoried. Wilderness areas and research natural areas (RNAs) are examples of areas that are not well inventoried due to their rugged and remote nature. The NRM database is being updated annually in an effort to improve survey and inventory data on the HLC NFs. Extensive survey and inventory projects are needed to fully capture the current extent of invasive plants across NFS lands located within the HLC NFs boundaries. These projects should be focused on areas within the HLC NFs that do not have associated invasive plant survey and inventory data and are considered to be at a greater risk of invasion. Secondarily, existing inventories should be revisited to determine the current status of the previously identified infestations.

Monitoring data is lacking to determine overall treatment efficacy and success of restoration. According to FSM 2900, an area treated against invasive species has been "restored" when the targeted invasive species defined in the project plan was controlled or eradicated directly as a result of the treatment. To accurately characterize past treatment and restoration success additional qualitative and quantitative monitoring data will need to be collected.

Additional monitoring data is also needed to determine the annual rate of spread of invasive plants on the HLC NFs. Rate of spread is typically expressed as a percent and provides critical information for invasive plant management decisions. Defining the annual rate of spread helps to inform necessary treatment levels (acres per year) when designing invasive plant management goals and scope of work.

Potential Vegetation Types

Existing Condition

Potential natural vegetation (PNV) is based on climax successional theory which states that vegetation communities are constantly changing and moving toward an endpoint, or "climax" (Pfister et al. 1977). Potential natural vegetation can be represented by classification systems that define *potential vegetation types* (PVT) to describe the climax state. Plant communities that would develop over time given no major disturbances are similar within a potential vegetation type. Thus, they serve as references to understand site productivity, biodiversity, pattern of existing and future vegetation, growth potential, species distribution, and disturbance type and frequency. Potential vegetation types are not used to suggest that the climax state is desirable or achievable given the role of natural disturbance. Existing vegetation represents a single point along the successional pathway of a potential vegetation type and varies depending on each site's unique history.

Habitat types (Pfister et al. 1977; Muegler and Stewart 1980; USDA 2005) are used to classify potential vegetation. Many individual habitat types have been defined; these are grouped into associations with similar characteristics. The HLC NFs utilize mid-scale habitat type groups to describe ecosystem diversity, which nest within broader groups. These groups provide the basis to define ecosystems. Habitat types are a relatively static concept; therefore, using them to stratify and estimate key characteristics provides a meaningful depiction of ecosystem diversity. Table 2.17 summarizes forested habitat type groups used for the HLC NFs.

Table 2.17 Forested potential vegetation groups for HLC NFs

Broad Potential Veg Group	Habitat Type Group	Description
Warm Dry	Hot Dry	The driest potentially forested sites adjacent to or within the ecotone with grass/shrubland. Limber pine is the climax species. Tree species that may be dominant include limber pine, juniper, and ponderosa pine. These sites would historically burn with frequent low severity fires that would maintain an open savannah condition of these early seral species or grass/shrub conditions.
	Warm Dry	Ponderosa pine habitat types where ponderosa dominates all phases and natural frequent fire would maintain open conditions. This group also contains the driest Douglas-fir habitat types, where open-grown ponderosa pine or Douglas-fir with bunchgrasses would dominate given a natural frequent low severity fire regime[1]; without disturbance, Douglas-fir eventually dominates.
	Moderately Warm Dry	This group includes more moist Douglas-fir habitat types, where frequent disturbance would usually maintain open-grown ponderosa pine or Douglas-fir with grass and brush understories[1]. These types can also support a mix of lodgepole pine or western larch. Stands become dense and dominated by Douglas-fir over time with no disturbance.
	Moderately Warm Moderately Dry	Regionally, this group is typified by grand fir types not present on the HLC NFs. It also includes productive Douglas-fir habitat types that could occur on the HLC NFs, but are not currently identified on plots, where Douglas-fir or lodgepole pine can dominate. The natural fire regime would have been mixed severity to create a mosaic of even-aged and/or open stands of Douglas-fir. Components of ponderosa pine or larch can occur.

Broad Potential Veg Group	Habitat Type Group	Description
Cool Moist	Cool Moist	Moist subalpine fir and dry Engelmann spruce habitat types, where site conditions support high species diversity which may include Douglas-fir, Engelmann spruce, lodgepole pine, subalpine fir, and western larch[1]. Some sites may be dominated by lodgepole pine after stand-replacing fire[1].
	Cool Wet	The moistest Engelmann spruce and subalpine fir habitat types. They are generally forested riparian areas along streams or associated with wetlands where the natural fire interval is usually long[1]. Often the climax species dominate. Douglas-fir, lodgepole pine, aspen or other hardwoods can be present.
	Cool Moderately Dry to Moist	Drier subalpine fir and Engelmann spruce habitat types and most lodgepole pine habitat types which are often dominated by lodgepole pine under a natural regime of infrequent, stand replacing wildfire. Mixed severity fires were also common and can promote a mosaic of lodgepole pine, Douglas-fir, western larch and possibly whitebark pine although it tends to not have a competitive advantage[1].
Cold	Cold	The highest elevation subalpine fir and lodgepole pine climax types, where whitebark pine may be present with lodgepole pine, subalpine fir, and Engelmann spruce. Most natural fires were low severity because of discontinuous fuels, although high severity occurred at long intervals[1]. Whitebark pine would be favored with a natural fire regime.
	Cold Timberline	Whitebark pine climax types on the HLC NFs. Whitebark pine is usually both the existing and climax vegetation because these types are above the cold limits of most other species[1]; the natural fire regime was variable including low and mixed severity (generally 35-300+ year intervals) as well as stand-replacing fires at long intervals.

[1]USDA 2005

Table 2.18 summarizes non-forested habitat type groups. Non-forested types are less clearly distinguishable between potential and existing vegetation using existing data, and unlike the forested types are named based on species rather than site type (Manning 2009). The groups described are based on habitat types; other factors such as soil type greatly influence the biophysical settings upon which non-forested communities develop.

Table 2.18 Non-forested potential vegetation groups for HLC NFs

Broad Potential Veg Group	Habitat Type Group	Description[1]
Grassland	Bluebunch Wheatgrass	The driest grassland potential vegetation type, where bluebunch wheatgrass responds well after fire and can dominate early seral communities. Bare soil, clubmoss, and invasive species are common on these low productivity sites after disturbance. Mid and late seral communities contain high proportions of native grasses and forbs.
	Western Wheatgrass	Annual grasses, annual forbs, and shallow-rooted perennial short grasses dominate early seral stages. Perennial plants become dominant in later seral stages, including native warm (blue grama) and cool season grasses and forbs.
	Fescue	The most mesic and productive grasslands in which communities have greater amounts of mesic forbs, higher cover, and more species richness than other grassland types. Annual grasses and forbs, introduced grasses and forbs, and sometimes clubmoss dominate early seral conditions, with bare soil prominent. Mid and late seral stages become dominated by native grasses such as Idaho and rough fescue and forbs.
Mesic Shrubland	Mesic Shrubland	Mesic shrublands are characterized by dense canopy cover of mesic shrubs forming continuous thickets, often via cloning. Most species are root crown sprouters and respond well to natural fire. Species present include chokecherry and snowberry.
Xeric Shrubland / Woodland	Low Shrubland	Shrublands at the hottest and driest sites at low elevations. Low and perhaps black sagebrush are the overstory dominants, usually with low cover. Rubber and green rabbitbrush and white horsebush may be present along with dry grasses such as bluebunch wheatgrass, needle-and-thread, and Sandberg bluegrass in the understory. Natural fire would promote a mosaic of conditions of native plant associates.

Broad Potential Veg Group	Habitat Type Group	Description[1]
	Mountain Shrubland	Higher elevations mesic sites, often dominated by mountain big sagebrush at low to moderate cover with high cover of graminoids and forbs. Sagebrush may have higher cover in communities altered by grazing. Natural nonlethal and mixed severity fire promote a mosaic of sagebrush which regenerate via seed, along with the fire-sprouting species threetip sagebrush, rubber and green rabbitbrush, and white horsebrush. Natural fire may increase sprouting shrubs and promote a mosaic of native plants.
	Xeric Shrubland	Low elevation, hot, dry sites where Wyoming and basin big sagebrush are the overstory dominants with low to moderate cover. Rubber and green rabbitbrush and white horsebush may be present. Dry grasses such as bluebunch wheatgrass, Sandberg bluegrass, and needle-and-thread dominate undergrowth. Nonnative annual grasses and noxious weeds may be present. Regrowth following fire tends to be slow.
	Mountain Mahogany Woodland	These communities are dominated by curlleaf mountain mahogany in most successional stages. Sites are typically on hot, dry, steep, and rocky soils or rock outcrops. Wyoming big sagebrush, rubber and green rabbitbrush, along with juniper may be present with low cover. Bluebunch wheatgrass and needle-and-thread usually dominate the understory. These communities typically did not burn due to their rocky nature.
	Juniper Woodland	Juniper woodlands can be split into two groups based on ricegrass or bluebunch wheatgrass understories. Both types are dry. The ricegrass type is slightly more mesic, and succession involves an initial grassland stage followed by a mesic shrub stage, green ash stage, and then juniper dominance. The bluebunch wheatgrass type is drier. After the early grassland stage, juniper becomes dominant with no intermediate stages.
Riparian / Wetland	Aspen Woodland	Aspen woodlands are dominated by aspen at later stages in succession and typically associated with riparian areas or wet hillslope areas.
	Riparian/Wetland	This group includes ***riparian shrub*** types on wide valley bottoms, occupied by dense willow or riparian shrubs. These types also occupy stream banks and benches in narrow, steep valley bottoms where shrub cover ranges from continuous to spotty and conifer encroachment is common. ***Riparian shrub/graminoid*** types occur on wide flat valley bottoms with a mosaic of shrubs and herbaceous vegetation. ***Wetland graminoid*** types are characterized by dense, continuous cover of rhizomatous sedges, rushes and grasses, with mesic and hydric forbs. Finally, the ***riparian deciduous tree*** type is characterized by cottonwood with shrubs, forbs and graminoids in the understory.
Alpine	Alpine Herbaceous & Shrub	Alpine types occur above treeline; they occupy the highest mountaintops and ridges. Sites are harsh with frost heaving, minimal soil development, low nutrients, wind deflation and short growing seasons. Alpine herbaceous types have low to moderate cover of graminoids and forbs. The alpine shrub type supports various communities, including artic willow, mountain avens, mountain and moss-heather.

[1]Manning 2009

Potential vegetation classifications also delineate sparsely vegetated areas and those covered with rock, ice, or snow where a potential vegetation type is not applicable or not discernable.

Habitat type groups are identified with the R1 Summary Database based on the habitat types recorded on FIA and FIA intensification plots. Queries show that only about 3% of the HLC NFs has a non-forested potential vegetation type; however non-forested vegetation (or cover type) is more extensive due to natural disturbance regimes. Scree/rock/ice occurs on about 2% of the HLC NFs. For the plots with a forested habitat type, the figure below shows the proportions of habitat type groups using base FIA data that fully represents the HLC NFs. The most common forested habitat type groups are moderately warm and dry; and cool moderately dry to moist.

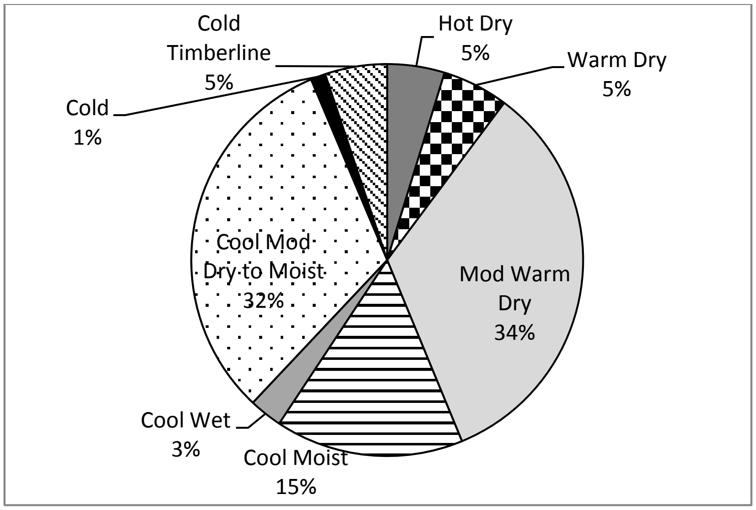

Figure 2.23 Proportion of habitat type groups on potentially forested plots, HLC NFs – R1 Summary Database

The distribution of forested habitat type groups across GAs is a function of terrain, climatic patterns, and biophysical characteristics. Figure 2.24 displays the acres of forested habitat type groups by GA, utilizing the FIA intensification data where completed, and the base FIA data in GAs without a complete intensification. The hot dry habitat type group is relatively rare, occurring with the most extent in the Little Belts GA. Warm dry types are prevalent in the Big Belts, whereas the cold types are more prevalent in the Rocky Mountain Range GA.

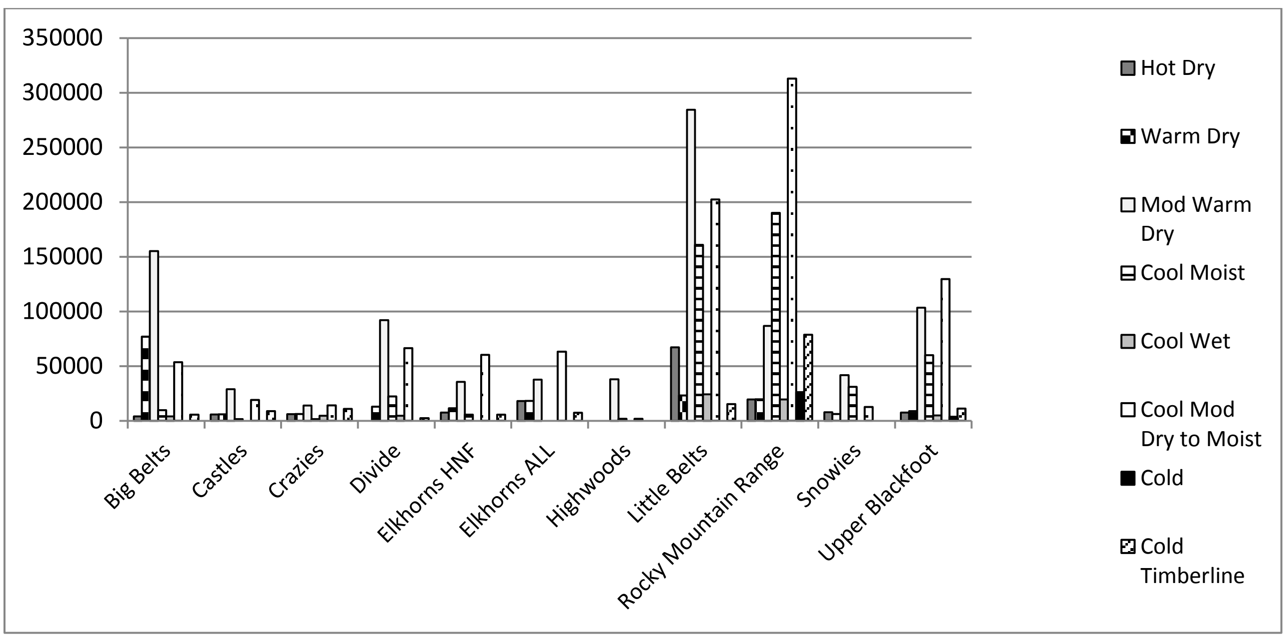

Figure 2.24 Acres of forested habitat type groups by GA - R1 Summary Database

Extensive non-forested habitat types are found on low elevation private lands between the mountain ranges; they are less prevalent within the HLC NFs administrative boundary. Non-forested habitat type groups are not currently classified in the R1 Summary Database. Therefore, potential vegetation mapping is used to provide proportions of non-forested habitat type groups; refer to appendix B. Where non-forested potential types are mapped, the bluebunch wheatgrass group is the most common. The alpine type is not currently mapped, but is known to occur. Errors with the depictions of xeric shrubland and sagebrush are in the process of being rectified.

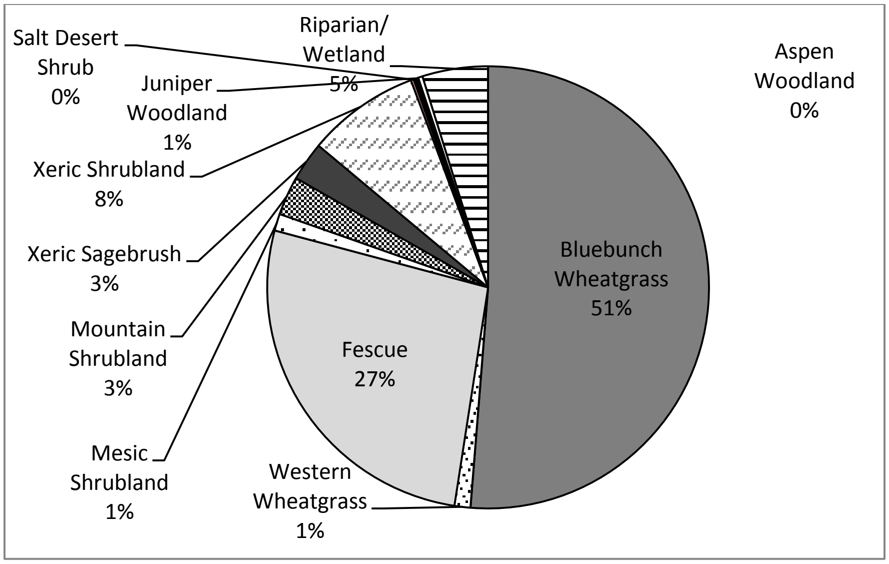

Figure 2.25 Proportion of non-forested habitat type groups, HLC NFs – VMap

The VMap product is also used to estimate the acres of non-forested types by GA. Because of the difference in the data sources, the acres of non-forested types (VMap) and forested habitat type groups (R1 Summary Database) do not add up to the correct acres for each GA.

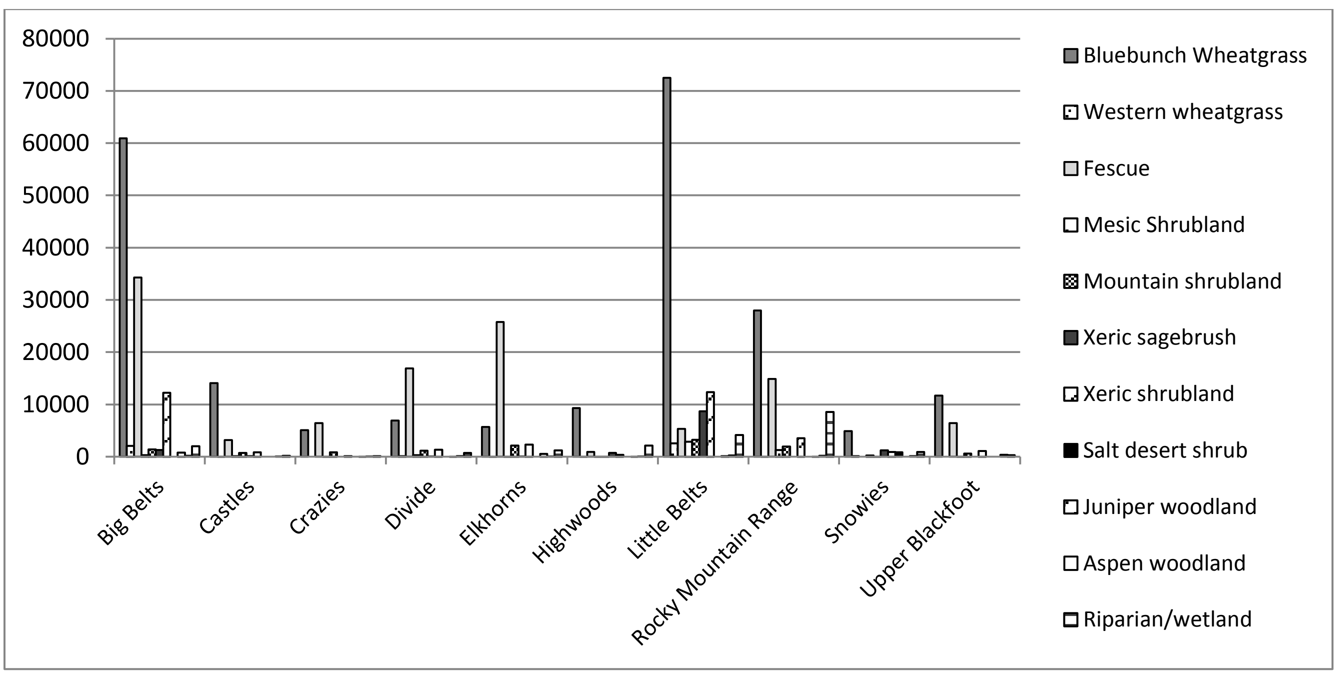

Figure 2.26 Acres of non-forested habitat type groups by GA - VMap

Please refer to map 8 in appendix A, Potential Vegetation.

Trend

Because they are based on physical site factors, potential vegetation types are generally considered to be a "fixed" part of the ecosystem. However, with climate change and shifts in moisture, temperature and other factors, potential vegetation types may actually change over time.

Vegetation Composition

Existing Condition

Lifeform and Cover Types

Existing vegetation is not the same as potential vegetation; the array and condition of the species currently present on a site represent just one point along the successional pathway represented by a potential vegetation type. Species composition is complex; composition gradates and changes through time based on successional pathways and disturbances. See map 9 in appendix A, Existing Vegetation Groups.

The broadest depiction of existing vegetation is *lifeform*. The R1 Classification System (Barber et al. 2011) defines the dominant lifeform for each plot or polygon based on the type of dominant vegetation from six broad categories: *tree, shrub, grass, forb, sparse, and non-vegetated*. Tree life forms are the most common and are estimated to represent nearly 88% of the HLC NFs within the administrative boundary. The estimate for non-forested lifeforms totals about 12%. Of these, shrub lifeforms are the most common. Non-forested life forms may dominate sites with a forested potential vegetation type; thus, non-forested lifeforms represent a higher proportion of the HLC NFs than non-forested habitat type groups discussed in the section above.

Table 2.19 Proportion of life forms on the HLC NFs, R1 Summary Database Base FIA plots

Lifeform	% Area
Tree	87.7
Shrub	4.89
Grass	1.60
Forb	1.85
Sparse	2.82
Non-vegetated (rock, ice)	1.14

The composition of existing vegetation is further characterized by *dominance types*, which describe the species making up the plurality of vegetation (Barber et al. 2011). There are many dominance types on the HLC NFs. These types are grouped into meaningful associations, or *cover types*. Table 2.20 defines the cover types used. Detailed classification logic for non-forested dominance types is currently not defined in the R1 Summary Database; therefore, non-forested cover types reflect those currently discernable with remotely sensed map products (VMap) and will be further refined through the Forest Plan revision process.

Table 2.20 Forested and nonforested cover types

Cover Type	Description
Grass	Grass can dominate most non-forested habitat types, and in some cases forested habitat types. Species can include forbs; rough fescue; Idaho fescue; western wheatgrass; bluebunch wheatgrass, needle-and-thread grass; tufted hairgrass; little bluestem; prairie sandreed; green needle grass; needlegrass; wheatgrass; timothy; crested wheatgrass; blue grama; kentucky bluegrass; buegrass; cool season short grass mix; cool season mid grass mix; warm season mid grass mix; and warm season short grass mix.
Dry Shrub	The dry shrub cover type may occur on most non-forested habitat types as well as some forested habitat types. Shrubs include sagebrush; antelope bitterbrush; shrubby cinquefoil; skunkbush sumac; curl-leaf mountain mahogany; greasewood; rabbitbrush; low shrub; saltbush, spinless horsebrush; soapweed yucca sagebrush, and rabbitbrush. These areas may also contain limber pine and juniper, especially in ecotones.
Riparian Grass/ shrub	This cover type can occur in riparian areas, typically non-forested woodland or riparian habitat types, but also potentially in forested habitat type groups such as Cool and Wet. This type includes species such as willow, alder, mountain brome, smooth brome, dry sedge, wet sede/spikerush/juncus, and annual brome.

Cover Type	Description
Mesic Shrub	Mesic shrubs most commonly dominate mesic shrub habitat type groups. Species may include chokecherry, plum; rose; snowberry; huckleberry; mallow ninebark; white spirea, and buffaloberry.
Sparse	Sparsely vegetated areas include areas with less than 10% cover of grass, shrub, or tree cover. These often occur in areas dominated by rock, ice, and snow.
Ponderosa Pine	This cover type includes sites dominated by ponderosa pine, juniper, or limber pine. A minor component of Douglas-fir can be present. Ponderosa pine is an early seral, shade intolerant, fire resistant species that is found on a narrow elevation band between non-forested ecotones and Douglas-fir. This type usually grows on the Warm Dry forested habitat type group, but also on Hot Dry and Moderately Warm and Dry.
Dry Douglas-fir	Dry sites dominated by Douglas-fir, with potential components of ponderosa pine, limber, or juniper. Douglas-fir is one of the most common species on the HLC NFs. It is moderately shade and drought tolerant, which enables it to function as both an early and late seral species. This type occurs commonly on Warm Dry, Moderately Warm Dry, and Moderately Warm Moderately Dry habitat type group.
Mixed Mesic Conifer	Sites dominated by Douglas-fir which can be mixed with lodgepole pine, western larch, and/or subalpine fir/spruce. This type is found on sites more moist and productive than the dry Douglas-fir type. This cover type is found most commonly on Cool Moderately Dry to Moist habitat type groups, but can also occur on Cool Moist types or Moderately Warm Moderately Dry.
Western larch Mixed Conifer	Sites dominated by western larch, with potential components of Douglas-fir, lodgepole pine, and/or spruce. Western larch is a deciduous conifer, shade intolerant, early seral and resistant to fire that competes best on the cool, moist sites. This type is typically on the Cool Moderately Dry to Moist habitat type group.
Lodgepole Pine	Sites dominated by lodgepole pine with minor components of other species. Lodgepole pine is a very abundant species on the HLC NFs, growing under a wide range of conditions. Where dominant it is often single-storied. Without disturbance it succeeds to Douglas-fir, spruce, and/or subalpine fir. This cover type can occur on multiple habitat type groups, most commonly Cool Moderately Dry to Moist.
Aspen /Hardwood	Areas dominated by aspen, cottonwood, and birch, often with shrubs such as willow and alder. This type often occurs in association with riparian and moist upland areas. Without disturbance, conifers will eventually dominate. This cover type can be found in almost all habitat type groups.
Spruce/fir	Subalpine fir and/or Engelmann spruce dominate, with minor components of other species. These are often climax forests. Where these shade-tolerant climax species have become dominant, stands are usually multi-layered and dense. This cover type can occur on any of the habitat types in the broad Cool Moist or Cold potential vegetation groups.
Whitebark pine	The whitebark pine cover type occurs at the high elevations, commonly on the Cold habitat type group (where it is perpetuated by disturbance) or Cold Timberline habitat type group (where it is the most common dominant). Alpine larch is a potential component but is not known to occur on the HLC NFs. Minor components of subalpine fir, spruce, or lodgepole pine may occur. Whitebark is a shade intolerant, moderately fire resistant species. Ongoing mortality to the exotic blister rust fungus has reduced its extent.

The R1 Summary Database can be used to summarize cover types. Only the forested types are broken into detail; a classification system for non-forested cover types is not yet developed, therefore estimates in this analysis group all non-forested types together. Further, the dry Douglas-fir and mixed mesic conifer types are not distinguishable with current queries; both types are dominated by Douglas-fir and are grouped together in this analysis. Estimates for the HLC NFs utilizing base FIA plots show that the dry Douglas-fir/mixed mesic conifer and lodgepole pine cover types are the most common. The proportions displayed equate to over 823,000 acres being dominated by Douglas-fir, and nearly 796,000 acres dominated by lodgepole pine. Pine types have been recently impacted by the mountain pine beetle, which is not reflected in the base FIA used to characterizes the HLC NFs as a whole. The western larch cover type does not appear on any FIA or FIA intensification plots, but is known to occur on the far western portion of the Upper Blackfoot GA.

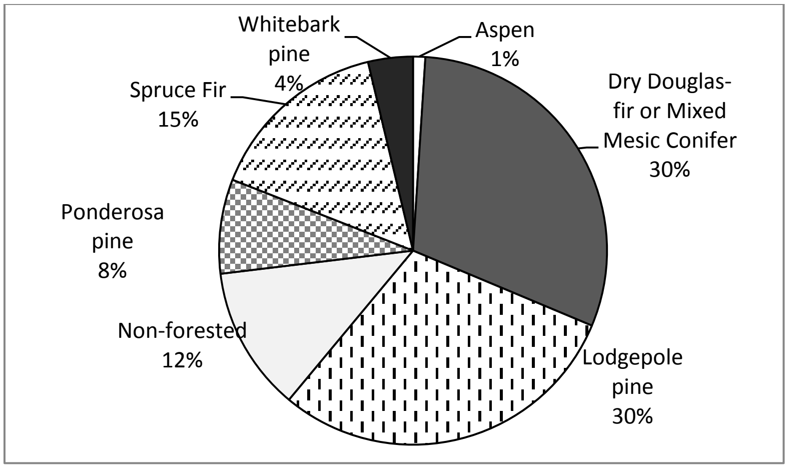

Figure 2.27 Cover type proportions on the HLC NFs, R1 Summary Database, base FIA plots

FIA data is also summarized by GA, utilizing the most complete dataset which includes re-measurements since the mountain pine beetle outbreak in GAs with a completed FIA intensified grid sample. This shows that Douglas-fir and lodgepole pine cover types are common on most GAs. Non-forested cover types are also common but most prevalent in the Highwoods, Elkhorns, Crazies, and Big Belts GAs. The relationship between existing vegetation and potential vegetation is visible when comparing this to the Potential Vegetation section. For example, the Snowies GA contains a high proportion of the ponderosa pine cover type; however, most of that GA has Douglas-fir habitat types. Therefore, historic disturbance regimes played an important role in establishing a dominance of ponderosa pine in these areas.

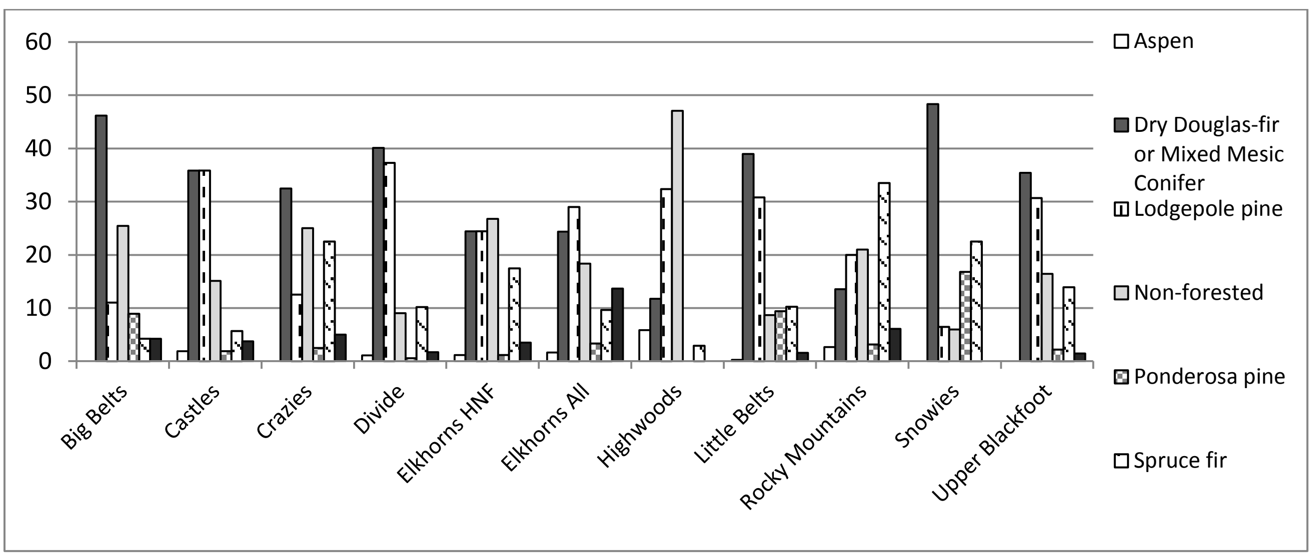

Figure 2.28 Cover type proportion by GA, R1 Summary Database, base FIA and FIA intensification data

Acres of cover types by GA are shown in Figure 2.29. The most whitebark pine and aspen cover types occur in the Rocky Mountain Range GA, followed by the Elkhorns, Big Belts, and Little Belts GAs. The ponderosa pine cover type is most extensive in the Little Belts, Big Belts, Snowies, and Rocky Mountain Range GAs.

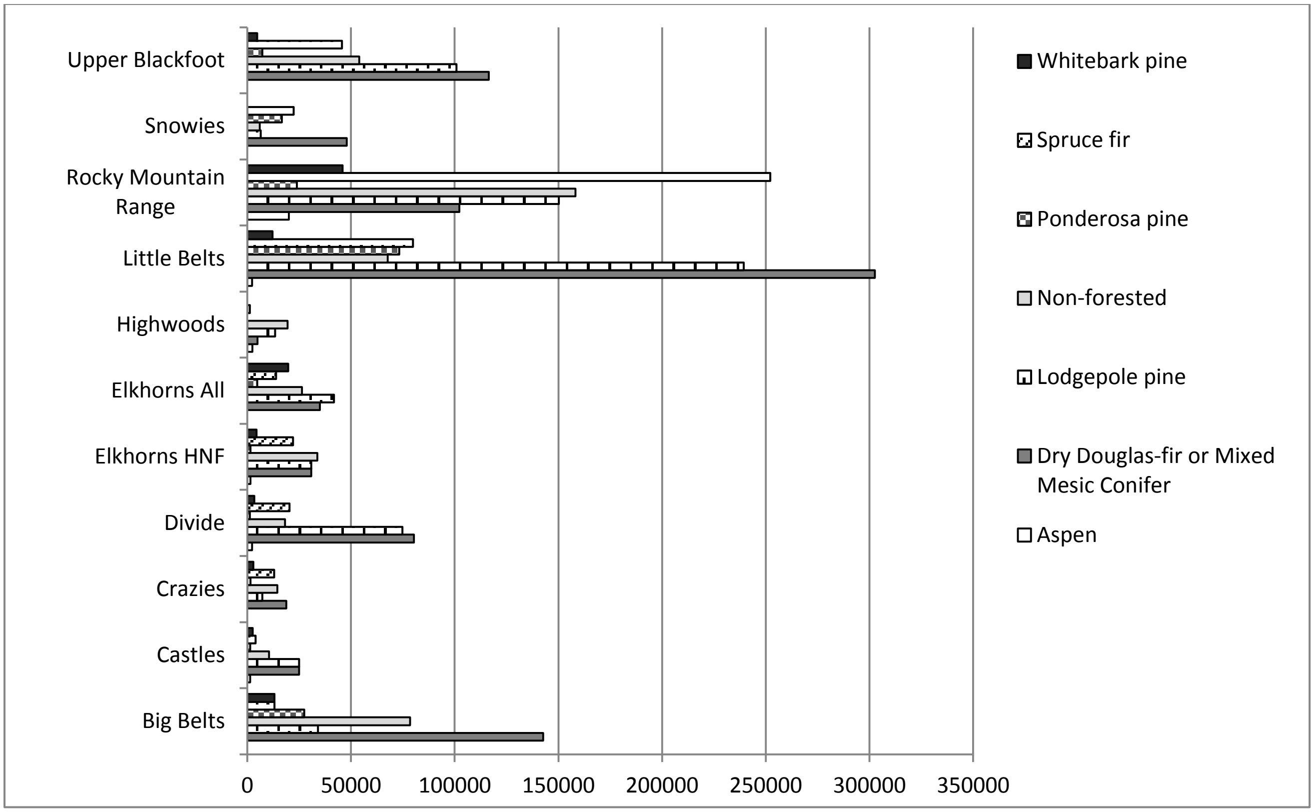

Figure 2.29 Acres of cover type by GA, R1 Summary Database, base FIA and FIA intensification data

Cover types can also be summarized with VMap. This product provides additional information particularly for non-forested types. VMap shows over 570,000 acres in the HLC NFs administrative boundary as non-forested cover types. Where non-forested types are mapped, grasslands and sparse areas are the most abundant. The Rocky Mountain Range GA contains a high number of acres with sparse cover; these areas correspond to rocky cliffs and snow covered areas. Please refer to appendix A for a figure depicting cover types.

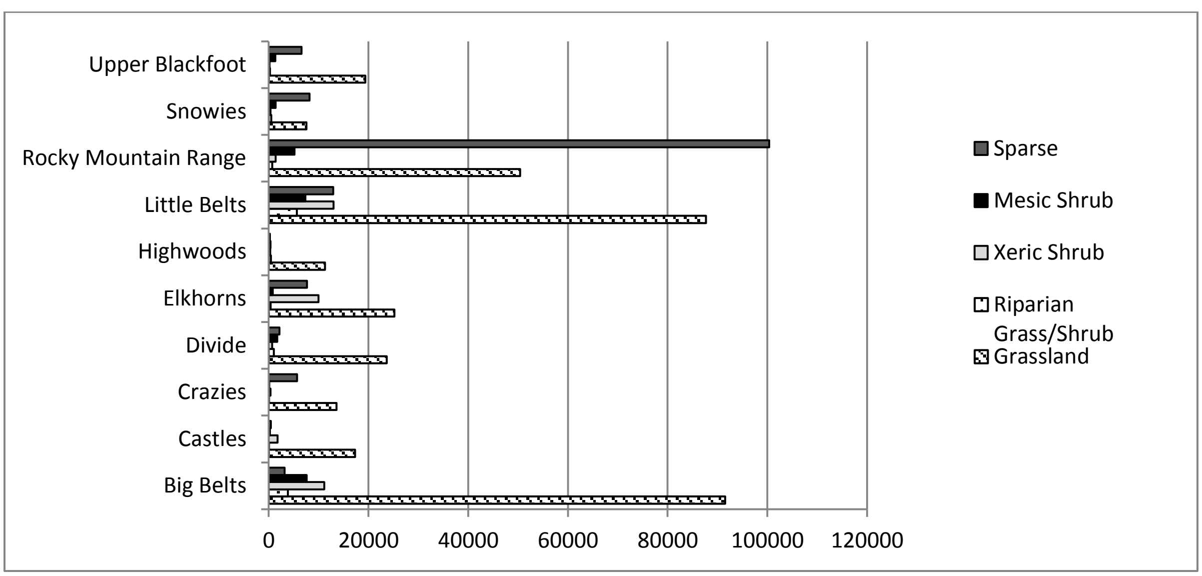

Figure 2.30 Non-forested cover types by GA, acres, R1 VMap

Riparian and Wetland Areas

Riparian areas and wetlands are important elements of the ecosystem which can be described based on potential vegetation, existing vegetation, topography, and hydrological features. As shown in the potential vegetation summary, a small proportion of the HLC NFs is mapped with riparian/wetland potential vegetation. Riparian grasses and shrubs are also an existing cover type. Vegetation classifications do not include hydrological features; therefore, riparian and wetland areas are also depicted using National Wetland Inventory (NWI) data provided by the Montana State Natural Heritage Program (MTNHP). NWI maps riparian and wetland areas based on aerial imagery, hydrological feature mapping, soils, and vegetation layers. NWI map data was added to the HLC NFs vegetation layer (VMap). Table 2.21 describes the riparian and wetland types. Potential plant species of conservation concern (SCC's) are also noted in the table and will be discussed later in this chapter.

Table 2.21 Riparian and wetland types, National Wetland Inventory, mapped on the HLC NFs

Type	Description
Freshwater Emergent Wetland	These wetlands typically correspond to the Wetland Graminoid habitat type group, although there are inclusions of other types. While the riparian shrub/grass cover type is common, other cover types, including conifers, also occur. Plants associated with the Wetland SCC[1] guild may occur.
Freshwater Forested Wetland	These wetlands typically correspond to Riparian Deciduous Tree or Cool Wet habitat type groups. A wide variety of cover types can occur, although spruce, cottonwood, aspen, and Douglas-fir are the most common. Plants associated with the Wetland SCC[1] guild may occur.
Freshwater Forested/Shrub Wetland	These wetlands typically correspond to Riparian Deciduous Tree or Cool Wet habitat type groups. A wide variety of cover types can occur, although dry shrub, mesic shrub, and cottonwood are the most common. Plants associated with the Wetland SCC[1] guild may occur.
Freshwater Scrub-Shrub Wetland	These wetlands typically correspond to the Riparian Shrub and Riparian Shrub/graminoid habitat type groups. Cover types are most often grasses, shrubs, and mesic shrubs with some aspen and conifer types. Plants associated with the Wetland SCC[1] guild may occur.
Riparian Emergent	These riparian areas generally correspond to the Wetland Graminoid habitat type group, and are typically dominated by riparian grass cover types although other plants and conifers can occur. Plants associated with the Riparian SCC[1] guild may occur.
Riparian Forested	These wetlands typically correspond to Riparian Deciduous Tree or Cool Wet habitat type groups. Many cover types can occur, although spruce, subalpine fir, cottonwood, and aspen are the most common. Plants associated with the Riparian SCC[1] may occur.
Riparian Scrub-Shrub	These areas typically correspond to the Riparian Shrub and Riparian Shrub/ graminoid habitat type groups. Cover types are most often grasses and shrubs with some aspen and conifers. Plants associated with the Riparian SCC[1] guild may occur.
Freshwater Pond; Lakes	These are water bodies and not directly associated with potential vegetation or cover types. These areas are typically coded as Water in potential and existing vegetation data and map layers.
River; Riverine	These are linear water bodies and not directly associated with potential vegetation or cover types. These areas are typically coded as Water in potential and existing vegetation data and map layers

[1]Potential Plant Species of Conservation Concern

Riparian and wetland types are mapped on over 70,000 acres of the HLC NFs administrative area, less than 3%. These types are more extensive on private lands. See map 10 in appendix A, Wetlands and Riparian Areas. The chart below displays the acres by GA. Freshwater emergent wetlands are the most common type. The Highwoods GA has few to none of these areas mapped. The Little Belts GA appears to be unique in the occurrence of riparian emergent areas.

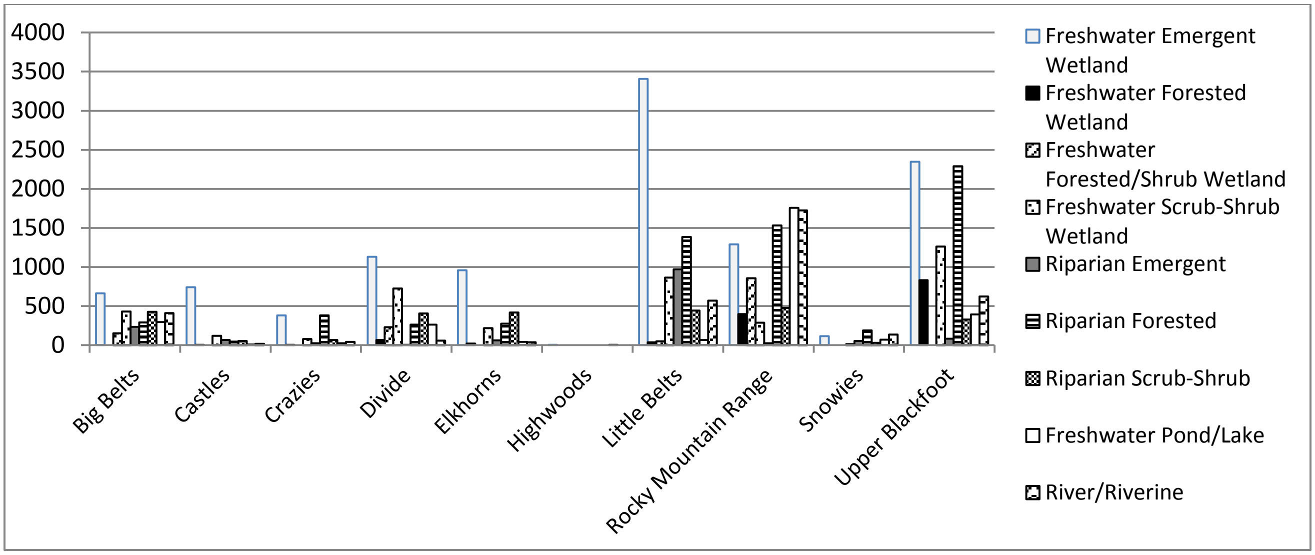

Figure 2.31 Acres of riparian areas and wetlands on the HLC NFs by GA (National Wetland Inventory)

Individual Tree Species Presence

Cover types are meaningful associations of dominant vegetation. However, species can occur in multiple cover types depending upon succession and disturbances. For example, components of ponderosa pine that occur in Douglas-fir cover types may indicate areas where Douglas-fir has become dominant in the absence of fire. Therefore, the presence and distribution of species is important to understanding ecosystem diversity and function. FIA and FIA intensified grid data can be used to summarize species presence/absence and (trees per acre). Potential plant species of conservation concern (SCC) or public interest (SPI) are assessed in later sections. Species presence is also assessed by ecosystem at the end of this chapter. Plant species in the understory or in non-forested cover types are too numerous to be displayed. The acres where individual tree species are present are summarized for the HLC NFs in the table below. Appendix A contains a tree presence/absence chart by GA.

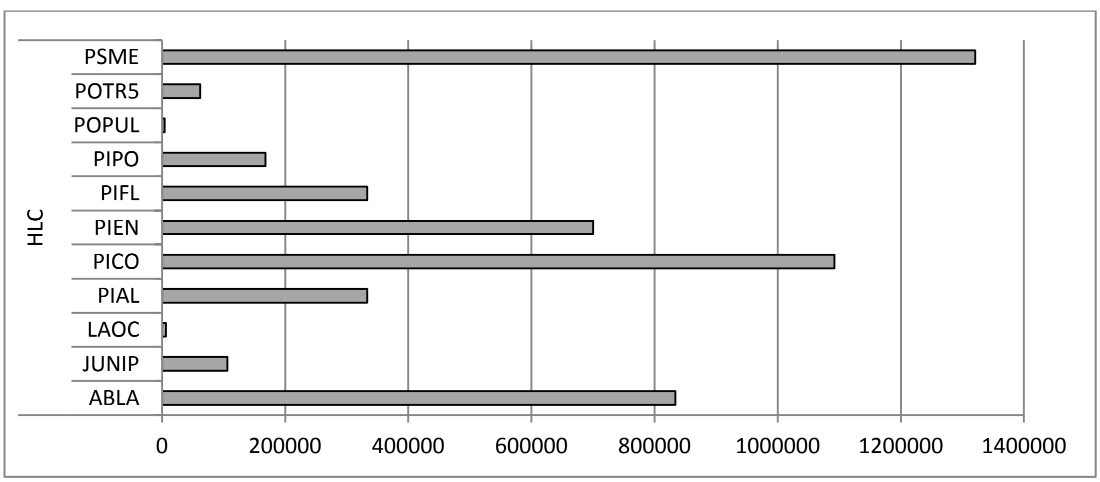

Figure 2.32 Individual tree species presence on the HLC NFs - acres

The data re-iterate that in addition to being the most common cover types, Douglas-fir and lodgepole pine are by far the most widely distributed tree species on the HLC NFs, each occurring on over a million acres. Spruce and subalpine fir trees are also common. Some of the least common species, such as aspen and ponderosa pine, are of high interest for ecosystem diversity and habitat. Cottonwood and western larch are the least common trees.

Trend

Unlike potential vegetation, cover types are constantly in transition. Without disturbance, cover types slowly transition from early seral, shade intolerant species to late seral, shade tolerant species. Disturbances may intervene at any point in the successional trajectory. The exclusion of fire since modern settlement has generally resulted in a higher proportion of late seral, shade tolerant species at the expense of shade-intolerant types, a trend which mirrors that of the larger Northern Rocky Mountain ecoregion (USDA 2003). This is most evident in types where high frequency, low severity fires would have been common, such as the hot dry and warm dry habitat type groups. On many of these sites, Douglas-fir has become dominant over early seral species such as ponderosa pine. On more mesic sites, Douglas-fir can act like an early seral species, giving way to subalpine fir or spruce with no disturbance. Similarly, many sites that would have been dominated by whitebark pine have transitioned to subalpine fir due to the absence of fire and the introduction of white pine blister rust. Stand replacing disturbances on sites capable of supporting lodgepole pine tend to perpetuate its dominance; where stand replacing disturbance has not occurred, succession or minor disturbances can hasten succession to spruce/fir.

A 2003 SIMPPLLE analysis (USDA 2003) estimated of the abundance of cover types present historically. Estimates represent the percent of acres on forested habitat types averaged over 50 decades. The analysis areas are not consistent with current GAs. Similarly, the cover types assessed were defined differently. Proportions have been summarized by cross-walking to current definitions of cover types and GAs. Table 2.22 shows the average abundance of historic cover types. Maximum and minimum estimates can be found in the project record.

Table 2.22 Summary of historic cover types, average % abundance, adapted from USDA 2003

2003 HRV Analysis Area	Historic Average % Cover Type						
	Ponderosa pine	Dry Douglas-fir/ Mix Mesic Conifer	Lodgepole pine	Aspen/ Hardwood	Spruce/Fir	Whitebark Pine	Non-forested
1 - North Little Belts GA; Most Snowies GA	20.8	28.6	14.8	6.5	3.4	1.1	24.7
2 – West Little Belts GA, North Big Belts GA; Highwoods GA	6.8	35.2	19.2	21.6	3.1	0.8	13.4
3 – Northern Rocky Mountain Range GA	1.1	26.3	12.1	16.0	33.3	0.8	10.4
4 – Southern f Rocky Mountain Range GA	1.4	27.7	26.9	4.5	18.5	0.0	18.0
5 – Upper Blackfoot GA, Northwest Divide GA	7.6	28.1	24.4	8.6	2.8	0.0	27.4
6 – Most Big Belts GA; eastern Elkhorns GA	12.5	31.4	12.9	11.3	0.6	0.1	30.5
7 – Western Elkhorns GA, most of Divide GA	5.0	21.4	36.9	17.6	3.8	0.1	14.6
16 – Crazies GA	2.7	22.7	30.3	4.9	4.5	0.1	33.2
17 – Southern Little Belts GA; Castles GA; southern Snowies GA.	9.0	16.6	22.9	8.0	2.8	0.0	40.4

Because of the differences in the 2003 and current vegetation data, care must be taken in making direct comparisons. Still, general trends can be identified relative to the departure from historic conditions. The ponderosa pine cover type appears to have been more abundant historically in some GAs. For example, the Big Belts are represented by 2003 HRV analysis area #6, which was estimated to have the ponderosa pine type on 12.5% while the current estimate is about 8.9%. Similar trends are observed in the Snowies GA (20.8% versus 16.8%) and Upper Blackfoot (7.6% versus 2.2%). The dry Douglas-fir/mixed mesic cover types appear to be generally more abundant than they were historically. The lodgepole pine type is generally similar or not greatly different than historic estimates. Aspen/hardwood types, however, appear to be notably less common than they were historically on all GAs. Conversely, spruce/fir types appear to be more common. Non-forested types appear to be generally less common than they were historically. The depiction of whitebark pine cover types historically is lower than would be expected and this type appears to be more common currently. This is not consistent with the latest knowledge concerning whitebark pine and may reflect limitations in the historic cover type modeling.

Future trend in vegetation composition will be greatly influenced by human actions as well as climate change and natural disturbance processes. Fire suppression will likely continue to alter successional processes, generally to favor shade-tolerant species, although vegetation treatments and/or wildfires may mitigate this influence somewhat. Warmer, drier climates will influence species distributions and successional processes in complex and uncertain ways; the possible influence of climate change is discussed in chapter 4 - Climate Change and Baseline Assessment of Carbon Stocks. For example, species better adapted to warm, dry conditions such as ponderosa pine may gain a competitive advantage in some areas. Vegetation composition influences, and is in turn influenced by, spatial heterogeneity of landscapes and interrelated ecosystem drivers.

Vegetation Structure and Function

Structure, connectivity, and pattern are key ecosystem characteristics. At the broad to mid-scale, this analysis uses the R1 Classification System to describe four classified elements of structure: *tree size class, forested density classes, non-forested density classes, vertical structure classes, and forested age classes.* Connectivity and pattern are described more qualitatively. Additional structures of interest are discussed in the Special Ecosystem Components section, including old growth, large trees, snags, and woody debris.

Tree Size Class

Existing Condition

Tree size is depicted by tree diameter. The variability of tree sizes is simplified into five size classes that are determined using the basal area weighted diameter for a plot or polygon. Individual or small amounts of smaller or larger trees may occur in a given size class. In particular, large tree remnant structures are key ecosystem characteristics and summarized as *special components*. Size classes may be used to draw conclusions regarding successional stage to an extent; however, the correlation between size and age is imperfect and variable.

Table 2.23 Tree size classes

Tree Size Class	Description
Seedling/Sapling	Polygon or plot averages < 5" diameter. Due to small tree size and crown widths, usually ample sunlight is able to reach the forest floor and abundant grasses, forbs and shrubs are a dominant feature. When summarizing VMap data, transitional areas are also included in this size class.
Small Tree	Polygon or plot averages 5 to 9.9" diameter. Usually limited sunlight reaches the forest floor and shade tolerant understory grasses, forbs and shrubs may dominate. In more open forests, early successional, shade intolerant understory plants can persist.
Medium Tree	Polygon or plot averages 11 to 14.9" diameter. As with the small tree class, usually the more shade tolerant plants will dominate forest floor vegetation based on typical density.
Large Tree	Polygon or plot averages 15-19.9" diameter. Shade tolerant vegetation usually dominates in the undergrowth. This class usually represents the late successional forest condition.
Very Large Tree	Polygon or plot averages >20" diameter. These sites are rare due to productivity and disturbance regimes found on the HLC NFs. Shade tolerant vegetation usually dominates in the undergrowth. This class usually represents the late successional forest condition.

FIA data provides estimates of the proportions of size classes on forested areas of the HLC NFs; data summarized for the plan area do not include the FIA grid intensification plots and have not been re-measured since the recent mountain pine beetle outbreak. The data show that the small size class is the most prevalent, followed by medium; over 2/3 of the FIA plots on the HLC NFs are classified into these two classes. Seedling/sapling forests make up a substantial part of the ecosystem (17%) but large and very large tree size classes are relatively rare. In pine dominated forests the mountain pine beetle outbreak may have recently caused changes in this distribution; some of the large or medium tree areas to become dominated by seedling/sapling or small tree.

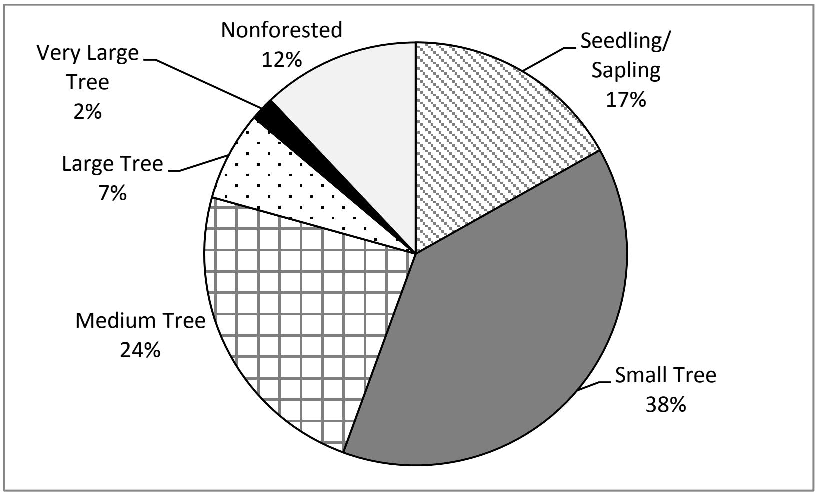

Figure 2.33 Proportion of size class on the HLC NFs, R1 Summary Database

Size class data is also summarized for each GA; this includes FIA intensified grid plots where available, which better depict conditions that have resulted from the mountain pine beetle outbreak. Most GAs follow the same trend as the HLC NFs overall in terms of the proportion of size classes. Some GAs, such as the Castles, have a high 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.

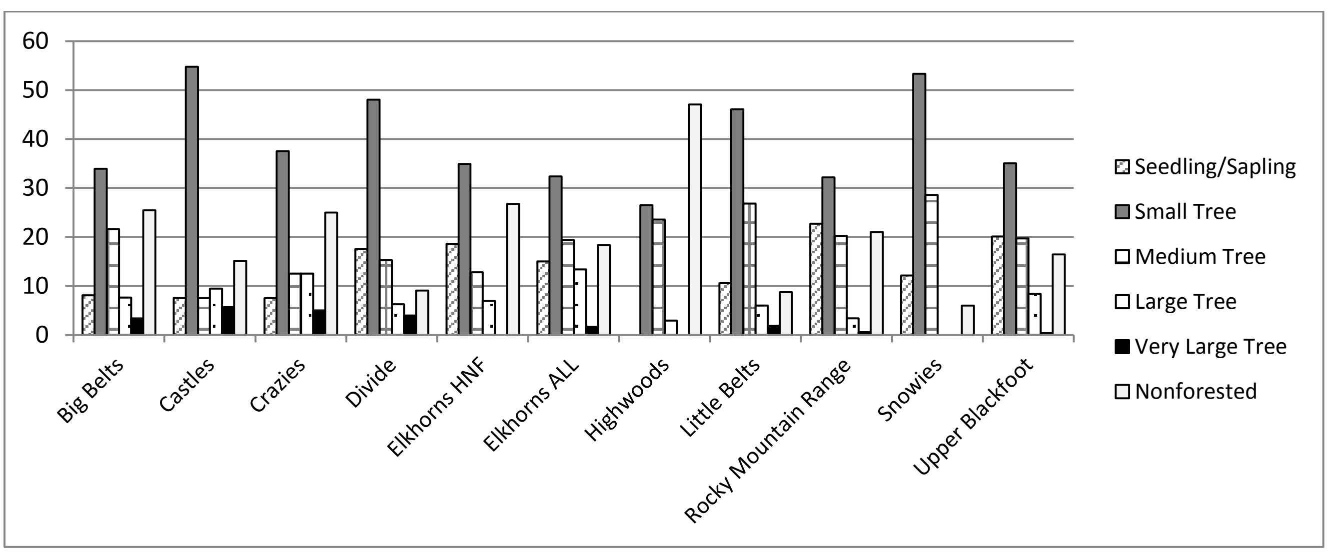

Figure 2.34 Size classes by GA, R1 Summary Database.

Please refer to map 11 in appendix A, titled Tree Size Class.

Trend

Size classes change as forests grow, and depend upon individual species traits, site productivity, climate, and disturbances. Some species, such as lodgepole pine, typically do not grow larger than the small or medium class based on the traits of the species and a short-lived nature adapted to stand-replacing disturbance regimes. Other species such as Douglas-fir or ponderosa pine are long-lived and capable of growing to large sizes especially when open growing conditions are maintained. In some areas, fire suppression may have caused decreases in the proportion of seedling/sapling forests that would have been created by stand-replacing disturbances. Similarly, the lack of low-intensity disturbances in long-lived cover types may have caused a decrease in the large and very large size classes by perpetuating high densities where individual tree growth is inhibited. The overall result of these two trends may have been an increase or bulge in the small and medium tree size classes.

A SIMPPLLE analysis (USDA 2003) generated estimates of size classes present historically. Estimates represent the percent of acres present in each class, averaged over 50 decades. The analysis areas are not consistent with the current GAs. However, the definitions of size class were very similar. The proportions were summarized by cross-walking the SIMPPLLE classes to the current definition of size class and GAs. Table 2.24 shows the average abundance of historic size classes. The maximum and minimum estimates are in the project file.

Table 2.24 Summary of historic size classes, average % abundance, adapted from USDA 2003

2003 HRV Analysis Area	Historic Average % Size Class					
	Seedling / Sapling	Small Tree	Medium Tree	Large Tree	Very Large Tree	Non-Forested
1 - North part Little Belts GA; Most of Snowies GA	17.5	13.5	13.3	29.4	1.7	24.7
2 – West part Little Belts GA, North part Big Belts GA; Highwoods GA	23.5	16.3	12.8	31.6	2.5	13.4
3 – Northern part of Rocky Mountain Range GA	24.2	20.5	15.5	23.2	6.1	10.4
4 – Southern part of Rocky Mountain Range GA	24.9	15.8	14.1	22.7	2.9	17.6
5 – Upper Blackfoot GA, small Northwest part Divide GA	26.6	11.8	10.5	22.3	1.5	27.4
6 – Most Big Belts GA; eastern part of Elkhorns GA	22.6	11.0	9.0	25.4	1.5	30.5
7 – Western part of Elkhorns GA, most of Divide GA	26.6	19.0	16.0	22.7	1.2	14.6
16 – Crazies GA	21.0	13.4	12.9	18.2	1.5	33.2
17 – Southern Little Belts GA; Castles GA; Small southern part Snowies GA	17.3	12.8	10.6	17.9	1.0	40.4

Because of the differences in the 2003 data and methods versus how we currently depict vegetation, care must be taken in making direct comparisons or placing emphasis in exact values. However, some general trends can be identified. Primarily, it appears that seedlings/saplings and large trees are less abundant today in most GAs, while the small tree and medium tree classes are more abundant - in some cases double or more their historic average. The very large tree class was always relatively rare and in most GAs is somewhat similar to the historical condition, although in the Big Belts and Crazies GAs this class may actually be more prevalent today than it was historically. The very large tree class appears to be well below the historic average in the Rocky Mountain Range

GA. High proportions of mid successional forest, which may be associated with high tree density, multiple canopy layers, and homogenous conditions across the landscape, increase the likelihood that fuel characteristics could support a fast moving and intense crown fire. These conditions may also increase the susceptibility of forests to insect and disease, due to greater abundance of hosts species and increased tree stress (USDA 2003).

Future trends in size class will be influenced by human actions as well as climate and natural disturbance processes. Fire suppression may continue to alter successional processes, generally to favor medium size classes, although vegetation treatments and wildfires may mitigate this influence somewhat. Warmer, drier climates will influence successional processes in complex and uncertain ways as discussed in chapter 4 - Climate Change and Baseline Assessment of Carbon Stocks. For example, warm conditions may increase the extent and severity of disturbances which increase the amount of early seral forests, or, in some cases, to thin some forests and allow for greater individual tree growth. However, drier conditions may also inhibit tree growth in some areas. Spatial heterogeneity will influence, and be influenced by, interactions of drivers such as wildfire and insects and their feedbacks with size class distributions.

Forested Density Class

Existing Condition

The density of existing forested vegetation is depicted by *canopy cover*, which is a measure of the vertical coverage of tree crowns in a stand as a percentage of the land area. There are four tree density classes in the R1 Classification System, in addition to two non-forested classes, which simplify canopy cover.

Table 2.25 Density (canopy cover) class descriptions

Canopy Cover Class	Description
Non-forested	<10% tree canopy cover. Corresponds to grass or shrub dominance types.
Sparse	<10% tree canopy cover not considered a grass/shrubland – such as rock scree.
Low Tree Cover	10-25% canopy cover. These tend to be open, dry forest types in transition areas with grass/shrublands; in more productive forests that have been recently disturbed; or seedling/ sapling forests where the regeneration has not yet closed.
Moderate Tree Cover	26-40% canopy cover. This class tends to represent open growing cover types and/or early to mid-seral forests where canopies have not completely closed.
Mod/High Tree Cover	41-60% canopy cover. This class tends to represent more closed canopy cover types and mid to late seral forests where canopies have begun to close.
High Tree Cover	>60% canopy cover. These are very dense forests and tend to be either seedling/saplings, cover types that tend to grow at high density such as spruce/fir, and/or mid to late successional forests where canopies have closed.

FIA data provides estimates of the proportions of density classes on forested areas across the HLC NFs; data summarized for the plan area do not include the FIA grid intensification plots and have not been re-measured since the recent mountain pine beetle outbreak. The data show that the high tree cover class is by the most prevalent, followed by moderate to high cover; over 2/3 of the FIA plots on the HLC NFs are classified into these cover classes. The low tree cover density class is relatively rare (7%), although the non-forested and sparsely vegetated areas make up nearly 20%. In pine dominated forests, the mountain pine beetle outbreak may have recently caused changes in this distribution; some of high density areas may have shifted into more open classes.

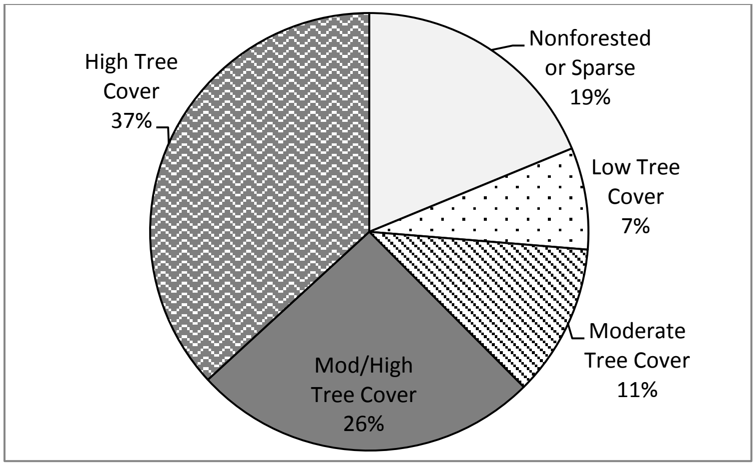

Figure 2.35 Proportion of canopy cover classes on the HLC NFs, R1 Summary Database, base FIA data

Data also summarized for each GA; this includes FIA intensified grid plots where available, which better depict conditions that have resulted from the mountain pine beetle outbreak. Most GAs follow the same trend as the HLC NFs overall in terms of the proportion of density classes. Some GAs, 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.

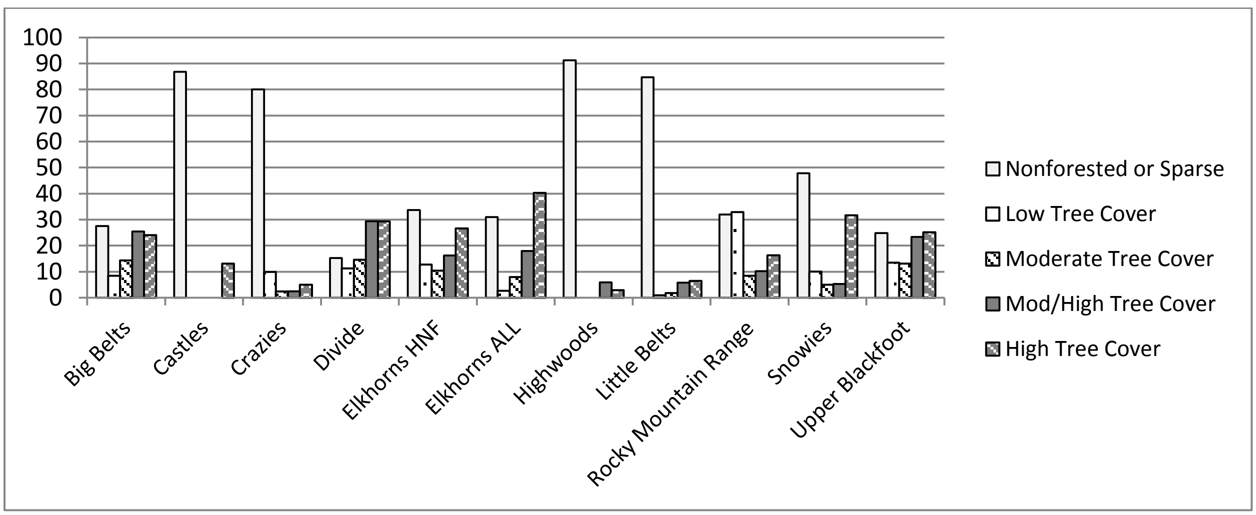

Figure 2.36 Canopy cover classes by GA, R1 Summary Database.

Please refer to map 12 in appendix A, Tree Canopy Class.

Trend

The trend of density class is driven by natural succession, individual species traits, and disturbance processes. In general, density increases over time as tree grow and tree crowns expand. Mortality functions such as competition and low severity disturbances can conversely create more open conditions over time. Some cover types, such as lodgepole pine, naturally grow at high density. Others, such as ponderosa pine, typically grow at more open densities with natural disturbance regimes. 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. Higher densities tend to predispose these forests to stand-replacing mortality from fire and insects.

The currently available SIMPPLLE analysis (USDA 2003) did not estimate the abundance of density classes that were present on average historically. However, the increasing proportion of medium-sized or mid seral forest is often associated with an increase in number of high tree densities (USDA 2003).

Future trends in density classes will be influenced by human actions as well as climate change. Fire suppression will likely continue to alter successional processes, generally to favor the development of denser forests, although vegetation treatments and wildfire may mitigate this influence. Warmer, drier climates will influence successional processes in complex and uncertain ways as discussed in Chapter 4 - Climate Change and Baseline Assessment of Carbon Stocks. For example, warm conditions may increase the extent and severity of disturbances which increase the amount of non-forested areas, or to thin some forests and reduce density class. Drier conditions may also inhibit tree growth in some areas. Spatial heterogeneity will influence, and be influenced by, interactions of drivers such as wildfire and insects and their feedbacks with forest density.

Non-forested Density Classes

Existing Condition

The density of non-forested vegetation (grass, forbs, and shrubs) is also of interest. Please refer to Chapter 6, Ecosystem Services and Multiple Uses – Range for more information relative to lands suitable for grazing. The canopy cover of forbs, grasses, and shrubs across the HLC NFs is estimated by lifeform. Canopy cover is also meaningful by habitat type, but estimates are not currently available. Data are shown from the base FIA grid, which represents the entire HLC NFs plan area, and the FIA Intensified grid, which does not represent the entire plan area (refer to appendix B). Where completed, the intensified plots provide additional statistical accuracy. For most estimates, the values of the two datasets are similar, with the greatest variance seen in the grass lifeform because it has few plots available on the base FIA grid. The average canopy cover of these non-forested vegetation categories ranges from about 2% to nearly 30%.

Table 2.26 Canopy cover of non-forested vegetation by Lifeform, R1 Summary Database

Lifeform	% Canopy Cover Forbs		% Canopy Cover Grasses		% Canopy Cover Shrubs	
	Base FIA	FIA 4x	Base FIA	FIA 4x	Base FIA	FIA 4x
Tree	12.68	10.03	7.29	8.83	16.20	20.31
Grass	6.5	4.84	44.17	29.34	4.58	2.45
Shrub	8.44	10.66	16.41	19.85	21.20	21.77
Forb	20.67	20.64	25.58	26.93	3.25	2.25

Trend

Please refer to the Potential Plants of Conservation Concern and Invasives sections in this chapter, and Chapter 6, Ecosystem Services and Multiple Use – Range for more information regarding non-forested vegetation.

Forest Vertical Structure Class

Existing Condition

The vertical structure of forested vegetation is depicted by *vertical structure class*, which classifies plots or polygons based on the number of canopy layers present. These layers often, but do not necessarily, correspond to tree cohorts or age classes. There are four vertical structure classes (Barber et al. 2011).

Table 2.27 Vertical structure class descriptions

Vertical Class	Description
1	Single-storied, dominated by a single canopy layer. This usually corresponds to even-aged stands which is typical of some cover types such as lodgepole pine.
2	Two-storied, with a dominant overstory and an understory which usually corresponds to a second age class but may also represent a suppressed layer the same age as the canopy.
3	Three-storied, with three distinct layers present, which often correspond to a dominant overstory and two younger age classes but may also represent suppressed layers of the same age as the dominant canopy.
C	Continuous canopy layering. This usually corresponds to shade tolerant cover types such as spruce/fir and/or forests at or near climax where shade tolerant layers have established.

FIA data provides estimates of the proportions of vertical structure class on forested areas across the HLC NFs; data summarized for the plan area do not include the FIA grid intensification plots and have not been re-measured since the mountain pine beetle outbreak. The data show that the single-storied class is the most prevalent, making up over 2/3, in part due to the high proportion of cover types that commonly grow in this structure (lodgepole pine and Douglas-fir). Two and three storied plots are rare, and the continuous class makes up 15%. The recent mountain pine beetle outbreak may have diversified structure classes in affected pine-dominated forests.

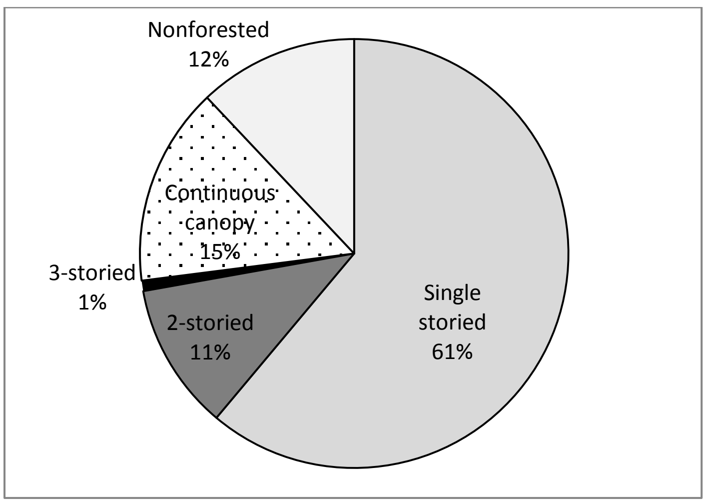

Figure 2.37 Proportion of vertical structure classes on the HLC NFs, R1 Summary Database, base FIA plots

Data also summarized for each GA; this includes FIA intensified grid plots where available, which better depict conditions that have resulted from the mountain pine beetle outbreak. The prevalence of single-storied plots holds true for all GAs. The continuous category is notably present in the Snowies. Vertical structure is not mapped.

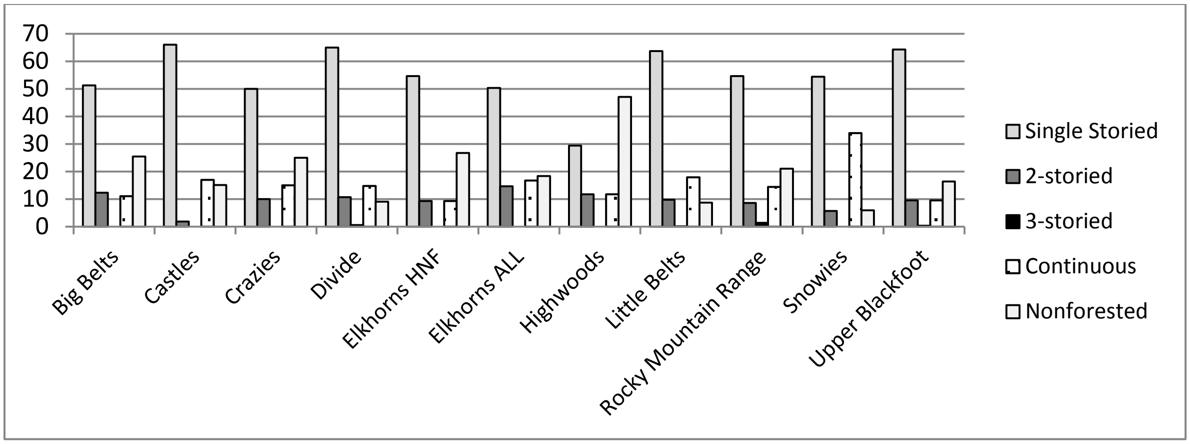

Figure 2.38 Proportion of vertical structure classes by GA.

Trend

As with the other elements of structure, vertical structure class is driven by succession, individual species traits, and disturbances. Some cover types, such as spruce/fir, naturally develop a continuous canopy structure made up of multiple layers of shade tolerant species. Other types, such as ponderosa pine, would tend to have the number of canopy layers reduced periodically by frequent natural fires, although these events would also tend to promote an uneven-aged character. Conversely, natural fire in some Douglas-fir stands would create small canopy openings where understory layers could establish; in the absence of fires, stands remain in a closed single-storied condition. Some types such as lodgepole pine tend to grow in a single-storied condition which is perpetuated by periodic stand replacing disturbances. In the absence of disturbance these forests can slowly develop shade tolerant canopy layers.

The available SIMPPLLE analysis (USDA 2003) did not estimate the vertical structure classes that were present historically. However, the increasing proportion of medium-sized, or mid-successional forest, is often associated with increasing densities and an increase in number of forest canopy layers in some forest types (USDA 2003). Therefore in some areas, such as Douglas-fir and mixed conifer forests, the continuous canopy condition may be more prevalent than it was historically when fires would have killed trees establishing in the understory. However, the converse could also be true in dry forest types like ponderosa pine, where repeated fire would have continually opened the canopy and promoted establishment of multiple canopy layers in a widely spaced distribution. In these sites, fire exclusion may have caused a closed canopy, single storied condition to develop. A high abundance of a single-storied structure is reflective of the natural condition in lodgepole pine types.

Future trends in vertical structure will be influenced by the same interrelated processes as discussed for the other elements of forest structure, including the feedbacks with ecosystem drivers and spatial heterogeneity. Warmer, drier climates will influence successional processes in complex and uncertain ways as discussed in Chapter 4, Climate Change and Baseline Assessment of Carbon Stocks.

Forest Age Class

Existing Condition

Age class can provide information regarding the seral stage and function of forests. The relationship between age and size class is imperfect at best. For example, a small or medium size lodgepole pine stand may be quite old; conversely, a large size class stand of Douglas-fir growing on a productive site is not necessarily so. Generally, in terms of “old forest habitat”, structural features such as size and density are more important than the age of the trees. However, age can be meaningful in terms of processes such as insect and disease susceptibility.

Table 2.28 Age class descriptions

Age Class	Description
<20	Dominated by trees <20 years old. For most cover types, this represents and early seral phase of stand development. Usually corresponds to the seedling/sapling tree size class.
20-99	Dominated by trees 20-99 years old. For most cover types, this represents a mid-seral phase of stand development, although some (such as lodgepole pine) would be approaching late seral. This age class usually corresponds to the small or medium tree size classes.
100-199	Dominated by trees 100-199 years old. For most cover types, this represents a late seral phase of stand development and often corresponds to medium to large size classes depending on species.
200+	Dominated by trees over 200 years old. For most cover types, this represents a late seral or possibly old growth condition. This age class is not likely to occur in some types, such as lodgepole pine. This class usually corresponds to the medium, large, or very large size class depending on species.

FIA data provides estimates of the proportions of age class on forested areas across the HLC NFs; data summarized for the plan area do not include the FIA grid intensification plots and have not been re-measured since the mountain pine beetle outbreak. The data show that the 20-99 class is the most prevalent, making up about half of the FIA plots; this corresponds to a mid-seral successional stage for most cover types. The mid to late seral class, 100-199 years old, is also very common. Together these two classes (20-199 years old) made up over 80% of the area. The young class, less than 20 years old, makes up about 11%. The oldest class, where old growth is the most likely to develop for the long-lived cover types, is relatively rare at 5%. The recent mountain pine beetle outbreak may have shifted some highly affected pine-dominated forests into younger age classes.

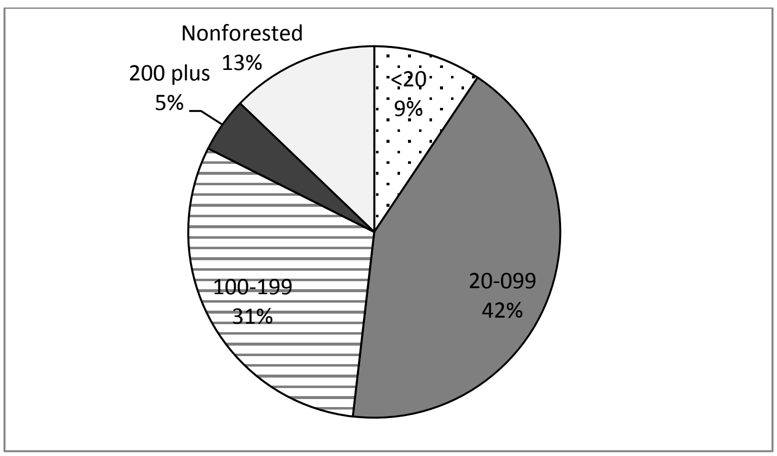

Figure 2.39 Proportion of age classes on the HLC NFs, R1 Summary Database, base FIA data

Data has also been summarized for each GA; this includes FIA intensified grid plots where available, which better depict conditions that have resulted from the mountain pine beetle outbreak. A prevalence of mid to late seral classes is demonstrated on all GAs. Young plots (<20 years old) are most common in the Elkhorns, Rocky Mountain Range, and Upper Blackfoot GAs due in part due to recent wildfires. The mountain pine beetle has caused substantial mortality of large trees, but because of its feeding preferences it leaves behind biological legacies such as small trees and other species. While it does alter structure and composition, bark beetle infestation does not necessarily cause a shift to a younger age class in a stand the way a stand-replacing fire would.

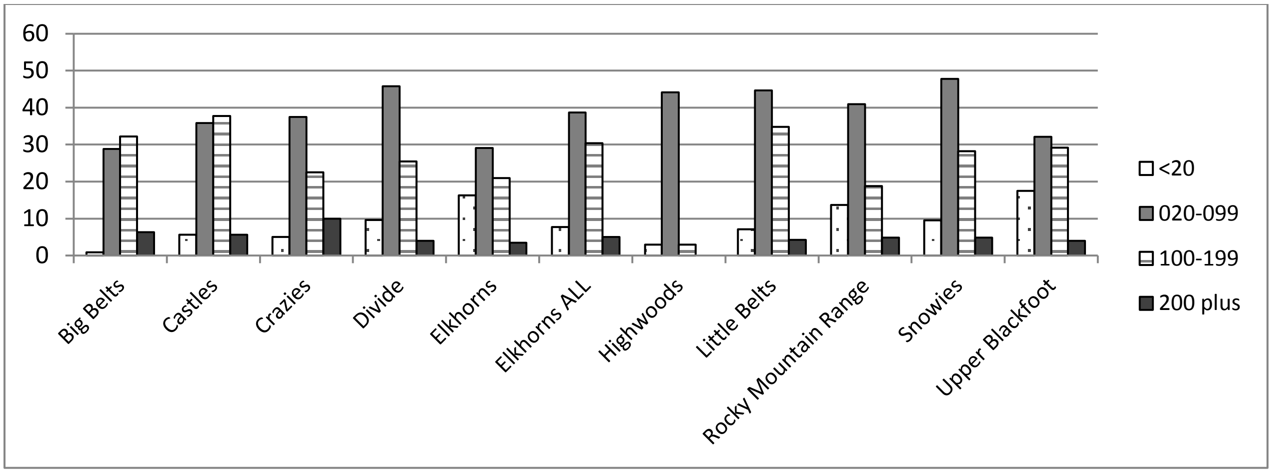

Figure 2.40 Age class by GA, R1 Summary Database, base FIA and FIA intensification plots

Age class is not mapped, although there is some general correlation between tree size classes and age. Generally, the oldest age classes occur where the largest tree sizes are mapped.

Trend

Age class is relatively homogeneous on the HLC NFs, which is a result of (and in turn influences) the ecosystem processes described in the Ecosystem Drivers section. Past and future trends are relatively analogous to those described for the size class distribution on the landscape. The age structure of the existing forests is likely more homogeneous than it was historically. The 2003 SIMPPLLE analysis (USDA 2003) did not generate estimates of the historic proportion of age classes, other than correlations that can be made related to size classes.

Connectivity and Pattern

Existing Condition

The spatial pattern of vegetation on the landscape is as a key ecosystem characteristic because it affects ecological processes, including wildlife and plant dispersal. It affects spread rate and shape, risk and intensity of such disturbance processes as fire and insect or disease activity. Connectivity of forests and ecosystems can be affected by natural landscape factors such as topography, soils, variation in precipitation, and wildfire but can also be affected by human developments and activities. It is also one of the most complex attributes of ecosystems to quantify. The ultimate goal of understanding connectivity and pattern is to better understand the appropriate mosaic of conditions that make up a resilient and functioning landscape.

Heterogeneity is the quality of consisting of dissimilar elements, as with mixed habitats or cover types occurring on a landscape (Turner et al. 2001). Heterogeneity on forest landscapes may occur as mosaics of patches generated by many events, but also may be created by single large events that occur infrequently (Kashian et al. 2005). Because landscapes are dynamic and unique there is no optimal landscape mosaic that will increase all ecosystem services; however land managers can intervene to sustain ecosystems services (Turner et al. 2012). Generally a resilient landscape is made up of a mosaic of age classes, composition, and succession stages because variability ensures that not all areas are equally susceptible to the same drivers at the same time. Spatial heterogeneity in terms of the ecosystem components described in this chapter is influenced by feedbacks with interrelated ecosystem drivers, and has implications for important ecosystem services such as reforestation, timber productivity, wildlife habitat quality, watershed health, and carbon storage (Turner et al 2012).

Connectivity and spatial pattern are also meaningful in the context of biodiversity and the genetic flow of plant material, which has implications for the adaptability of vegetation in the context of future conditions. Seed dispersal strategies, e.g. the ability of species to establish on sites after disturbance, will depend on spatial heterogeneity and the suitability of future site conditions including climate conditions and the characteristics of microsites. Genetic diversity greatly influences the adaptability of plants to changing conditions. Maintaining a diverse and robust genetic base is therefore a primary foundation of resilience. Participation of the HLC NFs in the Regional tree improvement program, which includes the collection of genetic plant materials and out-planting tests, plays an important role in understand the genetics of populations which in turn is important not only to predict the impacts of climate change on forests and rangelands, but also to evaluate management options for responding to climate change (Scott et al 2013).

Many elements of composition and structure could be assessed as a means to understand landscape heterogeneity. Those identified as key ecosystem characteristics include the following:

- *Forest openings*: Abundance, average and range of the sizes of early successional forest patches created by stand-replacing disturbance (transitional and seedling/sapling size classes).
- *Large Multi-Storied patches*: Amount and extent of 3000+acre patches of 2-3-C storied.
- *Ecosystem Connectivity*: By cover type, the average and range of connected patch sizes; patch frequency/density; and perimeter (edge).

Not all of these elements can be addressed with the data and analysis tools available at the writing of this assessment. These are addressed in brief and identified as data gaps.

Forest Openings

Openings in the forest, such as those created after a stand-replacing disturbance, are the most distinct, easily detectable structural conditions in a forested landscape. They are meaningful for habitat for 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. forest "edge"). They also represent the crucial initiation point in forest successional development, the foundation upon which rests the character and pattern of the future forest. For management purposes, it is critical to understand the size of openings expected under a natural disturbance regime. This aspect is not well understood or defined in current Forest Plan direction for maximum sizes of openings that can be created by harvest.

A robust analysis of the extent, size, and abundance of forest openings is not currently available. It is desirable to estimate these metrics for each ecosystem type on the HLC NFs as a part of the Forest Plan process. These metrics will help us understand the existing condition of forest openings and may help inform plan components. Preliminarily, VMap indicates that across the HLC NFs as a whole, there are over 3,000 patches mapped as "transitional", where forest cover has not yet reestablished following disturbance, with an average patch size of 63 acres. The largest patch is over 31,000 acres, located in a recent fire area on the Rocky Mountain Range GA and highly variable in shape. Smaller patches are generally attributable to mountain pine beetle, small patches of high severity fire or, to a lesser extent, harvest. Early successional forests which are mapped in VMap as seedling/saplings are present on over 16,000 patches across the HLC NFs, with an average size of 17 acres and a maximum size of over 22,000 acres. Please refer to map 13 in appendix A, Early Seral Forest Openings.

Large Multi-Storied Patches

Large multi-storied patches are a key ecosystem characteristic for some wildlife species. Vertical structure class provides an indication of multi-storied conditions. Currently, this attribute is not mapped. While plot data provides this information, it must undergo an analysis process to attribute spatial polygons because remote imagery cannot depict this variable. This analysis is not complete at the writing of this assessment.

Ecosystem Connectivity

The connectivity of specific ecosystems - defined by potential vegetation types, as well as combinations of cover types, size classes, and densities – is also meaningful for disturbance processes, genetic flow, and wildlife habitat. A full analysis of the connectivity of all ecosystems is not available at the writing of this assessment. A brief analysis of the connectivity of potential vegetation groups is provided in the Ecosystem Diversity: Key Characteristics by Potential Vegetation section.

Trend

The patch and pattern of vegetation present on the landscape today has been influenced by many factors including climate, disturbance regimes, and human management. Relatively little is currently known regarding the historic patch and pattern of forest openings, multi-storied patches, and ecosystem connectivity until a more detailed natural range of variability analysis can be conducted. There has been a general trend of decreasing patch size and increased landscape fragmentation compared to the historic condition in the Upper Missouri River Basin, which includes the HLC NFs plan area (USDA 2003). The potential future effects of climate change are complex and uncertain. For example, warming conditions may increase the extent and severity of natural disturbances, which may increase the patch size and connectivity of early seral forest openings and increase the amount of edge in the landscape pattern. Large continuous areas of multi-storied forests may have actually been promoted in the current condition by fire suppression. There may be consequences in terms of genetic diversity and opportunities for regeneration as a result of potentially larger, more severe disturbances. 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).

Information Needs

Incorporating a vegetation classification for non-forested habitat types in the R1 Summary Database would enhance analysis. Additional query tools in the R1 Summary Database could enhance our ability to estimate forb, grass, and shrub cover on meaningful ecosystem types to better depict the health and condition of these types.

In addition, enhanced mapping of potential vegetation types using current data for both forested and non-forested communities would be beneficial. The map utilized for this assessment is being refined to better represent the abundance and distribution of potential vegetation types. Additional data to refine our understanding of potential plant communities associated with riparian areas should also be incorporated.

A detailed natural range of variation (NRV) analysis using new data sources would provide more certainty on the historic distribution of composition, structure, and connectivity of forested and non-forested plant communities, and how conditions compare to the existing condition. A clear understanding of the historic metrics of forest openings by vegetation type or biophysical setting and GA would help inform our understanding of appropriate harvest size limits. Modeling of climate scenarios into the future would also help inform the expected trends. The development of a fully attributed spatial layer to be used for vegetation modeling, which includes associating plot data to all spatial polygons, is necessary to complete the assessment of connectivity and spatial heterogeneity, including large multi-storied patches and ecosystem connectivity. The potential for more sophisticated landscape ecology metrics should be assessed to answer the questions regarding ecosystem connectivity.

Greater knowledge of vegetation/soil relationships is needed to ensure site forest plan objectives; plan components; and project level implementation are consistent with land capability. National Cooperative Soil Surveys provide spatial data layers of soil characteristics for the entire HLC NFs, except the wilderness areas. Recent analytic methods demonstrate the relationship between specific soil characteristics and vegetation resilience or restoration opportunities. For further information see the soil section of chapter 3, Watershed, Aquatic, Soil and Air Resources.

Threatened, Endangered, Proposed, and Candidate Plant Species, and Potential Species of Conservation Concern

Introduction

Biological plant diversity is one of the cornerstones of a healthy ecosystem. When diversity is threatened or lacking, the ecosystem can lose balance. To mitigate potential loss of diversity, agencies have listed species at risk (endangered, threatened, or sensitive) to protect their viability and habitat. Monitoring of these species helps measure the extent of threats to ecosystems. This section addresses plant species considered important for their contribution to biological diversity and ecological integrity, and plants for which their long-term persistence in the plan area is at risk. For the assessment, plant species known to be native to the plan area were assessed to see if they could potentially fit into one of the categories directed and defined by the National Forest System Land Management Planning Final Rule and Record of Decision (i.e., 2012 Planning Rule) detailed in 36 Code of Federal Regulations [CFR] § 219.9 and the associated directives in FSH 1909.12.5. These categories are:

- At-risk species:
  - Federally recognized threatened, endangered, proposed, or candidate species;
  - SCC (species of conservation concern);
- Focal species; or
- Species of public interest.

Species federally listed as threatened or endangered, proposed, and candidate are listed for the HLC NFs by the United States Department of the Interior, USFWS Ecological Services, Montana Field Office (9/23/2014). Under provisions of the Endangered Species Act (ESA) of 1973, federal agencies are directed to conserve endangered and threatened species and to ensure that actions authorized, funded, or carried out by these agencies are not likely to jeopardize the continued existence of threatened or endangered species, or result in the destruction or adverse modification of their critical habitats.

Under the 2012 Planning Rule, plant species at risk in the plan area will be designated *species of conservation concern* (SCC). In addition to federally listed species, this assessment reviews plants identified as species of concern by the Montana Natural Heritage Program (MTNHP) and those of cultural significance for potential SCC designation. The Planning Rule states that a potential SCC is any species “other than federally recognized threatened, endangered, proposed, or candidate species, that is known to occur in the plan area and for which the Regional Forester has determined that the best available scientific information indicates substantial concern about the species’ capability to persist over the long-term in the plan area” (36 CFR §219.9; FSH 1909.12 Chapter 10, part 12.52). The list of SCC is identified by the Regional Forester in coordination with the supervisor HLC NFs. For the assessment, a *potential SCC* list is generated, because it can be refined to add or remove species through the plan revision process.

The MTNHP provides rankings that categorize the risks to viability associated with each species they evaluate (Table 2.27). These rankings, along with the other criteria in FSH 1909.12, Chapter 10, section 12.52 and CFR 219.9(b)(3), were used to develop the list of potential SCCs for the HLC NFs.

Table 2.29 Global and Montana state rankings

Ranking		Definition
Global	State	
G1	S1	At high risk because of extremely limited and/or rapidly declining population numbers, range and/or habitat, making it highly vulnerable to global extinction or extirpation in the state.
G2	S2	At risk because of very limited and/or potentially declining population numbers, range and/or habitat, making it vulnerable to global extinction or extirpation in the state.
G3	S3	Potentially at risk because of limited and/or declining numbers, range and/or habitat, even though it may be abundant in some areas.
G4	S4	Apparently secure, though it may be quite rare in parts of its range, and/or suspected to be declining.
G5	S5	Common, widespread, and abundant (although it may be rare in parts of its range). Not vulnerable in most of its range.

Table 2.30 Montana species of concern description

Montana Natural Heritage Program Ranking	Code	Description
Species of Concern	SOC	Native taxa at-risk due to declining population trends, threats to their habitats, restricted distribution, and/or other factors. Designation as a Montana Species of Concern or Potential Species of Concern is based on the Montana Status Rank, and is not a statutory or regulatory classification. Rather, these designations provide information that helps resource managers make proactive decisions regarding species conservation and data collection priorities. See the latest Species of Concern Reports for more detailed explanations and assessment criteria (http://fieldguide.mt.gov/).

Focal species are those whose status provides meaningful information regarding the effectiveness of the plan components in maintaining or restoring the desired ecological conditions and species diversity within the plan area. They would be selected on the basis of their functional role in ecosystems (36 CFR § 219.19). Focal species are not necessarily at-risk species or species of public interest. Focal species are not specifically identified for the Assessment but will be a key element to the forest planning process in the future.

Species of public interest (36 CFR § 219.6; FSH 1909.12, part 13.35) include one or more of the following:

- Fish, wildlife, and plant species commonly enjoyed and used by the public for hunting, fishing, trapping, gathering, observing, or sustenance, including cultural or tribal uses.
- The conditions and trends in the plan area associated with these species and their uses.
- The impacts of hunting, fishing, or plant collection on ecological integrity and species diversity.
- The contribution of the use and enjoyment of these species to social and economic sustainability.

Threatened, Endangered, Proposed, and Candidate Species: Whitebark pine

While no federally listed or proposed plant species are known to occur on the HLC NFs, there is one candidate species: whitebark pine (*Pinus albicaulis)*. Following a petition to list whitebark pine under the ESA, the U.S. Fish and Wildlife Service (USFWS) conducted a 12-month status review in 2010. The finding, published on July 19, 2011 (FR 76[138]: 42631-42654), determined that listing the species under the ESA is warranted but precluded by higher priority listing actions. As a result, whitebark pine is a candidate species and the USFWS has assigned it a listing priority number of 2, indicating the threats are imminent and of high magnitude.

Existing Condition

Whitebark pine, a native five-needled pine, is a key ecosystem component growing at the highest forested elevations in cold, windy, snowy, and generally moist climatic zones (Arno and Hoff 1989) that are difficult for plants and animals to inhabit. These areas are naturally limited in species diversity, and whitebark is an important component. Its tolerance to cold, superior hardiness on harsh microsites that exist after a fire, unique method of seed dispersal, and resistance to lower intensity fires allows it to compete in the upper subalpine zone. On productive upper subalpine sites, whitebark is the major seral species that in the absence of fire is eventually replaced by shade tolerant species, while on harsh upper subalpine forests and at treeline it can dominate as climax vegetation (Keane et al. 2012). Whitebark provides a food source and shelter to squirrels, bears and other animals, aids in the protection of soil and water quality in the sensitive high basins, acts as a "nurse tree" for other conifers, and fills a host of other roles (Tomback et al. 2001). Whitebark pine ecosystems were maintained through fire and insect regimes and regenerate best in open, sunny conditions (Tomback et al. 2001).

According to base FIA data, living whitebark pine trees are present on 12.21% of the HLC NFs, representing about 333,350 acres. It is dominant on far fewer acres; the whitebark pine cover type occurs on only 4%. This indicates that in some areas live whitebark trees are a minor component in areas dominated by other species such as subalpine fir. By GA, living whitebark presence varies from 0 to over 35%. The GAs with the highest proportion of living whitebark trees are the Crazies, Castles, Elkhorns, and Rocky Mountain Range. Base FIA is used for the estimates across the HLC NFs; these plots do not depict the potential changes in areas recently impacted by the mountain pine beetle outbreak which has killed some whitebark pine.

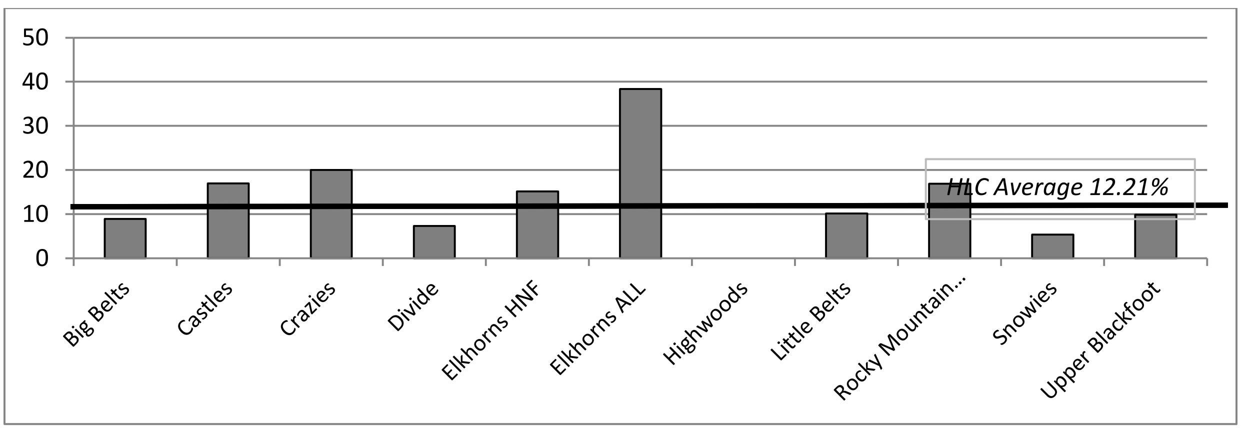

Figure 2.41 Percent of plots with live whitebark pine present, all size classes, Base FIA Data

Plot data is also used to estimate acres with live whitebark pine by GA; newly measured FIA intensified grid data is utilized for GAs where it is available. This data generally reflects conditions present after the recent mountain pine beetle outbreak. While the Elkhorns have a large proportion of whitebark present relative to the size of the landscape, larger GAs such as the Rocky Mountain Range and Little Belts have more acres with whitebark pine. In Figure 2.42, the estimates of acres with living whitebark trees are shown by two size classes: less than or greater than five inches in diameter. Plots can contain both small and large trees. In most GAs, small living whitebark trees are more prevalent than larger trees. This is most evident in the Little Belts, where nearly half of the plots with whitebark contain only small trees, and may indicate that there are limited mature seed trees. This may be in part due to younger trees being less impacted by blister rust, but also reflect areas regenerating after wildfires or stands where the larger trees have been killed by mountain pine beetle. In other GAs, such as the Rocky Mountain Range, the larger trees are more prevalent which may indicate a lack of suitable seedbeds for younger trees to establish.

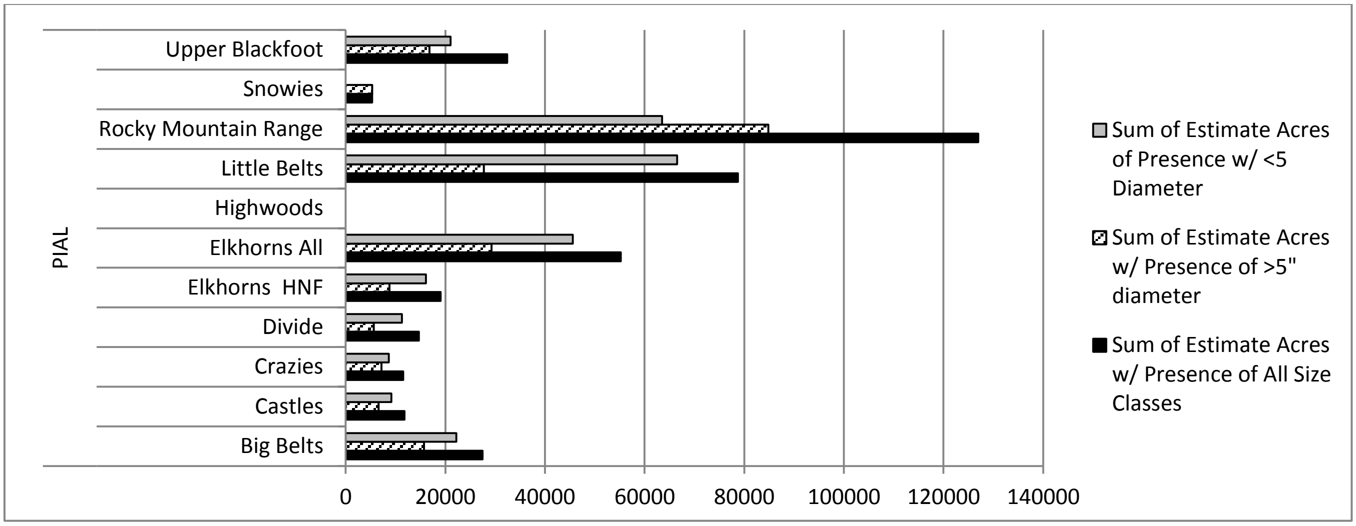

Figure 2.42 Estimated acres by GA with live whitebark pine present, by size class – R1 Summary Database

Several interrelated threats to whitebark were identified in the listing finding (USDI 2011) which raise concerns about the long-term viability of whitebark ecosystems; all of these factors are in play on the HLC NFs.

- *Fire Suppression*: After a century of suppression, many whitebark stands are experiencing a species conversion to shade-tolerant trees, and a lack of suitable seedbeds for regeneration. The balance of a natural fire regime with related vegetative successive processes has been disrupted, and as a result whitebark pine has lost its competitive advantage (USDI 2011).
- *Climate Change*: In a warmer climate, the species' fundamental habitat may shift to cooler sites at higher elevations and latitudes. Recent studies indicate that whitebark pine is one of the most vulnerable tree species in the northern Rocky Mountains to climate change (Hansen and Phillips 2015). Climate suitability is projected to decline dramatically by the end of the century and the adaptive capacity of whitebark pine is thought to be relatively low because dispersal is fairly limited, it is often outcompeted by other subalpine conifers, and it is highly susceptible to mountain pine beetle and blister rust (Hansen and Phillips 2015).
- *White Pine Blister Rust*: White pine blister rust (*Cronartium ribicola*) is an exotic fungal disease against which whitebark has limited resistance. Since blister rust was introduced to North America in 1910, it has spread through the range of five-needled pines. As this disease has moved into fragile, high-elevation ecosystems, normal successional pathways have been altered. Because the disease is exotic, these trees have limited defenses. Blister rust typically infects nearly all individuals of the host species, causing branch and stem cankers in trees that eventually kill most trees.
- *Mountain Pine Beetle*: 5-needled pines are susceptible to this aggressive bark beetle. In densely stocked stands, whitebark is more likely to be attacked because of stress from competition. Mountain pine beetle accelerates the loss of key mature cone-bearing trees.

Trend

Based on a preponderance of data, the USFWS concluded that there is an ongoing pattern of substantial decline of whitebark pine on the majority of its range (USDA 2011a). They predict whitebark pine forests may become extirpated and its ecosystem functions rendered obsolete in the foreseeable future. Analysis at the regional scale indicates that the abundance of live whitebark pine has decreased from 18.3% of periodic FIA plots containing at least one live whitebark pine tree, to 15.8% in the annualized inventory (USDA 2010c). A stand-level study conducted on the HLC NFs found mortality of larger whitebark pine from mountain pine beetle to be up to 95% (Sturdevant and Kegley 2006). Further, local surveys conducted in 2005 on four whitebark areas found that percent mortality from blister rust up to 95%, and that rust was present in 29-100% of the stands surveyed (USDA

2012a). The loss of whitebark pine has altered the structure, wildlife habitat values, and long-term stability of these high elevation ecosystems. The Big Belts GA appears to be one of the heaviest infection areas of white pine blister rust on the east side of Region 1 (USDA 2003).

The loss of whitebark has 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, such as grizzly bear food resources. The decline in whitebark pine is expected to continue into the future. The percentage of whitebark that are resistant may increase slowly through the process of natural selection, if five-needled pines are given a chance to regenerate (Tomback et al. 2001). Principles of whitebark pine restoration (Keane et al. 2012) may include:

- Promoting rust resistance, by a) supporting selective breeding programs to develop and deploy blister-rust resistant whitebark; b) facilitating and accelerating natural selection for rust resistant trees by reducing competition, providing openings for natural seed dispersal and seedling survival; and c) planting seedlings from trees known to have some level of resistance.
- Conserving genetic diversity, by collecting seeds and planting genetically diverse seedlings.
- Saving seed sources, by protecting mature seed-producing resistant whitebark pine trees so that apparent rust-resistant seeds can be harvested in the future; and
- Employing restoration treatments, including limiting the spread of blister rust, using fire to encourage regeneration, implementing silvicultural cuttings to reduce competition and increase vigor and reduce likelihood of MPB attacks, planting rust-resistant seedlings to accelerate the effects of selection, and promoting natural regeneration and diverse age class structures to maintain ecosystem function and reduce landscape level beetle hazard, and to provide large populations for selection for rust resistance.

The current forest plans do not contain specific standards or guidelines related to maintaining whitebark pine.

Information Needs

Improved mapping of the current condition for whitebark pine is needed to focus restoration efforts. Additionally, an understanding of how downscaled climate predictions may affect whitebark pine is needed.

Potential Plant Species of Conservation Concern

Using Forest Service Natural Resource Manager (NRM), MT Natural Heritage Program (MTNHP) databases, and the current Regional Forester Sensitive Species list, a master list of potentially at-risk plant species known to occur on the HLC NFs was compiled for this assessment. The 2012 forest planning rule provides direction for determining potential SCC. The list of potential SCCs must include the following (FSH 1909.12 Section 12.52):

- Species with the status ranks of G/T 1-2 on the NatureServe ranking system;
- Species that have been petitioned for federal listing and for which a positive “90-day finding” has been made; and
- Species that are federally delisted within the past 5 years, and other delisted species for which regulatory agency monitoring is still considered necessary.

When developing the list of potential SCCs, consideration must also be given to (FSH 1909.12 Section 12.52):

- Species with status ranks of G-T 3 or S 1-2 on the NatureServe ranking system;
- Species listed as threatened or endangered by the relevant States, federally recognized Tribes, or Alaska Native Corporations;
- Species identified on other relevant Federal, State, federally recognized Tribes, or Alaska Native Corporations lists as being a high priority for conservation;

- Species identified as SCCs in adjoining NFS plan areas (including plan areas across regional boundaries);
- Species that have been petitioned for Federal listing and for which a positive "90-day finding" has been made;
- Species for which the best available scientific information indicates there is local conservation concern about the species' capability to persist over the long-term in the plan area due to:
  1. Significant threats to populations or habitat from stressors on and off the plan area.
  2. Declining trends in populations or habitat.
  3. Restricted ranges (narrow endemics, disjunct populations, or species at the edge of their range).
  4. Low population numbers or restricted habitat within the plan area.

All potential SCCs must meet the following mandatory requirement (FSH 1909.12 Section 12.52):

> *The best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area. Information may come from a variety of population sources, including Federal and State agencies, literature, local information on occurrence and population status, subbasin analyses, broad-scale assessments, and information available from local species experts and other organizations.*

Since there is little information published about many at-risk plant species and their viability, biology, habitat, etc., the majority of species statuses are derived from expert opinion and/or panel consensus, specifically at bi-annual meetings held by the Montana Native Plant Society in conjunction with the Montana Natural Heritage Program. Additional considerations for determining potential plant SCC's are found in FSH 1909.12 Section 12.53, including but not limited to taxonomy, distribution, abundance, demographics, diversity, habitat requirements and condition, ecological function, important biological interactions, threats or limiting factors to persistence, influence of uncharacteristic natural events, effects of climate change and susceptibility to stressors caused by human activities, and Endangered Species Act information.

The Forest Service NRM TESP and the MTNHP databases were both used to determine which species to consider and their locations in relation to the HLC NFs. NatureServe and the MTNHP's Montana Field Guide were also used to reference global and state ranks. State ranks are determined at bi-annual meetings held by the Montana Native Plant Society and the MTNHP. Professional botanists from around the state meet to discuss plant species, viability and habitat, as well as appropriate state ranks. The results are posted on the MTNHP's website via the Plant Species of Concern report. Few plant species have published information such as status reports and conservation strategies. Federally listed species have published information (e.g., population trends, viability, threats, monitoring data, and conservation strategies), which is required for listing. State listed species occasionally have such information, but listing is predominantly based on expert opinion and panel consensus.

Existing Condition

All potential SCC species were assessed by species guild groupings. Table 2.31 lists plant species at risk, including federally recognized species and potential SCC located on the HLC NFs and summarizes the information that is known about them. Existing conditions and trend information for potential SCC is described in more detail in sections following the sections by species guild. The potential SCC list will be further developed and refined during the Forest Plan revision process.

Table 2.31 Plant species at risk

Species Name	Federal Status	State Status	Global/ State Rank	Habitat	Guild(s)	Most Recent Observation	Conservation Concerns/ Threats	Rationale for Inclusion
Federally Recognized Species								
Gymnosperms (Conifers)								
Pinus albicaulis (whitebark pine)	Candidate	SOC	G3G4/S3	Tolerates poor soils, steep slopes, windy exposures, and tree-line environments; subalpine to alpine.	Rocky Habitats	2014	Highly susceptible to mountain pine beetle outbreaks and white pine blister rust.	G3 ranking
Potential Species of Conservation Concern								
Ferns and Fern Allies								
Botrychium ascendens (upward-lobed moonwort)	FS Sensitive	SOC	G3/S3	Meadows; montane.	Grasslands, Mesic Meadows, Riparian	1948	Vulnerable to activities such as weed invasion, weed spraying and road maintenance.	G3 ranking
Botrychium paradoxum (peculiar moonwort)	FS Sensitive	SOC	G3G4/S3	Grasslands, meadows, and openings in wet, low-elevation forest; montane.	Grasslands, Mesic Meadows, Riparian	1988	Vulnerable to livestock grazing, weed invasion and recreational uses.	G3 ranking
Gymnosperms (Conifers)								
Pinus flexilis (limber pine)	-	-	G4/S5	Rocky slopes and ridges; montane, occasionally subalpine, rarely plains and valleys.	Rocky Habitats, Xeric Ecotone	2014	Highly susceptible to mountain pine beetle outbreaks and white pine blister rust.	Local conservation concern. Significant threats to populations and habitats on and off the plan area and declining trends in population and habitat.
Angiosperms (Flowering Plants)								
Adoxa moschatellina (muskroot)	FS Sensitive	SOC	G5/S3	Vernally moist places in the mountains at the bottom of undisturbed, open rock slides that have cold air drainage.	Rocky Habitats; Moist Forest	2002	Road and trail development may potentially impact populations.	Local conservation concern. Significant threats to populations and habitats on and off the plan area, a restricted range, and low populations and restricted habitat in the plan area.
Agoseris lackschewitzii (pink agoseris)	-	PSOC	G4/S3S4	Subalpine wet meadows where soil is saturated throughout the	Mesic Meadows; Rocky Habitats	1996	Regional endemic. Known from southwest MT, east-central ID, and northern WY.	Local conservation concern. Is a narrow endemic and has low populations and restricted habitat in the plan area.

Species Name	Federal Status	State Status	Global/ State Rank	Habitat	Guild(s)	Most Recent Observation	Conservation Concerns/ Threats	Rationale for Inclusion
				growing season.				
Amerorchis rotundifolia (round-leaved orchis)	FS Sensitive	SOC	G5/S3	Spruce forests around seeps or along streams, often in soil derived from limestone; montane.	Moist Forest, Riparian, Wetlands	1993	Information on threats faced by the species, as well as trend data is lacking.	Species of local conservation concern. Low populations and restricted habitat in plan area.
Aquilegia brevistyla (short-styled columbine)	FS Sensitive	SOC	G5/S2S3	Open forest and stream banks; montane.	Moist Forest, Riparian	2013	MT populations are highly disjunct form the main portion of the species' range in Canada and AK.	S2 ranking
Aquilegia jonesii (Jones' columbine)	-	PSOC	G4/S3S4	Stony, calcareous soil of ridges, outcrops, talus slopes, often in cushion plant communities; exposed montane sites to occasionally alpine.	Rocky Habitats	1991	Endemic to MT and WY. Vulnerable to grazing and other disturbances, and predicted higher temperatures and altered precipitation patterns from global warming.	Local conservation concern. Significant threats to populations and habitats on and off the plan area, is a narrow endemic, and low populations and restricted habitat in plan area.
Astragalus convallarius (lesser rushy milkvetch)	FS Sensitive	SOC	G5/S3	Grasslands and open ponderosa pine woodlands in the valleys and foothills; valleys to montane.	Grasslands, Mesic Meadows	2002	Vulnerable to development, grazing, and noxious weed invasion.	Local conservation concern. Significant threats to populations and habitats on and off the plan area, shows declining trends in habitat, a restricted range, and low populations and restricted habitat in plan area.
Astragalus lackschewitzii (Lackschewitz's milkvetch)	FS Sensitive	SOC	G2G3/S2 S3	Open, gravelly and rocky slopes and ridgetops with calcareous soil and talus; subalpine to alpine.	Rocky Habitats	2011	MT endemic restricted to high elevation, gravelly and rocky slopes and ridges.	G2 and S2 ranking
Atriplex truncata (wedge-leaf saltbush)	-	SOC	G5/S3	Alkaline soil of steppe, moist meadows; valleys to montane.	Mesic Meadows, Shrub-Steppe	2000	Known from two extant occurrences in MT.	Species of local conservation concern. Has a restricted range and has low populations and restricted habitat in plan area.
Betula pumila var. *glandulifera* (bog birch)	-	-	G5/SNR	Wet, organic soils of swamps, fens; valleys to lower montane.	Wetlands	2014	Scattered throughout the western third of MT and known from two locations in the state.	Species of local conservation concern. Has a restricted range and has low populations and restricted habitat in plan area.

Species Name	Federal Status	State Status	Global/ State Rank	Habitat	Guild(s)	Most Recent Observation	Conservation Concerns/ Threats	Rationale for Inclusion
Cardamine rupicola (cliff toothwort)	-	SOC	G3/S3	Limestone talus; upper subalpine to alpine.	Rocky Habitats	1979	MT endemic known from three populations.	G3 ranking
Carex crawei (Crawe's sedge)	FS Sensitive	SOC	G5/S2S3	Wet, gravelly or sandy soil along streams or pond margins. Occurring in valleys and montane foothills, especially on calcareous parent material.	Riparian, Wetlands	1997	Rare in MT. Vulnerable to alterations in natural disturbance regimes or hydrology as well as developments, such as road construction.	S2 ranking
Carex incurviformis (coastal sand sedge)	-	SOC	G4G5/S2 ?	Wet turf often along small streams; alpine.	Riparian, Wetlands	1995		S2 ranking
Cirsium longistylum (longstyle thistle)	-	SOC	G2G3/S2 S3	Meadows, moist forest openings, roadsides; upper montane to lower subalpine.	Mesic Meadows, Moist Forest	2004	Threats posed by invasive weeds and an introduced bio-control agent provide reason for concern.	G2 and S2 ranking
Cypripedium parviflorum (small yellow lady's-slipper)	FS Sensitive	PSOC	G5/S3S4	Moist to wet, often calcareous meadows, fens; plains, valleys, montane.	Mesic Meadows, Wetlands, Riparian	1993	Vulnerable to a variety of land uses and activities, including development, livestock grazing and timber harvesting.	Species of local conservation concern. Significant threats to populations and habitats on and off the plan area and has low populations and restricted habitat in plan area.
Cypripedium passerinum (sparrowegg lady's slipper)	FS Sensitive	SOC	G4G5/S2 S3	Wet, calcareous, organic soil of confierous forests, seeps, often beneath spruce at the forest-fen ecotone; montane.	Mesic Meadows, Riparian, Wetlands	2008	Threats posed by invasive weeds and the introduced biocontrol agent do provide reason for concern.	S2 ranking
Delphinium bicolor subsp. *calcicola* (limestone larkspur)	-	PSOC	G4G5T3 T4/S3S4	Shortgrass prairie and grass-sagebrush communities on limestone-derived soils, usually with coarse fragments at the surface, or on	Grasslands, Shrub-Steppe	1992	Endemic to shaley, calcareous soils in the montane zone of southwest and south-central MT.	T3 ranking

Species Name	Federal Status	State Status	Global/ State Rank	Habitat	Guild(s)	Most Recent Observation	Conservation Concerns/ Threats	Rationale for Inclusion
				limestone outcrops.				
Draba densifolia (denseleaf draba)	-	SOC	G5/S2	Gravelly soil of exposed slopes, ridges; montane to alpine.	Rocky Habitats	2002	Livestock grazing, invasive weeds and off-road ATV use impact some populations.	S2 ranking
Drosera anglica (English sundew)	FS Sensitive	SOC	G5/S3	Occurrence restricted to Sphagnum fens.	Wetlands	2007	Vulnerable to ski area expansion and fire. Plants are also sensitive to and negatively impacted by trampling of peat mats on which the species grow.	Species of local conservation concern. Significant threats to populations and habitats on and off the plan area, shows declining trends in habitat, and has restricted habitat in plan area.
Drosera linearis (slenderleaf sundew)	FS Sensitive	SOC	G4/S2	Occurrence restricted to Sphagnum fens.	Wetlands	2007	Only known from four populations in Montana.	S2 ranking
Eleocharis rostellata (beaked spikerush)	FS Sensitive	SOC	G5/S3	Spring-fed, marly marshes, calcareous fens; valleys to montane.	Wetlands	1976	Vulnerable to hydrologic alteration and development.	Species of local conservation concern. Significant threats to populations and habitats on and off the plan area, shows declining trends in habitat, and has restricted habitat in plan area.
Epipactis gigantea (giant helleborine)	FS Sensitive	SOC	G4/S2S3	Stream banks, lake margins, fens with springs and seeps, often near thermal waters.	Riparian, Wetlands	1991	Vulnerable to hydrologic changes and development.	S2 ranking
Erigeron lackschewitzii (Lackschewitz's fleabane)	FS Sensitive	SOC	G3/S3	Open, gravelly, calcareous soil and talus on ridgetops; subalpine to alpine.	Rocky Habitats	2001	Endemic to Montana and adjacent Alberta.	G3 ranking
Erigeron linearis (desert yellow fleabane)	FS Sensitive	SOC	G5/S2	Dry, often rocky soil from foothills up to moderate elevations, frequently with sagebrush.	Grasslands, Moist Forest, Rocky Habitats, Shrub-Steppe	1998	The occupied habitats and populations are susceptible to negative impacts from invasive weeds.	S2 ranking

Species Name	Federal Status	State Status	Global/ State Rank	Habitat	Guild(s)	Most Recent Observation	Conservation Concerns/ Threats	Rationale for Inclusion
Gentianopsis macounii (Macoun's fringed gentian)	FS Sensitive	SOC	G5/S2	Wet, organic soil of calcareous fens or wet meadows with standing water in valleys and foothills; fens.	Wetlands	1994	Rare in MT.	S2 ranking
Goodyera repens (lesser rattlesnake plantain)	FS Sensitive	SOC	G5/S3	North-facing, mossy forested slopes; montane.	Moist Forest	2014	Occurrences are vulnerable to disturbances that open or reduce the canopy such as timber harvesting and fire.	Species of local conservation concern. Significant threats to populations and habitats on and off the plan area, shows declining trends in habitat, has a disjunct range, and has low populations and restricted habitat in plan area.
Gratiola ebracteata (bractless hedgehyssop)	-	SOC	G4/S2	Drying mud along ponds, streams, and rivers.	Wetlands, Riparian	1986	Rare and peripheral in MT.	S2 ranking
Juncus hallii (Hall's rush)	FS Sensitive	-	G4G5/S4	Moist grasslands and sedge meadows from montane to alpine zones. Flats or benches on gentle mid-to-upper slopes. Does not tolerate shade of other plants.	Grasslands, Mesic Meadows	2012		Species of local conservation concern. Has a disjunct range, and has low populations and restricted habitat in plan area.
Kelseys uniflora (One-flower kelseya)	-	-	G5/S4	Crevices and vertical limestone cliffs	Rocky Habitats	2014	Endemic to MT.	Local conservation concern. Is a narrow endemic and has restricted habitat in the plan area.
Kobresia simpliciuscula (simple kobresia)	FS Sensitive	SOC	G5/S3	Montane fens to moist tundra; montane to alpine.	Rocky Habitats, Wetlands	2004	Rare in MT.	Local conservation concern. Has a restricted range, and low populations and restricted habitat in plan area.
Lesquerella klausii (Rogers Pass bladderpod)	-	SOC	G3/S3	Open shale slopes and gravelly areas, typically in bunchgrass communities; montane to	Rocky Habitats	2009	Endemic to Broadwater, Lewis and Clark, and Meagher Counties.	G3 ranking

Species Name	Federal Status	State Status	Global/ State Rank	Habitat	Guild(s)	Most Recent Observation	Conservation Concerns/ Threats	Rationale for Inclusion
				subalpine.				
Leymus innovatus (downy ryegrass)	FS Sensitive	SOC	G5/S2	Moist meadows, forest margins and openings along rivers and streams; valleys to lower montane.	Mesic Meadows, Moist Forest, Riparian	1995	Rare in MT, where it is currently known from a few scattered sites east of the Divide.	S2 ranking
Neotorularia humilis (low northern rockress)	FS Sensitive	SOC	G5/S2	Sparsely vegetated, vernally moist, calcareous soil in alpine zones and similar sites with sparse vegetation cover.	Mesic Meadows, Rocky Habitats	2011	Known from three locations in the state, including one site in which only one plant was observed. The second population occurs in an area with historical mining activity and may have been detrimentally impacted.	S2 ranking
Oxytropis podocarpa (stalkpod locoweed)	FS Sensitive	SOC	G4/S1	Scree; white dryas alpine plant community.	Rocky Habitats	1989	Rare in MT.	S1 ranking
Phlox albomarginata (whitemargin phlox)	-	-	G4/S4	Stony, calcareous soil of grasslands, rock outcrops; valleys to (rarely) subalpine.	Rocky Habitats	2014	Endemic to southwest MT and adjacent ID. The type locality is near Helena.	Species of local conservation concern. Low populations and restricted habitat in the plan area.
Phlox missoulensis (Missoula phlox)	FS Sensitive	SOC	G3/S3	Open, exposed, limestone-derived slopes in foothills to exposed, windswept ridges in subalpine zones.	Grasslands, Rocky Habitats	2014	State endemic. Some populations threatened by noxious weeds, recreational use, and development.	G3 ranking
Physaria saximontana var. *dentata* (rocky mountain twinpod)	-	SOC	G3T3/S3	Typically found in limestone-derived talus, fellfields, and gravelly slopes at moderate to high elevations.	Rocky Habitats	2011	State endemic.	G3 ranking

Species Name	Federal Status	State Status	Global/ State Rank	Habitat	Guild(s)	Most Recent Observation	Conservation Concerns/ Threats	Rationale for Inclusion
Polygonum douglasii subsp. *austiniae* (Austin's knotweed)	FS Sensitive	PSOC	G4/S3S4	Open, gravelly, sparsely-vegetated (mostly barren or easily eroded) slopes with shale-derived soils. Associated with ponderosa pine and bluebunch wheatgrass habitat types with little vegetative cover.	Rocky Habitats	2013	Sparsely distributed in mountainous areas of Montana. Some sites, along forest roads, are susceptible to weed invasion and other disturbances.	Species of local conservation concern. Shows declining trends in population and habitat, and has low populations and restricted habitat in the plan area.
Potamogeton obtusifolius (bluntleaf pondweed)	FS Sensitive	SOC	G5/S3	Shallow water of lakes, ponds, and sloughs and slow moving (lotic) streams in the valley, foothill, and montane zones.	Wetlands, Riparian		Vulnerable to impacts associated with development, recreation and increased sediment and nutrient loads.	Species of local conservation concern. Significant threats to populations on and off the plan area from stressors including responses to management, low populations and restricted habitat in the plan area.
Potentilla nivea var. *pentaphylla* (fiveleaf cinquefoil)	FS Sensitive	SOC	G5T4/S3	Dry, shallow, gravelly soil or talus and scree of exposed ridges, slopes, and summits; montane to alpine.	Rocky Habitats		Rare in MT.	Species of local conservation concern. Low populations and restricted habitat in the plan area.
Ranunculus pedatifidus (northern buttercup)	FS Sensitive	SOC	G5/S3	Moist meadows and open woodlands; montane to alpine.	Mesic Meadows, Moist Forest	2003	Rare in MT.	Species of local conservation concern. Significant threats to populations on and off the plan area, low populations and restricted habitat in the plan area.
Saussurea densa (dwarf sawwort)	-	SOC	G4/S2S3	Calcareous soil of talus slopes and rocky, open slopes; alpine.	Rocky Habitats	1997	Known from a handfull of small occurrences in MT. Limited data are available for most occurrences leading to the uncertainty in the species' rank.	S2 ranking
Schoenoplectus subterminalis (water bulrush)	FS Sensitive	SOC	G4G5/S3	Open water and boggy margins of ponds, lakes, and sloughs at 0.1-3 m depth; valleys,	Riparian, Wetlands	2007	Vulnerable to changes in water levels or increases in nutrient and sediment loads associated with development, agriculture or adjacent timber harvesting.	Species of local conservation concern. Significant threats to populations and habitats on and off the plan area, and has low populations and restricted

Species Name	Federal Status	State Status	Global/ State Rank	Habitat	Guild(s)	Most Recent Observation	Conservation Concerns/ Threats	Rationale for Inclusion
				foothills, and montane.				habitat in the plan area.
Sphenopholis intermedia (slender wedgegrass)	-	PSOC	G5/S3S4	Wet site inhabiting, often in disturbance-prone settings.	Riparian, Wetlands	2009	Rare in MT.	Species of local conservation concern. Restricted range, low populations and restricted habitat in the plan area.
Bryophytes								
Scorpidium scorpioides (scorpidium moss)	FS Sensitive	SOC	G4G5/S2	Wet soil in calcareous seeps and fens.	Wetlands	1993		S2 ranking
Sphagnum fimbriatum (sphagnum)	-	SOC	G5/S1		Wetlands	1987		S1 ranking
Lichens								
Solorina spongiosa (chocolate chip lichen)	-	SOC	G4G5/S1 S2	In moist moss mats on soil, adjacent to springs, seeps, waterfalls, and creeks; subalpine to alpine.	Wetlands, Riparian	1975	Known from a few locations in western and central portions of Montana.	S1 ranking

Species Guilds

At-risk species were grouped into species guilds, based on similar ecological conditions and habitat needs, for the purpose of identifying and evaluating relevant information about them. These groupings were made based on the ecological conditions necessary to maintain or, in the case of federally listed threatened or endangered species, recover each group member (FSH 1909.12 Section 12.54). Plant species at-risk found on the HLC NFs were placed in one or more of the following guilds:

- Grasslands
- Mesic meadows
- Moist forests
- Riparian
- Rocky habitats
- Shrub-steppe
- Wetlands
- Xeric ecotone

Grasslands

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. Grasslands are usually forb species rich and commonly include buckwheat, phlox, silky lupine, yarrow, *Penstemon*, and sticky geranium, among others. Species richness is generally relatively high but may vary by moisture regime. Various shrub species may occur with low cover, and include shrubby cinquefoil, bearberry, Woods' rose, snowberry, and horizontal and common juniper. Scattered pockets of ponderosa pine, limber pine, and Rocky Mountain juniper occur on shallow, skeletal soils or resistant bedrock. Slope and moisture regime divide grasslands into two general types within the plan area. The grasslands on the moister north and east facing slopes, or at higher elevations, are dominated by Idaho fescue and rough fescue. The grasslands on drier sites, (e.g., lower elevation and/or solar loaded southwest facing slopes) are dominated by Idaho fescue and bluebunch wheatgrass. Grasslands range in size from small patches to large open parks, from montane to foothill zones.

Based on existing vegetation (VMap), nearly 350,000 acres across the HLC NFs are dominated by dry or bunchgrass grasslands. Grasslands are present on all GAs, with the most acres occurring on the Big Belts and Little Belts (over 80,000 acres each). Habitat type groups represent the climax vegetation of a site. Grassland habitat type groups (bluebunch wheatgrass, western wheatgrass, and fescue habitat types) are mapped on over 338,000 acres on the HLC NFs. This is similar to, but slightly less than, where grasslands currently dominate because in some areas dominated by grass, other vegetation (shrubs or trees) may be the climax type. The Big Belts and Little Belts GAs contain the most acres of potential grassland types. Proportionate to total GA area, the range of grassland types varies from over 30% on the Big Belts to less than 5% in the Snowies.

Plant species at risk associated with grassland habitats include:

- *Botrychium ascendens* (upward-lobed moonwort),
- *Botrychium paradoxum* (peculiar moonwort),
- *Astragalus convallarius* (lesser rushy milkvetch),
- *Delphinium bicolor subsp. calcicola* (limestone larkspur),
- *Erigeron linearis* (desert yellow fleabane),

- *Juncus hallii* (Hall's rush), and
- *Phlox missoulensis* (Missoula phlox)

Threats to grasslands include fire suppression, agricultural conversion, heavy grazing, noxious species invasion, tree encroachment, and human development.

Mesic Meadows

Mesic meadow habitats occur at lower montane to subalpine elevations where soils, snow deposition, or windy conditions limit tree growth. Meadow habitats are generally moist, sometimes seasonally so and may dry up late in the summer. Meadows occur in mosaics with shrublands or forests, or are adjacent to alpine communities across the plan area. They are generally dominated by perennial graminoids and mesic forbs. Scattered shrubs or trees may be present, but are not abundant. These meadows are limited on the landscape and occupy fringe habitats adjacent to wetter meadows or forest swales.

This guild is not well represented in vegetation mapping of potential or existing vegetation because they are small inclusions in forested or shrublands. They are typically drier than riparian/wetland meadows which have seasonally high water tables. Mesic meadows may have a high water table early in the growing season, but this will dry out sooner and thus has species like Idaho fescue, *Trisetum*, and mountain brome along with tufted hairgrass. They may occur adjacent to sparse, high elevation rocky sites.

The following at-risk plant species occupy meadows:

- *Botrychium ascendens* (upward-lobed moonwort),
- *Botrychium paradoxum* (peculiar moonwort),
- *Astragalus convallarius* (lesser rushy milkvetch),
- *Delphinium bicolor subsp. calcicola* (limestone larkspur),
- *Erigeron linearis* (desert yellow fleabane),
- *Juncus hallii* (Hall's rush), and
- *Phlox missoulensis* (Missoula phlox)

Threats to meadows include heavy grazing, off-road vehicle use, hydrologic modifications, and potentially a reduction in snowpack resulting from climate change.

Moist Forest

Moist forest is typified by shady conditions and high levels of moisture. This includes north and some east facing slopes as well as mesic to wet microsites which are influenced by cool air pockets or areas with considerable soil moisture throughout the growing season. Dominant tree species include Engelmann spruce, subalpine fir, and Douglas-fir. The shrub layer may be represented by Sitka alder, mountain maple, various huckleberry species, gooseberry, and/or thimbleberry. The herbaceous understory is often diverse and consists of mesic forbs, graminoids, and in the wetter sites, ferns and fern allies. Moss cover is often high. Moist forest habitats occur within a matrix of drier spruce-fir or lodgepole pine forest habitats across the plan area.

This guild is primarily associated with the spruce/fir forested cover type. Based on FIA plots, about 15% of the HLC NFs administrative area is dominated by the spruce/fir cover type (over 420,000 acres). Not all of these areas contain the plants of interest in this SCC guild, but represent the area where potential exists. This cover type is present on all GAs, with the most acres occurring on the Rocky Mountain Range GA (over 250,000 acres). This guild would be most likely to occur in the forested cool moist and cool wet potential vegetation groups. Together these types represent about 18% of the HLC NFs, over 545,000 acres. This is similar to, but greater than, where spruce/fir dominates because other species may currently dominate on some of these types. The Rocky Mountain Range, Little Belts, and Upper Blackfoot GAs contain the most acres of the cool moist and cool wet habitat type groups. Proportionate to GA area, these types cover a maximum of 30% on Rocky Mountain Range and Snowies GAs to a minimum of less than 3% in the Castles.

At-risk plant species associated with moist forest include:

- *Amerorchis rotundifolia* (round-leaved orchis),
- *Aquilegia brevistyla* (short-styled columbine),
- *Cirsium longistylum* (longstyle thistle),
- *Leymus innovates* (downy ryegrass),
- *Erigeron linearis* (desert yellow fleabane),
- *Goodyera repens* (lesser rattlesnake plantain), and
- *Ranunculus pedatifidus* (northern buttercup)

Moist forests can be vulnerable to forest management, though the impact may vary by species. As a result of fire regimes that are modified from presettlement times, the resulting homogeneous forest structure places all of these species at risk for stand replacing fire.

Riparian

Riparian systems occur along creeks and rivers and occupy floodplains, stream banks, islands in rivers, narrow bands in steep channels, and backwater channels. This system is dependent on a hydrologic regime that has annual to episodic flooding. It is often comprised of a mosaic of communities dominated by trees but also includes a diverse shrub and herbaceous component. The key indicator species is black cottonwood, although other dominant tree species may include narrowleaf cottonwood, Engelmann spruce, and on drier sites, Douglas- fir, and Rocky mountain juniper. Dominant shrubs may include several species of willow, mountain alder, river birch, dogwood, hawthorn, and on drier sites or the dry fringe, chokecherry, rose, silver buffaloberry, Rocky Mountain maple and/or snowberry.

Multiple data and mapping sources exist to characterize areas where the riparian plant guild may occur. The classifications presented in the Potential Vegetation Types and Vegetation Composition sections present categories that represent riparian areas based on remote sensing of vegetation. Further, the National Wetlands Inventory (NWI) mapping information, refined by the Montana Heritage Program, is also incorporated in the HLC NFs vegetation layer which utilized information such as soils, topography, and hydrologic features to map riparian and wetland areas.

The riparian/wetland habitat type group is mapped (VMap) on just over 20,000 acres on the HLC NFs. Proportionately these types make 1% or less of the administrative area in each GA with the exception of the Highwoods where they are present on over 5%. The riparian shrub/grass cover type is mapped on less than 13,000 acres; indicating that some riparian/wetland habitat types are dominated by cover such as dry grasses, shrubs, trees, or sparse vegetation.

NWI information distinguishes three riparian types as well as river and riverine areas. This mapping source shows that nearly 22,000 acres on the HLC NFs are mapped as riparian emergent, riparian forested, or riparian scrub-shrub types; this is very similar to the amount of riparian/wetland habitat type groups. Of these types, the riparian forested category is the most common and is especially prevalent in the Upper Blackfoot GA. The riparian emergent type is primarily found in the Little Belts. Proportionately, riparian types make up less than 1% of all GAs, with the Upper Blackfoot and Crazies supporting the highest proportions at about 0.8%. NWI also shows that over 7,000 acres on the HLC NFs are river or riverine systems.

The following at-risk plant species may be found in a riparian system:

- *Botrychium ascendens* (upward-lobed moonwort),
- *Botrychium paradoxum* (peculiar moonwort),
- *Amerorchis rotundifolia* (round-leaved orchis),
- *Aquilegia brevistyla* (short-styled columbine),
- *Carex crawei* (Crawe's sedge),
- *Carex incurviformis* (coastal sand sedge),
- *Cypripedium parviflorum* (small yellow lady's-slipper),
- *Cypripedium passerinum* (sparrowegg lady's-slipper),
- *Leymus innovates* (downy ryegrass),
- *Epipactus gigantean* (giant helleborine),
- *Gratiola ebracteata* (bractless hedgehyssop),
- *Potamogeton obtusifolia* (bluntleaf pondweed),
- *Schoenoplectus subterminalis* (water bulrush),
- *Sphenopholis intermedia* (slender wedgegrass), and
- *Solorina spongiosa* (chocolate chip lichen)

Threats to the riparian system include heavy grazing, off-road vehicle use, invasive species, drought, recreation and climate change.

Rocky Habitats

This habitat includes natural rock outcrops as well as scree (i.e., talus) and covers a wide range of rock types, varying from acidic to highly calcareous. Vegetation is sparse or largely lacking. Bryophytes and lichens often occur in crevices and flourish on open rock surfaces where the competition from vascular plants is absent. Rock outcrop and scree habitats occur across the HLC NFs and are particularly characteristic of higher elevations, but may also be found at lower elevations.

This guild can be somewhat represented by "sparse" areas mapped in VMap. This category includes areas of ice, snow, and other areas with less than 10% vegetative cover. The most common type of these is rock/scree, and therefore sparse areas are likely to support the plants associated with rocky habitats. The sparse type is mapped on over 147,000 acres on the HLC NFs, or roughly 5%. By far the most acres and proportion of this type can be found on the Rocky Mountain Range GA (over 100,000 acres, nearly 13% of the GA). The Crazies, Elkhorns, Snowies, and Upper Blackfoot also each contain more than 5,000 acres. All of the other GAs contain smaller amounts, generally 1% or less, with the Highwoods and Castles containing the least (less than 500 acres each).

The following at-risk plant species have an affinity for rocky habitats:

- *Adoxa moschatellina* (muskroot),
- *Agoseris lackschewitzii* (pink agoseris),
- *Aquilegia jonesii* (Jones' columbine),
- *Astragalus lackschewitzii* (Lackschewitz's milkvetch),
- *Neotorularia humilis* (low northern rockcress),
- *Cardamine rupicola* (cliff toothwort),
- *Draba densifolia* (denseleaf draba),

- *Erigeron lackschewitzii* (Lackschewitz's fleabane),
- *Erigeron linearis* (desert yellow fleabane),
- *Kelseya uniflora* (one-flower kelseya),
- *Kobresia simplicuscula* (simple kobresia),
- *Oxytropis podocarpa* (stalkpod locoweed),
- *Phlox albomarginata* (whitemargin phlox),
- *Phlox missoulensis* (Missoula phlox),
- *Lesquerella klausii* (Rogers Pass bladderpod),
- *Physaria saximontana var. dentate* (rocky mountain twinpod),
- *Pinus albicaulis* (whitebark pine),
- *Polygonum douglasii subsp. austiniae* (Austin's knotweed),
- *Potentilla nivea var. pentaphylla* (fiveleaf cinquefoil), and
- *Saussurea densa* (dwarf sawwort)

Rocky habitats are often fragile systems. Although recreation and road construction are threats to rocky habitats, disturbance is often limited due to inaccessibility. Shifts in warming or drying trends, due to climate change, may also contribute to a change in range and/or distribution.

Shrub-Steppe

Shrub-steppe is generally typified by fine soils and mesic conditions but occurs at all slopes, aspects, and soil types, within the plan area. The community can exhibit a variable extent of shrub diversity but is typically dominated by mountain big sagebrush. In some areas of volcanic origin, antelope bitterbrush may be co-dominant. Where disturbance has been a factor, green and rubber rabbitbrush, white horsebrush or other shrubs may appear to be dominant. The understory is often high in perennial bunchgrass and forb species diversity.

Based on VMap, just under 39,000 acres across the HLC NFs (roughly 1%) have a xeric shrub cover type. This type is present on all GAs, with the most acres occurring on the Big Belts and Little Belts (over 11,000 acres each). The highest proportion of this cover type is found in the Elkhorns GA, where it represents over 6%. The shrub-steppe guild may be present on several habitat type groups: Mountain Shrubland, Xeric Sagebrush, Xeric Shrubland, and Salt Desert Shrub. These types together are present on just over 60,000 acres, representing about 2% of the HLC NFs. This is substantially greater than the area mapped with the xeric shrub cover type due in part to the limitations of mapping, but also because in some areas, other vegetation (grass or trees) are currently dominant. The Little Belts contains the most acres of shrub potential vegetation types, at over 24,000 acres. All other GAs contain around 5,000 acres or less. Shrub potential vegetation types proportionately range from a maximum of nearly 5% on the Big Belts GA, to a minimum of around 0.5% on the Upper Blackfoot GA.

At-risk plant species associated with shrub-steppe include:

- *Atriplex truncata* (wedge-leaf saltbush),
- *Delphinium bicolor subsp. calcicola* (limestone larkspur), and
- *Erigeron linearis* (desert yellow fleabane)

Threats to shrub-steppe include noxious weed invasion, fire exclusion, heavy grazing, and conifer encroachment. Climate change may also contribute to changes in the shrub-steppe communities as precipitation levels, fire frequency intervals, and fire intensities change.

Wetlands

Wetlands are characterized by standing water or season long inundation with a dominance of vegetation adapted to saturated, anaerobic soil conditions. They include wet meadows, swamps, marshes, fens, carrs, and similar areas. Soils exhibit characteristics of hydric conditions and are generally either mineral or organic. The accumulation of large amounts of organic material in some wetlands creates distinctive water chemistry. The vegetation complex is usually represented by a mosaic of herbaceous and woody plant communities. Many species occupying wetlands have rhizomatous root systems that provide excellent erosion control. Low willow species, bog birch, and bog blueberry are often the dominant woody species in a wetland system. Herbaceous species may be dominated by cattails, sedges, spikerushes, rushes, and/or bulrushes. Bryophytes, including sphagnum, are often well represented in fens.

Multiple data sources exist to characterize areas where the wetland plant guild may occur, including potential vegetation, cover types, and National Wetlands Inventory (NWI) information. The riparian/wetland habitat type group is mapped on just over 20,000 acres on the HLC NFs. The highest number of acres occurs in the larger GAs (Rocky Mountain Range and Little Belts); however, proportionately these types make 1% or less of the administrative area in each GA with the exception of the Highwoods where these types are present on over 5%. NWI information shows that over 35,000 acres on the HLC NFs are Freshwater Emergent Wetland, Freshwater Forested Wetland, Freshwater Forested/Shrub Wetland, or Freshwater Scrub/Shrub Wetland types. Of these types, the Freshwater Emergent (e.g., sedges, bulrushes) category is the most common (over 11,000 acres) and is especially prevalent in the Little Belts and Upper Blackfoot GAs. The Freshwater Scrub/Shrub type is the next most abundant (over 4,000 acres) and is found mostly in the Upper Blackfoot, Little Belts, and Divide GAs. The Freshwater Forested type (over 1,300 acres) is primarily found in the Upper Blackfoot and Rocky Mountain Range GAs. Finally, the Freshwater Forested/Shrub type is mapped on just over 1,200 acres primarily in the Rocky Mountain Range. Proportionate to its size, the Upper Blackfoot, Castles, and Divide GAs contain the highest proportions of mapped wetland areas, at about 1% each. NWI also shows that over 6,000 acres within the administrative boundaries of the HLC NFs are freshwater pond or lakes.

At-risk plant species associated with wetlands include:

- *Amerorchis rotundifolia* (round-leaved orchis),
- *Carex crawei* (Crawe’s sedge),
- *Carex incurviformis* (coastal sand sedge),
- *Cypripedium parviflorum* (small yellow lady’s-slipper),
- *Cypripedium passerinum* (sparrowegg lady’s-slipper),
- *Drosera anglica* (English sundew),
- *Drosera linearis* (slenderleaf sundew), and
- *Eleocharis rostellata* (beaked spikerush)

Threats to wetlands include alteration of the original hydrology or hydric soils (i.e. diversion, draining, development, road construction, heavy grazing, etc). Invasive species also pose a threat to wetland plant communities. In light of changing precipitation patterns, climate change presents a potential threat as well.

Xeric Ecotones

Ecotones are the boundaries between ecosystems and/or biomes (Allen and Breshears 1998). The xeric ecotone on for the HLC NFs is often sparsely vegetated and occupies the fringes of adjacent systems, particularly dry habitats. Scattered trees and shrubs including limber pine, Rocky mountain juniper, mountain mahogany, and bitterbrush are common. Herbaceous cover is often low due to limited soil development and xeric growing conditions. Species composition can vary widely, depending on the moisture regime and adjacent communities contributing to the seed source.

Xeric ecotones are complex because they overlap both forested and non-forested potential vegetation types and cover types. This guild is discussed using several non-forested potential and existing vegetation types mapped in the vegetation layer for the HLC NFs; as well as forested types that are summarized using the R1 Summary Database. Individual species presence data also provides context to the extent and distribution of ecotones.

Several cover types may represent ecotones. They are most likely to occur in the ponderosa pine cover type, which is present on nearly 160,000 acres across the HLC NFs. Within this cover type, areas dominated by limber pine or juniper are the most likely to be ecotones. There are just over 110,000 acres on the HLC NFs dominated by juniper or limber pine. Proportionately, this represents a maximum of over 8% in the Snowies GA, to a minimum of 0% in the Divide and Highwoods GAs. These species are most abundant in the Little Belts (over 48,000 acres, 6% of the GA), the Rocky Mountain Range (nearly 24,000 acres, 3% of the GA), the Big Belts (over 14,000 acres, nearly 5% of the GA), and the Snowies (over 9,500 acres, over 8% of the GA). Xeric ecotones may also occur in areas categorized as non-forested.

The presence/absence of limber pine and Rocky Mountain juniper (even where they are not dominant as a cover type) may depict potential xeric ecotones. Limber pine is present on over 340,000 acres on the HLC NFs, and Rocky Mountain juniper on over 125,000 acres. Acres may overlap where both species are present. Juniper is most widespread in the Big Belts GA (over 56,000 acres), Little Belts GA (over 26,000 acres), and Elkhorns GA (over 13,000 acres). It is present in lesser amounts on all GAs except the Crazies and Highwoods. Limber pine is most prevalent in the Little Belts GA (over 188,000 acres), Rocky Mountain Range GA (over 52,000 acres), Snowies GA (over 31,000 acres), and Upper Blackfoot GA (over 30,000 acres).

Several potential vegetation types may represent xeric ecotones, including the Juniper Woodland and Hot Dry habitat type groups. While juniper components are widespread, the Juniper Woodland habitat type group is mapped on less than 1,500 acres across the HLC NFs, mostly in the Big Belts and Elkhorns. The Hot Dry habitat type group (where limber pine is the climax species) is present on over 143,000 acres of the HLC NFs. This is greater than areas currently dominated by a limber pine, but far less than the areas where limber pine is present, due to disturbance and successional processes. The Hot Dry habitat type group is most prevalent in the Little Belts (over 67,000 acres), Rocky Mountain Range (over 19,000 acres), and Elkhorns GAs (over 18,000 acres). No Hot Dry habitat type group areas are identified on plots in the Divide or Highwoods GAs, but are present and represent between 4,000 acres and 8,000 acres on all other GAs. There are also potential for xeric ecotones to occur on the habitat type groups mapped and described for the Shrub-Steppe guild.

At-risk plant species associated with the xeric ecotone include:

- *Pinus flexilis* (limber pine)

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.

Trend

Trends of potential SCC are difficult to quantify. Monitoring is inconsistent and species lists change often. Potential SCC occupying habitats that are often disturbed, such as roadsides, suitable timberlands, and high recreation use areas, would be prone to removal of suitable habitat as well as direct removal of individuals, although some potential SCC plans can respond favorably to these disturbances. As these habitats are altered, species adapted to specific microclimates would have lower survival rates than the more common native species with wider amplitude of habitats. Threats to these habitats include direct disturbance (e.g., logging equipment, road building, road maintenance, grazing, and fire suppression activities), habitat alteration (e.g., canopy removal, edge effects from roads, herbicide, fire exclusion), climate change, and invasive species.

Habitats that are less subjected to land management activities, such as rocky habitats and wetlands, are more likely to be intact. The main threats to these areas include invasive species and climate change. In the past, roads were built along streams and through wetlands. Now there are protections for these habitats, yet some roads are still on the landscape in those areas and are still affecting those habitats.

Xeric ecotones are considered to be among the most sensitive to climate change (Means 2011). Lower treeline woodlands are often thought to be "invading" more desirable sagebrush and grass types due to fire exclusion and other management actions such as grazing; however, ecotones also naturally move elevationally based on the dynamics of vegetation, climate and fire (Means 2011). Douglas-fir encroachment can occur in ecotones and sagebrush/grassland areas. Studies done in areas near the HLC 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 (Heyerdahl 2006).

Historic conditions of community types were assessed in 2003 using a SIMPPLLE modeling analysis. In the Upper Missouri River Basin, which includes the HLC NFs plan area, there has been a substantial loss of upland herbland and shrubland communities, largely attributable to the transition to agriculture, and a substantial extent of these types also transitioned to upland woodland (USDA 2003). The shift to woodland was largely attributable to fire exclusion, but was often accelerated by grazing pressure (ibid).

Information Needs

Due to their rarity, obtaining a thorough inventory of potential plant SCCs is a challenge. Some species can be queried from FIA and FIA Intensification plot data; however, this sample is not designed to capture rare species and cannot fully reflect their potential abundance or condition. Grouping species into guilds helps expand the ability to map and analyze communities of interest. However, there is limited spatial information available for individual sensitive plants, because there is limited survey data and that data is not entered in a spatial format.

In the future the use of completed ecological site descriptions utilizing soil information may better inform our understanding of the natural potential of sites to support non-forested plant communities.

Observations of potential at-risk species are based on a compilation of the most current MTNHP database, the TESP database, and/or other local information sources. In the future improving consistent and central method of recording observations on the HLC NFs will assist with additional analysis to refine the potential SCC list.

Plant Species of Public Interest

In addition to potential SCCs, other plants and communities are of highlighted interest to the public or resource specialists. The values placed on these species include considerations such as high value or limited wildlife habitats, recreational uses, spiritual values, or importance to ecosystem integrity. Four plant guilds are identified as communities of interest;

- Grasslands

- Mesic shrubland
- Shrub-steppe
- Xeric ecotones

Twelve individual species are identified as plants of interest. These species may occur in the same communities or guilds with potential SCCs.

- *Artemisia tridentata* subsp. *vaseyana (*mountain big sagebrush)
- *Camassia quamash (*camas)
- *Cercocarpus ledifolius* (mountain mahogany)
- *Lewisia rediviva* (bitterroot)
- *Purshia tridentata* (antelope bitterbrush)
- *Salix* spp. (willow)
- *Prunus virginiana* (chokecherry)
- *Vaccinium membranaceum* (thinleaf huckleberry)
- *Juniperus scopulorum* (rocky mountain juniper)
- *Pinus flexilis* (limber pine)
- *Pinus ponderosa* (ponderosa pine)
- *Populus tremuloides* (quaking aspen)

Plant species of public interest also include culturally important plant and fungi species. On the HLC NF's these include species such as willow, small camas, thinleaf huckleberry, chokecherry, common beargrass, bitterroot, morel mushrooms, and serviceberry. Please refer to chapter 11, Cultural and Historical Resources and Uses for information regarding culturally important plants and fungi.

Grasslands

Please refer to the discussion of the Grassland SCC guild, as well as the discussion of non-forested vegetation types in the Vegetation Composition, Structure, and Function sections. This guild is of public interest due to its importance to grazing uses and wildlife habitat values.

Mesic Shrubland

Mesic shrublands are often associated with coniferous forests and occur as large landscape patches on moister sites (e.g., northeast facing slopes) or in smaller patches in grasslands. Because of the moisture regime, these shrublands can be very productive and therefore favored by wildlife. Dominant species include serviceberry, snowberry, chokecherry, shrubby cinquefoil, Wood's rose, and bearberry/kinnikinnick, among others.

These shrublands are small and not well-represented by mapping tools. Based on VMap, just over 26,000 acres across the HLC NFs (just under 1%) are dominated by the mesic shrub cover type. These types are present at least in small amounts on all GAs, with the most acres occurring on the Big Belts and Little Belts (over 7,000 acres each). Proportionately, this represents the highest amount on the Big Belts (over 2%). All other GAs contain less than 1%. Mesic shrubland potential vegetation types are mapped on just over 5,000 acres on the HLC NFs; however, mesic shrublands can also be found as persistent seral communities in forested potential vegetation types. The Little Belts and Rocky Mountain Range GAs contain the most acres of potential mesic shrubland types and the Big Belts contains very little. Proportionate to total GA area, mesic shrub potential vegetation types make up less than 1% of all GAs.

Shrub-Steppe

Please refer to the discussion of the Shrub-Steppe SCC guild, as well as the discussion of non-forested vegetation types in the Vegetation Composition, Structure, and Function sections. This guild is of public interest due to its importance to grazing uses and wildlife habitat values.

Xeric Ecotones

Please refer to the discussion of the Xeric Ecotone SCC guild. This guild is of public interest due to its importance to grazing uses and wildlife habitat values. Several key species associated with xeric ecotones will be addressed individually: Rocky Mountain juniper, limber pine, antelope bitterbrush, and big mountain sagebrush.

Artemisia tridentata subsp. *vaseyana (Mountain Big Sagebrush)*

Existing Condition

Mountain big sagebrush (*Artemisia tridentata* subsp. *vaseyana*), an aromatic shrub of the Asteraceae family, dominates much of the shrub-steppe plant community across the HLC NFs. It generally occupies open dry sites at elevations below montane forests where winters are cold and dry, spring and early summer months receive most precipitation, and drought is expected from mid-summer through the fall (Welch 2005; Smith 1940; Whitlock and Bartlein 1993). Sagebrush steppe vegetation, dominated by mountain big sagebrush, is also characterized by the presence of native forbs and cool season perennial bunch grasses (e.g., *Agropyron, Festuca, Koeleria, Poa, Stipa*).

Sagebrush steppe vegetation on the HLC NFs has high levels of native plant species diversity and provides essential habitat requirements for many wildlife species, such as the sagebrush sparrow (*Artemisiospiza belli*), greater sage-grouse (*Centrocercus urophasianus*), pronghorn antelope (*Antilocapra americana*), and sagebrush vole (*Lemmiscus curtatus*), while also providing valuable grazing land for livestock (e.g., Davies et al. 2012).

FIA and FIA intensified grid data was queried for occurrences of this species. The information is limited because only plants with at least 5% cover on a plot are recorded. Mountain big sagebrush was measured on about 5% of the Elkhorns GA but is also known to occur elsewhere on the HLC NFs.

Trend

Mountain big sagebrush is sensitive to encroachment by conifers; studies have shown that in southwestern Montana, it is declining due to competition from Douglas-fir (Gruell et al. 1986; Grove et al. 2005). Douglas-fir expansion into grass and shrub communities may in part reflect natural ecotone dynamics, but overgrazing, climate changes, and fire exclusion have likely caused more extensive encroachment than would be present naturally. A study conducted in close proximity to the HLC NFs plan area found that mountain big sagebrush canopy cover declined from >20% to <15% and <5% as Douglas-fir canopy cover increased beyond 20% and 35% respectively (Grove et al. 2005). This trend may continue, but may be mitigated by altering grazing or fire suppression activities. A management goal for areas dominated by mountain big sagebrush should include where possible the preservation of native plant species richness (e.g., Anderson and Inouye 2001).

Information Needs

The development of additional data queries and estimates of sagebrush may enhance our understanding of their extent and condition. In the future, the use of completed ecological site descriptions utilizing soil information may better inform our understanding of the natural potential of sites to support non-forested plant communities.

Camassia quamash (Camas)

Existing Condition

Camassia quamash (small camas) occurs in deep soils of wet meadows across the HLC NFs. It is important to traditional cultures for nutrition, ceremonies, or rituals. Please refer to chapter 11, Cultural and Historical Resources and Uses**.** FIA and FIA intensified grid data was queried for occurrences of this species. The information is limited because only plants with at least 5% cover on a plot are recorded. No occurrences of this plant were recorded but it is known to occur on the HLC NFs.

Trend

Camas is apparently secure in Montana. Because digging the roots destroys the entire plant, care should be taken with regards to harvest in order to maintain populations.

Information Needs

The HLC NFs do not have a data analysis set to identify the specific habitat where this species may occur, although in general it is associated with wetlands and wet meadows.

Cercocarpus ledifolius (Curl-leaf Mountain Mahogany)

Existing Condition

Cerocarpus ledifolius (curl-leaf mountain mahogany) is an evergreen shrub that generally occurs on limestone or sandstone stony slopes, cliffs, and rock outcrops from valleys to montane zones across the HLC NFs. It grows in a variety of plant communities on the HLC NFs, including rocky habitats, xeric ecotones, and shrub-steppe. While its flowers are small and inconspicuous, the silver-haired, spiral, persistent style attached to each seed is notable. It provides an important food and cover source for a variety of wildlife year-round. Traditional cultures have used it for fuel, dyes, and many important medicinal purposes. FIA and FIA intensified grid data was queried for occurrences of this species. The information is limited because only plants with at least 5% cover on a plot are recorded. No occurrences of this plant were recorded but it is known to occur on the HLC NFs.

Trend

Curl-leaf mountain mahogany is apparently secure in Montana. Although, with more frequent high severity fires, often related to increased fine fuel loads from exotic annual grasses, curl-leaf mountain mahogany populations are declining in many areas throughout its range (Ross 1999), as it is not a fire-sprouter and is killed by fires.

Information Needs

The development of summary database queries that allow for estimates specific to mountain mahogany within certain ecosystems may enhance our understanding of their extent and condition. Additionally, in the future the use of completed ecological site descriptions utilizing soil information may better inform our understanding of the natural potential of sites to support non-forested plant communities.

Kelseya uniflora (One-flower kelseya)

Existing Condition

One-flower kelseya is a unique species that occupies crevices and limestone cliffs on the Helena and Lewis and Clark National Forests. It creates large cushions and exhibits bright pink flowers in the spring. Naturalists seek out this plant for its unique habitat and early spring color. FIA and FIA intensified grid data was queried for occurrences of this species. The information is limited because only plants with at least 5% cover on a plot are recorded. No occurrences of this plant were recorded but it is known to occur on the HLC NFs.

Trend

One-flower kelseya is endemic to Montana where it is apparently secure. In the adjacent state of Wyoming, it is considered imperiled. Due to the unique habitat one-flower kelseya occupies, disturbance is unlikely to impact populations. Climate change may contribute to changes in range or extent of populations.

Information Needs

There is little information available, other than anecdotal accounts of where this species occurs.

Lewisia rediviva (Bitterroot)

Existing Condition

Bitterroot occurs in well drained soils of sparsely vegetated grasslands across the Helena and Lewis and Clark National Forests. It is important to traditional cultures for nutrition. Please refer to chapter 11, Cultural and Historical Resources and Uses. FIA and FIA intensified grid data was queried for occurrences of this species. The information is limited because only plants with at least 5% cover on a plot are recorded. No occurrences of this plant were recorded but it is known to occur on the HLC NFs.

Trend

Bitterroot is apparently secure in Montana. Because digging the roots destroys the entire plant, care should be taken with regards to harvest in order to maintain populations.

Information Needs

The HLC NFs do not have a data analysis set to identify the specific habitat where this species may occur.

Purshia tridentata (Antelope Bitterbrush)

Existing Condition

Purshia tridentata (antelope bitterbrush), a three to six foot tall shrub in the Rosaceae family, infrequently occurs on stony or sandy soil of grasslands, shrub-steppe, and open ponderosa-pine forest from valley to montane zones across the HLC NFs. Its fragrant, showy, yellow flowers bloom in early June, followed by the emergence of its distinguishing three-lobed leaves. It provides an important food and/or cover source for ungulates, rodents, birds, and several insect species. Traditional cultures also use bitterbrush for many medicinal purposes.

FIA and FIA intensified grid data was queried for occurrences of this species. The information is limited because only plants with at least 5% cover on a plot are recorded. Plots indicate that antelope bitterbrush is present on small areas of the Big Belts and Divide GAs.

Trend

The abundance and distribution of bitterbrush is largely influenced by climate and fire regimes. Seed caches from rodents and ants also play a vital role in the dispersal and regeneration of bitterbrush. As a shade intolerant, nitrogen-fixing shrub, it is an early colonizer on disturbed sites in several plant communities (e.g., xeric ecotones, shrub-steppe) on the HLC NFs. It competes with nonnative, invasive, annual grasses such as cheatgrass (*Bromus tectorum*), which are spreading rapidly throughout bitterbrush habitat. This invasion has increased fine fuel loads, causing more frequent high severity fires, where bitterbrush, considered a weak sprouter, is often killed. Sprouting ability following fire is influenced by fire severity and season, where bitterbrush may sprout following light-severity fires that occur in spring (Zlatnik 1999). In Montana, bitterbrush communities have experienced declines of 10-30% in population size, range extent, and/or occupied area during the past 30 years. This decline is likely due to habitat conversion, alteration, and more frequent high severity fires.

Information Needs

The development of summary database queries that allow for estimates specific to bitterbrush within certain ecosystems may enhance our understanding of their extent and condition. Additionally, in the future the use of completed ecological site descriptions utilizing soil information may better inform our understanding of the natural potential of sites to support non-forested plant communities.

Salix spp (Willow)

Existing Condition

Many species of willow exist, and are of interest because of their habitat value, limited extent, and pressures exerted by factors such as grazing and fire suppression.

Tall willows, including various species of tall-statured (typically up to 20 to 30 feet tall) willows, occur along streams in broad valley bottoms at low to mid elevations. They occur as a mosaic with various other riparian shrubs, graminoids and forbs in the understory, forming a riparian complex. Tall willow species include (but are not limited to): Booth's (*Salix boothii*), Geyer (*S. geyeriana*), Bebb (*S. bebbiana*), coyote (*S. exigua*), Drummond's (*S. drummondiana*), and whiplash (*S. lasiandra*) willow.

Low willows, including low-statured (typically up to 4 feet tall) willows occur in higher elevation valleys, usually associated with subalpine forests. They occur as a riparian strip along streams and also as a complex either associated with sinuous streams or in wet meadows or fens in wide, flat valleys associated with standing water. Low willow species include (but are not limited to): planeleaf (*S. planifolia*), wolf (*S. wolfii*), and mountain (*S. eastwoodiae*) willow. Bog birch (*Betula pumila*) and bog blueberry (*Vaccinium uliginosum*) may also be present in the low willow complex. Riparian/wetland graminoids and forbs are typically present in varying amounts, and can be present with high cover in a low willow/herbaceous vegetation mosaic or riparian/wetland complex.

FIA and FIA intensified grid data was queried for occurrences of this species. The information is limited because only plants with at least 5% cover on a plot are recorded. Plots indicate that willows are present on about 1% or less of the Divide, Little Belts, and Upper Blackfoot GAs, and on about 4% of the Rocky Mountain Range GA.

Trend

Willows require a seasonally high water table and free water in the soil to survive and regenerate. Most species are shade-intolerant and those species that occur along streams in narrow steep valleys will likely not persist if conifers overtop and shade them. Browsing pressure by both native and domestic ungulates can lead to loss of vigor and eventually death if it is chronic and persists. Coyote willow regenerates vegetatively; all other willows germinate successfully in bare, moist, mineral substrate, i.e., stream bars. Regeneration is less likely to occur on other substrates.

Information Needs

More quantitative inventory and monitoring of riparian areas and willows would further our understanding of the conditions and trends of willows.

Prunus virginiana (chokecherry)

Existing Condition

Chokecherry is often associated with mesic shrublands, moist forest, or riparian areas. It is important to traditional cultures for nutrition, ceremonies, rituals, and medicinal purposes. The berry is sought after and collected by members of the public for wildcrafting purposes. Please refer to chapter 11, Cultural and Historical Resources and Uses. It is also an important food source for many wildlife species.

FIA and FIA intensified grid data was queried for occurrences of this species. The information is limited because only plants with at least 5% cover on a plot are recorded. Plots indicate that chokecherry is present over small proportions (less than 3%) of the Castles, Highwoods, and Little Belts. However, it is known to be prevalent on private lands and other areas on the HLC NFs.

Trend

Chokecherry is secure within its range.

Information Needs

None.

Vaccinium membranaceum (thinleaf huckleberry)

Existing Condition

Thinleaf huckleberry occurs across the HLC NFs and prefers open coniferous woods. It is important to traditional cultures for nutrition, ceremonies, rituals, or medicinal purposes as well as a food staple for wildlife. Commercial collections also occur for wildcrafting purposes. Please refer to chapter 11, Cultural and Historical Resources and Use***s***.

FIA and FIA intensified grid data was queried for occurrences of this species. The information is limited because only plants with at least 5% cover on a plot are recorded. Plots indicate that huckleberry is present on all GA's, generally located on between 2% and 10% of the GA area. The Upper Blackfoot contains the most huckleberry, where it occurs on over 13% of plots due to the more moist climate.

Trend

The abundance and distribution of thinleaf huckleberry is largely influenced by disturbance including fire regimes. Although thinleaf huckleberry can be difficult to establish, it often responds to favorably to disturbance and in the absence of natural fire, thinleaf huckleberry is less productive than it would have been historically.

Information Needs

Little is known about the historic range of the extent of this plant, due to changes in the natural fire regime and extent of commercial harvesting.

Juniperus scopulorum (Rocky Mountain Juniper)

Existing Condition

Rocky mountain juniper is a primary component of xeric ecotones as well as an understory species in dry forested cover types. About 3.89% of FIA plots on the HLC NFs have Rocky Mountain juniper present in some abundance; this represents about 106,274 acres. FIA intensification plots or base plots are also used to indicate the acres of juniper presence by GA and split by size classes, as shown in Figure 2.43. The Big Belts has a notably higher than average presence of juniper, where it occurs on 18% of plots which represents over 55,000 acres. The Little Belts also has a substantial number of acres (over 25,000) with juniper. Most of the GAs have juniper on 2 to 4%, which represents less than 15,000 acres on each GA. No juniper was measured on any plots in the Crazies or Highwoods GAs. In most GAs, larger juniper trees are more widespread than smaller juniper trees, although both size classes are present in many areas.

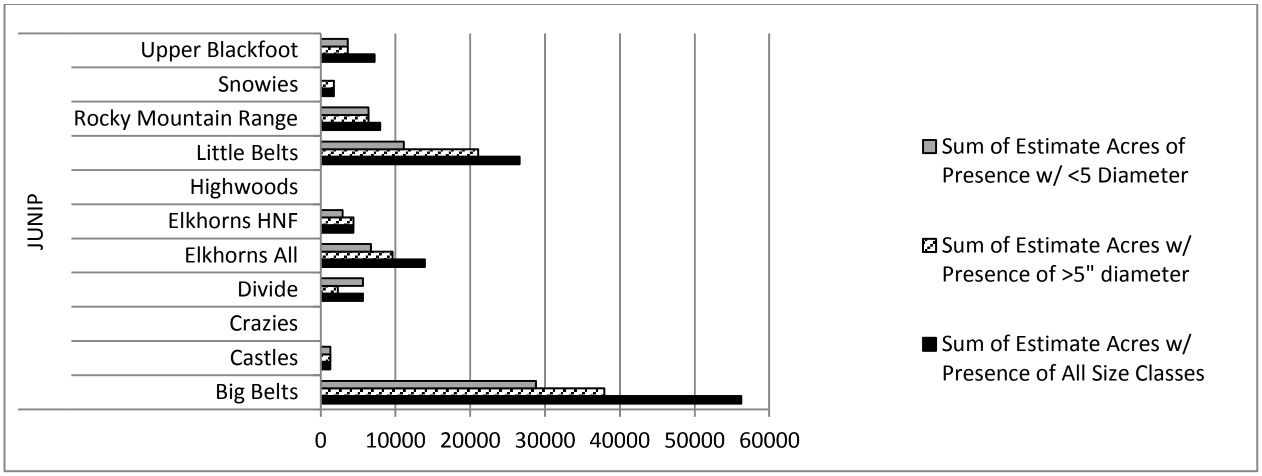

Figure 2.43 Estimated acres where juniper is present, by size class – R1 Summary Database

Trend

The abundance and distribution of juniper is largely influenced by climate and fire regimes. Juniper tends to become abundant in the later stages of succession in non-forested types, where it slowly becomes established after other grasses and shrubs. Wildfire serves to kill and consume the juniper in these areas as well as where it has developed as a ladder fuel in dry conifer forests. Although it is an important component, in the absence of natural fire juniper is likely more widespread and abundant than it would have been historically. Juniper expansion can lead to the decline of grass and shrublands and result in altered fire regimes. Refer to the trends discussed for xeric ecotones and limber pine; juniper is often associated with these plant communities.

Information Needs

A more detailed natural range of variability analysis with current datasets would improve our understanding of how the current condition of juniper compares to pre-settlement conditions.

Pinus flexilis (limber pine)

Existing Condition

Limber pine is a relatively long-lived, native five-needled pine which grows east of the Continental Divide. Although marginal for timber values, limber pine is an important pioneer species that provides watershed protection and wildlife habitat; it grows on dry sites at both upper and lower tree lines and in between on sites too harsh for other conifer species (Jackson et al. 2010). It is subject to many of the stressors as whitebark pine; the fungus that causes blister rust first infected Montana limber pine in the mid-to late-1930's and has been present in much of limber pine's range in Montana for over half a century (Jackson et al. 2010). It is a highlighted species within the xeric ecotone and rocky habitats guilds, and on the HLC NFs its presence appears to correlate with limestone substrates. It is known to grow in association with whitebark pine at high elevations on the HLC NFs. Lower treeline limber pine woodlands serve as ecotones between the sage/grass and forest/woodlands biomes; their expansion and contraction is due to dynamic relationships among vegetation, climate, and wildland fire (Means 2011). On more mesic sites where limber mixes with other tree species, mixed to high severity fires probably occurred much like the fire histories of whitebark pine in similar locations; however, lower treeline limber pine woodlands and isolates are thought to have a more frequent disturbance regime (Means 2011).

According to base FIA plots, limber pine is present on 12.21% of the HLC NFs, representing about 333,486 acres. The Little Belts and Snowies GAs contain a higher than average proportion of plots with limber pine (25-30%). Limber pine is present on a smaller proportion of plots in the Big Belts, Castles, Crazies, Rocky Mountain Range, and Upper Blackfoot, ranging from about 5 to 15%. Limber pine is uncommon in the Divide, Elkhorns, and Highwoods GAs, where it is present on less than 2%. Figure 2.44 depicts the acres where limber pine is present, by size class. This information shows that the Little Belts by far contains the most acres with limber pine present. In most GAs, small and large limber pines are relatively equally widespread.

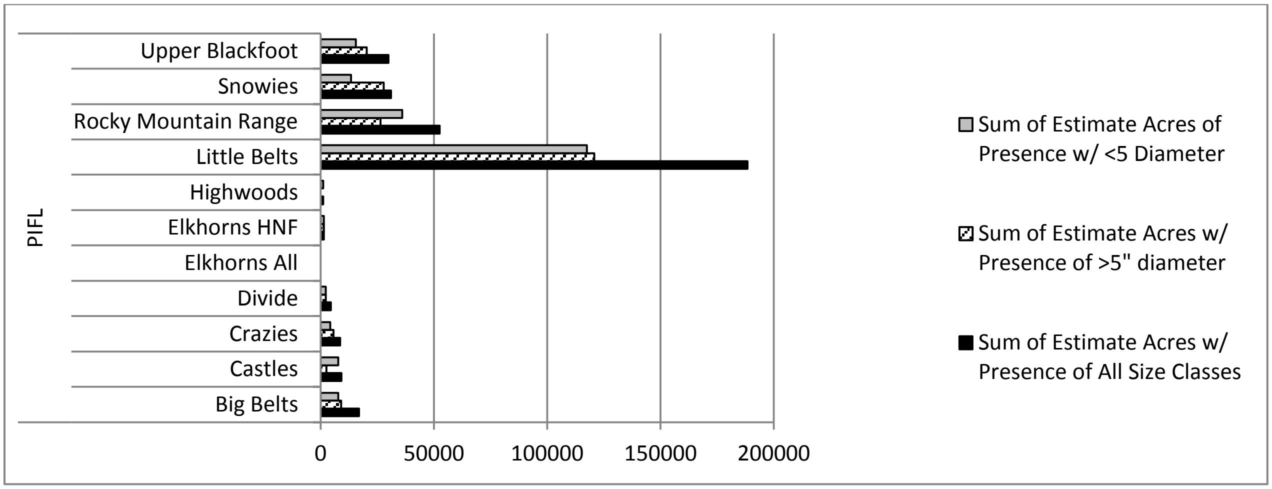

Figure 2.44 Estimated acres where limber pine is present, by size class – R1 Summary Database

Trend

Because of the influence of multiple threats, including white pine blister rust and mountain pine beetle, the trend of limber pine appears to be a decline. The decline in health and mortality of limber pine has been observed throughout central and eastern Montana, particularly on the Lewis and Clark National Forest where some stands are incurring nearly 100% mortality due to disease, winter damage, drought, and competition from other conifers (USDA 2003). While isolation and climate conditions of limber pine woodlands may have provided some protection in the past, recent studies show that these lower treeline woodlands are just as, or more, susceptible to white pine blister rust infections and mountain pine beetle infestations (Means 2011). The natural fire regime and the alteration thereof is an important influence on the abundance and health of limber pine. A study done in Colorado found that the reduction of overstory limber pine due to mountain pine beetle and its delayed maturation (it takes up to 50 years for young limber pine to produce cones), may leave limber pine especially susceptible to the stresses of bluster rust, competition, and climate change (Klutsch et al. 2011).

On sites conducive to other conifers, limber pine often colonizes recently disturbed areas, but eventually becomes relegated to a minor stand component due to shade intolerance (Jackson et al. 2010). 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). At higher elevations, insect and disease, fire exclusion, visual resources, wildlife habitat, and climate change issues are at the forefront of management concerns for limber pine; lower treeline communities not only have these issues, but also additional considerations related to livestock grazing, fuels management, and energy development (Means 2011). Chronic injury and mortality from white pine blister rust in conjunction with mountain pine beetle outbreaks has recently spurred heightened concern for the future of limber pine throughout its range (Jackson et al. 2010).

Information Needs

A more detailed natural range of variability analysis with current datasets would improve our understanding of how the current condition of limber pine compares to pre-settlement conditions. Further, much remains unknown in the realm of research regarding some specific qualities of limber pine, including but not limited to genetics, ecological roles, and predictive models based on climate changes (Means 2011).

Pinus ponderosa (ponderosa pine)

Existing Condition

Ponderosa pine is a shade-intolerant species that is highly resistant to fire mortality when mature due to its thick exfoliating bark, high open crown, high foliar moisture content, large buds, deep roots, and the ability to self-prune (Saveland et al. 1990). Habitats dominated by ponderosa pine are rare, occurring mostly adjacent to non-forested areas. This species also occurs as a component in dry Douglas-fir forests and as open, savannah trees in non-forested areas. It is a long-lived seral tree that is windfirm and desirable for wildlife habitat.

According to base FIA data, about 6.16% of plots have ponderosa pine present, representing about 168,149 acres, across the HLC NFs. The Snowies has the greatest proportion at over 22%. The Big Belts contain just over 10% and the Little Belts just over 8%. All other GAs have less, (generally 5% or less). As shown in Figure 2.45, the Little Belts contains the most acres of ponderosa pine (over 60,000). The species is present on a high proportion of the Snowies, but this represents just over 20,000 acres. The Big Belts also contain a substantial area with ponderosa pine at just over 30,000 acres. The Elkhorns GA has been known for its unique ponderosa pine cover type in the northwest corner. However, the recent mountain pine beetle outbreak has had a substantial effect, and currently only small ponderosa pine trees are represented over a relatively small area (less than 5,000 acres).

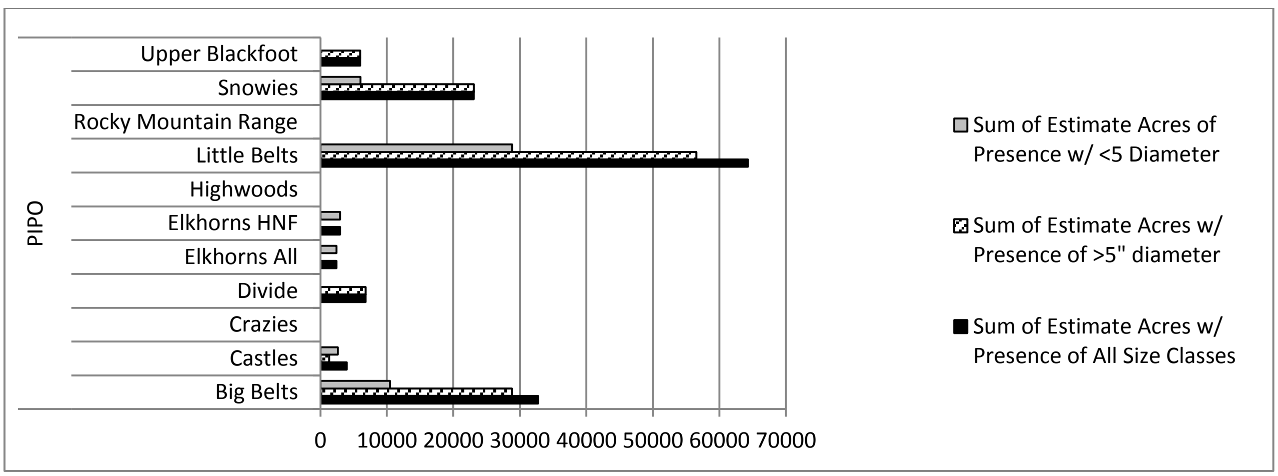

Figure 2.45 Estimated acres where ponderosa pine is present, by size class – R1 Summary Database

Trend

The distribution and structure of ponderosa pine has been affected by fire exclusion and mountain pine beetle. Fire exclusion has contributed to denser forests with greater competition for resources, higher stress and greater risk of insect attack and stand-replacing fire (Pollet and Omni 2002; Sala et al. 2005). Low-elevation ponderosa pine forests of the northern Rocky Mountains historically experienced frequent low-intensity fires that maintained open uneven-aged stands (Sala et al. 2005), but fires today are more often stand-replacing (Pollet and Omni 2002). 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 et al. 1982; Pollet and Omni 2002; Smith and Arno 1999). Ponderosa pine is susceptible to mountain pine beetle and secondary beetles. High density increases tree stress and decreases resistance to insect attack (Kolb et al. 1997).

The extent of pine mortality due to the recent mountain pine beetle outbreak may result in a potential loss of geographically adapted ponderosa pine seed producers in some areas. Changes in composition, structure, age class, and fuel loading have occurred in many areas. These changes have included shifts from ponderosa pine to Douglas-fir, reductions in density, reductions in average tree size, and in some cases a shift to an early successional stage. Ponderosa pine was probably more abundant historically, particularly in the Big Belts, Snowies, and Upper Blackfoot GAs (USDA 2003). Climate change may promote ponderosa pine in places where it can out-compete less drought-tolerant species; however, the expected increases in disturbance severity and extent may conversely eliminate ponderosa pine seed producers in some areas. Further, conditions may be too dry for ponderosa pine establishment in some areas. Recent surveys of planted ponderosa pine seedlings in the Northern Region of the Forest Service showed an overall third-year survival rate of only 63%, with drought being cited as the cause of mortality especially on southerly aspects (USDA 2015).

Information Needs

A more detailed natural range of variability analysis with current datasets would improve our understanding of how the current condition of ponderosa pine compares to pre-settlement conditions.

Populus tremuloides (quaking aspen)

Existing Condition

Aspen is highly valued for its contribution to biodiversity and habitat; with the exception of riparian areas, aspen communities are considered the most biologically diverse ecosystems in the Intermountain West (Campbell and Bartos 2001). Aspen is a seral, relatively short-lived species which requires full sunlight to regenerate (Shepperd 1996). The clonal habit of aspen adds to its uniqueness among tree species; even the most decadent clones should be recognized as superior genotypes that have survived the process of natural selection and are most likely some of the best suited genetic material for that site (Campbell and Bartos 2001). Aspen historically relied on fire or disease to remove the overstory, kill encroaching conifers, and stimulate a new generation of suckers from the existing clone root system (Shepperd 1990). Mature aspen trees inhibit the growth and success of new suckers via auxins in their common root system. Without periodic self-regeneration, aspen stands become decadent and deteriorate as root systems decline (Shepperd et al. 2001). Mature clones can also decline due to repeated animal herbivory or competition from invading conifers (Shepperd et al. 2001).

According to base FIA plots, 2.27% of the HLC NFs contain aspen (about 61,984 acres). The GAs with the highest proportions are the Divide, Highwoods, and Rocky Mountain Range, where aspen is estimated to occur on between 5 and 6%. The other GAs contain less than 3%. No aspen has been recorded on plots in the Crazies or Snowies GAs. The Rocky Mountain Range GA has by far the most acres with aspen (nearly 40,000).

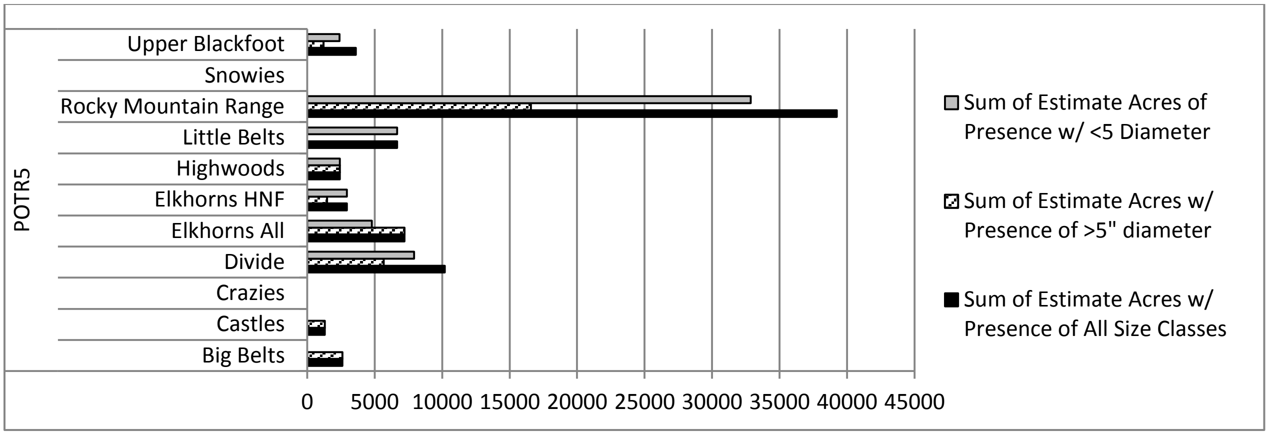

Figure 2.46 Estimated acres where aspen is present, by size class – R1 Summary Database

Trend

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 et al. 2001, Kaye et al. 2005). Without periodic disturbance, seral aspen may eventually disappear and be replaced by shade tolerant conifers (Shepperd 1996). Aspen clones that do sprout are impacted by big game because the suckers are a desirable food source. Reductions of Montana aspen forests are believed to be largely due to fire suppression activities over the past 100 years. According to a SIMPPLLE modeling analysis of historic conditions, aspen/hardwood cover types appear to be notably less common than they were historically on all GAs (USDA 2003).

The mountain pine beetle outbreak across many of the GAs has reduced competition to some aspen in pine stands, and could potentially allow them to increase in extent and vigor. Potential wildfires could both kill existing aspen stems and also stimulate new suckering that could increase the vigor and extent of aspen. When overstory stems are killed thousands of suckers sprout from the original root system and grow rapidly to form a new stand (Shepperd 1996). A stand replacing wildfire would likely promote aspen regeneration, although other factors such as insects, disease, animal herbivory and genetics also play a role in the long term success of aspen (Shepperd 2001). The influence of a warming climate might be to increase the extent and severity of disturbances which could reduce the cover of conifers and promote aspen in some cases. However, dry conditions may also render some sites unsuitable for aspen.

Information Needs

A more detailed natural range of variability analysis with current datasets would improve our understanding of how the current condition of aspen compares to pre-settlement conditions.

Special Ecosystem Components

Introduction

There are specific plant species, communities, and structures that are rare and/or are important for their contribution to specific habitat qualities or ecological integrity. These include:

- Old growth
- Snags
- Large live trees
- Coarse woody debris

Old Growth

Existing Condition

The concept of *old growth* involves not only the age of a forest but also structural and functional 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 et al. 1995). Old growth is a late-stage state of succession that is important to biological diversity and provides habitat for certain wildlife species such as bats, owls, and woodpeckers. This condition is not static and as old growth dies it is replaced by younger forests. Proactive old growth management may include promoting the resilience of younger forests so that they may become old growth in the future. Measurable criteria are needed to consistently define old growth; Green et al. (1992) definitions have been adopted for this purpose by Region 1 of the Forest Service.

Old growth is estimated with FIA and FIA intensified grid plots, using an old growth estimator tool (USDA 2010b) based on Green et al. (1992) definitions. Just over 13% of the HLC NFs, or 364,833 acres, is estimated to be old growth. Only base FIA plots are utilized at this scale because they represent the entire plan area; these plots have not been re-measured since the recent mountain pine beetle outbreak. It is likely that some old growth with a pine component has changed and may no longer be old growth. Figure 2.47 shows the percent old growth across the HLC NF's, and a comparison of the amounts within and outside designated wilderness areas. The confidence interval for the wilderness estimate is wide because these areas are smaller than non-wilderness areas and therefore have fewer plots. Another factor may be variability in vegetation. Estimates show that wilderness areas may have a slightly higher proportion of old growth than the area overall, but the ranges for the estimates overlap.

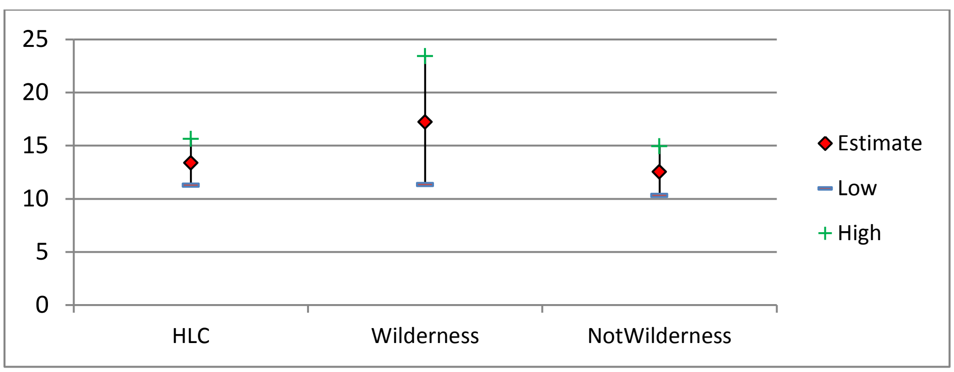

Figure 2.47 Percent old growth by land allocation, HLC NFs – R1 Summary Database – base FIA plots

FIA intensified grid plots are used to estimate old growth by GA; these plots better capture the conditions present after the recent beetle outbreak. For GAs without a complete intensified grid (the Rocky Mountain Range and Snowies GAs), base FIA plots are used. Confidence intervals vary based on the size of the sample and variability of vegetation. With the exception of the Highwoods, old growth is estimated to occur on five to twenty percent of all GAs. Elkhorns estimates are shown for two scales; 1) the HNF portion; and 2) the entire GA including the area on the Beaverhead-Deerlodge National Forest. This is because the intensified grid only covers the HNF area, but because of its higher number of plots (88) is considered to be a useful estimate. Base FIA plots are used to summarize the entire Elkhorns GA (19 plots). The Elkhorns All has a wide confidence interval, and the lower bound is within the range of the Elkhorns HNF estimate.

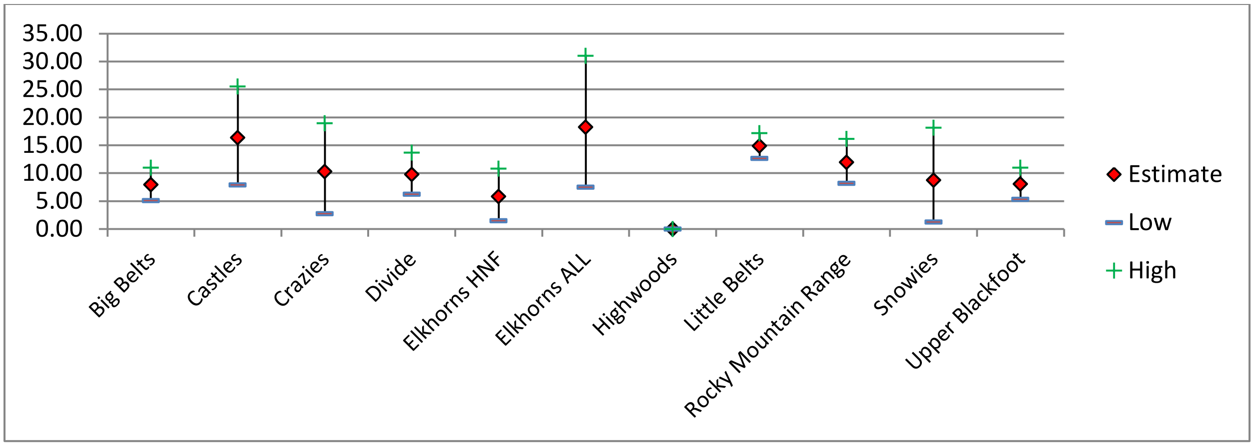

Figure 2.48 Percent old growth by GA – R1 Summary Database

It is also informative to summarize acres of old growth. Not surprisingly, the largest GAs (Rocky Mountain Range and Little Belts) support the most acres of old growth.

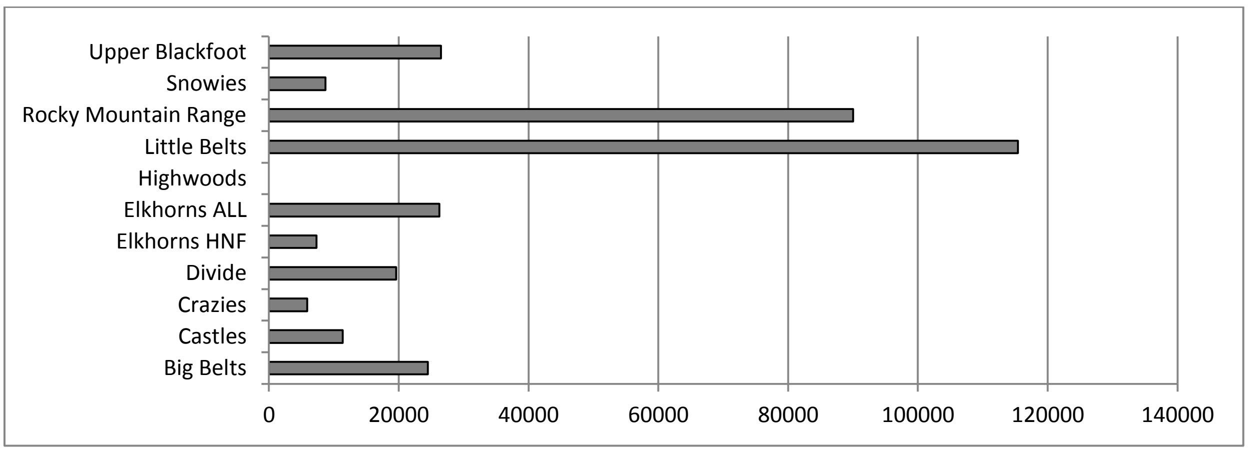

Figure 2.49 Estimated acres of old growth by GA – R1 Summary Database

Old growth by cover type across the HLC NFs plan area is estimated with base FIA plots (Figure 2.50). Habitat type groups and cover types are differentiated in the criteria required to be old growth. Old growth types dominated by lodgepole pine have a lower minimum age requirement than longer-lived cover types such as Douglas-fir and ponderosa pine. All cover types present on the HLC NFs have some proportion of old growth, with Douglas-fir being the most common old growth type. There are likely fewer old growth areas in the pine types as a result of the recent mountain pine beetle outbreak than what is shown in this estimate.

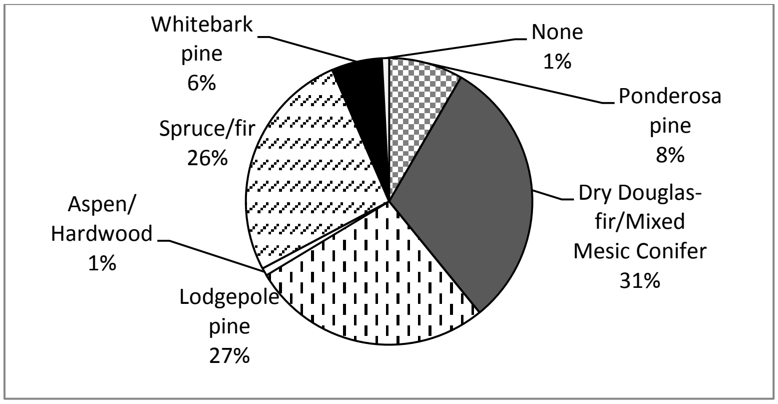

Figure 2.50 Cover type proportions of existing old growth on the HLC NFs, R1 Summary Database – base FIA plots

Trend

Natural processes in dynamic ecosystems cause a proportion of late successional forest to become old growth over time. Disturbances may also alter or remove old growth. Old growth is not a static phenomenon; old growth stands and trees are killed by insects, disease, windthrow, and wildfire and are replaced as younger trees age. Topography can influence the probability of old growth development. Areas protected from wildfire (e.g. riparian areas or sites near rock features) may support vegetation *refugia* and legacy components which are retained after disturbance and are therefore more likely to develop into old growth. 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). Drier ponderosa pine and Douglas-fir types developed under a more frequent disturbance regime (Arno et al. 1995, Tesch 1980) while higher elevation lodgepole types were largely established from stand-replacement events (Arno et al. 1993).

The abundance and distribution of old growth is influenced by the disturbance history of each GA. For example, the lack of old growth in the Highwoods GA may be due to its small size and extensive fire history; small island ranges are susceptible to fires that spread up from the surrounding prairie. Old growth in the Little Belts is relatively abundant; this GA has experienced few wildfires recently. However, a substantial proportion of this old growth is lodgepole pine which may be susceptible to insect or fire mortality. Pine old growth types have likely been impacted by the recent beetle outbreak across the HLC NFs. Large wildfires, particularly since the 1980's, have influenced the amount of old growth in many landscapes including the Big Belts, Upper Blackfoot, Rocky Mountain Range, and Elkhorns GAs. A mosaic of vegetation that allows for a stable quantity of old growth is limited in some GAs because factors such as climate, fire history, and human intervention have resulted in homogeneity. For example, the Highwoods is dominated by young tree classes. In the short term few older forests exist to become old growth; however, in the long term, a high proportion could become old growth all at once (barring disturbance). Conversely, GAs with a heterogeneity in age class, species composition, and structure, such as the Upper Blackfoot, can provide for a more stable proportion of old growth over time.

The amount of old growth in wilderness areas suggests that the existing quantity is within an expected natural range of variability. This may indicate that to a degree, the loss of old growth and large trees to early harvest practices, land conversions, and disturbances may have been tempered by actions such as fire suppression which preserved old growth that may otherwise have burned. However, fire exclusion has also altered old growth. Increasing tree densities and canopy layers may have increased tree stress and vulnerability to mortality from insects, pathogens, and high intensity crown fires. There is no quantitative assessment of historic old growth levels currently available. The 2003 historic range of variability analysis did assess size classes. In most cases the valuable old growth types (Douglas-fir and ponderosa pine) would be expected to occur most often in the very large tree class. The SIMPPLLE modeling conducted in 2003 concluded that, depending on the geographic area, between 1 and 6% of the landscape was in the very large tree size class (USDA 2003).

Increased drought, temperature stress, and disturbance may affect old growth persistence in the future; in the view of potential climate change affecting disturbance probabilities in the future, landscape pattern may become the most important factor in management influences (Bollenbacher and Hahn 2008). Developing resilience in old growth forests to avoid losses requires a solid understanding of disturbance regimes (ibid).

The current Forest Plans for the HLC NFs require that a certain proportion of the landscape be managed for old growth. The 1986 Helena NF plan requires that ten percent of each third-order watershed be managed for old growth, with a minimum stand size of 10 acres. The 1986 Lewis and Clark NF plan requires that five percent of the commercial forest land within a timber compartment be maintained in an old growth forest condition, with a minimum stand size of 20 acres. Additional considerations and criteria are associated with these standards.

Information Needs

A more extensive Natural Range of Variability Analysis with new data would help further our understanding of the natural and potential future quantities and conditions of old growth, as well as functional patch size requirements. Management of old-growth must be based on the anticipation of change; managers should design landscapes containing a mixture of communities, processes, and structures characteristic of natural conditions (Foster et al. 1996).

Snags

Existing Condition

Snags, or standing dead trees, provide important structural features and habitat. Living trees with decay or damage, such as dead tops, may also be valuable as habitat and to provide recruitment for future snags. Although all snags have value, large snags are of particular importance due to their rarity on the HLC NFs. Snags are created at multiple scales, ranging from single-tree mortality to extensive snag patches created by events such as fires or insect infestations. Smaller diameter snags are abundant in many areas on the HLC NFs due to the recent mountain pine beetle outbreak and wildfires. However, larger snags are relatively rare in part due to the growing conditions on the HLC NFs. FIA and FIA intensified grid data are used to summarize snags. Snags less than 10 inches in diameter are not estimated due to their limited habitat value. Three size classes of snags are assessed:

- *medium* (10-14.9” diameter);
- *large* (15-19.9” diameter); and
- *very large* (20”and greater diameter)

Base FIA data shows that there are 7.27 medium snags per acre across the HLC NFs; 1.44 large snags per acre; and 0.71 very large snags per acre. Base FIA does not reflect the conditions that may have recently changed due to insect or fires. Very large snags of seral species are valuable due to their longevity. Of the existing very large snags, most (58%) are Douglas-fir. Douglas-fir is the most common long-lived species on the HLC NFs, and it follows that it would be the primary source of very large snags. Less common species of very large snags include ponderosa pine, subalpine fir, whitebark pine, and Engelmann spruce. Medium-sized snags tend to be lodgepole pine, the most common tree species on the HLC NFs, because it does not tend to grow to a large size.

The chart below shows the snags on the HLC NFs administrative area with base FIA data, split by size class and summarized within and outside wilderness. This is done to discern if the processes that create snags are substantially different in areas which are largely precluded from human intervention (with the exception of fire suppression). Medium snags are the most prevalent, with wilderness containing more than non-wilderness, in part due to recent wildfires. Differences for large and very large snags are less pronounced; relatively few snags are present in these classes across the HLC NFS, inside and outside wilderness areas (generally less than 3 per acre).

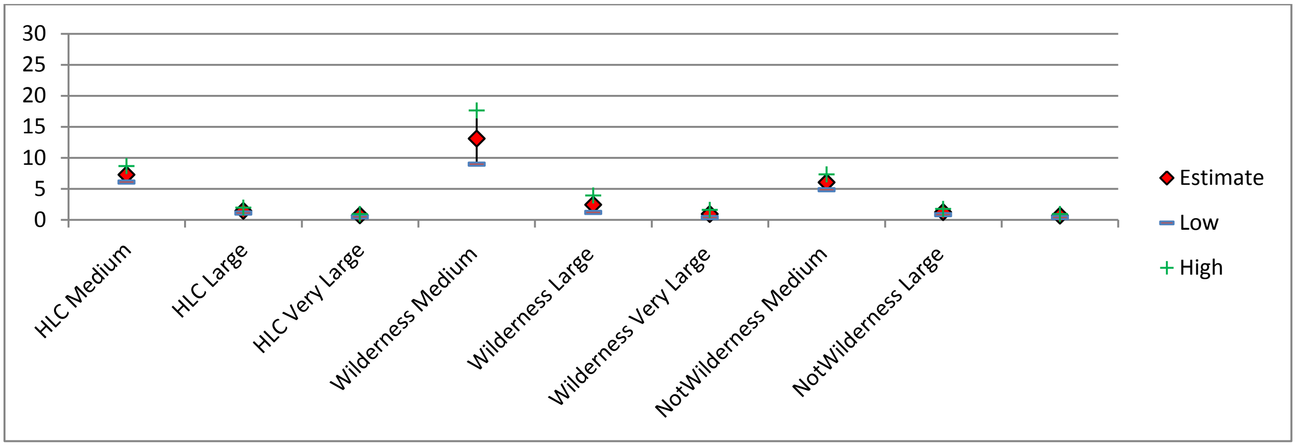

Figure 2.51 Trees per acre of small, medium, and large snags by land allocations – R1 Summary Database

The three figures below display estimated snags per acre by GA; these estimates utilize FIA intensified grid data for most GAs (all except the Rocky Mountain Range and Snowies GAs). The FIA intensified grid data better captures the current conditions of these areas than the base FIA used for Forest-wide estimates because they have generally been measured since recent disturbances.

Medium snags vary from a minimum of about 3 per acre in the Snowies GA to over 25 per acre in the Upper Blackfoot GA. The distribution of snags is patchy because they tend to be concentrated in areas of beetle infestations and wildfire. Large snags are less common, ranging from 0 in the Snowies to about 5 per acre in the Upper Blackfoot. The final figure shows the scarcity of very large snags. All GAs have between 0 and 2 per acre. The Big Belts, Elkhorns, and Upper Blackfoot contain the most very large snags due to their diversity in species composition. Also, in the Upper Blackfoot the climate regime is more conducive to growing larger trees.

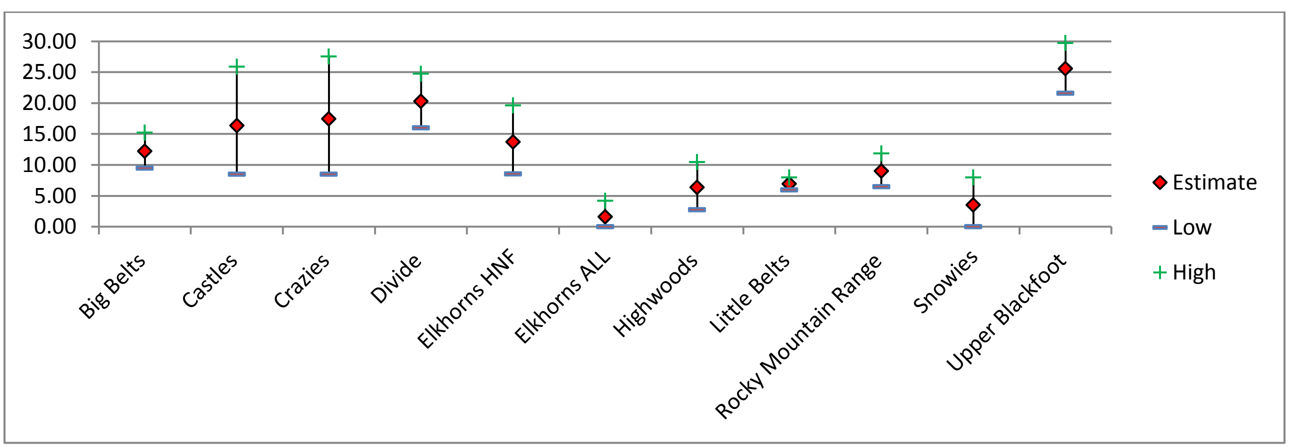

Figure 2.52 Medium snags per acre (10-14.9” diameter) by GA – R1 Summary Database

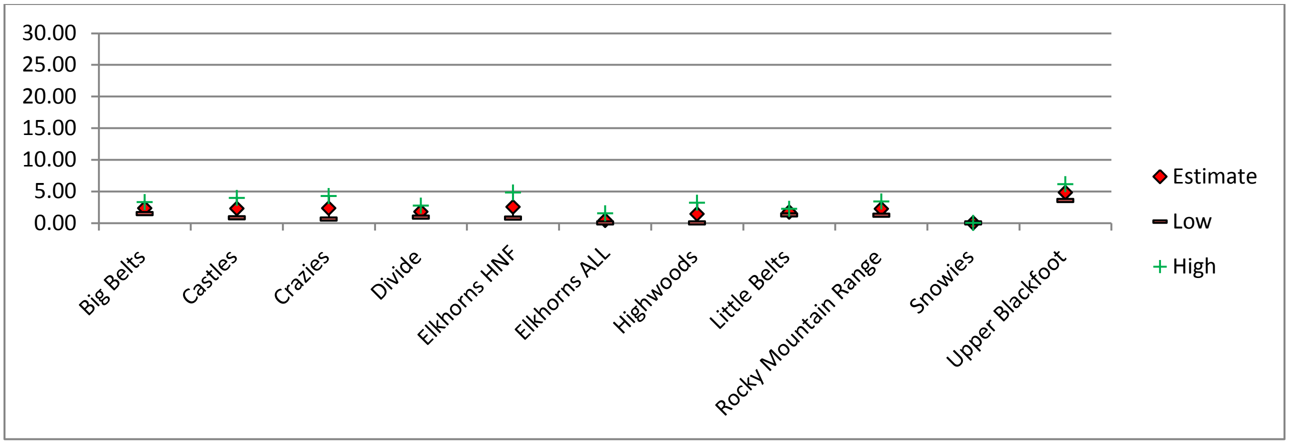

Figure 2.53 Large snags per acre (15-19.9" diameter) by GA – R1 Summary Database

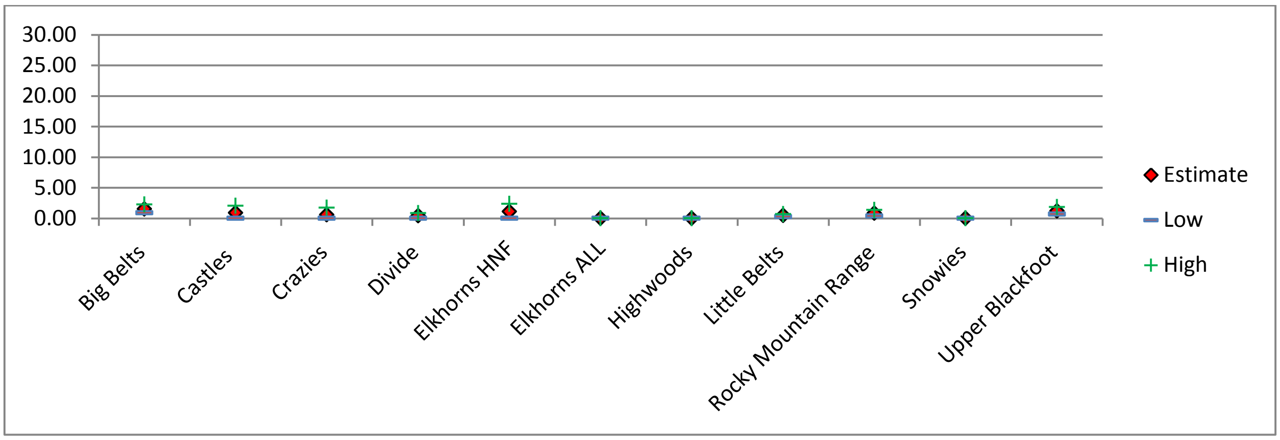

Figure 2.54 Very large snags per acre (20" + diameter) by GA – R1 Summary Database

Another recent analysis estimated snags and large live tree densities for Eastside National Forests in the Northern Region (Bollenbacher et al. 2008) based on FIA plots available in 2008. The report showed that large snags are rare in all types, but tend to occur in cool habitat type groups and are likely to be Douglas-fir or Engelmann spruce. Snags in lodgepole pine types are mostly distributed in the smaller size class. In cool habitat types and lodgepole pine, early seral stands have the most snags due to stand-replacing fires. Warm types have a more even distribution of snags into later seral stages because of a more frequent, less severe fire regime. All groups 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. This is due to 1) fewer trees living to an old age, 2) as trees age, they grow slower, never reaching large diameters, and 3) the inability of systems to contain large old trees and snags due to disturbances (Bollenbacher et al. 2008).

Trend

The snag resource is dynamic based on natural and anthropogenic influences. Disturbances create new snags, which in some areas may be offset by human actions such as salvage or firewood cutting. Actions that increase stand resilience can reduce the creation snags at small scales. In the short term, medium snags, especially lodgepole pine, are abundant on the HLC NFs. In the long term, this "pulse" of snags will be lost to natural attrition. The timing of when dead trees fall varies by species, the cause of mortality, and site conditions. Studies suggest that the range of when most trees fall is usually between 3 and 15 years after death (USDA 2000b, Mitchell and Preisler 1998, and Lyon 1977). A quantitative assessment of the historical abundance and distribution of snags is not currently available. Snags in wilderness areas may reflect a natural condition because disturbances have been allowed to occur and human management is limited, although some fire suppression has occurred. There are more medium snags inside wilderness than outside. Recent large fires are likely the drivers of this difference. For large and very large snags, there is not an appreciable difference between wilderness areas and the managed landscape. Large snags may be naturally rare on the HLC NFs (Bollenbacher et al. 2008).

Natural processes and disturbances will continue to create snags. Any factor that increases tree mortality will also increase snags. This includes the effects of a changing climate on tree stress, wildfires, and insects. Fire suppression interacts with natural snag processes. 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 NFs. Further, high stand densities can limit 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.

Information Needs

A natural range of variability analysis done with new data sources would enhance our understanding of the natural range of variability of snags on the HLC NFs.

Very Large Live Trees

Existing Condition

Very large trees (twenty inches in diameter or greater) are key ecosystem components because they provide habitat and a future source of very large snags. Large fire-resistant trees are important because they can persist for centuries, providing seed after disturbance and contributing to long-term forest sustainability. Douglas-fir and ponderosa pine are the common fire-tolerant species on the HLC NFs. Figure 2.55 displays estimates for very large live trees per acre on the HLC NFs, within and outside wilderness, using FIA intensified grid data for the GAs where it is available and base FIA data for the planning area overall and areas without a completed FIA intensified grid. The data show that there are just over 2 very large trees per acre overall on the HLC NFs. More large trees appear to be present outside of wilderness, although confidence intervals overlap. Most GAs have between 0.5 and 3 very large live trees per acre. The Big Belts GA contains the most very large live trees. Across the HLC NFs, very large live trees are slightly more abundant than very large snags. About 9% of the very large live trees are ponderosa pine and 77% are Douglas-fir. These are the most long-lived and valuable future snags.

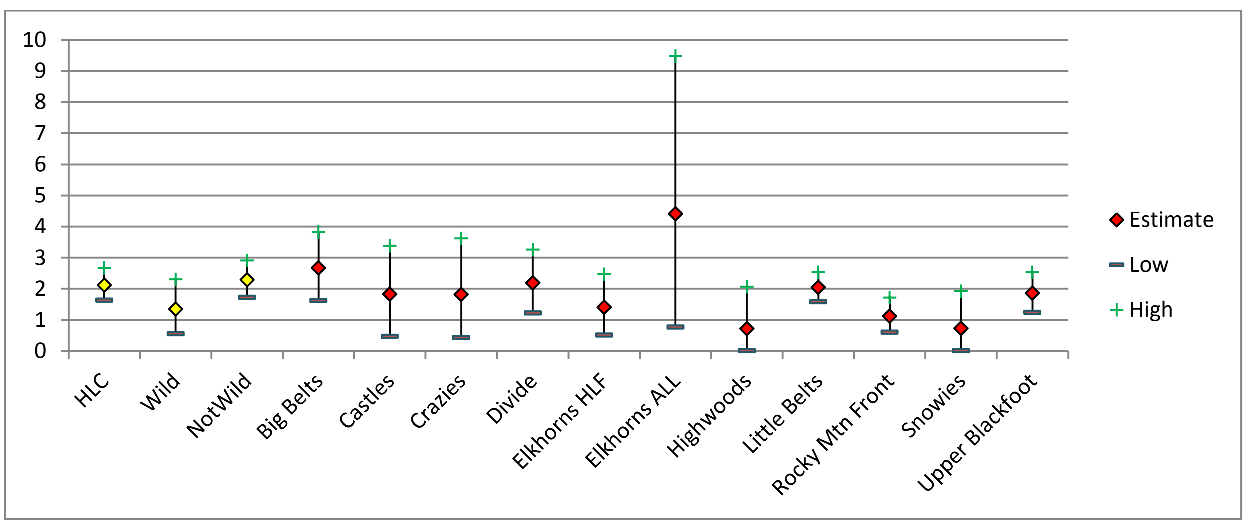

Figure 2.55 Very large live trees per acre (20”+ diameter) – HLC NFs, allocation, and GA – R1 Summary Database

Large trees tend to occur in areas classified in the large or very large tree size classes; however, large tree components also occur in areas dominated by smaller trees. Table 2.32 displays the very large trees per acre found within the size classes assigned to base FIA plots across the HLC. Very large tree components can be found in areas classified into smaller size classes. Depending on natural regimes, this may represent an infilling of smaller trees into sites that were historically maintained in a more open, large size class condition; or sites where the large tree remnants were left behind by the disturbance that initiated a new stand of trees.

Table 2.32 Very large trees per acre by size class category, HLC NFs, base FIA data, R1 Summary Database

Size Class	Average Very Large Trees per Acre
Nonforested	0
Seedling/Sapling	0
Small Tree	0.14
Medium Tree	3.15
Large Tree	13.36
Very Large Tree	41.12

Trend

The development of large trees is influenced by growing conditions, including climate and soil productivity, along with disturbances. Large trees may develop in areas where frequent disturbance maintains low stand density and provides ample resources for individual tree growth. Human management can also promote large tree growth by manipulating density and composition. Large tree development also occurs in refugia patches protected from disturbance. Refugia are commonly associated with mesic areas, which further enhance their ability to support tree growth. It is likely that some very large trees accessible to humans were cut during initial settlement. Additionally, recently large pine trees have been impacted by the mountain pine beetle. Some losses of large Douglas-fir to Douglas-fir beetle have also occurred, particularly near wildfire areas. Stand replacing fires may also have killed large trees; in some areas, fires may have been more severe than the natural regime due to fire suppression or other factors.

There is no quantitative assessment of historic large live trees currently available. The 2003 historic range of variability analysis did assess size classes. While scattered large live trees would occur in areas classified as smaller size classes, the highest numbers of large live trees occur in the very large tree size class. SIMPPLLE modeling conducted in 2003 concluded that, depending on the geographic area, between 1 and 6% of the landscape was in the very large tree size class (USDA 2003). If the amount of very large live trees in wilderness areas (between 1 and 2 per acre) is indicative of historical conditions, then the HLC NFs overall may be near or slightly above quantities that would be expected naturally.

Information Needs

A detailed natural range of variation analysis using new data sources would provide more certainty on the historic distribution of large live trees in the plan area and how these compare to the existing condition.

Coarse Woody Debris

Existing Condition

Coarse woody debris is wood lying on the ground surface with a diameter of at least three inches. This is a key ecosystem characteristic because of its importance to fire behavior, site productivity, nutrient cycling, and habitat. Woody debris is recruited as dead trees or branches fall, and is reduced as it decomposes. Decomposition occurs more slowly on dry sites than on moist sites. The quantity of downed wood is influenced by fire regimes. High severity regimes result in pulses of downed wood by allowing material to build up between infrequent fires and then consuming most of it in a single fire event. Conversely, sites with high frequency, low severity fires support a more consistent, low level of debris which is continually consumed and recruited by repeated fire events.

Figure 2.56 displays coarse woody debris estimates in tons per acre using FIA intensified grid data for the GAs where it is available. Base FIA data is used for the plan area overall and GAs without a complete FIA intensified grid. Across the HLC NFs, there is an average of 7.17 tons/acre. The amount in wilderness is slightly higher than that in non-wilderness, perhaps due to the greater extent of fires, although the ranges of estimates overlap. Estimates by GA range from a minimum of about 4 tons/acre in the Highwoods and Snowies, to a maximum average of 10 tons/acre in the Elkhorns. Landscapes that had large fires where the trees have fallen to the ground, such as the Elkhorns, have higher amounts of woody debris.

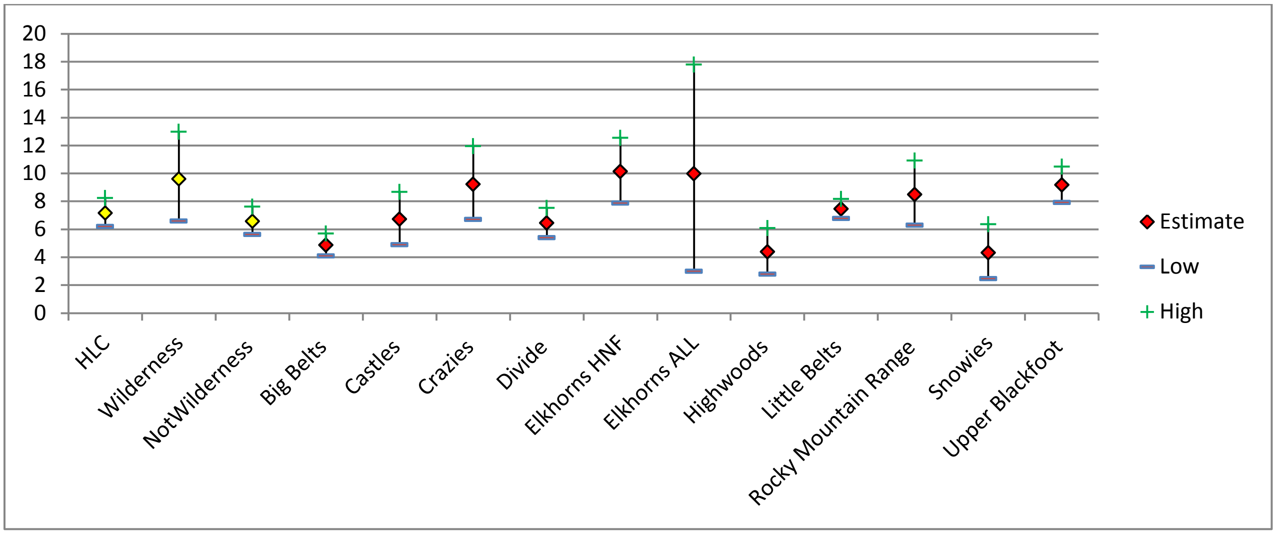

Figure 2.56 Tons per acre coarse woody debris >3" diameter – HLC NFs, land allocation, and GA – R1 Summary Database

Trend

Downed wood is recruited as snags and branches fall, and diminishes over time through decomposition or by being consumed by wildfire. Therefore, the trend of downed wood is intertwined with all of the disturbances and drivers such as climate that affect vegetation. Fire suppression, particularly on dry sites, has allowed for a buildup of downed wood in areas that would otherwise have been maintained at lower levels. Additionally, recent large scale mortality events such as the beetle outbreak are expected to create high downed woody debris levels across large areas in the short term. Homogeneity in forest conditions perpetuates pulse in downed wood. A quantitative analysis to estimate the quantity of downed wood present historically has not been conducted.

Information Needs

A detailed natural range of variation analysis using new data sources would provide more certainty on the historic distribution of coarse woody debris in the plan area, and how these compare to the existing condition.

Ecosystem Diversity: Key Characteristics by Potential Vegetation Type

Existing Condition

Previous sections have covered key characteristic concepts and estimated them by geographic area. Rather than a spatial depiction, in this section key characteristics to the extent possible are estimated for each habitat type group. As appropriate during the Forest Plan revision process, plan components may be applied to the Broad Potential Vegetation rather than to specific habitat type groups. Each habitat type group is analyzed here to provide a base for future analysis.

Hot Dry Habitat type Group

The hot dry habitat type group includes the driest potentially forested sites; limber pine is the climax species. There are 19 base FIA plots across the HLC NFs classified in this habitat type group.

Composition

Not surprisingly, the ponderosa pine cover type, which includes dominance types of juniper, limber pine, and/or ponderosa pine, is the most abundant. Non-forested types are also well-represented, indicative of the transitional nature of this habitat type group between a forested and non-forested condition. Douglas-fir cover types are present on about 20%. In some areas this may represent encroachment of Douglas-fir made possible by fire suppression which would otherwise have been inhibited by frequent fire.

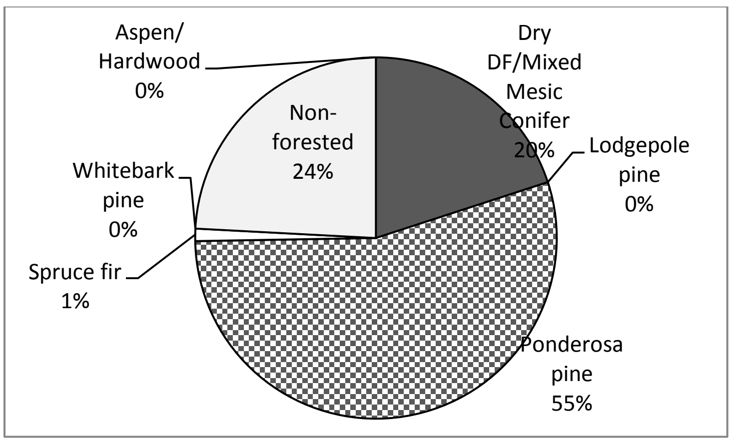

Figure 2.57 Cover type distribution in the hot dry habitat type group across the HLC NFs

The presence of tree species of interest in the hot dry group is shown in Table 2.33. Limber pine is present on a majority of these areas. This group also supports rocky mountain juniper and ponderosa pine.

Table 2.33 Presence of tree species of interest in the hot dry habitat type group

Rocky mountain juniper	Western larch	whitebark pine	ponderosa pine	Quaking Aspen	Limber pine
11.94%	0%	0%	11.94%	0%	63.33

Structure

Small tree size classes and non-forested conditions are common in the hot dry habitat type group. No plots are classified as very large tree. A substantial proportion of these sites are non-forested or very sparse (less than 9% canopy cover of trees). The remainder of plots are relatively equally distributed across the density classes. The high tree cover density class in particular may be a consequence of fire exclusion. Where forested, vertical structure tends to be single storied, with continuous (multi-storied) conditions also common. Most sites in the hot dry habitat type group, where forested, are under 100 years old; about 20% are over 100 with a small proportion (2%) over 200 years old. Most likely, the long-lived trees are ponderosa pine or limber pine.

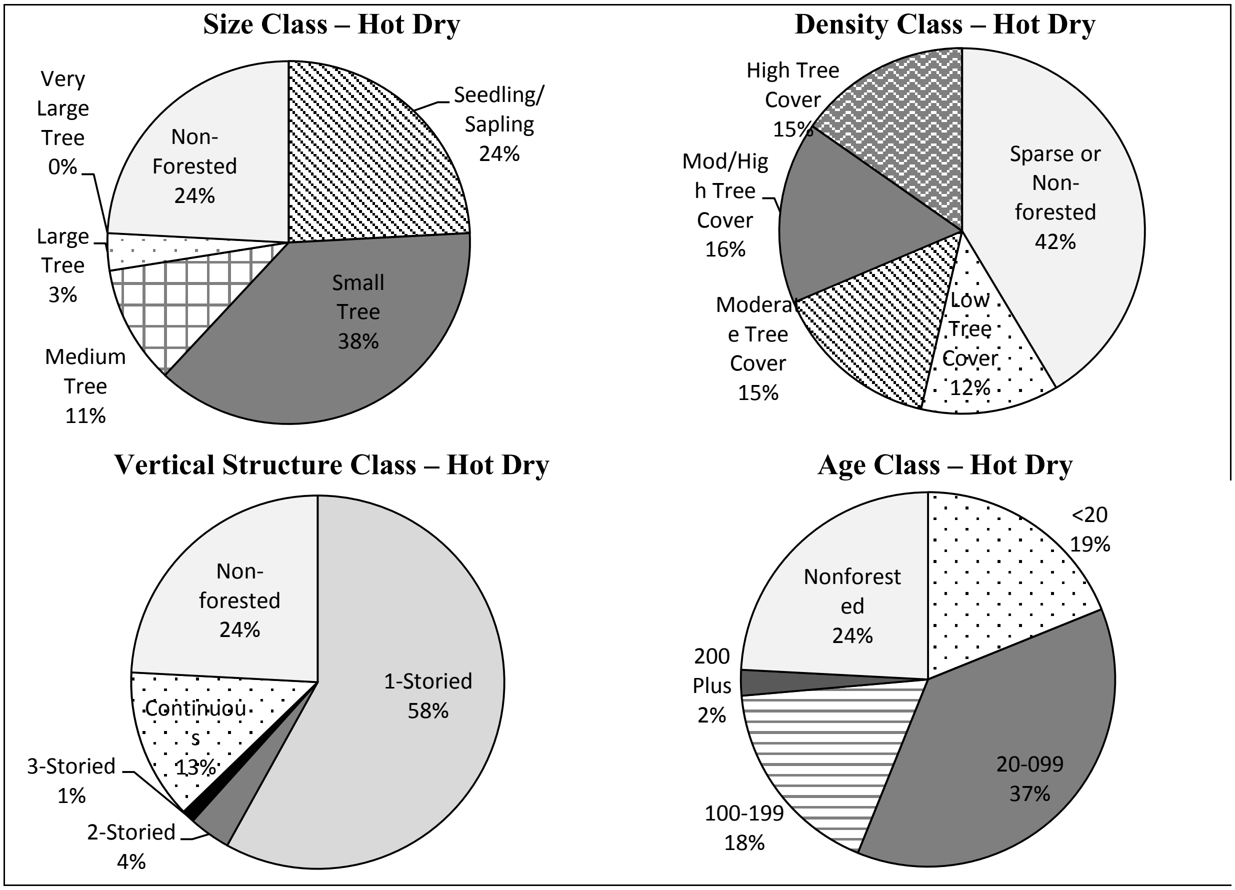

Figure 2.58 Size class, density class, vertical structure class, and age class in the hot dry habitat type group

It is estimated that 9.47% of sites in the hot dry habitat type group on the HLC NFs are currently old growth. The quantity of large and very large snags is very similar to the average for the HLC NFs overall, but there are substantially fewer medium snags. The large snags on these sites are most likely to be ponderosa pine.

Table 2.34 Estimates of snags per acre in the hot dry habitat type group

Medium	Large	Very Large
2.63	1.77	0.71

These sites have 0.53 very large live trees per acre, which is less than the HLC NFs average. Downed woody debris greater than three inches in diameter is relatively low, averaging 2.47 tons per acre. These dry sites would not be expected to have an abundance of downed wood.

Function

Hot dry habitat type group in general has low hazard for the insects for which hazard ratings are available in the Summary Database (Table 2.35). Western spruce budworm and Douglas-fir beetle have the potential to impact some areas based on Douglas-fir components. Mountain pine beetle can impact ponderosa and limber pine; the hazard to this insect may be lower today than it was prior to the mountain pine beetle outbreak because of the mortality of susceptible trees. The presence of, and hazard to, lodgepole pine from mountain pine beetle is negligible. The effect of blister rust and mountain pine beetle on limber pine survival and regeneration is important in this habitat type group (Jackson et al. 2010).

Table 2.35 Insect hazard ratings – hot dry habitat type group

Insect	No Hazard	Low Hazard	Moderate Hazard	High Hazard
Douglas-fir beetle	41.76%	46.02%	12.22%	0%
Western spruce budworm	41.76%	33.06%	18.52%	6.67%
Mountain pine beetle in ponderosa pine	88.98%	4.17%	6.85%	0%
Mountain pine beetle in lodgepole pine	97.22%	2.78%	0%	0%

Connectivity

An analysis of the connectivity within habitat type groups is not available at the writing of this assessment. Based on a natural regime of high frequency, low severity disturbance, it would be expected that openings in this type would be relatively small. The largest continuous patches of this habitat type group are found in the Little Belts and Rocky Mountain Range GAs.

Warm Dry Habitat Type Groups

There are 18 base FIA plots across the HLC NFs that have been classified into this habitat type group. These are ponderosa pine climax or very dry Douglas-fir climax types with bunchgrass understories.

Composition

Ponderosa pine and Douglas-fir cover types are the most abundant in the warm dry habitat type group. The aspen cover type is also present as a result of disturbances. Nonforested types are also represented, likely reflecting areas where disturbance has promoted a dominance of grasses or shrubs.

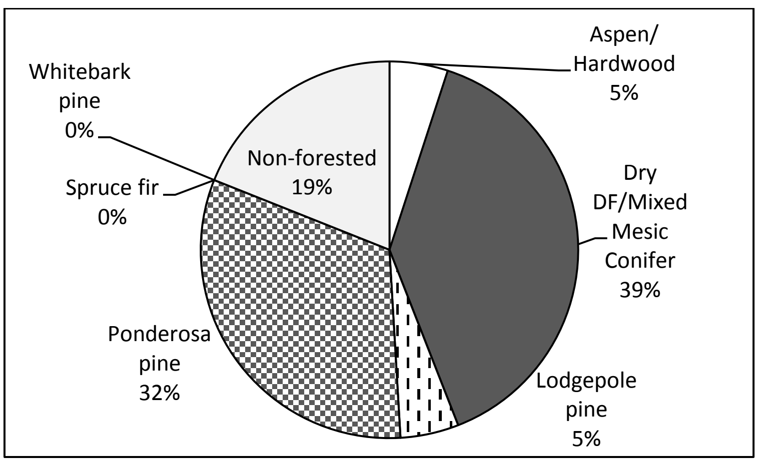

Figure 2.59 Cover type distribution, warm dry habitat type group

Tree species of interest are present in the warm dry habitat type group as shown in Table 2.36. Rocky mountain juniper, limber pine, and aspen are present. This group currently contains the greatest presence of ponderosa pine (over 35%). The presence of aspen is the same as the aspen/hardwood cover type, indicating that where it occurred it was dominant. A very small amount of whitebark pine was recorded; while some individuals may be present, whitebark pine would not expect to compete well on these warm dry sites.

Table 2.36 Presence of tree species of interest, warm dry habitat type group

Rocky mountain juniper	Western larch	whitebark pine	ponderosa pine	Quaking Aspen	Limber pine
15.63%	0%	1.25%	35.42%	5%	7.81%

Structure

In the warm dry habitat type group, the medium tree class is the most common but all size classes are represented. All density classes are represented, with high tree cover being the least common. Where forested, the vertical structure tends to be single storied or 2- storied. Most of these sites are under 100 years old or currently non-forested; about 24% are over 100 with a small proportion (4%) being over 200 years old. Estimates for the non-forested proportions vary slightly, due to rounding and the variables included in each estimate.

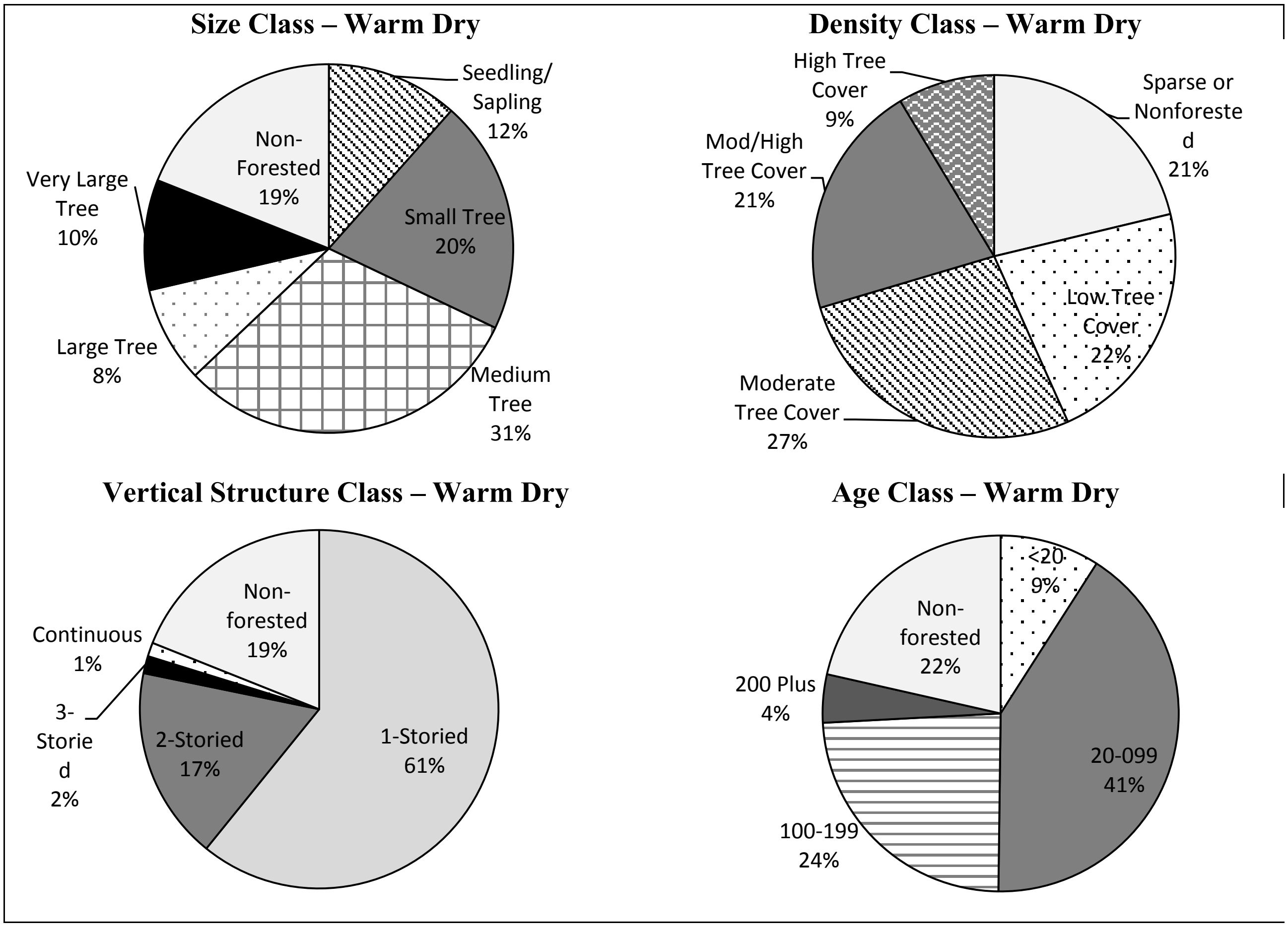

Figure 2.60 Size class, density class, vertical structure class, and age class - warm dry habitat type group

It is estimated that 8.24% of the warm dry habitat type group on the HLC NFs is currently old growth. The quantity of all snag classes is very similar to the average for the HLC NFs overall. The large snags on these sites are most likely to be ponderosa pine and Douglas-fir.

Table 2.37 Estimates of snags per acre, warm dry habitat type group

Medium	Large	Very Large
6.97	1.46	0.65

Warm dry sites average 5.05 very large live trees per acre, which is higher than the HLC NFs average. Downed woody debris greater than three inches in diameter is relatively low, averaging 0.59 tons per acre.

Function

The warm dry habitat type group in general has low to no hazard for the insect pests of interest. However, moderate hazard to Douglas-fir beetle and western spruce budworm is present on 15-20%, in areas of dense and/or multi-storied Douglas-fir. Moderate hazard to ponderosa pine is present on about a third of the plots, and may be lower today than it was prior to the beetle outbreak.

Table 2.38 Insect hazard ratings – warm dry habitat type group

Insect	No Hazard	Low Hazard	Moderate Hazard	High Hazard
Douglas-fir beetle	49.38%	22.5%	18.44%	9.69%
Western spruce budworm	49.38%	19.06%	16.56%	15%
Mountain pine beetle in ponderosa pine	64.58%	3.33%	30.83%	1.25%
Mountain pine beetle in lodgepole pine	92.50%	2.5%	5%	0%

Connectivity

An analysis of the patch metrics of forest openings and multi-storied patches within individual habitat type groups is not yet available at the writing of this assessment. Based on a natural regime of high frequency, low severity disturbance, it would be expected that openings in this type would be relatively small.

Moderately Warm Dry

There are 139 base FIA plots classified in this habitat type group; this is the most common habitat type group on the HLC NFs, representing 34% of the forested potential vegetation types. This group includes mesic Douglas-fir climax types with grass or shrub understories.

Composition

Douglas-fir is by far the most abundant cover type in the moderately warm dry habitat type group, with lodgepole pine also common. The ponderosa pine makes up less than 10%, although ponderosa pine would be expected to dominate on many of these sites under a natural disturbance regime. Some sites are currently dominated by grasses or shrubs, and the aspen cover type is also present in small amounts.

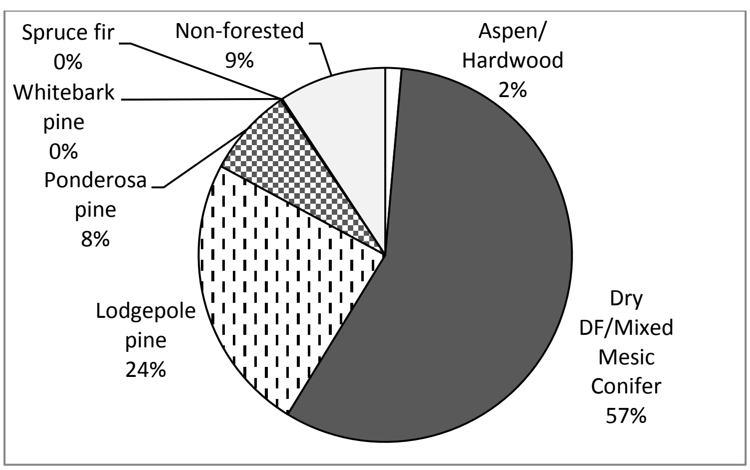

Figure 2.61 Cover type distribution, moderately Warm dry habitat type group

The presence of tree species of interest is shown in Table 2.39. Moderately warm dry habitat types support small amounts of all these species. While individuals are present, whitebark pine is not expected to thrive. The presence of ponderosa pine, limber pine, and aspen may be lower than historical levels due to fire suppression. The small amount of western larch occurs on the Upper Blackfoot GA, at the eastern edge of its range.

Table 2.39 Presence of tree species of interest, moderately warm dry habitat type group

Rocky mountain juniper	Western larch	Whitebark pine	Ponderosa pine	Quaking aspen	Limber pine
7.18%	0.19%	2.62%	12.73%	3.42%	10.78%

Structure

The small tree size class is the most abundant, with the medium class also common. The high tree density class is prevalent, with the moderate/high class also common. The homogeneity indicated by these variables is also reflected by the lack of age class diversity. Nearly half of these sites are 20 to 99 years old, and 37% are between 100 and 199. Few areas are younger or older. Similarly, most sites are single-storied. The homogeneity of this type is likely attributable to a combination of factors including large disturbances in the late 1800's, harvest during initial settlement, climate trends, and fire suppression.

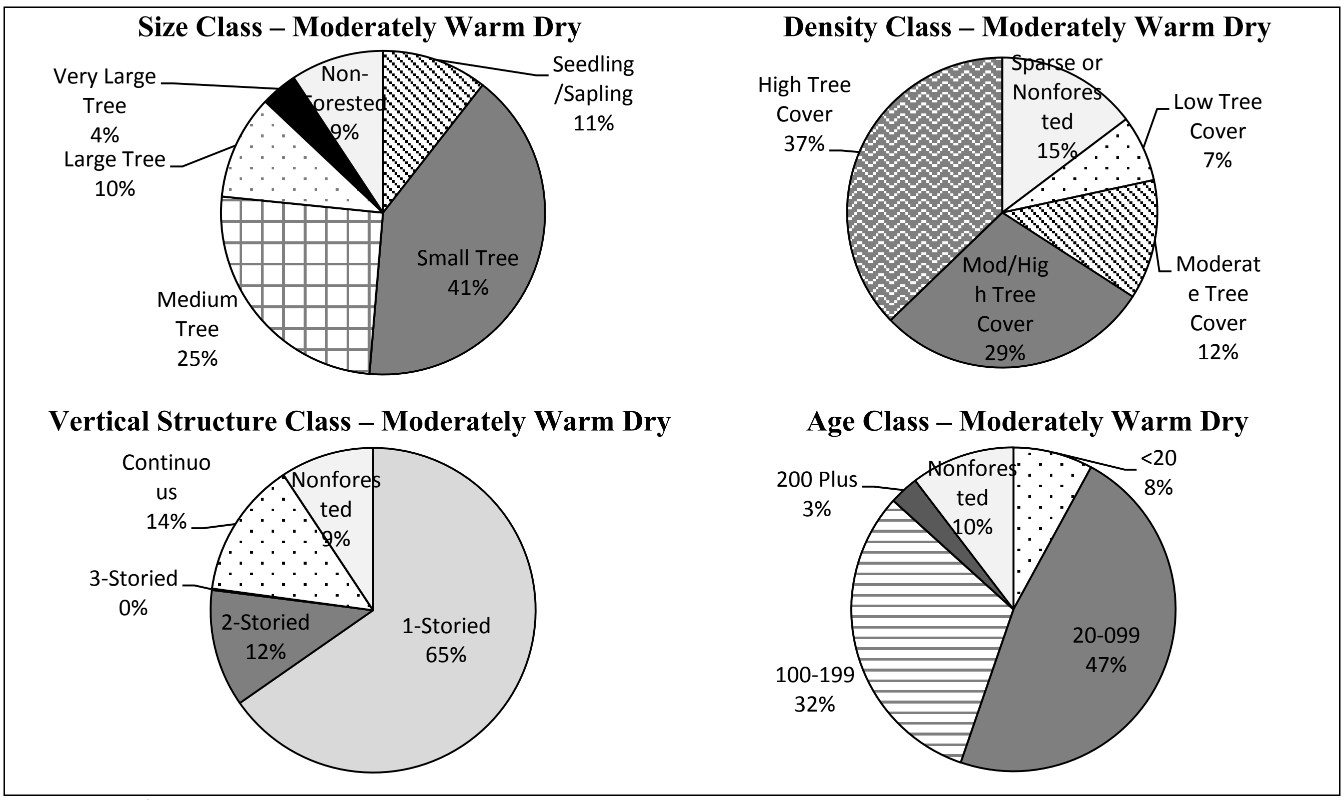

Figure 2.62 Size class, density class, vertical structure class, and age class - moderately warm dry habitat type group

It is estimated that 8.42% of the moderately warm dry habitat type group on the HLC NFs is currently old growth. The quantity of all snag classes is very similar to the average for the HLC NFs overall. The large snags on these sites are most likely to be ponderosa pine and Douglas-fir.

Table 2.40 Estimates of snags per acre, moderately warm dry habitat type group

Medium	Large	Very Large
5.1	1.07	0.79

These sites have 3.02 very large live trees per acre, which is higher than the HLC NFs average. Downed woody debris greater than three inches in diameter averages 4.59 tons per acre.

Function

Over half of the moderately warm dry habitat type group has a moderate or high hazard to Douglas-fir beetle and western spruce budworm. Mountain pine beetle hazard to ponderosa pine is low due the lack of this component, and may be lower today than it was prior to the beetle outbreak. Where lodgepole pine is dominant, it is generally at moderate hazard to the mountain pine beetle and may also have been recently altered by the outbreak.

Table 2.41 Insect hazard ratings – moderately warm dry habitat type group

Insect	No Hazard	Low Hazard	Moderate Hazard	High Hazard
Douglas-fir beetle	20.17%	34.26%	34.96%	10.62%
Western spruce budworm	20.01%	14.47%	30.21%	45.45%
Mountain pine beetle in ponderosa pine	85.35%	2.85%	8.21%	3.6%
Mountain pine beetle in lodgepole pine	66.65%	5.69%	19.62%	8.04%

Connectivity

An analysis of the patch metrics of forest openings and multi-storied patches within individual habitat type groups is not yet available at the writing of this assessment. Many large and well-connected patches of this common type are present on all GAs.

Cool Moist

There are 64 base FIA plots across the HLC NFs that have been classified into the cool moist habitat type group. This habitat type group includes the most common subalpine fir and Engelmann spruce climax types.

Composition

Spruce/fir, Douglas-fir, and lodgepole pine cover types are the most common types in this group. Ponderosa pine, whitebark pine, and aspen cover types are present on small amounts. Ponderosa pine would only be expected on the lowest elevation, driest sites, while whitebark pine would only be expected on the highest elevation sites. A small proportion of these sites are dominated by grasses or shrubs, likely due to recent disturbance.

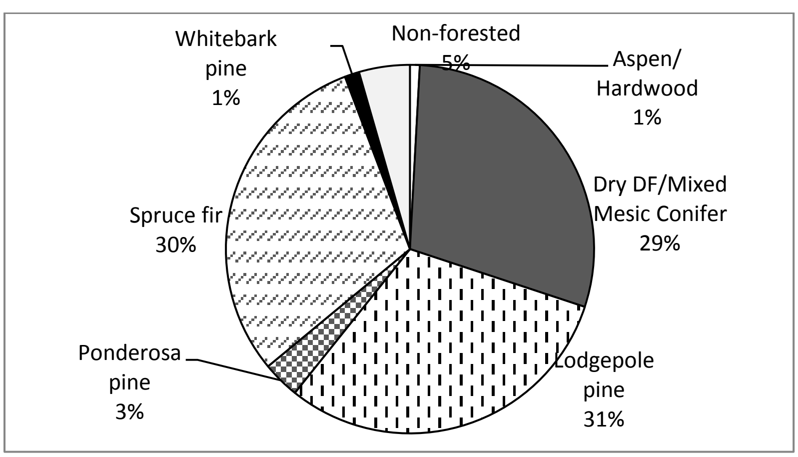

Figure 2.63 Cover type distribution, cool moist habitat type groups

The presence of tree species of interest is shown in Table 2.42. The cool moist habitat type group supports small amounts of all these species. Juniper is less common than on drier groups. The presence of western larch, ponderosa pine, limber pine, and aspen is dependent upon disturbances that promote open conditions to allow them to outcompete more shade tolerant Douglas-fir or subalpine fir. While the whitebark cover type is rare, whitebark individuals are present on over 10%. This group contains the most western larch, found on the Upper Blackfoot GA at the eastern edge of its range.

Table 2.42 Presence of tree species of interest - cool moist habitat type group

Rocky mountain juniper	Western larch	Whitebark pine	Ponderosa pine	Quaking aspen	Limber pine
0.42	1.13%	10.42%	0.34%	1.95%	9.58%

Structure

The small tree size class is the most abundant, making up almost half of the plots, with the medium class also common. These two classes together represent nearly 80%. No plots classify as very large tree. The high tree density class is present on nearly half of the plots. The moderate/high class is also common, and the low cover class rare. Homogeneity is also reflected by a lack of age class diversity. The vertical structure class tends to be single storied (likely common where lodgepole is dominant), or continuous, which is expected in spruce/fir or Douglas-fir types at the later stages of succession. The homogeneity is attributable to similar factors as described for the moderately warm and dry habitat type group.

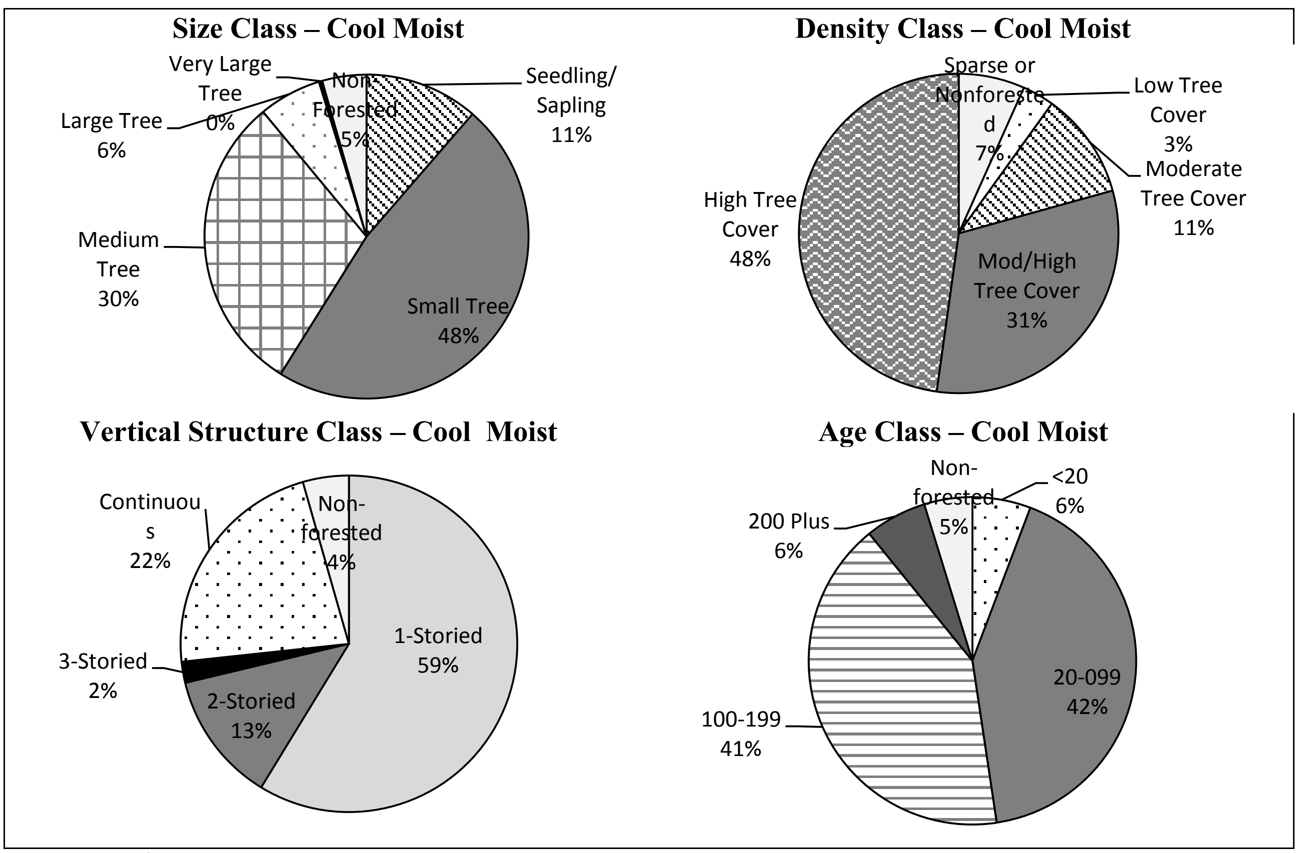

Figure 2.64 Size class, density class, vertical structure class, and age class - cool moist habitat type group

It is estimated that 21.17% of the cool moist habitat type group on the HLC NFs is currently old growth; this amount is higher than any other group, and substantially higher than the HLC NFs average. These sites also support a resource of snags as shown in Table 2.43. The quantity of medium snags is similar to the average for the HLC NFs overall, but there are fewer large and very large snags than the HLC NFs overall.

Table 2.43 Estimates of snags per acre, cool moist habitat type group

Medium	Large	Very Large
7.57	0.76	0.38

In addition, these sites have 2.11 very large live trees per acre, which is similar to the HLC NFs average. Downed woody debris averages 9.38 tons per acre, and is reflective of the higher levels of downed wood expected in moist types when compared to the drier types.

Function

Due to its rare occurrence, there is little mountain pine beetle hazard to ponderosa pine. Moderate to high hazard to all of the other insects is present on over a third of these sites. Hazard to Douglas-fir beetle is limited to where large Douglas-fir occurs, but western spruce budworm hazard is more extensive because it can also infest spruce/fir stands. Where lodgepole pine is dominant, just under half of the sites are estimated to remain at moderate or high hazard to the mountain pine beetle even after the outbreak.

Table 2.44 Insect hazard ratings – cool moist habitat type group

Insect	No Hazard	Low Hazard	Moderate Hazard	High Hazard
Douglas-fir beetle	46.5%	23.53%	21.5%	8.48%
Western spruce budworm	13.22%	9.32%	32.01%	45.45%
Mountain pine beetle in ponderosa pine	99.66%	0%	0.34%	0%
Mountain pine beetle in lodgepole pine	45.9%	10.23%	32.43%	11.44%

Connectivity

An analysis of the patch metrics of forest openings and multi-storied patches within individual habitat type groups is not yet available at the writing of this assessment. The largest patches appear to be found in the Little Belts and Rocky Mountain Range GAs, but this type is well distributed across the Upper Blackfoot and Divide GAs as well. Patches are smaller and more fragmented in the Elkhorns, Big Belts, Castles, and Crazies GAs.

Cool Wet

Only 10 base FIA plots across the HLC NFs have been classified into the cool wet habitat type group. These are not common types. This group includes the moistest subalpine fir and Engelmann spruce climax types which are generally associated with riparian areas.

Composition

The chart below shows the cover types present in the cool wet habitat type group on the HLC NFs. Nearly half of these sites have a lodgepole pine cover type, and nearly a third have a spruce/fir cover type. About a quarter of the plots are currently non-forested, and are likely dominated by riparian shrubs.

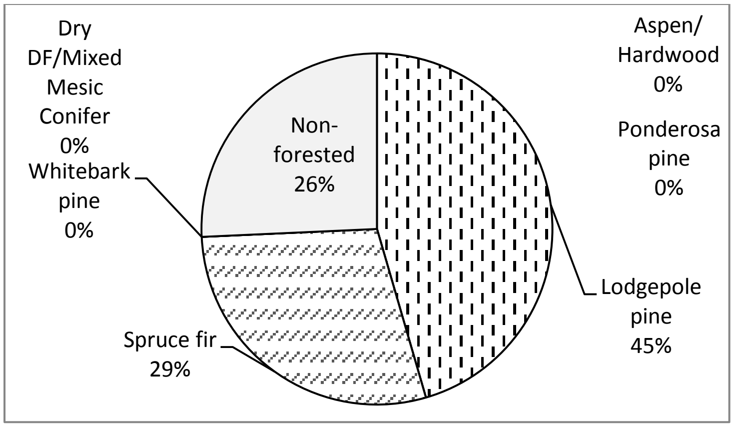

Figure 2.65 Cover type distribution, cool wet habitat type group

The presence of tree species interest is shown in Table 2.45. The small sample of these types supports a small amount of whitebark pine, and none of the other species. Aspen would have the potential to occur.

Table 2.45 Presence of tree species of interest - cool wet habitat type groups

Rocky mountain juniper	Western larch	whitebark pine	ponderosa pine	Quaking Aspen	Limber pine
0%	0%	5%	0%	0%	0%

Structure

The small sample of plots shows a fairly even distribution of size classes, with the exception of the very large class being rare. Density class tends to be moderate or high in forested areas. The vertical structure class tends to be single storied, or continuous, which is expected in spruce/fir at the later stages of succession. All age classes are also represented. While the >200 year old class is the least abundant, this habitat type group contains more of these older forests than most other types. This may be due to riparian areas being less subject to disturbances.

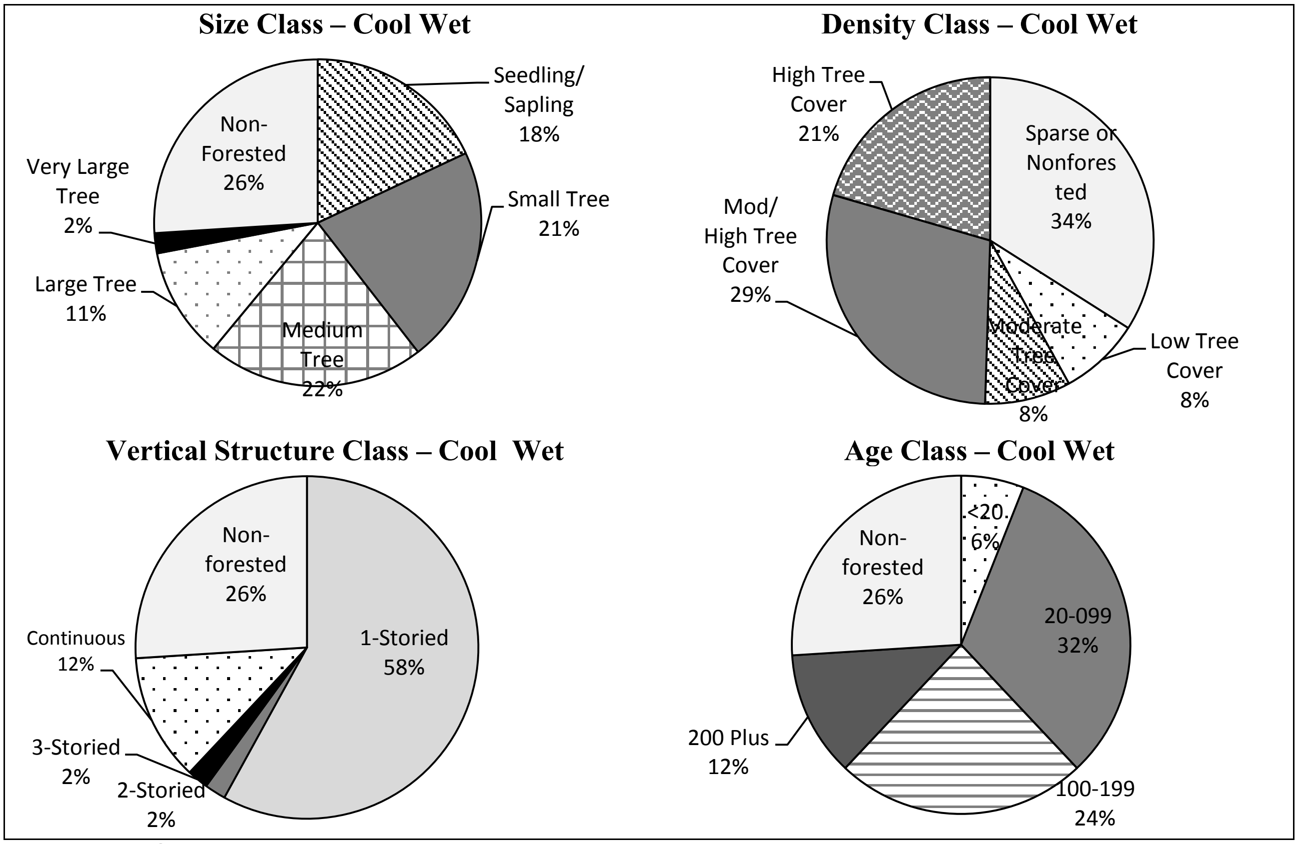

Figure 2.66 Size class, density class, vertical structure class, and age class - cool wet habitat type group

It is estimated that 12% of the cool wet habitat types on the HLC NFs are currently old growth; this amount is slightly higher than the HLC NFs average overall. The quantity of all classes of snags is more abundant in these types than the HLC NFs overall. These sites may retain large snags because they often occur in association with topographical features such as riparian areas and swales that are less subject to wind and other disturbances.

Table 2.46 Estimates of snags per acre, cool wet habitat type group

Medium	Large	Very Large
10.58	3.46	2.13

These sites are currently estimated to contain and average of 2.47 very large live trees per acre, which is similar to the HLC NFs average. Downed woody debris greater than three inches in diameter averages 17.17 tons per acre; this is reflective of the higher levels of downed wood expected in riparian areas.

Function

Generally insect hazard ratings for these sites are nonexistent to low. Little to no ponderosa pine occurs on these sites, and where it does occur Douglas-fir is a minor component. Western spruce budworm hazard is present in areas with spruce/fir. Where lodgepole pine is dominant, some mountain pine beetle hazard is present.

Table 2.47 Insect hazard ratings – cool wet habitat type group

Insect	No Hazard	Low Hazard	Moderate Hazard	High Hazard
Douglas-fir beetle	98%	0%	2%	0%
Western spruce budworm	52%	8%	24%	16%
Mountain pine beetle in ponderosa pine	100%	0%	0%	0%
Mountain pine beetle in lodgepole pine	54%	14%	22%	10%

Connectivity

An analysis of the patch metrics of forest openings and multi-storied patches within individual habitat type groups is not yet available at the writing of this assessment. Generally this type is present in small, fragmented patches on most GAs.

Cool Moderately Dry to Moist

The cool moderately dry to moist habitat type group is common on the HLC NFs, represented by 127 base FIA plots. This group includes dry subalpine fir and Engelmann spruce climax types along with lodgepole pine climax forests.

Composition

About half the plots in the cool moderately dry to moist have a lodgepole pine cover type. Spruce/fir and Douglas-fir cover types are also common. The whitebark pine cover type is less common. The aspen cover type is present but rare, in part likely due to fire suppression. Less than 10% of these plots are currently non-forested.

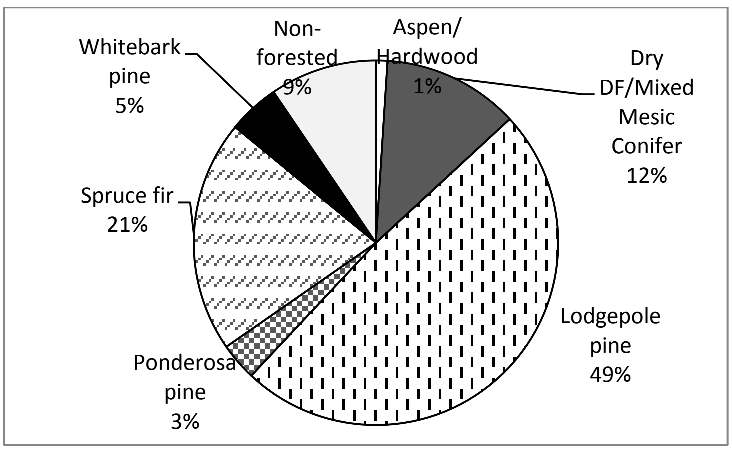

Figure 2.67 Cover type distribution, cool moderately dry to moist habitat type group

The presence of tree species of interest is shown in Table 2.48. Whitebark pine and limber pine occur and may grow together on limestone substrates. Neither species is common as a cover type, but are minor components which could be enhanced. Aspen occurs in small amounts and also has the potential to expand.

Table 2.48 Presence of tree species of interest - cool moderately dry to moist habitat type group

Rocky mountain juniper	Western larch	whitebark pine	ponderosa pine	Quaking Aspen	Limber pine
0.2%	0%	17.62%	0.2%	2.02%	10.89%

Structure

The cool moderately dry to moist habitat type group supports a fairly even distribution of seedling/sapling, small tree, and medium tree size classes. The large tree class is rare and no plots classified as very large tree. The most common density class is the high tree cover, and moderate/high cover is also common. Moderate and low tree cover classes are present on less than 10% each. Vertical structure class tends to be single storied, or continuous, which is expected in spruce/fir at the later stages of succession. Most of these sites are in the 20-99 or 100-199 age classes. This is partially due to the short-lived nature of lodgepole pine which dominates many of these sites.

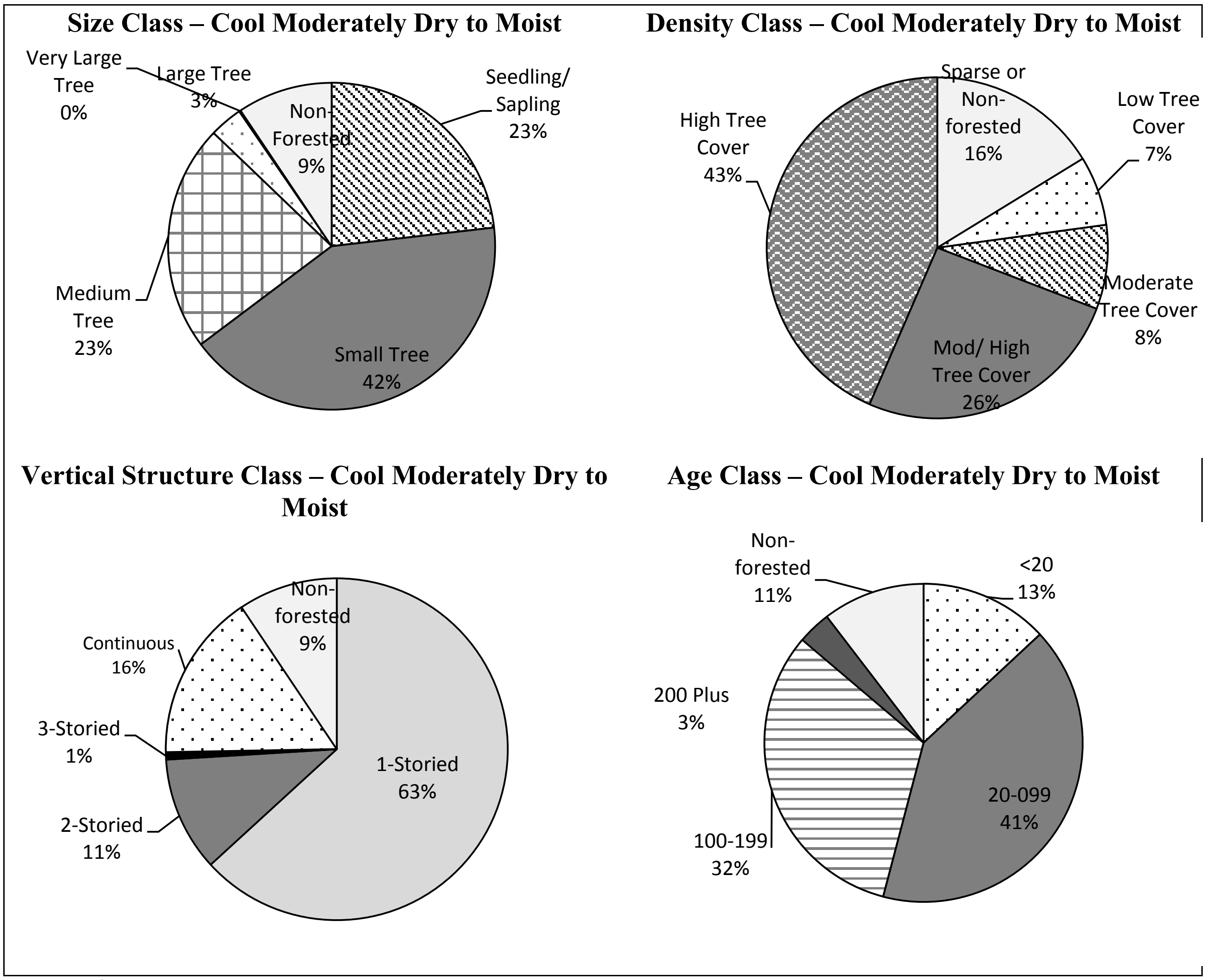

Figure 2.68 Size class, density class, vertical structure class, and age class - cool moderately dry to moist habitat type group

It is estimated that 15.43% of the cool moderately dry to moist habitat type group on the HLC NFs is currently old growth; this amount is higher than the HLC NFs average overall. There are more medium snags than in other groups, in part due to the preponderance of lodgepole pine likely present that has been impacted by the mountain pine beetle and/or recent wildfires. The large snag resource is similar to the HLC NFs average, but there are fewer very large snags on these types.

Table 2.49 Estimates of snags per acre, cool moderately dry to moist habitat type group

Medium	Large	Very Large
9.79	1.83	0.42

These sites are estimated to contain an average of 1.02 very large live trees per acre, slightly less than the HLC NFs average, in part because lodgepole pine is prevalent and tends to not reach a large size. Downed woody debris greater than three inches in diameter averages 10.17 tons per acre; this is reflective of the levels of downed wood expected in moist habitat types.

Function

About half of these sites contain moderate to high hazard to the western spruce budworm, where components of Douglas-fir and Engelmann spruce occur. Some Douglas-fir beetle hazard is also present. Little to no ponderosa pine occurs. Lodgepole pine is prevalent, and just over 40% of these sites are estimated to have moderate to high hazard to the mountain pine beetle even after the recent outbreak.

Table 2.50 Insect hazard ratings – cool moderately dry to moist habitat type groups

Insect	No Hazard	Low Hazard	Moderate Hazard	High Hazard
Douglas-fir beetle	71.49%	13.82%	13%	1.69%
Western spruce budworm	28.71%	19.46%	31.71%	20.12%
Mountain pine beetle in ponderosa pine	99.8%	0%	0.2%	0%
Mountain pine beetle in lodgepole pine	37.1%	19.69%	33.21%	10%

Connectivity

An analysis of the patch metrics of forest openings and multi-storied patches within individual habitat type groups is not yet available at the writing of this assessment. Generally this type is well distributed and connected in most GAs, with the exception of the northern Big Belts.

Cold

The cold habitat type group is uncommon and is represented by only 5 base FIA plots. Therefore estimates contain a high level of uncertainty. This group includes the highest elevation subalpine fir and lodgepole pine climax types, where whitebark pine may be present.

Composition

Most of the cold habitat type group currently supports the subalpine fir cover type. The whitebark pine, lodgepole pine, and non-forested cover types all occur on less than 10%.

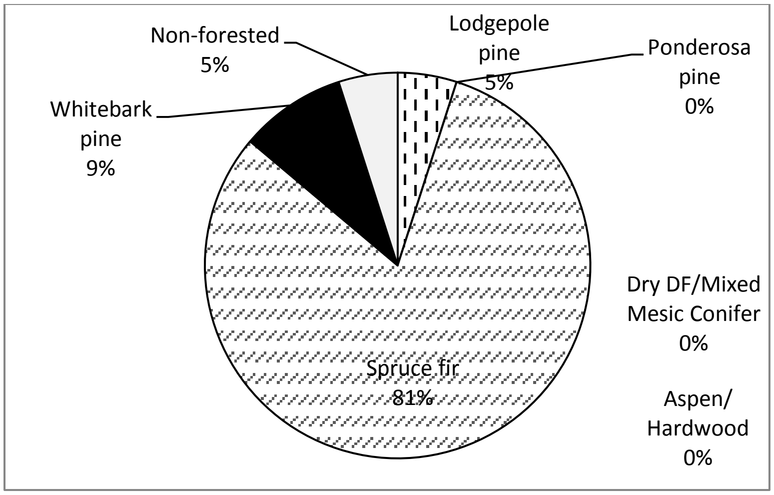

Figure 2.69 Cover type distribution, cold habitat type group

The presence of tree species of interest is shown in Table 2.51. Whitebark pine is present on nearly half of the cold plots, indicating that it is a minor component in some areas dominated by the subalpine fir cover type. The abundance of this species could likely be enhanced. No other tree species of interest occur.

Table 2.51 Presence of tree species of interest - cold habitat type group

Rocky mountain juniper	Western larch	whitebark pine	ponderosa pine	Quaking Aspen	Limber pine
0	0	45%	0	0	0

Structure

The small tree size class is the most prevalent. No plots classified as large or very large tree. The most common density classes are the moderate and high tree cover classes. The vertical structure class tends to be single storied or continuous. Most of these sites are in the 20-99 age class, with a notable 10% greater than 200 years old.

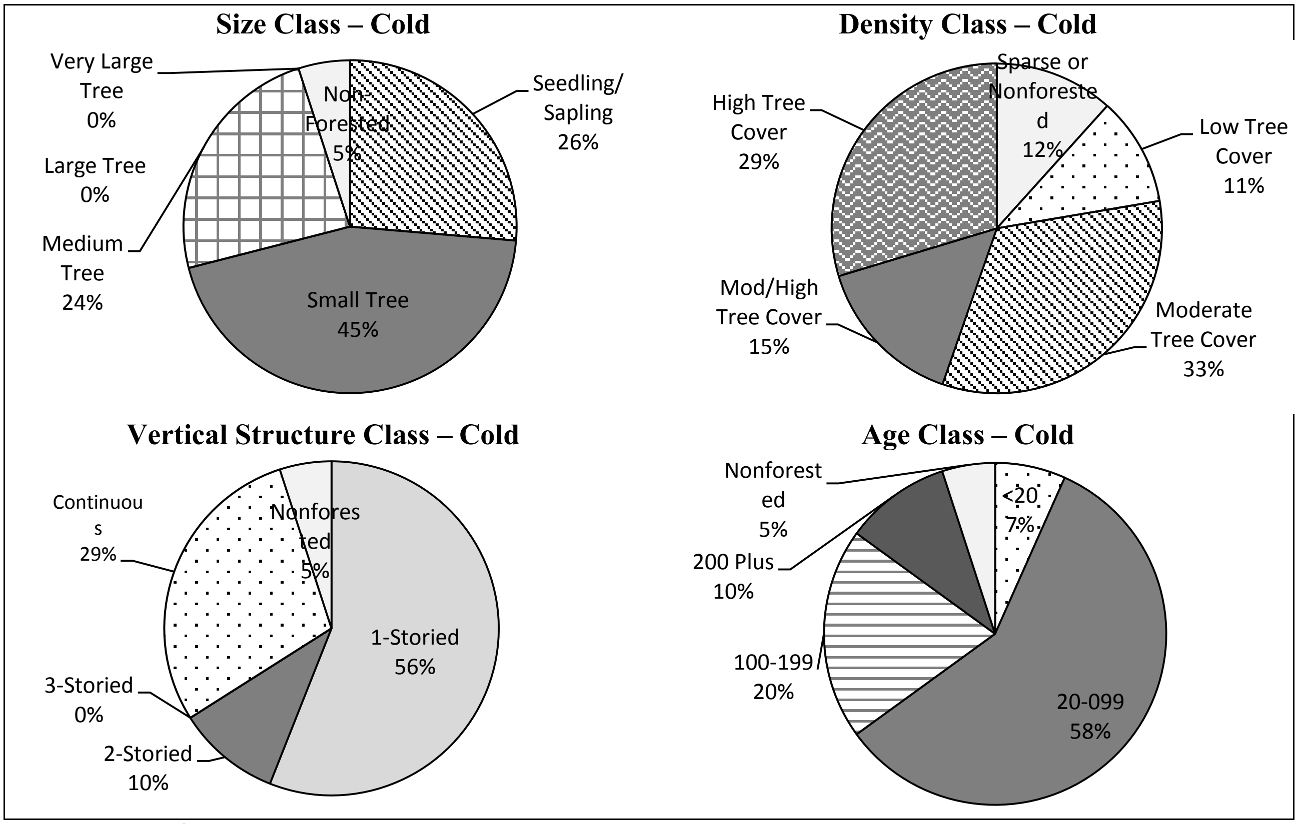

Figure 2.70 Size class, density class, vertical structure class, and age class - cold habitat type group

It is estimated that 25% of this group on the HLC NFs is currently old growth; this is the highest of all the habitat type groups, but is based on a small sample. These sites also support a resource of snags as shown in Table 2.52.

Table 2.52 Estimates of snags per acre, cold habitat type groups

Medium	Large	Very Large
7.6	1.2	1.2

These sites are estimated to contain an average of 1.2 very large live trees per acre. This is less than the HLC NFs average. Downed woody debris averages 14.73 tons per acre.

Function

About half of these sites contain moderate to high hazard to the western spruce budworm, likely based on components of Engelmann spruce. No Douglas-fir beetle hazard or mountain pine beetle hazard in ponderosa pine exist because these components do not occur. There are small amounts of mountain pine beetle hazard to lodgepole pine.

Table 2.53 Insect hazard ratings – cold habitat type group

Insect	No Hazard	Low Hazard	Moderate Hazard	High Hazard
Douglas-fir beetle	100%	0%	0%	0%
Western spruce budworm	0%	47%	15%	38%
Mountain pine beetle in ponderosa pine	100%	0%	0%	0%
Mountain pine beetle in lodgepole pine	85%	5%	5%	5%

Connectivity

An analysis of patch metrics of forest openings and multi-storied patches within individual habitat type groups is not yet available at the writing of this assessment. Patches are present but not very well connected in most GAs.

Cold Timberline

The cold timberline habitat type group is represented by 21 base FIA plots based on field collected habitat type. This group includes whitebark pine habitat types, where whitebark pine is the climax species.

Composition

Although whitebark pine is the climax species on these sites, only 34% of the plots classified as cold timberline are currently dominated by the whitebark pine cover type. The spruce-fir cover type is the most common, along with nonforested vegetation and lodgepole pine. Small amounts of the Douglas-fir and ponderosa pine cover types occur, although these species would generally not be expected to be vigorous on these sites.

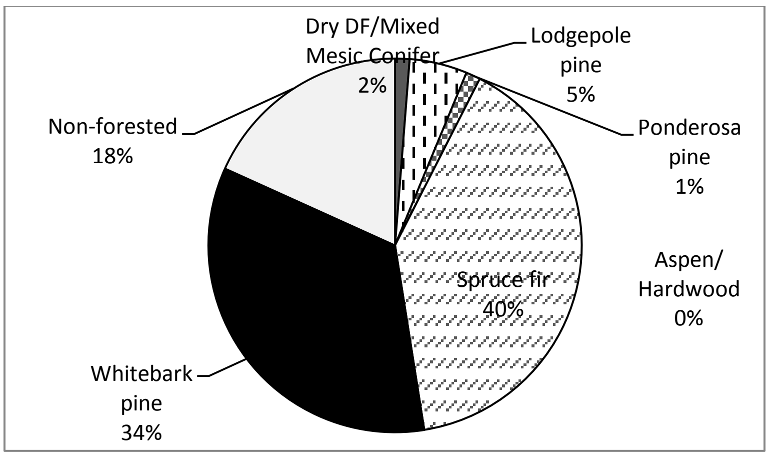

Figure 2.71 Cover type distribution, cold timberline habitat type group

The presence of tree species of interest is shown in Table 2.54. Whitebark pine and limber pine are important components and in some cases grow together on limestone substrates. Whitebark pine is present on most plots.

Table 2.54 Presence of Tree Species of Interest - Cold Timberline Habitat type group

Rocky mountain juniper	Western larch	Whitebark pine	Ponderosa pine	Quaking aspen	Limber pine
0%	0%	66.5%	0%	0%	5%

Structure

Most plots in the cold timberline habitat type group are classified in the seedling/sapling or small tree size classes. All density classes are relatively evenly represented. The vertical structure class tends to be single storied. Most sites are in the 20-99 age class categories. However, 18% are over 200 years old.

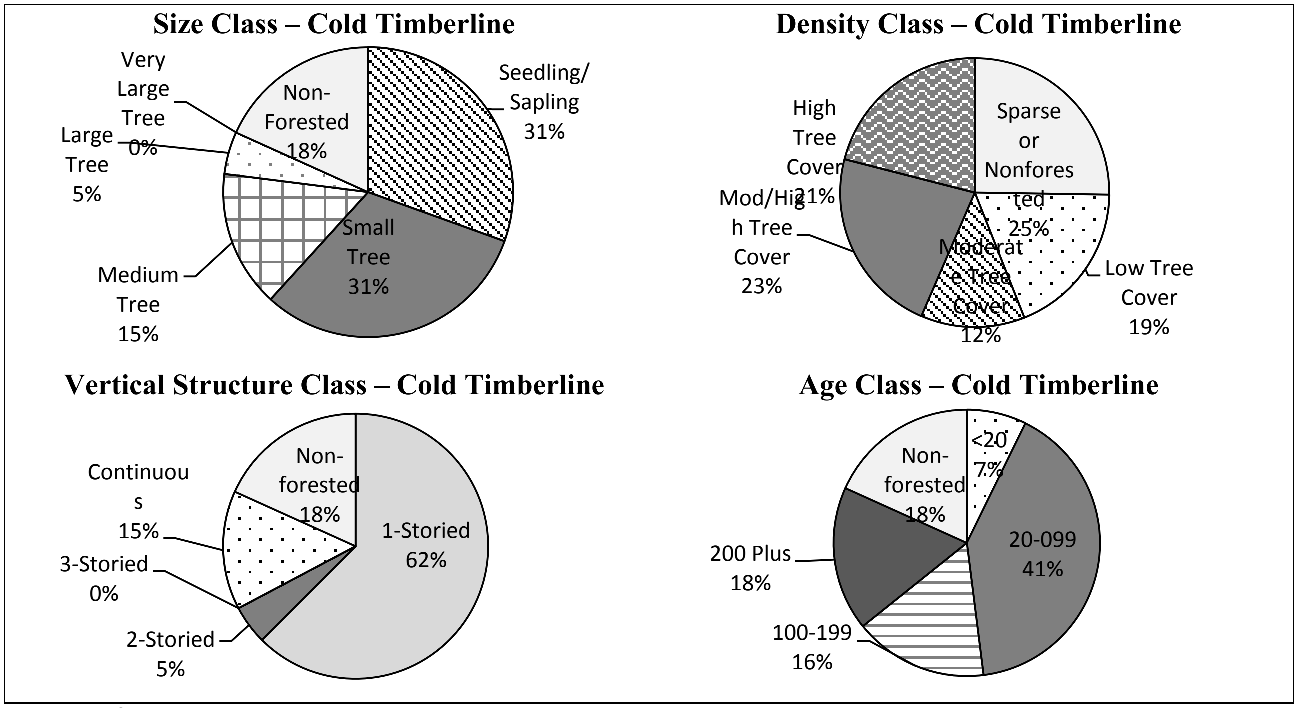

Figure 2.72 Size class, density class, vertical structure class, and age class – cold timberline habitat type group

It is estimated that 18.81% of the cold timberline habitat type group on the HLC NFs is currently old growth; this is much higher than the HLC NFs overall. There are more medium and large snags than in most other types, in part due to the mortality caused by blister rust, mountain pine beetle, and fires. The very large snag resource is lower than the HLC NFs average; these sites are harsh and resource-limited.

Table 2.55 Estimates of snags per acre, cold timberline habitat type group

Medium	Large	Very Large
9.82	4.12	1.32

These sites contain an average 0.35 very large live trees per acre, which is less than the HLC NFs average due in part to harsh, cold growing conditions. Downed woody debris averages 5.23 tons per acre.

Function

The cold timberline habitat type group is at generally low hazard to the pests of interest due to its composition. Some hazard to western spruce budworm and mountain pine beetle in lodgepole pine does exist where susceptible components occur. There is also hazard to whitebark pine from mountain pine beetle that is not currently reflected in available hazard rating estimates.

Table 2.56 Insect hazard ratings – cold timberline habitat type group

Insect	No Hazard	Low Hazard	Moderate Hazard	High Hazard
Douglas-fir beetle	90.25%	9.75%	0%	0%
Western spruce budworm	21.5%	38%	30.5%	10%
Mountain pine beetle in ponderosa pine	100%	0%	0%	0%
Mountain pine beetle in lodgepole pine	85.75%	8.25%	5%	1%

Connectivity

An analysis of patch metrics of forest openings and multi-storied patches by habitat type groups is not yet available at the writing of this assessment. Generally this type is the most extensive and connected in the Rocky Mountain range GA, followed by the Upper Blackfoot and Little Belts GAs. It is a rare and fragmented group overall, and is not mapped on the Divide, Highwoods, Snowies, or Castles GAs.

Non-forested Potential Vegetation Types

Non-forested vegetation is an important feature on the HLC NFs. The non-forested habitat type groups identified are not currently available for analysis with the R1 summary database. Many of the key ecosystem characteristics identified are most pertinent for forested systems. However, forested components do exist on plots that are not classified as forested types; these components may represent encroachment or ecotone areas where patches or inclusions of trees have established. In the future, additional analysis using enhanced data and mapping tools for non-forested vegetation may be possible.

Of the base FIA plots (41) without a forested potential vegetation type specified, about 61% are currently dominated by non-forested cover types. The remaining areas support forested cover types, including Douglas-fir, lodgepole pine, ponderosa pine, spruce/fir, and whitebark pine. The Douglas-fir type is the most common, occurring on 14% of the non-forested plots. Special tree species are also found on these sites, including juniper (1.39%), whitebark pine (5.83%), aspen (1.39%), and limber pine (13.33%). The juniper and limber pine likely represent xeric ecotone areas. Where forested cover types occur, they tend to be in the seedling/sapling, small tree, or medium tree size classes. About 4% of the non-forested plots support a forested size class of large or very large trees; these areas may represent open savannah conditions. About three-quarters of the non-forested plots support sparse density (less than 10% tree cover). Those areas that have a tree density assigned tend to be in the high cover class. These trees tend to be in either a single-storied or continuous vertical structure, and are in the 20-99 or 100-199 year old age classes. No old growth occurs in these areas, although about 1.36 very large trees per acre do occur. Coarse woody debris is low, as expected, at an average of 1.61 tons/acre. There are also snags in these areas, including 2.31 very large snags per acre which is higher than on the potential forested types. Hazard to western spruce budworm exists where components of Douglas-fir exist.

Trend

The trends of cover type, structure, function, and connectivity have been discussed in prior sections but not for each potential vegetation group separately. Trends for each group may vary but are similarly shaped by natural disturbances and processes, climate, fire suppression, and other human influences.

Historic Conditions

Low elevation, dry forests in Region 1, such as those found on the hot dry, warm dry, and moderately warm dry habitat type groups, have experienced perhaps the greatest magnitude of change in composition, structure and function because of fire suppression, forest management, and climate change (Hessburg and Agee 2003; Hessburg et al. 2005; Westerling et al. 2006). In many areas, changes include higher tree density, more multi-storied stands and ladder fuels, and a greater homogeneity of structures across the landscape which results in a greater probability for disturbances to affect large contiguous areas (Hessburg et al. 2005). Fire in many dry forests has shifted from low-intensity, high frequency regimes to moderate and high-severity regimes (Lehmkuhl et al. 2007). Many of these landscapes appear to be increasingly homogeneous in composition and structure. Douglas-fir is a primary component of the HLC NFs. A study conducted in the Elkhorns GA found that prior to 1900, xeric stands of Douglas-fir were generally lightly stocked with highly uneven-aged structures; the current condition appears to support a three-fold increase in the amount of closed canopy forests at the expense of grass, shrub, and open forest stands (Barrett 2005). Similar trends are likely to have occurred on other GAs.

The lodgepole pine cover type is common. Even though these sites have low frequency, high severity fire regimes, they have experienced shifts due to changes in climate and fire suppression. Traditional thinking generalizes lodgepole as even-aged forests across large landscapes that regenerate from stand-replacing disturbances, but these forests also burned in low-to mixed-severity events, creating variable age structures and patterns (Hardy et al. 2000; Kashian 2005). Infrequent stand replacing fires play a definite role; however, the interval between any two fires in one area might be only a few years (Fischer and Clayton 1983). While stand replacement effects would have been typical, there would also have been mixed and low severity fires that left remnants. In lodgepole pine types east of the Continental Divide, the crown fire cycle is 110-170 years (USDA 1990); however additional disturbances would occur more frequently. Typical fire events occur on a 3-6 year cycle burn with variable intensity; while fires that occur during a drought year in a 20-40 year cycle often burn with high intensity (ibid). A fire history study conducted on lodgepole pine types in the Tenderfoot Experimental Forest on the Little Belts GA found that mixed severity fires often occurred within 50 years of a previous fire, fueled by dense post-fire regeneration and snags (Barrett 1993). At the landscape scale, fire suppression (particularly of small fires) has had the effect of decreasing acreage burned in normal fire seasons and reducing the natural variability in landscape patterns (ibid). As a result, the larger, contiguous blocks of uniform stands are subject to large beetle outbreaks and catastrophic fires when fire weather is extreme (USDA 1990; Barrett 1993).

Non-forested habitat type groups have experienced shifts in composition and structure. In the Upper Missouri River Basin, including the HLC NFs plan area, there have been substantial 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 weed species (USDA 2003).

The connectivity of ecosystems influences characteristics such as watershed function, wildlife habitat quality, and the flow of genetic material. A study conducted on lodgepole pine forests in the Tenderfoot Experimental Forest on the Little Belts GA found that historic patches were 84-291 acres in size, compared to an existing condition of 15-163 acres, and pre-1940's landscapes had larger, more irregular, less contagious, and more diverse patches in the early seral non-forested and seedling/sapling stages (Hardy et al. 2000). A more detailed patch and pattern analysis is needed to better understand landscape patch size and connectivity. SIMPPLLE modeling conducted previously made estimates of the dominant transitions of terrestrial communities within the Upper Missouri River Basin (USDA 2003). The analysis found that late-seral and early-seral forests declined across the Basin while the extent of mid-seral communities increased. Pattern indices for montane forests indicated a trend toward increasing uniformity from historic to current conditions; while the lower montane and subalpine forests showed an increasing fragmentation trend (USDA 2003). While the aerial extent of the subalpine forest did not decline substantially, the mean patch size index decreased significantly (ibid).

Future Conditions

Consequences from a shifting climate will likely cause plant communities to undergo shifts in species compositions and/or changes in densities at landscape scales (Scott et al. 2013). Climate effects on vegetation will be dictated by moisture requirements of individual species, water holding capacity of the soil, solar energy inputs across aspect and slope, current landscape structure and composition, and the complicating factors caused by increased intensity of disturbances (ibid). Potential future shifts in composition will largely be driven by regeneration mechanisms. While mature forests have some adaptive capacity to tolerant change, young plants are more sensitive to the existing environment (ibid). The following trends with a warming climate are expected on the HLC NFs. The information is adapted from the summary for east-side forests in a Reforestation-Re-vegetation Climate Change Primer for the Northern Region (ibid).

- Hot dry and warm dry habitat type groups, typically dominated by limber pine or ponderosa pine, will experience reforestation needs most commonly from wildfire, in areas departed from a historic regime of low severity fire. Higher energy aspects may trend towards bunchgrasses and herbs. Douglas-fir may persist in swales or protected areas but be lightly stocked. There may be a shift to ponderosa pine in some cases but regeneration may be difficult on dry slopes after fire because seed is lacking and it may be limited by cold temperatures at some elevations. Areas featuring limber pine may shift to open savannah.
- Moderately warm dry habitat type groups, typically Douglas-fir dominated will also experience reforestation needs after fires and bark beetle outbreaks exacerbated by budworm defoliation, drought, and overstocking. The more exposed high energy sites may convert to savannah and bunch grasses; lower energy slopes may support open forests. There may be opportunities to plant ponderosa pine in these areas. On more moist sites, ponderosa pine may be favored over Douglas-fir at lower elevations and Douglas-fir may be favored over lodgepole pine at higher elevations. Root disease may expand where Douglas-fir vigor declines.
- Cool moist habitat type groups may experience reforestation needs after low and mixed severity fires or beetle outbreaks exacerbated by budworm defoliation. These sites will likely remain productive with a warmer climate, with Douglas-fir dominant or increasing on dry aspects. Lodgepole pine may also dominate and will generally be able to naturally regenerate, as well as subalpine fir in draws and protected areas. Stocking densities on drier aspects may be low.
- Cool wet habitat type groups may experience reforestation needs after mixed or high severity wildfires, especially in areas departed from a historic mixed severity regime, and/or beetle outbreaks exacerbated by budworm defoliation. Due to high water tables, generally spruce and lodgepole pine are expected to continue to regenerate, but shrubs, willows, and aspen may increase naturally after the loss of tree cover.
- Cool moderately dry to moist habitat type groups, typically dominated by lodgepole pine, may experience reforestation needs following stand-replacing fire or bark beetle outbreaks. With a warmer climate these sites may be maintained with lodgepole pine, except on the driest exposures where Douglas-fir may be favored. There could be some opportunities for whitebark pine and limber pine on some sites depending on soil types and cold limitations. Aspen may also be favored after conifer mortality, but because it will be limited to areas holding soil moisture it may ultimately be reduced or less vigorous.
- Cold and cold timberline habitat type groups, dominated by whitebark pine, subalpine fir, lodgepole pine, and/or spruce may experience reforestation needs created by bark beetles and high severity fires in areas departed from mixed severity regimes. Some of the driest and/or coldest areas with limited soil moisture may shift to a non-forested condition where reforestation of conifers is infeasible. However, these sites also may represent the greatest opportunity for whitebark pine to establish and expand where viable seed sources exist or via artificial planting.

Non-forested habitats may have opportunities to expand and out-compete forested vegetation with a warmer climate in some areas. Conversely, altered fire regimes and the expansion of invasive plants with a warmer climate may alter these communities. The increased amount of insect and fire disturbances on the landscape may promote a higher heterogeneity of densities and age classes on the landscape over time, as well as increase patch sizes and edges. Disturbances may increase the fragmentation of some habitats. These relationships are interconnected and difficult to predict.

Information Needs

An updated natural range of variability analysis should be conducted utilizing the best available data and models to assess the historic and potential future condition of key ecosystem characteristics for each ecosystem in the HLC NFs plan area.

Terrestrial Wildlife

Introduction

Process and Methods

For this assessment, terrestrial wildlife species known to occur on the HLC NFs were evaluated in the context of categories directed and defined by the National Forest System Land Management Planning Final Rule and Record of Decision (hereafter 2012 Planning Rule), detailed in the Code of Federal Regulations (36 CFR 219 2012). The Forest Service Handbook (FSH) provides specific, detailed direction called directives for implementing planning rules. The directives for implementation of the 2012 Planning Rule were not final at the time this assessment was prepared, but draft directives (FSH 1909.12 2013) were used to guide the evaluation of species.

The 2012 Planning Rule states that assessments must consider "Threatened, endangered, proposed and candidate species, and potential species of conservation concern present in the plan area" (36 CFR 219.6 (b)(5)). Under provisions of the 1973 Endangered Species Act (ESA), federal agencies are required to conserve threatened and endangered species and to ensure that actions authorized, funded, or carried out by federal agencies are not likely to jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification of their critical habitats.

Lists of threatened, endangered, proposed and candidate species present on each National Forest in Montana are maintained by the USDI Fish and Wildlife Service, Ecological Services, Montana Field Office and are available on their website http://www.fws.gov/montanafieldoffice/Endangered_Species/Listed_Species/Forests.html. The lists for the Helena and Lewis and Clark National Forests that were used for this assessment were updated on the website on 08 January 2015.

A species of conservation concern (SCC) is defined by the 2012 Planning Rule as a species "other than federally recognized threatened, endangered, proposed, or candidate species, that is known to occur in the plan area and for which the regional forester has determined that the best available scientific information (BASI) indicates substantial concern about the species' capability to persist over the long-term in the plan area" (36 CFR 219.9 (c)). The draft directives (FSH 1909.12 Chapter 10, part 12.52) state that the responsible official will coordinate with the regional forester to identify potential SCCs "relevant to the plan area and the planning process". The draft directives identify criteria for considering potential SCCs. These criteria are discussed in detail in the Terrestrial Vegetation section, beginning on page 78, under the heading "Potential Plant Species of Conservation Concern", and therefore are not repeated here.

The SCC discussed in this assessment are identified and discussed as 'potential SCC' because species may be added or removed as additional information is gathered and as analysis occurs throughout the plan revision process. The list was developed only for forest planning purposes; it does not confer special regulatory status on any species beyond existing state and federal statutes.

The 2012 Planning Rule requires the assessment to evaluate key ecosystem services and multiple uses (36 CFR 219.6 (b)(7)). These are identified in the draft directives as including the contributions of fish, wildlife, and plants to social and economic stability (FSH 1909.12, Chapter 10, part 13.35). The draft directives specifically call for identifying information regarding fish and wildlife species that may be commonly enjoyed and used by the public for hunting, fishing, trapping, gathering, observing, or sustenance, and assessing the conditions and trends of these species and their habitats. These considerations are discussed in chapter 6, Multiple Uses and ecosystem Services, focusing on the contributions of those species to social and economic sustainability. We have also considered in this section several of those species because they are important to the public for uses or activities such as hunting, trapping, gathering, sustenance, observing, or others, or that are of local or regional conservation interest but do not warrant designation as potential SCC at this time.

Scale

The scale at which wildlife species were evaluated in this assessment varies based on the species' characteristics as well as on the information available. For some wide-ranging species, such as grizzly bears and Canada lynx, discussion necessarily focused on the entire U.S. northern Rocky Mountains or a similarly large area. For other species, the assessment focused on the plan area (the HLC NFs) or at a smaller scale, such as the geographic area (GA). Information about the scale at which a species was evaluated is provided in the section for that species. Information regarding the presence of all species and/or habitats included in this assessment is provided, at a minimum, at the plan area, individual forest, and GA levels.

Section Organization

The 2012 Planning Rule states that assessments must "identify and evaluate existing information relevant to the plan area" for threatened, endangered, proposed, and candidate species, as well as for potential species of conservation concern present in the plan area (36 CFR 219.6(b)(5)). Discussions of existing information for certain species of interest is included, as well as described above. Information about individual species is organized into those groupings: species that are federally listed or proposed for federal listing, species that are potential SCC, and species of interest (SPI). Individual species evaluations include information regarding occurrence, habitat status, and population status in the plan area and other appropriate scale(s), to the extent that these are known. Each species evaluation also considers drivers, threats, and stressors for that species or its habitat, and where possible, historic condition along with expected trends for that species or habitat. Not all species have the same kind or amount of information available, so not all species evaluations will appear the same in organization and content. Where species assessments are lengthy or complex, a summary paragraph is provided to assist with comprehension of key points. Not all species assessments warranted such a summary.

To facilitate reference to the Terrestrial Vegetation section, which discusses the composition, structure and function that make up the habitats for each species, a "Habitat Association" section is included. An 'at-a-glance' table documenting all species considered as possible SCC or SPI in our initial evaluation, and a brief summary of the rationale for inclusion or exclusion in those categories is also included.

An effort was made to not repeat the extensive published and publicly available information regarding the biology and ecology of each species considered. Rather, that information is referred to and discussed in the context of the status and trend of the species and its habitat within the plan area. The purpose of this document is not to provide a complete summary of all that is known about each species that occurs in the plan area, but to use and refer to the most current information in such a way that it will provide direction for revising or developing forest management.

Existing Information

The best available data and science relevant to the plan area and management was used to inform the evaluation of each species considered in this assessment. The best available scientific information (BASI) included published literature where it was available and pertinent to the species and/or plan area, as well as unpublished literature or reports where published literature was not available or where information in such reports added additional information or clarification. Literature and reports were used are cited within the document and listed in the 'References' section. The BASI for species occurrence and distribution within or adjacent to the plan area included several databases, as well as local data or knowledge from professionals or other reliable sources, as described below. BASI for species status, trend, and level of conservation concern are summarized below, and are cited as appropriate within the write-up for each species, or in the project file. Information needs vary by species and are discussed in the section for each species, as needed.

The first step in evaluating wildlife species was to determine what species are known to occur in the plan area, and whether they are native (FSH 1909.12, Chapter 10, part 12.52c). The Montana Natural Heritage Program (MTNHP) maintains an extensive and detailed database of species occurrences throughout Montana. They provided spatial data of all known wildlife occurrences on the HLC NFs that was used as a starting point for identifying species present in the plan area. The MTNHP data is based on actual observations, classified according to type and reliability of observation; observations are obtained from their field efforts, as well as from other state and federal agencies and private organizations or individuals. The MTNHP data is currently the most accurate and comprehensive source of data regarding species occurrences in Montana.

Additional information on species occurrence in the plan area was obtained from the Natural Resource Information System (NRIS) Wildlife database. This database is used by the FS to record and maintain wildlife observations occurring on NF lands, based on inventory and monitoring work or other observation sources. The NRIS database has fewer species entered, and fewer observations overall than the MTNHP database, but it is an accurate source of data and an important contribution to overall information about species occurrence in the plan area.

Information from Breeding Bird Surveys, carried out and maintained by the Rocky Mountain Bird Observatory, and from the Region 1 Landbird Monitoring Program, overseen and maintained by the Avian Science Center at the University of Montana, is generally incorporated into the MTNHP and/or the NRIS databases. We referred specifically to these data sources, however, for additional information or clarification regarding species occurrences, distribution, and trend.

Information about species and habitat occurrences was sought from local, state, and federal biologists as well as private individuals either affiliated with groups known to gather such information, or individuals where the reliability and accuracy of information was strong. These contacts were made directly with personnel or individuals. This information supplemented the data from the MTNHP and NRIS databases and data provided by the individual NF units within the plan area. The public had the opportunity to provide input on SCC and other wildlife at a series of open houses held during the summer of 2014, but no specific comments or information about SCC came from those meetings.

Life history and ecology information for the species discussed in this assessment is obtained from literature cited in the document or project file, from the MTNHP's online Montana Field Guide (MTNHP 2014b) and from accumulated professional knowledge.

The MTNHP database (MTNHP 2014c) provides NatureServe rankings for all species in the database, and indicates whether those species are considered Species of Concern (SOC) by the State of Montana. Information about the basis for why a species is listed as a Montana SOC is available on the MTNHP website. For additional information regarding species occurrence, distribution, status, and conservation concerns, the Birds of Conservation Concern list compiled by the United States Fish and Wildlife Service (USFWS), the Montana Statewide Wildlife Action Plan, lists compiled and maintained by multi-agency groups such as Partners in Flight and by science-oriented non-governmental organizations such as the Audubon Society, and others were used. Where information from these sources was used it is cited, either in the document or project file.

Existing Condition

Habitat Associations

The 2012 Planning Rule emphasizes maintenance of ecosystem components as a means to maintain the diversity of plant and animal communities in the plan area (36CFR 219.9). Ecosystem components include those characteristics that define a system and maintain its integrity and diversity. Key ecosystem characteristics are identified in the Terrestrial Vegetation section and discussed in terms of their contributions as the basic elements of ecosystems (e.g., composition, structure, function, and connectivity; 36 CFR 219.19). The Terrestrial Vegetation section discusses the existing condition of those features, as well as drivers, stressors, and trends. That section also identifies plant species or guilds of conservation concern (potential plant SCC) and species or communities of public interest (plant SPI). All of these vegetation and ecosystem characteristics comprise the varied wildlife habitats that occur in the plan area.

Habitat is a key driver of the status and trend of many, if not most wildlife species. It is useful to understand the components of wildlife habitat in the terms used to describe them in the Terrestrial Vegetation section to better understand the existing status as well as the trends, drivers, and stressors of those habitats. Connecting habitat features to vegetation characteristics will also facilitate modelling and estimation of the extent and distribution of wildlife habitats in the past and potentially into the future.

In Table 2.57, the vegetation types and characteristics described in the Terrestrial Vegetation section are identified that are important to the wildlife species discussed in this section. The column titled "Habitat Type Groups" refers to the potential vegetation types discussed in Table 2.17. The columns titled "Cover Type" and "Vegetation Structure/Function/Special Components" refer to discussions of vegetation composition (page 54), structure and function (page 62). Those columns identify cover types (Table 2.20), tree size class (Table 2.23), density classes (Table 2.25), and vertical structure classes (Table 2.27), as well as connectivity and pattern (page 71). The column titled "Additional Considerations" includes other habitat components discussed in the Terrestrial Vegetation section as Threatened, Endangered, Proposed and Candidate plant species, SCC, or SPI (page 74), or wetland types (Table 2.21). The "Additional Considerations" column also references other sections, such as those discussing aquatic systems or minerals and geology, as those relate to habitat needs of a particular species.

Table 2.57 Terrestrial Wildlife species considered in detail, their habitat type group associations, specific vegetation components important to each species, and primary drivers and stressors affecting those types

Species	Applicable GA(s)	Habitat Type Groups (Terrestrial Vegetation p. 49-54)[1]	Cover Type (Terrestrial Vegetation p. 54-61)[1]	Vegetation Structure/ Function/Special Components (Terrestrial Vegetation section p. 62-73 and p. 116-139)[1]	Primary Drivers or Stressors to habitat characteristics (Terrestrial Vegetation section p. 6-49)[1]	Additional Considerations[2]
Threatened, Endangered, Candidate, Proposed Species (at-risk species)						
Grizzly bear (Threatened)	All	All	All	All	climate change	Riparian and wetland types (Table 2.21); Riparian SCC Guild (p. 90) in spring and fall; Rocky Habitats SCC Guild (p. 91) for cutworm moths in late summer; whitebark pine (p. 75-78) for pine nuts
Canada lynx (Threatened)	All	Cool Moist (broad group)	Lodgepole Pine, Spruce/Fir	Seedling/Sapling + High Density (summer); Medium Tree or larger + Moderate to High Cover + Vertical Structure 3 or C; Connectivity and Pattern, Coarse Woody Debris (denning)	fire regimes, insects, vegetation treatments	NA
Sprague's pipit (Candidate)	Little Belts	Grassland broad group	Grass	Non-Forested; Grass Canopy cover	invasive plant species, range management	Encroachment (Grassland SCC Guild p. 88; Xeric Ecotone SCC Guild, p. 94)
Potential Species of Conservation Concern (at-risk species)						

Species	Applicable GA(s)	Habitat Type Groups (Terrestrial Vegetation p. 49-54)[1]	Cover Type (Terrestrial Vegetation p. 54-61)[1]	Vegetation Structure/ Function/Special Components (Terrestrial Vegetation section p. 62-73 and p. 116-139)[1]	Primary Drivers or Stressors to habitat characteristics (Terrestrial Vegetation section p. 6-49)[1]	Additional Considerations[2]
Western (boreal) toad	All	All	All	Tend toward Continuous Vertical Structure "C"; Coarse Woody Debris	climate change	Proximity to ponds; Riparian and wetland types (Table 2.21)
Flammulated owl	Upper Blackfoot, Divide, Big Belts, Elkhorns	Warm Dry, Moderately Warm Dry	Ponderosa Pine, Dry Douglas-fir	Large to Very Large Tree; Low to Moderate Tree Cover; 1-2 Vertical Structure Class; Very Large Live Trees; Large to Very Large Snags	fire exclusion, mountain pine beetle, climate change	ponderosa pine (SPI, p. 104-105)
Lewis's woodpecker	Divide, Big Belts, Elkhorns	Warm Dry, Moderately Warm Dry	Ponderosa Pine, Dry Douglas-fir, Aspen/ Hardwood	Large to Very Large Tree, Low to Moderate Tree Cover, 2 Storied Vertical Class, Very Large Live Trees, Large to Very Large Snags	fire exclusion, mountain pine beetle, climate change	Riparian and wetland types (cottonwood- Table 2.21); past fires, Appendix A (cottonwood); ponderosa pine (SPI, p. 104-105)
Harlequin duck	Rocky Mountain Range, Upper Blackfoot	NA	NA	NA	climate change	Riparian and wetland types (Table 2.21); Chapter 3 (Watershed, Aquatic, Soil, and Air Resources).
Townsend's big-eared bat	Upper Blackfoot, Divide, Big Belts, Elkhorns	All	NA	NA	NA	Chapter 9, p. 7 (Caves) and p. 15-18 (mine management)

Species	Applicable GA(s)	Habitat Type Groups (Terrestrial Vegetation p. 49-54)[1]	Cover Type (Terrestrial Vegetation p. 54-61) [1]	Vegetation Structure/ Function/Special Components (Terrestrial Vegetation section p. 62-73 and p. 116-139) [1]	Primary Drivers or Stressors to habitat characteristics (Terrestrial Vegetation section p. 6-49)[1]	Additional Considerations[2]
Northern bog lemming	Rocky Mountain Range, Upper Blackfoot	Riparian/ Wetland	Riparian Grass/Shrub, Aspen/ Hardwood, Spruce/Fir	NA	climate change, vegetation treatment, grazing management	Wetlands SCC Guild (p. 93-94)
Species of Interest						
Viewing/Regional or local management interest						
Common loon	Rocky Mountain Range, Upper Blackfoot, Little Belts	NA	NA	NA	NA	Riparian and wetland types (Table 2.21)
Golden eagle	All	Grasslands	NA	NA	NA	Rocky Habitats SCC Guild (p. 91-92) for nesting
Peregrine falcon	All	Grasslands	NA	NA	NA	Rocky Habitats SCC Guild (p. 91-92) for nesting
Trumpeter swan	Rocky Mountain Range, Upper Blackfoot	NA	NA	NA	NA	Riparian and wetland types (Table 2.21)
White-tailed ptarmigan	Rocky Mountain Range	Alpine	Whitebark Pine, Sparse	Non-forested, Sparse	climate change	Rocky Habitats SCC Guild (p. 91-92)

Species	Applicable GA(s)	**Habitat Type Groups** (Terrestrial Vegetation p. 49-54)[1]	**Cover Type** (Terrestrial Vegetation p. 54-61)[1]	**Vegetation Structure/ Function/Special Components** (Terrestrial Vegetation section p. 62-73 and p. 116-139)[1]	**Primary Drivers or Stressors to habitat characteristics** (Terrestrial Vegetation section p. 6-49)[1]	**Additional Considerations**[2]
Northern goshawk	All	All broad groups except Hot Dry and Cold	All forested types except ponderosa pine and whitebark pine	Medium to Very Large Size Class; Moderate/High to High Tree Cover	vegetation treatments, fire regimes, insect infestations	NA
Wolverine	Rocky Mountain Range, Upper Blackfoot, Divide, Big Belts, Elkhorns, Little Belts	Alpine, Cold, Cool Moist	Whitebark Pine, Sparse, Spruce/fir	Non-forested, Sparse, Coarse Woody Debris, Connectivity	Climate change	Rocky Habitats SCC Guild (p. 91-92) for denning
Hunting/trapping interest						
Gray wolf	All	NA	NA	NA	NA	Habitats where ungulate prey is available
Elk	All	Grassland (winter range)	All Forested types (thermal and hiding cover)	Tend toward Mod/High to High Tree Cover; Vertical Structure Class 2-C	vegetation treatments, fire regimes, insects	NA
Mule deer	All	Warm Dry and Cool Moist, Grassland, & Xeric Shrubland/ Woodland broad groups	All	Connectivity	vegetation treatments, fire regimes insects	Use of areas in winter strongly tied to lack of snow accumulation

Species	Applicable GA(s)	Habitat Type Groups (Terrestrial Vegetation p. 49-54)[1]	Cover Type (Terrestrial Vegetation p. 54-61)[1]	Vegetation Structure/ Function/Special Components (Terrestrial Vegetation section p. 62-73 and p. 116-139)[1]	Primary Drivers or Stressors to habitat characteristics (Terrestrial Vegetation section p. 6-49)[1]	Additional Considerations[2]
Bighorn sheep	Rocky Mountain Range, Big Belts, Elkhorns	Non-Forested types, Hot Dry	Non-Forested, Ponderosa Pine	Non-Forested, Sparse, Low Tree Cover	fire regimes, vegetation treatments	Rocky Habitats SCC Guild (p. 91-92) for escape terrain, Xeric Ecotone SCC Guild (p. 94-95)
Mountain goat	Rocky Mountain Range, Highwoods, Big Belts, Crazies	Alpine, Cold	Sparse, Whitebark Pine, Spruce/Fir	Connectivity	climate change	Rocky Habitats SCC Guild (p. 91-92) for escape terrain
Moose	All except Highwoods	Cool Moist, Cold, Riparian/Wetland broad group	All forested except ponderosa pine, dry Douglas-fir, whitebark pine	All tree density classes (exclude non-forested and sparse), Connectivity	climate change, vegetation treatments, fire regimes	Riparian and wetland types (Table 2.21)

[1]Habitat type groups, cover type groups, and vegetation structure/function/special components all refer to sections within the Terrestrial Ecosystems chapter, as noted by page references

[2]'Additional characteristics' refers to various habitat or vegetation components in the Terrestrial Vegetation section that are not discussed in the topics covered by the other columns.

Threatened, Endangered, Proposed, or Candidate Species ('At Risk Species'; FSH 1909.12, Chapter 10, 12.5)

Grizzly Bear (Ursus arctos) - Threatened HNF and LCNF

Distribution

Grizzly bears are widely distributed throughout the Northern Continental Divide Ecosystem (NCDE), although it appears that bear density decreases toward the south end of the ecosystem (Kendall et al. 2009). The NCDE is contiguous with the grizzly bear population in the Rocky Mountains of Canada, and there are few geographic barriers within the NCDE that could disrupt movement of individuals (USDI 2013a).

Grizzly bears are known to occur in the Rocky Mountain Range and Upper Blackfoot GAs of the HLC NFs. These areas are part of the Northern Continental Divide Ecosystem (NCDE), which comprises approximately 8,933 square miles (23,137 sq km) entirely within the state of Montana (see map 34 titled Northern Continental Divide Grizzly Bear Recovery Zone and Grizzly Bear Management Situation in appendix A). The NCDE also includes portions of three other National Forests (Lolo, Flathead, and Kootenai); Glacier National Park; portions of the Blackfeet, Salish, and Kootenai Indian Reservations; Bureau of Land Management lands; and state-owned lands, including those managed by MT Fish, Wildlife and Parks and by the MT Department of Natural Resources and Conservation.

The entire Rocky Mountain Range GA and the portion of the Upper Blackfoot GA that is north of MT Highway 200 and contiguous with the Rocky Mountain Range GA are within the NCDE Recovery Zone. The area south of Highway 200 in the Upper Blackfoot GA, along with a portion of the Divide GA, were identified as a Grizzly Bear Distribution Zone in 2002, and more recently the entire Upper Blackfoot and Divide GAs are recognized as supporting grizzly bears, albeit at low density throughout much of the Divide GA (USDI 2013a). The grizzly bear population in the NCDE appears to be expanding in distribution, with the most marked expansion occurring to the southwest, and to the east onto the short-grass prairie on non-NFS lands (USDI 2013a; Mace and Roberts 2012).

Population Trend

Noninvasive hair snagging was completed in 2004, allowing the use of individual DNA samples to arrive at a population estimate of 765 bears in the NCDE as a whole at that time (Kendall et al. 2009). Also in 2004, Montana Fish Wildlife, and Parks (MTFWP) began a study to estimate the population trend of grizzly bears in the NCDE. That study found that between 2004 and 2011 the grizzly bear population was increasing at a rate of roughly 3% annually (Mace et al. 2012). MTFWP estimates that there are currently over 1,000 grizzly bears in the ecosystem (Mace et al. 2012). Population estimates for specific portions of the NCDE, including for individual National Forests or GAs, are not available and would not make sense to attempt because of the wide-ranging nature of grizzly bears and the lack of geographic barriers to movement within the NCDE. Kendall et al. (2009) documented that grizzly bear densities are highest in Glacier National Park, at the north end of the NCDE, and decrease toward the south of the ecosystem and along the periphery.

Food Habits

Grizzly bears use a wide variety of habitats within the NCDE, and on the HLC NFs. Grizzly bears generally have an omnivorous diet, although some bears within the NCDE may be almost entirely herbivorous (Jacoby et al. 1999; Schwartz et al. 2003; USDI 2013a). Grizzly bears are generalists, with high variability in diet among individuals, seasons, and years (Servheen 1981; Mattson et al. 1991a and 1991b; Schwartz et al. 2003; LeFranc et al. 1987; Felicetti et al. 2003 and 2004; USDI 2013a). In early spring, upon den emergence, grizzly bears seek areas where carcasses may be found, such as avalanche chutes and ungulate winter ranges, as well as low elevation private lands where livestock winter and calve. In spring and early summer, grizzly bears may move to low elevation where they feed on newly emerging vegetation such as sweet vetch, biscuit root, glacier lily, western spring beauty, grasses, sedges, cow parsnip, and angelica (Servheen 1981; Kendall 1986; Mace and Jonkel 1986; Martinka and Kendall 1986; Aune and Kasworm 1989; LeFranc et al. 1987; USDI 2013a).

In summer, grizzlies add berries such as huckleberry, buffaloberry, serviceberry, hawthorn, and chokecherry to their diet (Servheen 1981; Kendall 1986; Mace and Jonkel 1986; Martinka and Kendall 1986; Aune and Kasworm 1989; McLellan and Hovey 1995; Le Franc et al. 1987; USDI 2013a) and may move to areas where these foods are available. Some bears may also feed on army cutworm moths, which are found in high elevation talus slopes. This has been observed in Glacier National Park as well as in the Scapegoat Wilderness and on the Rocky Mountain Front (White et al. 1998; Sumner and Craighead 1973; Craighead et al. 1982; Aune and Kasworm 1989; USDI 2013a).

During late summer to early fall, grizzlies may continue to consume berries, and along the Rocky Mountain Range GA bears are known to descend to low elevation areas off National Forest land coinciding with the ripening of chokecherries. Some bears may begin to feed on meat at this time of year, reflecting the availability in some areas of gut piles and wounded animals resulting from big game hunting seasons. Consumption of the roots, bulbs, and corms of sweet vetches, biscuit root, and glacier lily is also common at this time of year (USDI 2013a). Prior to the spread of white pine blister rust in the NCDE, many grizzly bears fed on whitebark pine seeds, particularly in the Whitefish Range and on the Rocky Mountain Range GA (USDI 2013a). High mortality and infection rates of whitebark pine in the NCDE (Kendall and Keane 2001) have resulted in the loss of this food source to bears. Whitebark pine is currently a candidate species for listing under section four of the ESA, and is discussed in the Terrestrial Vegetation section, pages 75-78. It is noted there that mortality of whitebark pine on the HLC NFs may be up to 95% and that the decline is expected to continue into the future.

Habitat Status, including Connectivity

Habitats used by grizzly bears in the NCDE are varied, due to their ability to use a wide variety of foods and their large size and consequent need to consume a large amount of food during the non-denning period. Grizzly bear use of available habitats is driven by this constant search for food, as well as by their need to find mates, cover, security, and den sites. Grizzly bear habitat in the NCDE is not generally defined by specific habitat types or associations. Rather, habitat availability for grizzly bears depends on large tracts of varied habitats, which continue to be available throughout the NCDE. Spring and denning habitats occur throughout the area currently occupied by grizzly bears, and are being redefined as bears reoccupy historic ranges. Summer habitat, as described above, includes an enormous range of types, rendering it not useful to attempt to map at the scale of the plan area or even the GA.

Work has been done to assess both habitat and population connectivity within the NCDE in terms of habitat, demographics, and genetics. Kendall et al (2009) and Waller and Servheen (2005) indicated that there is potentially some human-caused fragmentation along U.S. Highway 2 west of the Continental Divide, where the Burlington Northern-Santa Fe rail line combines with highway traffic volumes and density of human dwellings and areas of human activity. Nevertheless, Waller and Servheen (2005) documented movements of both male and female grizzly bears within and through this corridor and Miller and Waits (2003) found that genetic connectivity is currently being maintained across this potential zone of fragmentation. Kendall et al. (2009) identified six subpopulations of grizzly bears in the NCDE, based on genetic analysis, but also concluded that there are few geographical barriers to the movement of grizzly bears within the NCDE. Proctor et al. (2012) determined through genetic testing and movement data that grizzly bears move freely across the U.S./Canadian border on the northern edge of the NCDE. Additional discussion of connectivity among grizzly bear populations is discussed under “Consideration of system stressors and drivers”.

Consideration of system drivers, stressors, and trends for grizzly bear

Mortality

Human activities are the primary factor impacting grizzly bear habitat security in the NCDE and elsewhere (USDI 2013a), and have been considered the primary factor driving grizzly bear mortality. Of 337 known grizzly bear mortalities documented between 1998 and 2011 in the NCDE, 86% (290) were human-caused (USDI 2013a). Management removals accounted for 89 mortalities, or 31% of the total. This is the largest source of known mortality for grizzly bears. Despite these mortalities, the survival rate for adult females, the most important cohort affecting population trend, remains approximately 95% (Mace et al. 2012). The majority of the known mortalities in the NCDE have occurred around the edges of the ecosystem (e.g. Mace and Roberts 2012) on or adjacent to private lands, with an increasing number occurring outside the boundaries of the NCDE Recovery Zone.

Management removals are usually associated with availability of attractants, or human or livestock food, with bears becoming food-conditioned and often habituated to human presence. A food storage order has been in place on National Forest System lands throughout the NCDE Recovery Zone since 1995. This order requires that all human, pet, and livestock food and attractants be stored in a manner to make them unavailable to bears, thus minimizing the potential for bears to become food-conditioned and to come into conflict that may result in removal of the bear. Because the majority of mortalities and removals occur off NFS lands, management actions on NFS lands may be limited in their impact on the bear population as a whole.

Habitat Security

Grizzly bear recovery in the NCDE has also hinged on maintaining areas where grizzlies are relatively secure from disturbance by humans. Large portions of the NCDE are within protected areas, such as national parks, designated wildernesses (roughly 1.5 million acres), or inventoried roadless areas (roughly 882,900 acres). These areas have formed the core of the NCDE Grizzly Bear Recovery Zone, which has been further stratified into Management Situations that correspond with likelihood of grizzly presence and potential for bear-human conflict (see map 34 titled Northern Continental Divide Grizzly Bear Recovery Zone and Grizzly Bear Management Situation in appendix A). Within the Recovery Zone portion of the plan area, most lands (882,900 acres) have been designated Management Situation 1(MS1), in which "[g]rizzly habitat maintenance and improvement … and grizzly-human conflict minimization will receive the highest management priority. Management decisions will favor the needs of the grizzly bear when grizzly habitat and other land use values compete" (IGBC 1986). An additional 64,640 acres in the Recovery Zone on the HLC NFs are designated as MS2, where, "[t]he grizzly bear is an important, but not the primary, use of the area. Minimization of grizzly-human conflict potential … is a high management priority" (IGBC 1986). MS2 areas are delineated entirely in the Upper Blackfoot GA north of Highway 200. Approximately 14,160 acres of the Recovery Zone on the HLC NFs is designated MS3, in which "[g]rizzly presence is possible but infrequent. Developments … and human presence result in conditions which make grizzly presence untenable for humans and/or grizzlies" (IGBC 1986). These areas are on the Rocky Mountain Range GA, and surround highly developed areas where there are concentrations of recreation residences and campgrounds.

In non-wilderness areas, habitat security has been achieved largely by managing motorized access. The Interagency Grizzly Bear Committee (IGBC) recommended in 1994 (IGBC 1994) that:

- less than 19% of a bear management subunit have > 1 mile per square mile of open motorized routes (OMRD - routes open to motorized access for all or part of the non-denning season);
- less than 19% of a subunit have > 2 miles per square mile of total motorized routes (TMRD - any motorized routes with potential to be used, even if currently closed year-round); and
- $\geq$ 68% of a subunit be in core (areas greater than 500 meters from an open motorized route and greater than 2500 acres in size).

The IGBC recommended numeric standards for subunits with ≥ 75% federal ownership, while they recommended that for subunits with less federal ownership, managers should maintain no net increase in OMRD and TMRD, and no net decrease in core. The LNCF did not formally adopt the IGBC recommendations into its 1986 forest plan. The LCNF has only two subunits that have ≥ 75% federal ownership but that are not in Congressionally-designated wilderness. The LCNF incorporated into their forest plan the Rocky Mountain Front Wildlife Guidelines (USDI et al. 1987), which recommend seasonal restrictions on motorized access in key wildlife habitats, including spring grizzly bear habitat, on the Rocky Mountain Ranger District (Rocky Mountain Range GA). The HNF also did not formally adopt the IGBC recommendations, but the HNF forest plan includes a standard to maintain an open road density of ≥ 0.55 miles per square mile in occupied grizzly bear habitat, as mapped in 1985.

Motorized access densities and core have been calculated for bear management unit subunits on the Rocky Mountain Range and Upper Blackfoot GAs, using protocols recommended by the IGBC. Table 2.58 displays the OMRD, TMRD, and core for all subunits in the Recovery Zone. The table shows values for entire subunits, as well as for the NFS-lands portion of subunits. Displaying the information this way allows a look at the contribution of NFS lands to grizzly bear habitat security in subunits that include other lands.

Table 2.58 Percent of BMU Subunit for the Rocky Mountain Range and Upper Blackfoot GAs in recommended motorized access density category or in core area, for NFS lands portion of subunit, and for entire subunit.

BMU Subunit	Open Motorized Route Density (% of subunit with >1mi/mi^2 OMRD)		Total Motorized Route Density (% of subunit with >2mi/mi^2 TMRD)		Core Area (% of subunit meeting definition of Core)	
	NFS lands only	Entire Subunit	NFS lands only	Entire Subunit	NFS lands only	Entire Subunit
Lewis and Clark NF : Subunits with ≥ 75% Federal ownership						
Lick Rock (Wilderness)	0	0	0	0	91	91
Roule Biggs (Wilderness)	0	0	0	0	89	89
South Fork Willow	14	14	4	3	80	78
West Fork Beaver	11	17	3	5	78	70
Lewis and Clark NF: Subunits with ≤ 75% Federal ownership						
Badger	0	0	0	0	96	94
Birch	0	0	0	0	98	93
Deep Creek	13	9	4	3	83	66
Falls Creek	0	0	0	0	96	85
Heart Butte	2	1	0	0	96	81
Pine Butte	12	7	3	2	81	67
Scapegoat	6	5	1	1	92	78
Teton	12	15	4	4	86	72
Two Medicine	3	3	1	1	91	87

BMU Subunit	Open Motorized Route Density (% of subunit with >1mi/mi^2 OMRD)		Total Motorized Route Density (% of subunit with >2mi/mi^2 TMRD)		Core Area (% of subunit meeting definition of Core)	
Helena NF : Subunits with ≥ 75% Federal ownership						
Arrastra Mountain	16	17	16	19	76	74
Red Mountain	24	24	20	21	60	58
Helena NF : Subunits with < 75% Federal ownership						
Alice Creek	9	10	14	17	74	70

Only the Red Mountain subunit on the HNF fails to meet all guidelines recommended by the IGBC for motorized access or core, but it meets the HNF forest plan standard of ≤ 0.55 miles per square mile of open roads. The Pine Butte subunit on the LCNF fails to meet the core recommendation when considered as a whole, but the recommended amount of core has been maintained on the NFS lands portion of that subunit. The calculations of core used above exclude areas within 500m of a 'high-use non-motorized trail' from core. Biologists working in the NCDE have evaluated that requirement, and have recommended that such trails no longer be excluded from core calculations (USDI 2013a).

Existing travel management for the southern two-thirds of the Rocky Mountain Range GA has been codified into law by Public Law 113-291: National Defense Authorization Act of 2015, which authorized additions to wilderness on the Rocky Mountain Range GA, as well as creating Conservation Management Areas (CMAs).

The USFWS has been working with the FS and other agencies and tribes to develop a grizzly bear conservation strategy that would guide management of grizzly bears in the NCDE after delisting occurs. Five National Forests, including the HLC NFs, that are part of the NCDE have agreed to amend their forest plans to incorporate provisions in the Draft Grizzly Bear Conservation Strategy (GBCS) (USDI 2013a). Under the GBCS, the area that currently forms the recovery zone would be designated as the primary conservation area (PCA). This area includes all of the Rocky Mountain Range GA and the portion of the Upper Blackfoot GA that is within the recovery zone, in addition to portions of the Flathead and Lolo NFs (refer to map 35 in appendix A, Proposed Grizzly Bear Conservation Strategy for a depiction of proposed management zone boundaries). In this area and in the area immediately surrounding it (designated as Zone 1 in the GBCS and including the remainder of the Upper Blackfoot GA), protections that include implementation of a food storage order, limits on expansion in the number and capacity of developed recreation sites, and limits on the density of motorized access routes would be established or maintained. In Zone 2, which would include the Divide, Big Belts, and Elkhorns GAs, food storage orders would be implemented to minimize potential for bear-human conflict in those areas.

Habitat and Population Connectivity

Habitat fragmentation occurs when continuous blocks of habitat are broken into pieces that are separated from one another by unsuitable habitats (Servheen et al. 2001). Habitat fragmentation usually also means habitat loss, as the area of the remaining pieces in sum is less than the area of the original contiguous block (Forman 1996), and each individual piece may be of decreased quality due to the influence of disturbance at the edges, and due to lack of habitat variety and resiliency within each smaller parcel. Habitat, and therefore population fragmentation, may also result in higher risk of extinction of local populations due to random events (Gilpin and Soule 1986) and reduction in genetic variety and resilience (Mills and Smouse 1994). Conversely, some level of movement and gene flow between separate populations, or "metapopulations" (Levins 1970), may reduce the probability of extinction (Soule 1987; Hanski 1999).

Grizzly bears in the lower 48 states are currently limited to five geographically separate areas in relatively small portions of the states of Montana, Wyoming, Idaho, and Washington (Servheen et al. 2001). Within Montana, grizzly bears are currently found in three distinct ecosystems that vary in their degree of isolation from one another and from other populations in the United States and Canada. Maintaining some level of dispersal among the multiple populations in the northern Rocky Mountains, and among populations in Montana and between Montana and Canada, is likely to improve survival and persistence of grizzly bears in these areas and overall (Boyce et al. 2001). An analysis of habitat fragmentation and connectivity found that fragmentation is nearly complete between the separate recovery areas in Montana (Servheen et al. 2001), which may increase the risk of negative genetic and demographic consequences within each population. However, as noted in the discussion under 'Habitat Connectivity', the NCDE population remains connected to populations in Canada, appears to have a relatively high level of genetic diversity (Kendall et al. 2009), and is currently expanding outside the boundaries of the Recovery Zone.

In their analysis, Servheen et al. (2003) found that fragmentation of grizzly bear habitat in Montana is largely associated with human development occurring on private lands in valley bottoms. They indicated that most public lands had "minimal" or "low" potential for impact to grizzly bear habitat connectivity, although where public lands were discontinuously distributed across the landscape, as in the checkerboard pattern of National Forest/private lands in some areas, the potential impact rose to "moderate". Although their model did not consider habitat quality as an important factor governing bear movements, Mace et al. (1999) documented strong associations between telemetry locations of radio-collared bears and certain broad categories of vegetation type. Effective 'linkage zones' between populations are areas that will support low density populations at certain times of year (Servheen et al. 2001); therefore they must contain habitat elements necessary for the survival of those animals during that time period. The IGBC (2004) used the methods developed by Servheen et al. (2001) to establish a process for assessing linkage zones for a variety of carnivores, including grizzly bears, based on home range size, average daily movements, use of certain habitat and vegetation types, and sensitivity to disturbance by certain human activities and developments, among other things.

The portion of the NCDE Recovery Zone encompassing the plan area consists largely of designated wilderness areas and inventoried roadless areas, and as such is relatively unlikely to experience fragmentation due to human activities. The Montana Highway 200 corridor through the Upper Blackfoot GA and private lands adjacent to Montana Highway 200, particularly in the Lincoln area, represent areas of potential fragmentation that could impact the southern end of the NCDE, as well as potentially affecting connectivity with the Greater Yellowstone Ecosystem grizzly bear population. The draft GBCS identifies areas south of Highway 200 on the Upper Blackfoot GA, as well as all of the Divide GA, as being within the proposed bear management Zone 2 (USDI 2013a). Although Zone 2 is not identified specifically as a connectivity area, it is recognized that minimizing human-grizzly conflicts in these areas will provide some opportunity for bears, particularly males, to travel between the NCDE and other ecosystems (USDI 2013a).

Climate Change
The Draft GBCS (USDI 2013a) states, "Climate change may result in a number of changes to grizzly bear habitat, including a reduction in snowpack levels, shifts in denning times, shifts in the abundance and distribution of some natural food sources, and changes in fire regimes. Most grizzly bear biologists in the U.S. and Canada do not expect habitat changes predicted under climate change scenarios to directly threaten grizzly bears. These changes may even make habitat more suitable and food sources more abundant. However, these ecological changes may also affect the timing and frequency of grizzly bear/human interactions and conflicts."

Information Gaps
A variety of means have been used to identify, measure, and map grizzly bear habitats. Potential spring and denning habitats, considered to be the areas where bears may be most sensitive to human disturbance, have been broadly mapped for only a portion of the plan area (the Rocky Mountain Range GA). These maps were created

over 20 years ago. More recent overall habitat mapping has been included as part of the NCDE Cumulative Effects Model (CEM) process, which was developed to facilitate analysis of proposed management activities in the context of existing habitat and other ongoing human activity. The model was found to be less accurate east of the Continental Divide and was adjusted to attempt to improve its utility there, but its accuracy remains somewhat in question. Outputs for habitat on the east side are not directly comparable to those generated for the west side.

Information on cause-specific mortality of grizzly bears is available for the NCDE as a whole, but is not as readily available for specific portions (e.g., GAs, or portions of GAs such as wilderness vs. non-wilderness, etc.). It is also not readily available by detailed cause, such as the portion of self-defense mortalities associated with hunters on NFS lands, etc. That data would be useful in identifying management concerns and needs among different areas.

Species Summary

Primary grizzly bear stressors include human-caused mortality, as well as habitat fragmentation, which can negatively affect gene flow. The HLC NFs actively minimize bear-human conflicts and bear mortality by limiting motorized access route density, applying seasonal restrictions to motorized access in key areas, designating MSs within the recovery zone, and enforcing a food-storage order. Although gene flow may be affected by habitat fragmentation across the NCDE as a whole, current habitat on the HLC NFs is anchored by large expanses of designated wilderness and inventoried roadless areas that are unlikely to be affected by human disturbance at a level that would impact bears. The current population trend for grizzly bears on HLC NFs is stable to increasing. Habitat also appears to be not limiting to grizzly bears in the NCDE or on the HLC NFs.

Canada Lynx (Lynx canadensis) - Threatened; and Canada Lynx Critical Habitat

Distribution

The plan area is within the Northern Rocky Mountain Range geographic area (NRMGA) for lynx (Interagency Lynx Biology Team 2013), which includes portions of Montana, Washington, Oregon, Idaho, Utah, and Wyoming. In Montana, lynx are primarily restricted to northwestern Montana from the Purcell Mountains near the Idaho border east to Glacier National Park, then south through the Bob Marshall Wilderness Complex to Highway 200 (Interagency Lynx Biology Team 2013). Therefore the majority of the plan area is outside the known or expected distribution of lynx.

In the plan area, Canada lynx occur as a resident population throughout the Rocky Mountain Range and Upper Blackfoot GAs, and in the northern portion of the Divide GA. This portion of their range within the NRMGA is considered to be within the Northwestern Montana/Northeastern Idaho core area (Interagency Lynx Biology Team 2013, USDI 2005). A “core area” is an area “with the strongest long-term evidence of the persistence of lynx populations supported by a sufficient quality and quantity of habitat” (Interagency Lynx Biology Team 2013), which consists of boreal forests with dense horizontal cover supporting snowshoe hare populations (refer to ‘Habitat Status and Connectivity’ section for a detailed description of lynx habitat). More specifically, core areas have verified evidence of long-term historical and current presence of lynx populations that are persistent despite periodic fluctuations, have evidence of reproduction within the past 20 years, and have boreal forest vegetation types, as described above, of the quality and quantity to support lynx and snowshoe hare (USDI 2005). The northwestern Montana/northeastern Idaho area coincides with the area in which Canada lynx Critical Habitat has been designated and is protected under the Endangered Species Act (see map 36 in appendix A titled Lynx Habitat).

According to the Lynx Conservation and Assessment Strategy (Interagency Lynx Biology Team 2013) and the Recovery Outline (USDI 2005), the remainder of the plan area occurs within secondary areas, with the exception of the Highwoods and Snowies GAs, which are considered peripheral. Secondary areas are defined as having “fewer and more sporadic current and historical records of lynx”, and no documentation of reproduction (USDI 2005). Peripheral areas have sporadic historical records of lynx, generally corresponding to cyclic population highs in populations in Canada (USDI 2005), and have no records or evidence of reproduction. Both these areas "may contribute to lynx persistence by enabling successful dispersal and recolonization of core areas, but their role in sustaining lynx populations remains unknown" (Interagency Lynx Biology Team 2013).

Most of the research on lynx in Montana has occurred west of the Continental Divide, so more detailed information regarding lynx distribution in the occupied portion of the planning area is not available. More work has been done to delineate lynx habitat within the plan area, as described under "Habitat Status and Connectivity".

Population Trend

No reliable information is available regarding the number of lynx or trend of the lynx population in the plan area or region-wide. Lynx are a solitary forest carnivore occurring in habitat types where visibility and access can be difficult. Non-invasive methods involving lures and hair snags, and track surveys have been used to detect lynx presence or absence in an area (McDaniel et al. 2000; Squires et al. 2012), but have not been used for estimates of population size on local or larger scales. Efforts in the region to maintain lynx populations have focused on maintaining habitat (see "Habitat Status and Connectivity" section).

Food Habits

Snowshoe hares are the primary prey of lynx throughout their range (Mowat et al. 2000; Interagency Lynx Biology Team 2013). Summer diets may contain a broader range of prey species, based on their availability, but summer diets have not been quantified in the southern part of lynx range, which includes the plan area. Red squirrels are an important secondary prey species in many areas, while grouse, northern flying squirrel, ground squirrels, porcupine, beaver, mice, voles, shrews, weasels, fish, ungulates, and ungulate carrion have all been reported in the diets of lynx in various portions of their range (Interagency Lynx Biology Team 2013). Lynx diets are limited primarily to snowshoe hare in winter due to snow characteristics and to the ecology of various alternate prey species.

Habitat Status and Connectivity

Lynx use habitats where their primary prey species are available. Broadly, Canada lynx habitat is defined as boreal forest. More specifically, snowshoe hares occur in boreal forests with dense horizontal cover that reduces their exposure to predators and provides access to food and thermal protection (Interagency Lynx Biology Team 2013). In western Montana, winter snowshoe hare density was highest in dense, mature forests, and in summer was highest in both dense young and dense mature forest (Interagency Lynx Biology Team 2013). Cover types supporting snowshoe hares include Engelmann spruce, subalpine fir, mixed spruce-fir, mixed aspen and spruce-fir, mixed lodgepole and spruce-fir, and lodgepole pine (refer to Table 2.57 and to the portions of the Terrestrial Vegetation section referenced). Generally snowshoe hare and lynx do not use drier habitats, including lodgepole pine types occurring on drier sites, or dry Douglas-fir types, because these do not provide dense horizontal cover. Habitat used by red squirrels, an important secondary prey species, overlaps snowshoe hare habitat extensively but does not generally extend to young forests that are not yet producing cones.

Potential Canada lynx habitat has been mapped for the plan area. In the past, lynx habitat maps used existing vegetation data derived from remote sensing, aerial photo interpretation, stand exams, or combinations thereof. Those maps were inconsistent across the plan area due to the varied availability of data sources, as well as to slightly different methodology, between and even within the two forests. In 2010 the east-side Forests of the Northern Region (Helena, Lewis and Clark, Custer, and Gallatin National Forests) began collaborating on a uniform method to map lynx habitat, along with habitat for some other species. This effort, referred to as the "East Side Assessment", was intended to develop reliable, consistent habitat mapping and modelling protocols that could be used for mid to large scale assessments of forest and habitat conditions.

Using the methods established in the East Side Assessment and the most recent vegetation data available, Canada lynx habitat was mapped for the plan area. Specific vegetation types, as well as features such as elevation and aspect, were selected as potential lynx habitat for each GA. These selections reflected information provided by each forest that some vegetation types produce lynx habitat under certain conditions and in certain landscapes but not in others. Mapping also included information on recent disturbances, using assumptions developed by the East Side Assessment team regarding the impacts of those disturbances on lynx habitat. Results are shown on the Lynx Habitat map in appendix A, and summarized in Table 2.59. Note that as of the publication of this assessment, the mapping method is undergoing some corrections, and results shown below are preliminary and subject to change. Nevertheless, the map and table provide an idea of the overall amount of Canada lynx habitat in the plan area and the relative amounts in the GAs comprising the plan area. This gives a broad picture of the ability of the plan area and GAs to potentially sustain lynx. Table 2.59 summarizes habitat into categories identified as 'currently suitable' or 'not currently suitable' but that may provide habitat at another time. Categorization of habitat as 'suitable' or 'not currently suitable' is based on vegetation composition and structure, whether habitat is a vegetation type that may produce lynx habitat but is not currently in a stage to do so, and by past disturbances. Currently suitable habitat includes multi-storied and stand-initiation stages of the forest types described above. Habitat categorized as not currently suitable includes the same types in the early stand-initiation and stem exclusion stages. Habitat identified as not currently suitable is expected to become suitable in time, as succession proceeds and horizontal cover develops.

Table 2.59 Canada lynx habitat on the Helena and Lewis and Clark National Forests, by Geographic Area

Geographic Area	Potential Habitat – Currently Suitable	Potential Habitat – Not Currently Suitable	Total Potential Habitat	Percent of Total Potential Habitat Currently Suitable	Percent of GA that is Potential Habitat	Percent of GA that is Non-Habitat
Big Belts	32,862	62,603	95,465	34%	21%	79%
Castles	12,946	18,178	31,124	42%	39%	61%
Crazies	21,995	10,000	31,995	69%	46%	54%
Divide	37,067	63,805	99,564	37%	43%	57%
Elkhorns	15,012	19,611	34,620	43%	20%	80%
Highwoods	6,126	8,157	14,283	43%	32%	68%
Little Belts	186,318	144,412	330,706	56%	37%	63%
Rocky Mountain Range	67,865	240,895	308,760	22%	39%	61%
Snowies	17,016	28,991	45,953	37%	38%	62%
Upper Blackfoot	84,205	135,014	219,150	38%	63%	37%

Approximately 10 mi^2, or well over 6,000 acres of primary habitat (e.g. spruce-fir forest) is required to provide the year-round needs of a single Canada lynx female. The actual amount required depends on a variety of factors, including the quality of habitat, abundance of hares, cycling of hare populations, availability and use of alternate prey species, etc. Nevertheless, Table 2.59 provides some idea of the ability of each GA to sustain a population of lynx over the long term.

It appears that the Castles, Crazies, Elkhorns, Highwoods, Big Belts, and Snowies GAs do not contain enough potential habitat to support more than a few individual lynx, likely below a threshold needed for a population to be demographically and genetically self-sustaining. Furthermore, these GAs are each isolated mountain ranges, separated from each other and from other lynx habitat by significant stretches of low elevation, often agricultural landscapes that do not support lynx or their primary prey species. Their size, isolation, and habitat characteristics likely preclude them currently or historically sustaining lynx populations. The Castles, Crazies, and Elkhorns GAs fall within the broadly drawn 'secondary habitat' area in the Lynx Recovery Outline (USDI 2005). Secondary areas contain boreal forest, but it may be inherently patchier and/or drier, and have snow or habitat conditions that are not favorable to lynx (USDI 2005). In peripheral areas, such as the Snowies and Highwoods GAs, habitat may occur in small patches not well connected to larger patches of high quality habitat (USDI 2005), such as in island mountain ranges (Interagency Lynx Biology Team 2013). These areas "are considered to be incapable of supporting self-sustaining populations of lynx" (Interagency Lynx Biology Team 2013). Due to their small size, inherent lack of habitat, and relative isolation, it is possible that the Castles, Crazies, Elkhorns, and even possibly the Big Belts GAs may function more as peripheral than secondary habitat.

The Little Belts GA contains more potential lynx habitat than the other GAs that occur east of Interstate 15, but this GA is also an isolated mountain range, and the nearest neighboring mountain ranges (Big Belts and Castles) do not appear capable of sustaining lynx populations. The lack of connectivity with the area of lynx distribution and core habitat in western Montana, combined with the patchiness of currently suitable lynx habitat at any given time in this GA makes it unlikely that a self-sustaining lynx population could exist in the Little Belts GA. The portions of the HLC NFs that are not considered secondary habitat are situated between the northwestern Montana/northeastern Idaho core area to the north, and the greater Yellowstone core area to the south. As such, these GAs may provide some level of connectivity between lynx populations at a regional scale, although the LCAS (Interagency Lynx Biology Team 2013) notes that the "contribution of lynx occurring outside of core areas to population dynamics and persistence within core areas is unclear".

The Divide GA does not contain a large amount of lynx habitat, but what occurs is largely west of the Continental Divide, and is contiguous with the Upper Blackfoot GA and adjoining the Garnet Range, which has the southernmost lynx population in Montana (Interagency Lynx Biology Team 2013). Core areas identified in the LCAS (Interagency Lynx Biology Team 2013), which include the Rocky Mountain Range and Upper Blackfoot GAs, contain larger patches of boreal forest and more lynx habitat in total. These areas are also well connected to large areas of Canada lynx habitat on the Flathead and Lolo National Forests to the west, and Glacier National Park to the north. It is likely that the northern portion of the Divide GA contributes to, and the Upper Blackfoot and Rocky Mountain Range GAs either support or contribute to, supporting a lynx population within that larger core area.

The primary factor causing Canada lynx to be federally listed as threatened was the lack of guidance for conservation of lynx and snowshoe hare habitat in NF Land and Resource Plans and Bureau of Land Management (BLM) Land use plans, since a large amount of lynx habitat occurs on lands managed by those agencies (USDI 2000). Consequently, National Forests in Region One amended their forest plans with the Northern Rockies Lynx Management Direction (NRLMD)(USDA 2007b), which applies to national forests that are considered 'occupied' by lynx. The purpose of the NRLMD is to "incorporate management direction in land management plans that conserves and promotes recovery of Canada lynx, by reducing or eliminating adverse effects from land management activities on NFS lands" (USDA 2007b). The NRLMD established standards and guidelines for managing lynx habitat and for managing projects or activities that occur within lynx habitat. The NRLMD also includes objectives and standards to maintain habitat connectivity within Lynx Analysis Units (LAUs) as well as within and among linkage areas. Potential linkage areas were identified in the NRLMD (USDA 2007b), and included areas connecting the GAs where lynx are found or that are considered either core or secondary areas. Linkage areas between GAs may be somewhat limited by the type of habitat existing between these GAs. Discussion of the relative connectedness or isolation of the GAs within the plan area is incorporated into the paragraphs above.

Forests having lynx habitat in Region One have delineated LAUs to facilitate project-level assessment and impact analysis. LAUs approximate the size of a female home range and were drawn using original habitat maps for each forest, capturing enough year-round habitat (approximately 10 mi^2 or roughly 6,430 acres of primary vegetation, such as spruce-fir forest) to support one female lynx. The LCAS (Interagency Lynx Biology Team 2013) recognizes that new vegetation databases and mapping efforts, such as the East Side Assessment, may result in adjustments or redrawing of LAUs, to preserve the original analysis and management intent. The LCAS also noted that because LAUs are a tool to guide management in core areas it is not necessary to delineate LAUs in secondary and peripheral areas.

Canada Lynx Critical Habitat

Canada lynx is the only federally listed wildlife species on the HLC NFs that also has designated critical habitat. The Rocky Mountain Range and Upper Blackfoot GAs, and the northern portion of the Divide GA are within Unit 1 of designated Canada lynx Critical Habitat (USDI 2014f). Critical habitat receives protection under Section 7(a)(2) of the Endangered Species Act. Areas identified as critical habitat contain the primary constituent elements (PCEs), which are specific biological or physical features that provide for a species' life history processes and are essential to the conservation of the species (USDI 2014f). The PCE for lynx is boreal forest landscapes supporting a mosaic of differing successional forest stages and containing:

a) Presence of snowshoe hares and their preferred habitat conditions, which include dense understories of young trees, shrubs, or overhanging boughs that protrude above the snow, and mature multistoried stands with conifer boughs touching the snow surface;

b) Winter conditions that provide and maintain deep fluffy snow for extended periods of time;

c) Sites for denning that have abundant coarse woody debris, such as downed trees and root wads; and

d) Matrix habitat…that occurs between patches of boreal forest in close juxtaposition (at the scale of a lynx home range) such that lynx are likely to travel through such habitat while accessing patches of boreal forest within a home range.

Component (a) is addressed in the 'Habitat Status and Connectivity' section, and is modelled as described above. Component (b) is less well-defined and not something that can be realistically modelled. Lynx may use a wide variety of habitats for travel among more suitable patches, depending on proximity to patches of foraging habitat, size, shape, and topography of intervening patches, quality of nearby foraging habitat, etc. The discussion titled 'Connectivity and Pattern' (p. 71) in the Terrestrial Vegetation section gives some idea of the relative patchiness of forest cover in the plan area as a whole, although analysis of some patch types remains incomplete as of the writing of this section. Component (c) is not discussed or modelled here, but is addressed broadly on page 115 of the Terrestrial Vegetation section under the heading 'Coarse Woody Debris".
Component (b) is highly variable in some portions of the plan area, and may be changing due to climate change (refer to chapter 4, Climate Change and Baseline Assessment of Carbon Stocks).

Consideration of system drivers and stressors for Canada lynx

Vegetation Management and Fire

Canada lynx rely on snowshoe hare, which require boreal forest that contains dense, horizontal cover. Therefore, disturbances that alter or remove horizontal cover or convert forest to unsuitable habitat types or conditions have the potential to impact Canada lynx. These disturbances include vegetation management and fire, which can be considered as both stressors and drivers of Canada lynx habitat. In general, treatments used in vegetation management remove trees and/or reduce horizontal cover through thinning or burning. Fires also have this effect, to varying degrees depending on fire intensity and severity.

Fire and certain types of vegetation management can also promote development of Canada lynx habitat by returning a stand or area to an earlier successional stage that may eventually provide habitat (such as dense, young regenerating forest), or by creating forest openings that promote development of multiple canopy layers. Therefore, maintaining a habitat mosaic of different successional stages within the forest types likely to be used by lynx is a key strategy for maintaining lynx presence. Squires et al. (2010) state, "Managers should prioritize retention of a habitat mosaic of abundant and spatially well-distributed patches of mature, multilayer spruce-fir forests and younger forest stands". Vegetation management activities, including prescribed fire, can be designed to increase potential future lynx habitat, to maintain connectivity among patches of existing lynx habitat, and to create patchiness of successional stages as recommended by Squires et al. (2010). Fires that burn with varying intensity and severity also help to perpetuate the mosaic of stages. Vegetation management can be used as a tool to help manage future wildfires by creating breaks or inconsistencies in fuels, thereby altering fire spread rate and direction. Care must be taken in core areas to maintain enough habitat to support a reproductive population of lynx. Use of properly delineated LAUs, as described above and in the LCAS (Interagency Lynx Biology Team 2013), helps to realize that management goal. The NRLMD specifies the degree to which lynx habitat can be altered in an area, with more restrictive management in high-functioning snowshoe hare habitat.

In the plan area over 496,900 acres are in designated wilderness, where vegetation management activities are limited to prescribed fire used for very specific purposes, and where naturally occurring wildfire has played an increasing role.

Climate Change

The LCAS (Interagency Lynx Biology Team 2013) addresses several possible effects of climate change on lynx. These include potential shifts in lynx distribution in terms of elevation and latitude, changes in hare population cycles, reductions in the amount of lynx habitat due to changes in snow suitability and persistence, and changes in the frequency and severity of disturbances such as wildfire and insects that impact habitat. Rates and magnitude of these changes and the manner in which they may interact are difficult or impossible to predict.

Specific to the HLC NFs, tree species that are key components of snowshoe hare, and therefore lynx habitat, including Engelmann spruce and subalpine fir, may decrease at lower elevations, possibly expand upward in elevation, and potentially become less resilient to disturbance (see p. 10-11 in chapter 4, Climate Change and Baseline Assessment of Carbon Stocks). This, combined with likely increased fire frequency and duration (p. 11 in that section), may result in overall decreases in habitat suitable for lynx. For the HLC NFs on the edge of current and historic lynx distribution, lynx habitat could decrease to the point that portions of the plan area that currently support lynx either permanently or as transients are no longer capable of doing so. Areas where habitat is limited or marginal, such as at the edge of a species' distribution are often the first areas to become uninhabited.

Information Gaps

No reliable information is available regarding the number of lynx or trend of the lynx population in the plan area or region-wide. As a generally solitary carnivore inhabiting areas of dense forest cover, lynx are difficult to census. That task becomes more difficult where lynx occur at low density or are intermittently present, as they appear to be throughout most of the GAs within the plan area. Attempts to determine simple presence or absence of lynx in an area can be difficult where lynx exist at low density or are intermittently present.

Most of the research on lynx in Montana has occurred west of the Continental Divide, so similar types of information are not available east of the divide. Protocols for detecting lynx presence using snow tracking have generally been developed in study areas west of the Continental Divide, where persistent snow cover exists and wind is rarely a factor. East of the divide, however, snow cover is less reliable and frequent wind makes tracking surveys difficult to implement.

The LCAS (Interagency Lynx Biology Team 2013) states that secondary and peripheral areas "may contribute to lynx persistence by enabling successful dispersal and recolonization of core areas, but their role in sustaining lynx populations remains unknown." Although habitat mapping, as described above, may provide some information about the relative potential of the various GAs to provide lynx habitat or contribute to the larger lynx population, the maps have not been validated with field studies, and the true potential of each GA to contribute to the larger population or to support dispersal remains unknown.

Lynx diets have been studied in northwestern Montana during winter, but summer diets have not been quantified in the southern part of lynx range, which includes the plan area.

Species Summary

Primary stressors to Canada lynx populations and habitat are considered largely to be disturbances that remove horizontal cover that provides cover and food for their primary prey, the snowshoe hare. These disturbances may also create lynx habitat, however, by returning forests to early successional stages, or by creating openings in mature forest, allowing multiple canopy layers to develop. Climate change may impact lynx habitat through changes in the amount, distribution, and persistence of snow, as well as changes in the amount and distribution of habitat types used by lynx and snowshoe hares. Canada lynx may be affected by habitat fragmentation, both man-made and naturally occurring. Several GAs in the plan area are small and have limited potential to provide lynx habitat; the relative isolation of these GAs decreases the likelihood that they contribute to the persistence of the larger lynx population. Canada lynx and lynx habitat in the Divide, Upper Blackfoot, and Rocky Mountains GAs, however, are well connected to larger areas of lynx habitat to the west.

Sprague's Pipit (Anthus spragueii) - Candidate HNF and LCNF

Distribution

Although Sprague's pipit is listed as a candidate species on both the HNF and the LCNF, it is likely present only as an occasional transient. There is one observation each in the Highwoods, Elkhorns, Rocky Mountain Range, and Castles GAs. None of these observations are within the past 20 years and they may be much older as information on observation date is documented only for very broad time periods (MTNHP data). None of the observations provided direct evidence of breeding.

There are four observations documented in the Little Belts GA, only one of which occurred in the past 15 years (an observation in 2000 as part of monitoring conducted by the Avian Science Center; MTNHP pod data). These observations provided only indirect/circumstantial evidence of breeding, as they were point count surveys detecting bird calls during the breeding season. There is no verified presence of Sprague's pipits breeding anywhere on the HLC NFs. The minimal observations that exist are more than two decades old, spread over a lengthy time span, and widely separated geographically.

The plan area is at the southwestern edge of the breeding distribution of the Sprague's pipit, which spans northward into Alberta, Saskatchewan, and Manitoba and eastward through the Dakotas. The greatest number of detections during the North American Breeding Bird Survey (BBS) between 2006 and 2012 were in central Alberta and extreme northeastern Montana (Sauer et al. 2014).

Population Trend

In the "12-Month Finding on a Petition to List Sprague's Pipit as Endangered or Threatened Throughout Its Range" (USDI 2010b), the USFWS summarized the best available information regarding the population status and trend of the Sprague's pipit. Using extrapolations from the long-term North American Breeding Bird Surveys (BBS), which have been carried out since 1966, as well as from the Canadian Grassland Bird Monitoring program, and the annual Christmas Bird Count, it appears that the population of Sprague's pipit has declined sharply throughout its range since at least 1966. Although BBS surveys in Montana have shown stable to increasing numbers since 2006 (Sauer et al. 2014), the trend for the entire United States and for the entire survey area, which includes portions of some Canadian provinces, appears to continue downward. Concerns over this trend prompted the petition for federal listing under the Endangered Species Act, as well as designation as a "species in greatest need of conservation action" in the "Birds of Conservation Concern", a list developed by federal, state, and non-governmental organizations via three continent-wide bird conservation plans. In September 2010 the USFWS determined that the Sprague's pipit warrants protection under the Endangered Species Act, but that listing is precluded by the need to address other listing actions of a higher priority.

Habitat Status and Trend

Sprague's pipits are strongly tied to native prairie grassland throughout their life cycle, preferring areas that have been regularly disturbed through grazing or mowing, but often using those areas after some time has passed following the disturbance (USDI 2010b). They require large areas (minimum of roughly 350 acres, range 170 to 775 acres) of native grassland during the breeding season. They tend to avoid grasslands with a significant shrub component.

Grasslands are present on all GAs, but the most acres of grassland occur in the Big Belts and Little Belts GAs (refer to Terrestrial Vegetation – Potential Plant Species of Conservation Concern – Grasslands guild). There is very little if any native grassland on the HLC NFs that meets the breeding requirements of the Sprague's pipit: i.e. greater than 350 acres in size, with no shrub component, that receives intermittent disturbance in a spatial and temporal pattern as described above that favors use by pipits (refer to Terrestrial Vegetation, p. 51-61 regarding non-forested vegetation and composition, p. 88-89 regarding the grassland SCC guild, and to chapter 6, Multiple Uses and Ecosystem Services – range). Individual patches that meet these requirements may occur scattered throughout the plan area, but they are likely widely separated and vary in their connectedness both geographically and in terms of availability due to time since disturbance. Some grasslands along the forest boundaries may be part of pipit habitat that occurs in the much more extensive grassland habitats on non-NFS lands.

The USFWS determined that approximately 2.1 percent of the total area in the Sprague's pipit U.S. breeding range remains suitable. Conversion of native grassland throughout U.S. history has been responsible for this decline. This trend continues, with ongoing conversion motivated by a variety of factors usually related to agriculture, but most recently includes development related to oil-shale production in some areas as well. It is expected that conversion will continue and that the rate may increase (USDI 2010b). In summary, the current habitat condition and trend is declining range-wide. Presence and distribution of grassland habitat in the plan area is described in the Terrestrial Vegetation section; grasslands in some GAs have been affected by conifer encroachment due to fire exclusion (e.g. in the Elkhorns GA, USDA 2012d), but specific trend information for the plan area or for each GA is not available as of the writing of this assessment.

Consideration of system drivers and stressors for Sprague's pipit

Vegetation Disturbance

Disturbances that reduce grasses to very low height or bare ground may preclude use by Sprague's pipits for a number of years, until the vegetation again reaches intermediate height (USDI 2010b). In Montana, some areas have not been re-colonized by pipits for 10-26 years after fire, or for up to 8 years following grazing by bison (USDI 2010b).

Modern grazing practices, which favor uniformity in grazing pattern and often result in overgrazing, may also decrease suitability of habitat for pipits, by removing grasses for lengthy time periods over large areas, reducing plant species diversity, and favoring growth of woody species that are not browsed by cattle. Lack of widespread fire in current prairie environments has also altered vegetation to forms not suitable for use by pipits (USDI 2010b). Fire exclusion from grasslands on NFS lands may also be resulting in decreases in size and abundance of grasslands (e.g., USDA 2012d).

Climate Change

Refer to chapter 4, Climate Change and Baseline Assessment of Carbon Stocks for information regarding potential impacts of climate change on native grasslands.

Potential Terrestrial Wildlife Species of Conservation Concern

Potential Species of Conservation Concern (SCC) are defined as "Any species, other than federally recognized threatened, endangered, proposed, or candidate species, that is known to occur in the plan area and for which the Regional Forester has determined that the best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area." (36 CFR 219.9; draft FSH 1909.12.52). The process used for identifying potential SCC is described near the beginning of this section, under the heading 'Process and Methods', and closely follows the process used by the Flathead National Forest as described in their Assessment (USDA 2014a). The list of SCC used in this assessment remains 'potential' because it may be refined to add or remove species as additional information is gathered and as analysis occurs throughout the plan revision process.

Conservation rankings listed for each species include the widely used NatureServe rankings at the global ("G-Ranks") and Subnational ("S-Ranks" scales). Numeric ranking used by this system is on a scale of 1 to 5, with 1 indicating species that are critically imperiled and 5 indicating species that are common, widespread, and abundant (NatureServe 2014). G-Ranks may differ substantially from S-Ranks, if a species is considered common globally, for example, but vulnerable or imperiled in a particular region or state. S-Ranks may be accompanied by an additional letter to indicate the seasonal portion of their range to which the ranking applies. For example, an S-Rank of 'S2B' indicates that the species is at risk or declining in its breeding range. A species may have different S-Ranks for different seasonal ranges. Use of two numbers for a ranking (e.g., G3G4) indicates uncertainty about the status of the species.

Conservation rankings provided below for each species also include whether the species is currently considered sensitive by the USFS or Bureau of Land Management (BLM). 'Sensitive' status is a broad designation not necessarily indicative of 'substantial concern regarding a species' ability to persist', as the 2012 Planning Rule requires for a species to be considered a potential SCC. However, that status provides additional information about the species at the regional scale.

Montana has additional conservation rankings that are useful in identifying species that may be of conservation concern (see information in MTNHP 2014b). Montana 'Species of Concern' (SOC) are species native to Montana that are thought to be potentially at risk due to declining population trends, threats to habitat, restricted distribution, or other factors. Montana also uses a MTFWP conservation tier ranking, indicating the level of conservation that is expected to be required to benefit the species. Conservation tier rankings range from 1-4, with 1 being 'greatest conservation need' and 4 indicating the least.

Partners in Flight (PIF) is a "cooperative venture of federal, state, provincial, and territorial agencies, industry, nongovernmental organizations, researchers" and others (Panjabi et al. 2012) that serves as a clearinghouse for information regarding status and conservation needs of birds throughout North America. PIF uses a widely accepted species assessment process to indicate status and conservation concerns of birds at both global and regional scales. PIF conservation status rankings are detailed in their "Handbook on Species Assessment" (Panjabi et al. 2012), and are used where appropriate below to provide information regarding regional conservation status of bird species.

Species Considered as Potential SCC

A number of species were considered as potential SCC, based on conservation rankings, information on local declines, or other factors, as outlined under 'Process and Methods' section. Not all species we considered warranted recommendation as Potential SCC at this time. A summary of information regarding the species considered; why they were considered; and the rationale for recommending or not recommending them as potential SCC is provided in Table 2.60. For simplicity, the table is organized by species group (i.e., amphibians, birds, mammals), and within each species group alphabetically by common name. Species recommended as Potential SCC are discussed in more detail following the table. Several species were recommended as 'species of interest' because of conservation concerns that are not of a magnitude to warrant recommendation as potential SCC, or because of their value to the public for viewing, hunting, trapping, or other activities. Those species are discussed in more detail in the 'Species of Interest' section that follows the discussion of individual species recommended as Potential SCC.

Table 2.60 Species considered but as Potential Species of Conservation Concern, and rationale for recommending or not recommending as Potential SCC.

Species Name	Conservation Rankings	Distribution in Plan Area	Rationale for considering and recommending or not as potential SCC
Amphibians			
Western/Boreal Toad (*Anaxyruas boreas*)	G4, S2, USFS Sensitive, BLM Sensitive, MT Species of Concern, FWP Conservation Tier 1	Documented throughout all GAs except Snowies GA.	Recommended as SCC because of statewide population declines and state rankings; plan area occurs on the eastern edge of distribution. Multiple threats and stressors exist, with some lack of clarity regarding potential contributions of varying sources to declines. Concerns regarding connectivity among breeding sites in plan area, presence of isolated breeding populations in geographically isolated mountain ranges.
Birds			
Bald eagle (*Haliaeetus leucocephalus*)	G5, S4, USFWS Delisted-Monitoring, BGEPA, MBTA, BCC, USFS Sensitive, BLM Sensitive, FWP Conservation Tier 1	Observations throughout plan area except in Snowies and Crazies GAs. Breeding limited to a few localized areas along the edges of Divide, Big Belts, and Little Belts GAs in proximity to large reservoirs.	Considered because recently delisted, and potential SCC on adjoining FNF. However: estimated 325 breeding pairs and over 450 territories in Montana and population steadily increasing through 2008 (MTFWP 2010). Majority of breeding habitat not on NFS lands, but along large reservoirs and major river systems.
Black rosy-finch (*Leucosticte atrata*)	G4, S2, MT SOC, FWP Conservation Tier 2	Total of 12 observations in Big Belts, Little Belts, Divide, Elkhorns, and Castles GAs, but all observations ca. 1983 or older.	Considered because of S2 ranking, PIF rankings (PIF Science Committee 2014) indicate regional conservation concern. However, plan area at northern edge of range, no documentation of presence in plan area for over 30 years.
Brewer's sparrow (*Spizella breweri*)	G5, S3B, MT SOC, BLM Sensitive, FWP Conservation Tier 2, PIF Species of Regional Concern for BCR 10 and 17	Observations and likely breeding activity in all GAs except Rocky Mountain Range, Snowies, and Crazies.	Considered because of declines in MT BBS (Sauer et al. 2014), PIF Regional Concern and indication as species in need of Management Action. Dependent on sagebrush habitats that occur primarily off NFS lands. Not enough information regarding contribution of NFS lands to overall population to warrant recommending as SCC.
Clark's nutcracker (*Nucifraga Columbiana*)	G5, S3, FWP Conservation Tier 3	Widely distributed throughout plan area.	Considered because potential SCC on adjoining FNF. Apparently widespread on HLC NFs, not identified as species of regional concern in BCR 10 or 17 (PIF Science Committee 2012). Breeding Bird Surveys relatively stable in MT (Sauer et al. 2014). Declines in whitebark pine not as severe in plan area as on other NFs, also presence of ponderosa pine, limber pine and Douglas-fir for alternate forage.

Species Name	Conservation Rankings	Distribution in Plan Area	Rationale for considering and recommending or not as potential SCC
Common Loon (*Gavia immer*)	G5, S3B, MT SOC, USFS Sensitive, BLM Sensitive, FWP Conservation Tier 1	Observations on Rocky Mountain Range, Upper Blackfoot, and Little Belts GAs, and on edge of Big Belts and Divide GAs associated with adjacent large reservoirs.	Considered because Potential SCC on adjoining FNF, and MT SOC and Cons. Tier 1 rankings. No breeding has been documented in plan area, which lacks suitable breeding habitat. Recommend as Species of Interest for viewing and conservation interest. Plan area within migration corridor, recording of observations should be encouraged.
Flammulated owl (*Otus flammeolus*)	G4, S3B, USFS Sensitive, BLM Sensitive, MT Species of Concern, FWP Conservation Tier 1, PIF Species of Regional Concern for BCR 10	Observations in Upper Blackfoot, Divide, Big Belts, and Elkhorns GAs.	Considered because Potential SCC on adjoining FNF, and MT SOC and Conservation Tier rankings and PIF ranking. Recommended as Potential SCC because of concerns regarding status of and declines in mature, open Ponderosa pine type, affected by recent heavy insect infestation on the HNF and by fire exclusion. Scarcity of observations despite presence of habitat indicates possibly low numbers. HNF portion of plan area is at eastern edge of distribution.
Golden Eagle (*Aquila chrysaetos*)	G5, S3, MT SOC, USFWS BGEPA, MBTA, BCC, BLM Sensitive, FWP Conservation Tier 2	Documented throughout plan area, breeding documented only in Big Belts, Castles, Divide, Little Belts, and Rocky Mountain Range GAs.	Considered due to ongoing significant mortality (poisoning, collisions with wind turbines and electric lines), PIF considers species of regional concern in BCR 17 (PIF Science Committee 2012). Portions of plan area contain concentrations of optimal nesting habitat. No clear evidence of decline in plan area, or of impact of forest management activities on population. Recommend as Species of Interest for viewing and conservation. Monitoring of nesting areas should be encouraged, consideration in issuance of special use permits for above-ground energy development.
Gray crowned rosy-finch (*Leucosticte tephrocotis*)	G5, S2B, MT SOC, FWP Conservation Tier 2	Total of4 recent (<15 years old) observations in Big Belts (1), Divide (3), and Rocky Mountains (1) GAs. Two additional recent observations on FNF along boundary with Rocky Mountain Range GA. Six historic observations in other GAs (Castles, Divide, Little Belts, Highwoods).	Considered because of S2B status. Not enough information regarding presence and distribution in plan area, or on potential threats, to warrant recommending as SCC.
Harlequin duck (*Histrionicus histrionicus*)	G4, S2B, USFS Sensitive, BLM Sensitive, MT Species of Concern, FWP Conservation Tier 1	Known breeding pairs on the Rocky Mountains and Upper Blackfoot GAs. Single males observed at northwestern edge of Big Belts GA, northwestern edge of Little Belts GA, and in Crazies GA but no breeding documented there.	Considered because of S2B status, MT Species of Concern, FWP Conservation Tier, and Potential SCC on adjoining FNF. Recommend as Potential SCC because of inherently low population size, narrow habitat requirements, lack of resilience (inability to recolonize vacant habitats), vulnerability of large portion of the population to single events.

Species Name	Conservation Rankings	Distribution in Plan Area	Rationale for considering and recommending or not as potential SCC
Lewis's woodpecker (*Melanarpes lewis*)	G4, S2B, MT Species of Concern, FWP Conservation Tier 2, PIF Species of Regional Concern for BCR 10 and BCR 17	Observations primarily in the northwestern Big Belts GA, with evidence of breeding there. Two additional observations on private land immediately adjacent to the Elkhorns and Divide GAs. Historic (>20 years ago) records on the Divide, Little Belts, Castles, and Highwoods GAs.	Considered because of S2B status, MT SOC and PIF Species of Regional Concern. Recommended as Potential SCC because of reported declines in MT, concern over declines in preferred habitat (large diameter, open understory ponderosa pine) due to fire exclusion and possibly insects. Concern also that species was documented historically in some GAs but has had no recent observations, possibly indicating decline in presence/abundance/distribution.
Northern Goshawk (*Accipiter gentilis*)	G5, S3, BLM Sensitive, MT SOC, FWP Conservation Tier 2, PIF bird of Regional Concern for BCR 17	Habitat and documented occurrences throughout plan area.	Considered because of concerns raised by portions of public regarding impacts of management on species and habitat. Habitat and occurrences widespread throughout Region and plan area. Regional population appears stable to increasing. Use of habitats appears to be broader than originally thought (MTNHP field guide, USFS data). Recommend as Species of Interest due to ongoing attention by public, also interest by falconers in some GAs.
Olive-sided flycatcher (*Contopus cooperi*)	G4, S4B, FWP Conservation Tier 1, PIF Bird of Regional Concern for BCR 10	Observations and breeding activity throughout plan area with exception of Snowies GA.	Considered because of PIF Regional Concern ranking and possible declines in BBS on HNF portion of plan area. Widespread observations of breeding activity throughout plan area, Breeding Bird Surveys in MT appear stable (Sauer et al. 2014). Not enough or conflicting information regarding regional or local concerns or trend in plan area to recommend as SCC.
Peregrine Falcon (*Falco peregrinus*)	G4, S3, USFWS Delisted-Monitoring, USFS Sensitive, BLM Sensitive, FWP Conservation Tier 2	Observations throughout the plan area except Highwoods, Elkhorns and Crazies GAs. Breeding documented in Little Belts, Big Belts, Rocky Mountain Range, and Upper Blackfoot GAs.	Considered because in post-delisting monitoring status, and due to relatively narrow habitat requirements. Widespread, population stable to increasing in MT since 1980s (MTNHP field guide), reaching end of mandated post-delisting monitoring period. Recommend Species of Interest due to presence of breeding habitat and interest for viewing.
Trumpeter Swan (*Cygnus buccinators*)	G4, S3, MT SOC, USFS Sensitive, BLM Sensitive, FWP Conservation Tier 1	Recent breeding activity on Rocky Mountain Range GA only, other recent observations in Big Belts and immediately adjacent to NFS lands in Upper Blackfoot GA. Historic observations in Divide and Castles GAs.	Considered because of recent breeding presence in one GA, and ongoing efforts to increase number of breeding and wintering areas in MT. Lack of established breeding activity, probable lack of suitable breeding and wintering habitat except on two GAs where both may be limited. MT population appears stable (MTHNP field guide). Recommend as Species of Interest for viewing and conservation. Continued documentation of occurrences and indications of breeding should be encouraged.

Species Name	Conservation Rankings	Distribution in Plan Area	Rationale for considering and recommending or not as potential SCC
Veery (*Catharus fuscescens*)	G5, S3B, MT SOC, FWP Conservation Tier 2	Documented in all GAs except Crazies.	Considered because Potential SCC on adjoining FNF, and apparent declines in MT Breeding Bird Surveys (Sauer et al. 2014). Appears widespread in plan area, with evidence of breeding throughout. The PIF Science Committee (2012) does not indicate Regional concern. Not enough information regarding regional or local concerns or trend in plan area to recommend as SCC.
White-tailed ptarmigan (*Lagopus leucura*)	G5, S3, MT SOC, FWP Conservation Tier 2	Found only in high elevation areas of Rocky Mountain Range GA. Some evidence of breeding, not well inventoried.	Potential SCC on adjoining FNF. Very limited habitat and distribution in plan area. Rocky Mountain Range GA likely does not contribute to sustaining larger population. All observations in areas protected by Wilderness designation. Recommend as Species of Interest (Rocky Mountain Range GA) due to broader concerns regarding potential impacts of climate change, and need for additional observations and information.
Mammals			
Fisher (*Pekania pennanti; formerly Martes pennanti*)	G5, S3, MT SOC, FWP Conservation Tier 2, USFS Sensitive, BLM Sensitive	Most recent Regional assessment of fisher habitat (USDA FS 2014) indicates less than 5,000 acres of fisher habitat on HNF, none on LCNF. Four observations on Rocky Mountain Range GA in past 15 years, but 2 of those are unconfirmed tracks. Four observations on Upper Blackfoot GA, 3 of which were harvested animals.	Regional Assessment (USDA 2014e) indicates low acreage of potential habitat on HNF does not meet Minimum Critical Area, which is based on median home range size. Plan area does not have capability to sustain fisher population or to contribute to sustaining fisher population. All confirmed occurrences in plan area were likely transient individuals.
Gray wolf (*Canis lupus*)	G4, S4, USFWS Delisted-Monitoring, USFS Sensitive, BLM Sensitive, FWP Conservation Tier 1, FWP Hunted/Trapped	Found potentially throughout plan area; as of 2011 packs established in all but Highwoods, Snowies, Castles and Big Belts GAs.	MTFWP data indicates wolf population and distribution increasing rapidly and steadily since early 2000s. Population sustains annual hunting and trapping mortality. Nearing end of required post de-listing monitoring period; monitored by FWP for hunting and management. Recommend as Species of Interest due to hunting/trapping interest.
Northern bog lemming (*Synaptomys borealis*)	G5, S2, USFS Sensitive, MT Species of Concern, FWP Conservation Tier 1	Documented only on Rocky Mountain Range GA; potential habitat in Upper Blackfoot GA.	Considered because MT Species of Concern, FWP Conservation Tier, Potential SCC on adjoining FNF. Recommend as Potential SCC because of rare and localized occurrences, specialized habitat needs, occurrence in disjunct sup-populations, limited dispersal ability, plan area at southern edge of distribution.

Species Name	Conservation Rankings	Distribution in Plan Area	Rationale for considering and recommending or not as potential SCC
Townsend's big-eared bat (*Corynorhinus townsendii*)	G3G4, S3, USFS Sensitive, BLM Sensitive, MT Species of Concern, FWP Conservation Tier 1	Only 14 observations in plan area, in Big Belts and Little Belts GAs.	Considered because MT Species of Concern, FWP Conservation Tier, Potential SCC on adjoining FNF. Recommend as Potential SCC because of rare and localized occurrences, specialized habitat needs, low number of confirmed breeding colonies in MT, downward trend of western US population, potential for management of caves and abandoned mines to have impact.
Wolverine (*Gulo gulo*)	G4, S3, USFS Sensitive, BLM Sensitive, FWP Conservation Tier 2	Documented in all GAs except Highwoods, Snowies, and Castles; though the single record from Crazies is 40-year-old trapping record.	In August 2014 the USFWS determined wolverine listing under ESA not warranted; climate change was listed as reason for concern, but USFWS determined effects not likely to endanger wolverine now or in foreseeable future. Analysis in listing proposal (USDI 2013b) indicates most forest management activities have little impact on wolverines. Recommend as Species of Interest due to ongoing conservation concern and need for additional information and observations.

Species Recommended as Potential SCC

Western (Boreal) Toad (Anaxyuras boreas)

Proposed as SCC for all GAs except Snowies GA.

Conservation Rankings

G4, S2, USFS Sensitive, BLM Sensitive, MT Species of Concern, MTFWP Conservation Tier 1

Distribution/Occurrence within the Plan Area

Western toads have been documented in all but the Snowies GA. The plan area exists at the eastern edge of the toad's distribution, with occurrences at the eastern edge of the Castle, Little Belt, and Highwoods mountain ranges (Maxell et al. 2003). This species occurs throughout western Montana and mountainous areas of the western United States and Canada, extending northward into southeastern Alaska (MTNHP 2014b).

Habitat Use and Distribution

In general, western toads breed in temporary and permanent ponds, lakes, streams, and road ditches, with a preference for shallow, warm areas with mud or silt bottoms (Maxell 2000). These areas provide nursery habitat from the egg stage through metamorphosis. Juveniles are often present in wetlands adjacent to breeding sites, and may overwinter along the borders of sites where they developed (Nussbaum et al. 1983; MTNHP 2014b). Adult toads are largely terrestrial and may move more than 4 km from water after breeding.

Habitat for this species appears to be occur throughout the plan area (refer to Terrestrial Vegetation, Riparian and Wetland Table 2.21 and text; and Chapter 3, Watershed, Aquatic, Soil, and Air Resources). There have been eleven observation locations documented in the Big Belts, one in the Castles, five in the Crazies, at least 18 in the Divide, three in the Elkhorns, one in the Highwoods, approximately 20 in the Little Belts, approximately 38 in the Rocky Mountain Range GA, and at least 35 in the Upper Blackfoot GA (MTNHP data).

Drivers, Stressors, and Trends

Western toads require relatively shallow, warm wetlands or ponds with mud or silt bottoms to successfully reproduce. Although toads may travel relatively long distances after breeding, proximity to forest where microsites providing moisture and cover (e.g., burrows, rocks, logs, rootwads) occur is likely important to maintenance of toad populations. Toads may use streams and rivers connected or in close proximity to breeding sites as travel routes to nonbreeding-season habitats. Therefore, maintaining connectivity between known or potential breeding sites, potential travel routes, and forest cover may be important. Road construction, timber hauling, timber harvest, and fuel reduction activities all have the potential to negatively impact toads through disruption of travel routes or directly through crushing, as toads may congregate near roads, or travel in large numbers, making them vulnerable to being run over by vehicles (Maxell 2000).

Factors that impact the water level, temperature, or vegetation in breeding sites may impact use of those areas for breeding, or success of breeding activity. Livestock grazing in shallow breeding ponds may remove emergent vegetation used by larvae, and trampling by livestock may crush large numbers of tadpoles. Changes in hydrology or water temperature due to natural events, such as wildfires or beaver activity, may also impact breeding sites. Studies of western toads in Glacier National Park found that they increased in numbers after wildfires in 2001 and 2003 (Hossack and Corn 2007, Hossack et al. 2013). The increases occurred in burned areas but not in unburned areas. This finding suggests that fires, whether natural or prescribed, may create conditions such as warmer water temperatures due to lack of forest canopy, or increased nutrition due to increased siltation in ponds, that may benefit western toads for some period after fire occurs. Changes in beaver activity have been observed to correlate with changes in the number of tadpoles observed at a pond that has been monitored on the LCNF multiple times annually for over 15 years (LCNF unpublished data). While causality has not been determined, it appears that observed changes in water depth, flow, and temperature related to beaver activity at that site may have impacted breeding activity or success. Small breeding ponds created by seeps may dry out in some years before metamorphosis occurs, killing tadpoles and rendering reproduction entirely unsuccessful at that site for the year. In sum, a variety of human-caused and natural disturbances or occurrences may impact the availability or success of a breeding site in a given year. Therefore, maintaining a number of breeding sites scattered across the landscape, connected by streams and by forest that provides microsites as described above, may be key to maintaining widespread breeding populations of western toads. This may be particularly important east of the Continental Divide, near the edge of western toad distribution and where the landscape is generally drier.

Maxell and others (Maxell 2000; Maxell et al. 2003) have noted a population decline since the 1990s in Montana. Declines in this species have occurred regionwide in the western U.S. as well (MTNHP 2014b). Reasons for the decline are not clear, and may involve a variety of factors acting alone or in combination, including introduced chytrid fungus (*Batrachochytrium dendrobatidis*); contamination by fertilizer, herbicides, or pesticides; trampling by livestock or crushing by vehicles; increased UV radiation at high elevation breeding sites; alteration of breeding site hydrology through livestock management or management of beavers; introduction of predatory fish into formerly fishless areas; and others.

Rationale for Potential SCC Designation

State status indicators, as well as information regarding statewide population declines, indicates substantial concern regarding long-term persistence. Individual breeding sites may be highly variable in breeding success annually, pointing to the need to maintain numerous breeding sites well connected to suitable nonbreeding season habitat. Multiple threats and stressors exist, including some related to forest management activities. Lack of clarity regarding source of population decline, along with suggestions that multiple factors may be causing decline, add concern. The plan area occurs at the eastern edge of the species distribution, where it is important to maintain populations and prevent overall decline in distribution.

Information Gaps
Although some surveys have been done, a complete survey for potential and actual breeding sites for western toads has not been completed through the plan area. Analysis of specific parameters associated with breeding sites (e.g., size of water body, temperature, water depth, presence of fish, vegetation characteristics, etc.) to develop a predictive model that could be applied to existing wetland inventories would be a useful tool for estimating abundance and distribution of potential breeding sites in the plan area.

Although mortality factors affecting toads have been described, it is not currently understood the degree to which each, or combinations of factors, may be currently driving western toad population trends. Little if anything is known about the actual success of known breeding sites on the HLC NFs. Although tadpoles and juveniles are documented when present during surveys, some sites appear to experience complete mortality of tadpoles prior to metamorphosis. The frequency with which this happens, and whether it is truly complete or whether some individuals survive to metamorphose would provide information regarding the contribution and dynamics of specific breeding sites to the larger population. Information regarding the degree to which connectivity among breeding sites is required in the generally drier, east-side NFS lands is also not available.

Flammulated Owl (Otus flammeolus)

Proposed as SCC for HNF portion of the plan area only, based on lack of current and historic occurrence on the LCNF.

Conservation Rankings
G4, S3B, USFS Sensitive, BLM Sensitive, MT Species of Concern, MTFWP Conservation Tier 1, Partners in Flight Species of Regional Concern for Bird Conservation Region (BCR) 10.

Distribution/Occurrence Within the Plan Area
The breeding range of this species extends from southern British Columbia southward into Mexico (MTNHP field guide), corresponding strongly with the distribution of ponderosa pine and Jeffrey pine (Nelson et al. 2009).

Flammulated owl surveys were carried out throughout Region One in 2005, and included transects throughout the HLC NFs (Cilimburg 2006). Flammulated owls were detected only on the HNF, in the Upper Blackfoot, Divide, Big Belts and Elkhorns GAs. Owls were again detected in 2008 surveys throughout the HNF, as well as 'citizen science' surveys carried out on the HNF in 2014. Surveys were not carried out on the LCNF in 2008. The lack of detections in 2005 strongly suggests that the LCNF does not support a population of flammulated owls. The plan area crosses the eastern edge of the mapped distribution of flammulated owls (MTNHP 2014b), with the Little Belts, Highwoods, Castles, Crazies, and Snowies GAs outside the known range of the species.

The Rocky Mountain Range GA of the LCNF is included in the range-wide distribution map but lacks ponderosa pine. It was not surveyed in the 2005 or 2008 efforts. However, flammulated owls were not detected in surveys for several owl species carried out throughout the Rocky Mountain Range GA in the early 2000s (G.Frye, Rocky Mountain Front Institute of Natural History, pers. com.).

Habitat Use and Distribution
Flammulated owls appear to prefer dry, open, mature and old-growth forests usually with ponderosa pine or Jeffrey pine. In Montana, flammulated owls are associated with mature and old-growth xeric ponderosa pine and ponderosa pine/Douglas-fir stands (USDA 2011d). USDA 2011d discusses studies that have documented breeding locations in Region One in Douglas-fir forest types, as well as in grand fir, western larch, spruce-fir, lodgepole pine, and mature quaking aspen stands, although McCallum (1994) notes that the species shows a strong preference for ponderosa pine and Jeffrey pine throughout its range, and it has not been found on the Rocky Mountain Range GA, which lacks ponderosa pine. These birds require large snags with cavities, commonly excavated by pileated woodpecker, northern flicker, or sapsuckers (Cilimburg 2006). Flammulated

owls are not colonial nesters, but will aggregate around clusters of nest cavities created by woodpeckers (Samson 2006).

Nelson et al. (2009) used Forest Inventory and Analysis (FIA) data to estimate potential flammulated owl habitat in the United States. They characterized habitat as including the presence of ponderosa pine or Jeffrey pine types, presence of trees at least 12 inches dbh or canopy height of at least 30 feet, and tree density of 121-283 trees per acre or canopy cover of 30-80%. Based on these characteristics, they estimated that there were about 18,533 mi^2 of potential breeding habitat in the United States.

Samson (2006) characterized flammulated owl nesting habitat based on studies in southwestern Montana and central Idaho, in order to estimate and map abundance and distribution of goshawk habitat throughout the Region. He characterized owl habitat region-wide, and also by ecological province. The parameters used in that effort are described in detail in Samson (2006) and include specific tree dominance groups, ranges of canopy cover, structure class, basal area, and presence of snags. Using data gathered from forest inventory analysis (FIA) field studies, Samson (2006) estimated flammulated owl nesting habitat throughout Region One, and by national forest. Bush and Lundberg (2008) updated those and concluded that that there are approximately 10,200 acres of potential flammulated owl nesting habitat on the HNF, and approximately 8,800 acres on the LCNF. Using updated data, estimates were made using recent FIA data for the plan area by GA as shown in Table 2.61. These estimates are based on field data, with a 90% confidence interval. Estimates for all but the Highwoods, Rocky Mountain Range, and Snowies were made using FIA data that included a greater number of sampled plots (4x-Intensified Grid) than were available for estimates for those three GAs. Refer to appendix B for a summary of FIA and FIA intensified grid data and methodology.

Table 2.61 Estimated Flammulated Owl Nesting Habitat on the Helena and Lewis and Clark National Forests, by Geographic Area, with 90% Confidence Interval

Geographic Area	Estimated Habitat Acres	90% CI - Low	90% CI- High
Big Belts	9,525	4,098	15,757
Divide	4,608	1,158	8,666
Elkhorns	1,828	0	5,330
Upper Blackfoot	9,284	3,963	15,263
TOTAL HNF	*25,245*	*9,219*	*45,016*
Castles	1,423	0	4,100
Crazies	0	0	0
Highwoods	0	0	0
Little Belts	*11,432*	*5,759*	*17,665*
Rocky Mountain Range	0	0	0
Snowies	1,241	0	4,583
TOTAL LCNF	*14,096*	*5,759*	*26,348*

Although the estimates made by Bush and Lundberg (2008) are somewhat lower than those derived from the more recent data, their estimates fall within the confidence intervals of the more recent estimates. These data vary in precision, based not only on which FIA data set (intensified grid versus base FIA data) was available for use, but also by the number of sampling plots within each area as well as on the total number of plots that included characteristics selected for by the model. Areas that show a larger confidence interval generally had fewer plots from which to extrapolate. Nevertheless, these data provide a general idea for the potential of each area to provide flammulated owl habitat. The estimates made using FIA data area also not spatial, and as such are unable to represent where in a GA or NF the flammulated owl nesting habitat may occur, in what patch sizes, etc. Determination of actual potential of an area to support flammulated owls should include field validation and systematic surveys for nesting owls.

Drivers, Stressors, and Trends

Although habitat appears to be well-distributed and relatively abundant in Region One, ponderosa pine forests have decreased in abundance and distribution, and their structure has changed over the last century. The ponderosa pine cover type is less prevalent on the HLC NFs than the dry Douglas-fir/mixed mesic conifer and lodgepole pine cover types, and is probably less abundant than it was historically (refer to the Terrestrial Vegetation section p. 60-61).

Nelson et al. (2009) noted that settlement and development, logging, and wildfire exclusion due largely to suppression, have resulted in a loss of ponderosa pine forest habitat or changes in species composition, where ponderosa pine is no longer a dominant component. Fire exclusion allows growth of young Douglas-firs that suppress recruitment of shade intolerant and large diameter trees, and may reduce the amount of open understory needed for flammulated owl foraging (Samson 2006). A lack of low-intensity disturbance may have caused a decrease in the larger size classes of trees in some cover types (refer to the Terrestrial Vegetation section p. 63-64) in the plan area. Samson (2006) stated that "[t]imber management is an insignificant influence on the landscape in comparison to suppression of fire", in terms of its influence on flammulated owl habitat.

Samson (2006) displayed information showing a decline in the open understory important to flammulated owls as compared to the period 1938-1942, and widespread increases in the relative abundance of Douglas-fir, particularly in the seedling-sapling stage. Notably, however, the FIA data used by Samson (2006) also showed slight increases in ponderosa pine on the HNF and LCNF during that time. Throughout the Region, larger size Douglas-fir increased in abundance except on the LCNF.

Rationale for Potential SCC Designation

Globally, flammulated owls may be relatively secure, but there is concern in Montana. Although Samson (2006) indicated that there is no current evidence that the flammulated owl is decreasing in numbers in Montana, ongoing concerns regarding the availability and trend of stands of large, open ponderosa pine, in the plan area is cause for concern with respect to flammulated owl habitat on the HLC NFs. Ponderosa pine has been impacted by recent heavy insect infestation on the HNF. Habitat appears to be present on the HLC NFs but few flammulated owls have been documented. The HLC NFs occurs at the edge of the species range, with the eastern portions of the plan area outside of the known distribution of the species. Although there may not be sufficient habitat on the HLC NFs to sustain a population of flammulated owls, the HNF portion of the plan area may contribute to sustaining the larger population of owls in western Montana. Maintaining adequate potential habitat on the HNF portion of the HLC NFs may be important to preventing contraction of the species' range in Montana.

Information Gaps

Surveys for flammulated owls in appropriate habitat on the LCNF have been somewhat limited, so that information regarding the potential presence of owls in some GAs is lacking.

Lewis's Woodpecker (Melanarpes lewis)

Proposed as SCC for Divide, Elkhorns, and Big Belts GAs only, based on current and historic distribution and apparent need for ponderosa pine forest type.

Conservation Rankings
G4, S2B, MT Species of Concern, MTFWP Conservation Tier 2, Partners in Flight Species of Regional Concern for Bird Conservation Regions 10 and 17.

Distribution/Occurrence within the Plan Area
Lewis's woodpecker occurs throughout the western United States and breeds northward into southern British Columbia and Alberta. It is a summer resident throughout southern, central, and western Montana. The plan area is at the eastern/northeastern edge of its distribution in Montana.

Lewis's woodpecker has been documented in recent years primarily in the northwestern portion of the Big Belts GA, where there is indirect evidence of breeding activity. Two additional recent observations were made on private land immediately adjacent to the Elkhorns and Divide GAs. A few historic records exist from the Divide, Little Belts, Castles, and Highwoods GAs.

Habitat Use and Distribution
Habitat use information is from the MTNHP field guide (MTNHP 2014b). Lewis's woodpeckers in western North America are closely associated with open ponderosa pine forest, particularly old-growth stands maintained by fire. They may also rely on large, old cottonwood stands in riparian areas. These birds are not well adapted to excavating cavities in hard wood, and sometimes rely on cavities created by northern flickers or similar-sized cavity nesters. The presence of large, soft snags in burned areas may be important. Lewis's woodpeckers also require a brushy understory for foraging.

Habitat availability and distribution on the plan area may be similar to that described for flammulated owls, and more specifically including older ponderosa pine types that have experienced low-severity fire. Information regarding the age of burns most used by Lewis's woodpeckers is conflicting, with some studies reporting use of mainly older burns where brushy understory has had time to develop, and others reporting use mainly between 2 and 20 years post-fire (MTNHP 2014b).

Drivers, Stressors, and Trends.
As discussed for flammulated owls, mature to old ponderosa pine forests may appear to have decreased in abundance throughout the western United States. Lewis' woodpeckers are associated with burned forests, so fire exclusion is likely to have a negative impact on habitat availability. Lack of fire allows growth of young Douglas-firs that suppress recruitment of shade intolerant and large diameter trees used by these birds. Fire exclusion may also limit the recruitment of large, soft snags used by Lewis's woodpeckers for nesting. Management in dry forests for flammulated owls may accommodate the needs of Lewis's woodpeckers (MTNHP 2014b).

Rationale for Potential SCC Designation
Lewis's woodpeckers appear to be secure globally, but declines have been reported in Montana (Sauer et al. 2014, MTNHP 2014b). Concern exists over declines in mature to old ponderosa pine forest as well as old riparian cottonwood, combined with fire exclusion and possible declines in the number and availability of large, soft snags. The HLC NFs occurs at the edge of the species range. Due to their use of burned habitats, Lewis's woodpeckers may require very large areas of potential habitat (old ponderosa pine and old riparian cottonwood) through which they can move opportunistically as habitat becomes available and eventually declines in suitability. The plan area may not be able to sustain a population of Lewis's woodpeckers, but may contribute to sustaining the larger population in western Montana. Maintaining adequate potential habitat on the HNF portion of the HLC NFs may be important to preventing contraction of the species' range in Montana.

Harlequin Duck (Histrionicus histrionicus)

Range, historic distribution, and suitable habitat appear to be limited to the Rocky Mountain Range and Upper Blackfoot GAs only.

Conservation Rankings
G4, S2B, USFS Sensitive, BLM Sensitive, MT Species of Concern, MTFWP Conservation Tier 1

Distribution/Occurrence within the Plan Area
The HLC NFs represents the easternmost distribution of the western North America population of harlequin ducks. This population breeds from northwestern Wyoming through northern Montana, eastern and northern Idaho, and into Oregon, Washington, and possibly northern California. The harlequin duck is an uncommon and localized breeder in Montana, with most breeding occurring west of the Continental Divide and in Glacier National Park.

Harlequin ducks are known to breed on the Rocky Mountain Range and Upper Blackfoot GAs. Single males have been observed along the Missouri River on the northwestern end of the Big Belts GA, on the Smith River along the northwestern edge of the Little Belts GA, and on the East Boulder River in the Crazies, GA, but these are single, unrepeated observations with no evidence of breeding. An additional historic observation was recorded on the eastern edge of the Castles GA sometime prior to 1985, but information about that observation is not available.

Habitat Use and Distribution
During the breeding season, harlequin ducks use clear, low gradient, fast moving mountain streams with abundant aquatic insects (Cassirer et al. 1993). Availability of loafing sites such as rocks, logs, gravel bars and streamside cobble appears to be an important component of habitat. Woody debris in or immediately adjacent to suitable streams may be important for nesting, and overhanging streamside vegetation can be important in providing broods with security from avian predators.

Research in northern Idaho and in Glacier National Park indicated that harlequin ducks preferred streams adjacent to old growth and mature forest (Cassirer and Groves 1990), but on the Rocky Mountains GA 40 percent or fewer of harlequin observations were adjacent to mature forest, 25 percent were adjacent to immature forest, and only 4 percent were adjacent to old growth (USFS unpublished data; USDA 2011d). More observations (40 percent) occurred in areas with a tree/shrub mix on the streambank than in areas with trees, shrubs, or grass alone. Harlequins continued to occupy and breed successfully in three traditionally-used streams on the Rocky Mountain Range GA after severe, stand-replacing fires occurred removing both nearby forest cover and streamside vegetation (USFS unpublished data; USDA 2011d). These streams were geographically widely separated and affected by three separate wildfires. The continued occupancy and breeding success suggests that streamside habitat may play less of a role in habitat choice and breeding success than previously thought.

Observations of banded harlequin duck females have shown that they return to their natal streams, often establishing breeding areas on streams near or overlapping those of their mothers (Reichel and Genter 1993). The high degree of fidelity to natal streams may have as much or more of an influence on stream use than non-stream habitat characteristics.

Breeding has been documented on streams throughout the Rocky Mountain Range GA, with the greatest number of observations on the West and South Forks of the Sun River. Some streams, including the Dearborn River and its tributaries, and Falls Creek, at the south end of the Rocky Mountain Range GA, appear to provide appropriate habitat but periodic surveys have not documented occupancy or breeding activity. Breeding has been documented on the Blackfoot River on the Upper Blackfoot GA, but systematic surveys have not been carried out to identify whether breeding occurs on other streams as well.

Drivers, Stressors, and Trends
Across North America, the range of the harlequin duck has decreased dramatically from historic levels (Genter 1993). Local populations may be stable, although there is little or no information about harlequins in Montana prior to the late 1980s, and currently available information is not sufficient to detect population trend.

Loss or degradation of habitat, disturbance by humans, water pollution in coastal wintering areas, and hunting on wintering areas have all been identified as potential threats (Genter 1993). Activities or events that result in nest abandonment or failure, or loss of broods are of concern in part because harlequins do not have an opportunity to re-nest after failure or brood loss. Males depart for the coastal wintering areas soon after nesting commences, while females that have experienced nest failure or brood loss remain on the breeding stream throughout the nesting season.

Human activities of greatest concern are those that can result in nest abandonment or separation of broods from females. Rafting and fishing activity may have thresholds above which they are not compatible with harlequin duck breeding success. Changes in amount and timing of stream flow may impact breeding success as well. High stream flows during nesting may destroy nests, and high flows during early brood rearing may cause loss of broods. Mining, timber harvest, fire, hydropower development and management, and climate change all have the potential to alter the timing, amount, and duration of stream flow.

Density of harlequins appears to be relatively low in the plan area, with fewer than one pair per 5km on the Rocky Mountain Range GA (USFS unpublished data), and often only one or two pairs occupying an entire stream. Loss of one or more female(s) or broods on a stream may result in the stream remaining unoccupied, due to the strong fidelity shown by females for their natal streams.

Rationale for Potential SCC Designation
The plan area is at the eastern edge of distribution, and GAs where it occurs contributes to sustaining the western population of this species. Low population size, restricted distribution, narrow habitat requirements, small numbers, and vulnerability of large portion of the population to single events (high streamflows, coastal oil spills) are all significant concerns.

Information Gaps
Distribution of harlequin ducks throughout the plan area is not fully known, due to lack of systematic surveys in all but the Rocky Mountains GA.

Extensive data from surveys on the Rocky Mountains GA have not been analyzed, but might provide a detailed picture of habitat use and needs for harlequin ducks east of the Continental Divide, and a comparison for published information regarding harlequin habitat use gathered in Idaho and western Montana.

Harlequin duck population numbers and trend, as well as information about survival and reproductive success on breeding streams, are not available. This information is exceptionally difficult to obtain, because of the remoteness and terrain where ducks breed, their reclusive nature, and their individual distribution on breeding streams.

Townsend’s Big-Eared Bat (Corynorhinus townsendii)

Proposed as SCC for HNF portion of the plan area only, and the Little Belts GA based on lack of occurrence in other GAs.

Conservation Rankings
G3G4, S3, USFS Sensitive, BLM Sensitive, MT Species of Concern, MTFWP Conservation Tier 1

Distribution/Occurrence within the Plan Area
Townsend’s big-eared bats are found throughout western North America, from British Columbia south into Mexico, with endangered sub-species in the Ozarks and Central Appalachian regions of the central and eastern U.S. (Schmidt 2003). The western Townsend’s big-eared bat is has a widespread distribution but occurs at low densities across its range (USDA 2013g).

Only fourteen observations of Townsend's big-eared bat have been documented on the HLC NFs, all in the Big Belts and Little Belts GAs, with one just outside the Divide GA on adjoining non-NFS land. All were at or near mines or caves. Surveys were carried out throughout the Northern Region from 2005-2008, and on previously un-surveyed portions of the LCNF in 2010, resulting in two of the 14 observations.

Habitat Use and Distribution

The Townsend's big-eared bat forages in a variety of habitat types, although it typically does not use large clear-cuts or regenerating stands in early seral stages (USDA 2013g). The bat requires spacious cavern-like structures for roosting during all stages of its life cycle, typically roosting in caves or mines. Roosting has been documented less frequently in large tree hollows, buildings, or under bridges (USDA 2013g). Temperature and airflow are important for both hibernacula and maternity colonies (Pierson et al. 1999). Although disturbance is a concern, the maternity colony at Lewis and Clark Caverns in Montana has persisted for over a century despite daily exposure to tour groups, although numbers of bats there have been steadily declining (USDA 2013g).

At least two observations of Townsend's big-eared bats in the plan area were in association with mines, in the Big Belts and Divide GAs. Numerous mines and caves occur throughout the plan area, with concentrations in some areas of the Divide and Little Belts GAs. Many or most of the known mines and caves have not been inventoried for big-eared bats, and a comprehensive inventory of caves throughout the plan area is not logistically feasible. Therefore, the actual distribution of both habitat and bat presence in the plan area remains unknown.

Drivers, Stressors, and Trends.

Cave and mine disturbance and closures are key threats to Townsend's big-eared bats. Mine closure activity on the HLC NFs has been driven by a need for public safety due to a variety of concerns at closed and abandoned mine sites (see chapter 9, Renewable and Nonrenewable Energy and Mineral Resources). Where Townsend's big-eared bats are found, installation of bat-friendly gates or other closure devices allow bats to continue to use caves and abandoned mines while providing for public safety (MTNHP 2014b).

Disturbance due to recreational activity has the potential to displace bats at hibernacula or maternity colonies. White-nose Syndrome (WNS), a disease associated with a highly virulent fungus (*Pseudogymnoascus destructans*) has devastated bat populations in the Northeastern U.S. causing increased conservation concern for bat populations in North America (Frick et al. 2010; Frick et al. 2015). Although WNS has wiped out enormous numbers of bats in the eastern and central U.S., and now occurs throughout much of the eastern portion of the range of C. townsendii, it has not yet been detected in Montana. However, the cold loving fungus that causes WNS is a soil microbe (Blehert et al. 2009) and recreational activity in caves and mines has the potential to spread the disease.

Townsend's big-eared bats feed primarily on moths but will consume a variety of insect prey, often gleaning insects directly from vegetation surfaces. Pesticide and herbicide use in the vicinity of known roosting sites and maternity colonies can reduce insect prey availability. Townsends bats have been shown to have high site fidelity, often foraging and travelling within close proximity to their roosting site (Fellers and Peirson 2002)

Rationale for Potential SCC Designation

Townsend's big-eared bat is considered globally secure, but locally imperiled or vulnerable due to its rare and localized occurrence throughout its range, as well as its specialized habitat needs (MTNHP 2014b, Naturserve, 2014). Only two confirmed breeding colonies are known in Montana, as well as several confirmed hibernacula sites (USDA 2013g). The western population appears to be experiencing a downward trend, including lower numbers at one of two known maternity colonies in the state. The plan area has numerous closed or abandoned mines and an active program dealing with those mines, that has great potential to impact potential Townsend's big-eared bat roosting and maternity sites. The potential spread of WNS could further exacerbate these threats.

Information Gaps
Little is known about the abundance and distribution of Townsend's big-eared bat or its habitat in the plan area.

Northern Bog Lemming (Synaptomys borealis)

Proposed as SCC for Rocky Mountain Range and Upper Blackfoot GAs only, due to known distribution in Montana. Additional surveys should be carried out for species and potential habitats throughout the plan area.

Conservation Rankings
G5, S2, USFS Sensitive, MT Species of Concern, MTFWP Conservation Tier 1

Distribution/Occurrence within the Plan Area
The northern bog lemming occurs throughout Canada, with its range extending into the U.S. in Montana as well as northern Idaho, Washington, Minnesota, and portions of New England. The lemming's range in Montana is in the mountainous western portion of the state, extending eastward only far enough to include the Rocky Mountain Range and Upper Blackfoot GAs. Montana, and the plan area in particular, are at the extreme southern edge of the species' range in North America.

Northern bog lemmings have been detected in only one location in the plan area, on the Rocky Mountain Range GA. Surveys for the species require intensive small mammal trapping in potential habitat and thus are difficult to carry out. Furthermore, identification of the species requires having the animal in hand. Therefore its distribution in the plan area is not known.

Habitat Use and Distribution
Bog Lemmings have been found in wet meadows, fens, and bog-like environments in a variety of community types, including Engelmann spruce, subalpine fir, birch, willow, sedge, spikerush, or combinations of those (MTNHP 2014b; refer to the Terrestrial Vegetation section and aquatics chapter for more information regarding these habitats). Areas with extensive moss mats, particularly sphagnum, are the most likely places to find the species. This habitat type likely occurs in disconnected, fragmented patches throughout the species' range, and is difficult to adequately map.

Drivers, Stressors, and Trends.
Management activities or disturbances that alter the hydrology of wetlands are likely the most important potential stressors to northern bog lemmings. Management activities that could impact lemming habitat include certain types of timber harvest, livestock grazing, or any sort of direct impact to moss mats.

Climate change, with its potential to alter hydrology and plant communities likely is a threat to northern bog lemming populations in Montana. Because bog lemmings in Montana appear to exist as isolated small sub-populations with limited connectivity, loss of individual sub-populations may easily become permanent losses, as recolonization is relatively unlikely. Northern bog lemmings in the plan area may be at the extreme southern edge of a relict population, and therefore may be vulnerable to range contraction due to climate change.

Rationale for Potential SCC Designation
The plan area occurs at the extreme southern end of northern bog lemming distribution. The species occurs in disjunct subpopulations, with narrow and very specific habitat requirements. Bog lemming's small size and therefore limited dispersal ability makes the possibility of recolonization of habitats, or recovery of habitats from disturbance very low.

Information Gaps
The distribution of northern bog lemmings and their habitat within the plan area is not known, nor is there an estimate of population size or trend within the plan area.

Terrestrial Wildlife Species of Interest

There are several terrestrial wildlife species that are neither federally listed nor Species of Conservation Concern, but that are of interest to the public or to Forest or wildlife managers. Some of these species were not recommended as potential SCC, as detailed in Table 2.60, but remain of local or regional concern because of specific conservation or management issues. Rationale for not recommending them as potential SCCs, along with the reasons they remain of interest, are listed in Table 2.60. In addition to the concerns listed there, most of these species are of interest to the public for the viewing opportunities they provide. These species are as follows:

- Common loon - viewing, regional management interest
- Golden eagle – viewing, regional management interest
- Peregrine falcon – viewing, regional management interest
- Trumpeter swan – viewing, regional management interest
- White-tailed ptarmigan – viewing, regional management interest
- Gray wolf – hunting/trapping

No further discussion of these species is warranted in this assessment, per the requirements of the 2012 Planning Rule and the draft directives. Lack of detailed evaluation of these species in the assessment reflects in part the fact that they are not likely influenced by management of vegetation in the plan area, but are primarily influenced by other management actions, such as hunting or certain recreational uses, or activities occurring off NFS lands or elsewhere in their range.

Species that may be influenced by vegetation or other forest management activities, and that are of interest because of their value for hunting, viewing, or local management interest, are discussed below. They are grouped according to the primary area of interest.

Species of Interest for Hunting or Trapping

This section addresses the ecology of several species that are important for hunting or trapping, and discusses the drivers and stressors that influence population size, trend, and distribution. Refer also to the chapter 6, Multiple Uses and Ecosystem Services for a discussion of hunting activity and its importance to the human population.

Elk (Cervus elaphus)

Distribution

Elk occur throughout the Rocky Mountains and adjoining areas of the western United States and Canada, and in isolated smaller populations throughout western and central North America. In Montana elk are found primarily in the western half of the state, and they occur throughout the HLC NFs planning area. Map 37 in appendix A, titled Elk and Moose Distribution, shows elk distribution by season, as mapped by MTFWP in the HLC NFs and on adjoining lands. While the plan area includes sizeable areas of winter range, the majority of elk wintering areas occur on lower elevation, non-NFS lands, varying by GA.

Population Trend

Elk numbers have been increasing in Montana and throughout the west since the early to mid-1900s (MTFWP 2004). Elk are managed and counted, however, by elk hunting districts (HDs) or elk management units (EMUs) for which population and habitat objectives have been set (MTFWP 2004). The most recent elk counts, as well as information regarding whether the unit (HD or EMU) is at, above, or below the objective established in the statewide plan is displayed in Table 2.62.

Table 2.62 2014 Estimated Elk Population and Trend by GA; data from MT FWP (http://fwp.mt.gov/fishAndWildlife/management/elk/)

GAs Included	Elk Management Unit	Hunting District(s)	Elk Plan Objective (Observed Elk)	2014 or Most Recent Number Elk Observed	Status: Over, At or Below Objective	Estimated Actual Elk Numbers*
Rocky Mountain Range	Bob Marshall	415	200	278	Over	348
		422**	500	1673	Over	2091
		424, 425	2500	2768	Over	3460
		441, 442	500	634	Over	793
Elkhorns	Elkhorn	380	2000	1736	At	2170
Big Belts	West Big Belt	392	1100	1313	At	1641
	Bridger	390	900	1997	Over	2496
		391	550	1608	Over	2010
	East Big Belt	446	950	2637	Over	3296
	Devils Kitchen	445, 455	2200	3928	Over	4910
Crazies	Crazy Mountains	315	1000	1246	Over	1558
		580	975	3933	Over	4916
Castles	Castle Mountains	449, 452	600	1548	Over	1935
Little Belts	Little Belt	413	500	385	Below	481
		416	475	941	Over	1176
		418	150	110	Below	138
		420, 448	1200	1163	At	1454
		432	325	431	Over	539
		454	250	315	Over	394
		540	600	1617	Over	2021
Highwoods	Highwood	447	700	1556	Over	1945
Snowies	Snowy	411 (north)	400	1065	Over	1331
		511 (411 west)	400	398	At	498
		530	(?)	3142	(?)	3928
Upper Blackfoot	Bob Marshall	281	500-700	651	At	814
	Granite Butte	293***	750	565	Below	706
		339	700	750	At	938
		343	700	650	At	813
	Garnet	298	600	1087	Over	1359
	Birdtail Hills	421, 423	500	860	Over	1075
Divide	Deer Lodge	215	1400	2234	Over	2793
		318	500	527	At	659
		335	600	1187	Over	1484
	Granite Butte	343	700	650	Over	813

* Estimated numbers assume 80% of elk are observed (http://fwp.mt.gov/fishAndWildlife/management/elk/)
**HD 422 includes part of Upper Blackfoot GA but is listed only once, under the Rocky Mountain Range GA, which includes the majority of HD 422
*** HD 293 includes part of the Divide GA but is listed only once, under the Upper Blackfoot GA, which includes the majority of HD 293

Hunting districts and EMUs generally encompass non-NFS lands, and some cross boundaries between GAs. Nevertheless, Table 2.62 provides some information regarding elk population for each GA. Of 34 units in which elk are counted and numeric objectives are established by MTFWP, 22 are above objective, 8 are at objective, 3 are below objective. For one unit in the Snowies GA, counts were switched from one region and EMU to another in recent years, so comparisons of counts and objectives are unclear.

The Little Belts has two HDs that are below objective. HD 413 includes the northwest portion of the Little Belts mountain range, but at least half the HD is on non-NFS lands. HD 418 is on the eastern edge of the Little Belts mountain range, and only a small portion of the HD is on NFS land. The Upper Blackfoot and Divide GAs share one HD that is below the established population objective. That HD includes a large area of non-NFS land, as well. It is important to remember that units in which elk numbers are over objective are also in non-compliance with established management goals, and may represent management needs and challenges that differ from, but are no less important than, those units that are below population objective. Each EMU or HD has specific management objectives and challenges, outlined in the Montana Elk Management Plan (MTFWP 2004). Overall, it is important to keep in mind that elk population numbers are influenced by a variety of factors that interact, as discussed below under the heading 'Consideration of system drivers and stressors for elk'.

Food Habits and Habitat Use

Elk are habitat generalists, foraging on a wide variety of grasses, forbs, and occasionally on shrubs or other browse (Table 2.57). They typically summer in higher elevation areas, often on NFS lands, where both forage cover are available. Winter habitat usually occurs at lower elevation in forests intermingled with shrubfields and meadows, or on private, often agricultural lands. Small groups of elk may remain over winter at higher elevation where slopes consistently blow free of snow. Use of specific areas and habitats may change over time due to a variety of factors that may include changes in vegetation, patterns of human use, weather and climate patterns, changes in the behavior of individuals and groups of elk, and others.

Habitat Status

Elk populations have generally increased in numbers and expanded in range over the past 30 years, since the HNF and LCNF Forest Plans were adopted. Patterns of public access to both public and private lands can play a significant role in elk use of the landscape, as can other types of human disturbance at certain times of year. Predators may also play a role in elk numbers, distribution and movement patterns in some areas (MTFWP 2004). Vegetation, in terms of forage, thermal regulation, and security from predation by humans and other predators also plays a role. Biologists have been attempting for decades to define the roles that each of these factors play in elk ecology and therefore in management of elk habitat on public lands. Elk management over the past 30 years has focused on components of what has variously been termed hiding cover, security cover, secure habitat, effective habitat, and effective cover, as well as others. A group of USFS and MTFWP biologists recently summarized and evaluated that body of work, and developed common terms and recommended methods for assessing certain aspects of elk habitat on lands east of the Continental Divide in Montana and including portions of the HNF (the Upper Blackfoot GA and portions of the Divide GA) immediately west of the divide (USDA and MTFWP 2013). The agreed-on concepts and terms are 'elk security', 'habitat effectiveness', and 'cover'. These definitions and methods will frame the discussion of elk habitat in this assessment, and provide a starting point for understanding elk habitat management into the future.

The concepts of elk security, habitat effectiveness, and cover are best applied at the scale of an elk herd unit (EHU), also called an elk analysis unit (EAU). Edge et al. (1986) noted that cow elk segregate into discrete herds that show fidelity to specific geographic areas, and that area provides the best area on which to evaluate the impacts of various management activities on elk. Elk herd units were mapped for the HLC NFs as outlined in the collaborative document (USDA and MTFWP 2013) prepared by the USFS/MTFWP group described above.

Comparison of elk habitat security, effectiveness and hiding cover over time in order to discern trend is made difficult or impossible due to inconsistencies in the way these features have been defined, as well as changes and inconsistencies in methodology and available data used in the past and currently. One goal of the East-Side Assessment process, as described above in the Canada lynx section, is to establish a uniform and repeatable method for measuring those parameters, which may allow for analysis of trend in the future. Meanwhile, discussion of the potential impacts of various processes and disturbances is provided in the section titled "Consideration of system drivers and stressors for elk".

Habitat Security

Habitat security is a concept specific to the vulnerability of elk to both disturbance and mortality during the hunting season. Habitat security has been defined as "the protection inherent in any situation that allows elk to remain in a defined area despite an increase in stress or disturbance associated with the hunting season or other human activities" (Lyon and Christensen 1992; USDA and MTFWP 2013). Although the concept of elk security was originally discussed in terms of concerns regarding heavily logged and roaded public lands west of the Continental Divide, the concept is applied broadly to encompass areas where elk may be displaced from public lands where hunting pressure exists, onto adjoining private lands where limited access may provide greater security. The collaborative USFS/MTFWP East-Side Assessment group used the term 'elk security, and suggested that local wildlife and land management biologists develop numerical parameters such as size of area, distance from roads, etc., that define security for a particular area (USDA and MTFWP 2013).

The NFS participating in development of the East-Side Assessment defined security, for the purposes of mapping it on NFS lands, as areas greater than one half mile from motorized routes that are open during the hunting season, and greater than or equal to 250 acres in size (USDA 2013f). Using those methods, elk security was mapped for the plan area. Private roads within the NFS boundary were included as open routes, because elk response to roads is not based on ownership, and the USFS has no authority to manage the timing or frequency of travel on those routes. See map 38 titled Elk Secure Areas in appendix A, and in Table 2.63.

Table 2.63 displays the total acreage and percent of each GA that is considered secure, as well as the number of EHUs within each GA and the number of those EHUs with at least 30 percent of the acreage on the NFS lands portion of the unit that meets the definition of secure habitat. The choice of 30 percent is based on Hillis et al. (1991), who recommended that security areas should comprise at least 30% of a valid analysis unit. Although the existing HNF and LCNF forest plans include specific, but different standards for security that are specific to season, using 30% here provides a convenient and familiar reference by which to attempt to understand the relative number of herd units that achieve certain level of elk security. Actual elk security, as noted by the collaborative group (USDA and MTFWP 2013), will vary by area and depend greatly on local factors, some of which (such as detailed, small-scale topography) that are not captured by this broad scale mapping effort. The group also concluded that establishing a specific, quantifiable cover recommendation was not supported by the literature.

Table 2.63 Acreage and percent of elk secure areas by GA, and percent of Elk Herd Units that are secure, by GA, considering only NFS lands

GA	Secure Acreage	Percent Secure	Total Number of Elk Herd Units	Number EHUs ≥30% Secure
Big Belts	116,977	26%	17	10
Castles	15,796	20%	4	2
Crazies	26,240	37%	2	1
Divide	69,224	30%	7	2
Elkhorns	73,629	42%	9	6
Highwoods	25,713	58%	3	2
Little Belts	281,663	31%	21	12
Rocky Mountain Range	608,475	78%	14	14

GA	Secure Acreage	Percent Secure	Total Number of Elk Herd Units	Number EHUs >30% Secure
Snowies	82,607	68%	6	5
Upper Blackfoot	187,255	54%	9	7

Elk herd units encompass lands other than NFS lands, so the information in Table 2.63 should be interpreted with care. Most research discusses security at the scale of the EHU, and recommendations for analysis made by the combined USFS and MTFWP group were made at that scale (USDA and MTFWP 2013). The secure acreage provided by NFS lands alone is displayed, and the proportion of each GA that is considered secure for elk, as a means of displaying the degree to which NFS lands contribute to elk security on the landscape. Doing so also enables the FS to look at the relative contribution of GAs to elk security in the planning area as a whole.

Habitat Effectiveness

Habitat effectiveness is similar to the concept of elk security, but addresses the impact of motorized routes on elk during the summer (i.e., the non-hunting season). The east-side group evaluated methods for determining elk habitat effectiveness. The group defined habitat effectiveness as the "percentage of available habitat useable by elk outside the hunting season" (USDA 2013f), and recommended methods for calculating elk habitat effectiveness as part of the East Side Assessment process. Route density, grouped into broad categories, is used as a proxy or indicator for habitat effectiveness (USDA 2013f); lower route densities are assumed to indicate greater habitat effectiveness. It is important to remember that the term 'habitat effectiveness' as used here, refers only to potential impacts of motorized access, and does not address other factors that may influence habitat quality or use, such as vegetation type, topography, predation, livestock grazing, recreational developments, and other human uses.

Habitat effectiveness is displayed for each GA on map 39 in appendix A (Elk Secure Habitat Map) and in Table 2.64. As with habitat security, effectiveness is displayed for NFS lands only. Private roads within the NF boundary were included as open routes, because elk response to roads is not based on ownership, and the USFS has no authority to manage the timing or frequency of travel on those routes. Due to the complexity of the dataset, Table 2.64 displays information only at the level of the GA, as an indicator of the contribution of each GA in providing useable habitat for elk during the summer. Detailed information for specific EHUs is available in the project file, and is most useful at the site-specific or project level. The distribution of effective habitat within each GA is shown on the Elk Secure Habitat map in appendix A.

Table 2.64 Habitat effectiveness expressed as a percent of NFA lands in each GA within each effectiveness category

Geographic Area	Percent of Total NFS Acres in 0.0 mi/mi^2	Percent of Total NFS Acres in 0.1-1.0 mi/mi2	Percent of Total NFS Acres in 1.1-2.0 mi/mi2	Percent of Total NFS Acres in 2.0+ mi/mi2
Big Belts	37%	20%	24%	19%
Castles	11%	20%	34%	35%
Crazies	40%	26%	19%	13%
Divide	27%	23%	24%	26%
Elkhorns	41%	21%	25%	13%
Highwoods	52%	17%	21%	10%
Little Belts	26%	22%	31%	21%
Rocky Mountain Range	77%	4%	4%	1%
Snowies	67%	14%	14%	5%
Upper Blackfoot	51%	16%	13%	19%

Table 2.64 gives a general idea of the relative contributions of the NFS lands in each GA to overall elk habitat effectiveness. Habitat effectiveness is intended as, essentially, an indicator of the potential value of an area due to lack of potential disturbance due to motorized access and human uses associated with it, during the summer when elk generally spend more time on NFS lands at higher elevation than on the lower elevation, non-NFS portions of EHUs.

Cover

Forest cover is important to elk for bedding, foraging, thermal regulation, and other year-round functions (USDA 2013f). Therefore, cover dynamics have the potential to impact elk habitat use (Peek et al. 1982). The east-side group recommended that cover be managed in each EHU within the natural range of variation for the GA where it is located. The group also developed methods for mapping forest types likely to be currently providing cover for elk (referred to as existing cover), and forest types likely to produce cover but that are currently impacted by disturbances such as fire, harvest, insect or disease (affected cover). This methodology, part of the East-side Assessment process, includes a display of acreage that may have been affected by disturbance in the past, as shown in the vegetation data layer used, but that may have recovered and be currently providing cover (potentially recovered). The mapping method also includes display of acreage of other forest types that may not have structure and canopy characteristics generally understood to be important to elk, but that may occasionally be used by them (other forest cover). Detailed parameters used in this mapping effort can be found in the project file. The group recommended that elk cover be mapped separately for the spring/summer/fall season and for winter, because of the migratory nature of elk and often geographically separate areas used by elk during these different seasons. Cover for elk was mapped, as displayed in the two maps in appendix A (40 - Elk Spring, Summer, and Fall Hiding Cover and 41 - Elk Winter Hiding Cover). Results are also displayed in Table 2.65 and Table 2.66.

As with the other components of elk habitat, only the portion of cover on NFS lands within the EHUs has been mapped. Vegetation maps used for the mapping process include only NFS lands and a limited area beyond the NF boundary. These maps and tables provide some indication of the contribution of NFS lands in each GA in providing cover that may be used by elk. As with habitat security, the number of EHUs within each GA that have at least 30 percent cover as an index for comparison has been displayed. The choice of 30 percent is based on existing forest plan standards to maintain "30 percent or great[er] effective hiding cover" on summer/fall range, and "35 percent or greater hiding cover" on summer range, subject to "hydrologic and other resource constraints" (USDA 1986a). It must be noted, however, that the eastside group concluded that a specific quantifiable cover recommendation was not supported by the scientific literature (USDA and MTFWP 2013). For this discussion, 30 percent is used as a convenient and familiar reference point by which to compare the relative amount of security provided by the EHUs within each GA.

Table 2.65 Percent elk cover by GA for the Spring/Summer/Fall season, and number of EHUs with ≥30% Existing Cover

GA	Percent Existing Cover	Percent Affected Cover	Percent Potentially Recovered	Percent Other Forest	Total Number of Elk Herd Units	Number EHUs With ≥30% Existing Cover
Big Belts	29%	0%	0%	6%	17	10
Castles	41%	0%	0%	12%	4	3
Crazies	25%	0%	0%	5%	2	0
Divide	33%	0%	0%	6%	7	3
Elkhorns	38%	0%	0%	4%	9	6
Highwoods	7%	0%	0%	0%	3	0
Little Belts	62%	0%	1%	10%	21	19
Rocky Mountain Range	34%	0%	1%	11%	14	8
Snowies	56%	0%	1%	19%	6	5
Upper Blackfoot	37%	0%	1%	12%	9	5

Table 2.66 Percent elk cover by GA for the winter season, and number of EHUs with ≥30% existing cover

GA	Percent Existing Cover	Percent Affected Cover	Percent Potentially Recovered	Percent Other Forest	Total Number of Elk Herd Units	Number EHUs ≥30% Cover
Big Belts	19%	0%	1%	9%	17	7
Castles	14%	0%	0%	8%	4	0
Crazies	33%	0%	0%	7%	2	1
Divide	41%	0%	0%	6%	7	5
Elkhorns	29%	0%	0%	4%	9	2
Highwoods	58%	0%	0%	3%	3	3
Little Belts	10%	0%	0%	3%	21	2
Rocky Mountain Range	9%	0%	0%	2%	14	1
Snowies	7%	0%	0%	1%	6	0
Upper Blackfoot	29%	0%	1%	5%	9	6

Some habitat was categorized as ‘affected’, but it was a relatively small amount of acreage that becomes insignificant at the GA scale. Also, it is important to recall that a large amount, often the majority, of winter range for elk is in the portion of EHUs that are not on NFS lands. Also, by nature winter range tends to be more open, occurring in drier areas at lower elevation or on open slopes where forage is accessible.

Wildlife Management Areas and the Elkhorns Wildlife Management Unit

Eight state-owned wildlife management areas (WMAs) adjacent to NFS lands throughout the plan area were established in past decades, primarily to secure winter range for elk. Monitoring of vegetation on the WMAs indicates that most appear to be maintaining acceptable forage condition, with the exception of the Sun River WMA, adjacent to the southern portion of the Rocky Mountain Range GA (MTFWP 2004).

Approximately 160,000 acres of the Elkhorns GA is managed cooperatively by the USDA FS, MTFWP, BLM, and USDA NRCS as the Elkhorn Mountains Wildlife Management Unit (WMU) with the purpose of actively managing habitat in the unit for diverse and healthy wildlife and fish habitats. Although management of the Elkhorns WMU is not directed solely at elk, the unit encompasses a large amount of elk winter range, and provides year-round habitat for a herd of roughly 2,000 elk.

Consideration of system drivers and stressors for elk

The main factors affecting elk productivity are nutrition, climate and weather, hunting, other human disturbances, predation, and to some extent disease (MTFWP 2004). Elk distribution is a key management concern, as well, and is influenced by the interrelationships among forage availability, hunting and other human disturbances, and land ownership patterns.

Human Access and Land Ownership Patterns and Trends

Human access impacts elk by potentially disturbing or displacing them, which may impact foraging opportunities and incur energy costs, particularly during winter when elk may already be nutritionally stressed. Human access also affects the quantity and pattern of mortality during hunting season. And patterns of human access on NFS lands, primarily during hunting season, may affect the degree to which elk become displaced onto private lands. That, in turn, may affect foraging opportunities and define the set of management tools available.

In past decades, lack of hiding cover created by large scale timber harvest combined with increasing road density in some areas was problematic for elk, making them vulnerable to disturbance and to excessive harvest (e.g. Lyon et al. 1985; Hillis et al. 1991; Unsworth and Kuck 1991; MTFWP 2004). Standards and guidelines based on that work were included in forest plans for both the HNF and LCNF to ensure that minimum cover was maintained when projects were planned that would impact vegetation, and to manage open road densities in a way to cause minimal disturbance to elk. Limits on road density to benefit other species, such as for maintaining grizzly bear secure habitat, has also likely reduced human access in some areas compared to the 1970s and 1980s, and created more security for elk as well. The east-side group (USDA and MTFWP 2013) supported and updated the conclusion that providing some level of security from disturbance by humans may be important to maintaining healthy elk populations, but there was consensus that establishing uniform numeric standards across broad landscapes was not supported by the body of research reported in the scientific literature, or by professional experience. Security areas on NFS lands may also be important in managing elk harvest during hunting season, by affecting distribution of elk and harvest.

There is a need, however, to balance elk security needs with hunter opportunity (MTFWP 2004) and to achieve elk population management goals. In some HDs and EMUs, management challenges center largely around the issue of limited hunting access to private land. A lack of public access for hunting on private land and the resulting differences in hunting pressure on public versus private land can play a major role in elk distribution and population dynamics (MTFWP 2004, USDA and MTFWP 2013). In recent years, the overall trend in Montana has been toward decreased public access to hunting on private land.

Hiding Cover

Hiding cover has been defined as "vegetation capable of hiding 90 percent of a standing adult elk from the view of a human at a distance equal to or less than 200 feet" (Lyon and Christensen 1992). Forest types with either multiple canopy layers or other dense horizontal structure can provide hiding cover. Management practices or disturbances such as fire, harvest, or insect infestation that impact these forest types will affect hiding cover. The degree to which elk may be affected, however, will depend on the size and configuration of the disturbance, proximity to other areas of hiding cover, patterns of human access, topography, proximity to forage, and other factors. Disturbances that affect large areas, such as large stand-replacing fires or insect infestations, are likely to have a larger impact on elk, but those impacts may be modified by the other features mentioned above in addition to effects on forage availability. Past management of NFS lands in Montana was based on a relatively large scale road building and timber management program that has in recent years shifted to smaller, more focused harvest aimed largely at fuel reduction (USDA and MTFWP 2013). Many forested areas harvested through the 1970s have regenerated into healthy sapling and pole sized stands that provide hiding cover. Insect infestation has been a recent disturbance affecting large areas particularly on the HNF portion of the plan area, but impacts to hiding cover and potentially to elk, if they occur, may not yet be apparent. Although hiding cover is likely important to elk, the east-side group concluded that specific, numeric targets for hiding cover are not supported by the body of research reported in the scientific literature, and that cover should be maintained with the natural range of variation (NRV) for each GA (USDA and MTFWP 2013).

Forage

Forage is a key attribute affecting elk population dynamics and distribution. A great deal of focus has been on elk winter range, because elk may be nutritionally stressed during winter. East of the Continental Divide in Montana, elk forage in grasslands but often seek cover in adjacent timber stands (Lyon et al. 1985). In some areas, canopy cover may be important to maintain access to forage by interrupting snow deposition in areas or at times where snow is deep. Past management recommendations have therefore focused on maintaining blocks of cover on winter range. Mackie et al. (1998), however, cited information indicating that elk benefit more from forage quality and quantity than from cover during the winter. Forage quality and availability can be affected by elk distribution and population size. Patterns of human access and land ownership may influence winter forage by restricting elk to certain areas, where larger populations of elk have the potential to over-utilize forage.

Cook (2011) noted that management of forage on summer range may be important to management of elk population dynamics and distribution. In both summer and winter, grazing, fire, and timber management can affect elk forage. Grazing by livestock, if not managed carefully, can create declines in native grass species favored by elk, and may encourage growth of woody species that are not used by elk or that provide lower quality forage. Fires can remove timber encroachment into meadows and grasslands, and may stimulate growth and productivity of some forage species. Some timber harvest practices may impact both forage and cover, although scale, habitat type, topography, and treatment type all influence the potential impact to elk. Invasive plant species such as spotted knapweed and others may influence habitat quality for elk on some winter ranges.

Species Summary

Elk use a wide variety of landscapes and vegetation types, but are generally considered to require adequate year-round forage, security from disturbance and predation by humans and other predators, and in some situations thermal cover. Security may be of greater importance during hunting season, but the need for this varies substantially by area. In the past, elk management on NFS lands was focused on maintaining security in the context of large clearcuts and extensive road networks. Current land management practices have shifted away from large scale, even-aged harvest and away from construction of new roads. Elk management concerns may vary greatly by area, but in some areas a key elk management concern is elk use of private land, and hunter access (or lack of it) to those private lands. Availability of adequate winter range is a concern in some areas, and is an additional management concern related to elk use of private lands. Elk management in many areas also centers around herds being either under or over population objectives.

Mule Deer (Odocoileus hemionus)

Distribution

Mule deer are found throughout the western United States, and throughout the state of Montana and the plan area (see map 42 in appendix A, Mule Deer Distribution). The plan area comprises both summer and winter range, with winter range generally at lower elevations near the boundary of NFS lands and extending onto adjacent non-NFS land.

Population Trend

Statewide, the mule deer population has ranged between 265,000 and 288,000 from 2008 through 2014 (MTFWP 2014a). Population estimates are also made by MTFWP regions. The plan area occurs within four MTFWP regions. The population estimate for 2014 is shown, along with the 10-year average, providing some indication of the current status relative to recent trend.

Table 2.67 Mule deer population estimates for 2014 and for the 10-year average, by region, with GAs indicated by region

(data from http://fwp.mt.gov/fishAndWildlife/management/deer/)

FWP Region	Geographic Areas	2014 Estimate	10-year Average
2	Upper Blackfoot, western Divide	12,640	18,131
3	Eastern Divide, Elkhorns, Big Belts	41,420	40,345
4	Rocky Mountain Range, eastern Big Belts, Little Belts, Castles, northern Snowies	63,604	63,357
5	Crazies, southern Snowies	40,370	56,480

Unsurprisingly, mule deer numbers throughout the plan area vary by year and area, with some areas appearing to maintain a relatively stable population while other estimates may indicate decline or increase, depending on the area. Mule deer numbers are influenced by a variety of factors including hunting, climate and weather, forage, predation, and others. The 2014 estimates in Table 2.67 indicate that the mule deer population appears to be stable in some parts of the state, but may be declining (comparing the current estimate to the 10-year average), in some regions.

Food Habits and Habitat Use and Status

Mackie et al. (1998) summarized the results of extensive research on mule and white-tailed deer in Montana, providing what continues to still be the best source of information on mule deer habitat use in Montana. In montane environments mule deer seem to prefer mature Douglas-fir with a patchwork of understory diversity providing succulent forbs, browse, and some grasses. Mackie et al. (1998) also found that vegetation structure and composition appeared to be less important than lack of snow accumulation in determining areas used by mule deer in winter. South or west-facing slopes with low accumulations of snow or where snow frequently blows free may be used. However, in mountain-foothill environments, which occur throughout much of the plan area, mule deer generally move to lower elevations where lower snow depths allow access to a variety of forb and browse species. Where agricultural lands are available in winter, they may be preferred use areas for mule deer. In most areas, winter forage is unlikely to meet the nutritional needs of mule deer (Wallmo et al. 1977, Mackie et al. 1998), so deer survive by minimizing energy expenditure. Therefore, lack of disturbance on winter range may be an important selective factor in mule deer use of wintering areas.

Consideration of system drivers and stressors for mule deer

Disturbance creating an irregular pattern of diverse understory in mature Douglas-fir forest is key to maintaining mule deer fawn-rearing habitat. Low-intensity fire, certain vegetation treatment types, and low-level beetle infestation can create openings that promote understory growth in a pattern that likely benefits mule deer. Snow accumulation seems to be a key factor determining habitat use during winter, but factors that affect the availability or quality of forage on winter ranges may contribute to mule deer population dynamics and distribution.

Hunting by humans is likely a significant influence on mule deer numbers, as well as an influence on habitat use in some areas. Predation by wolves and mountain lions may influence mule deer population dynamics and distribution. The preference shown by mule deer for forested habitats interspersed with a brushy understory that provides hiding cover may moderate the potential for predation by other wildlife or by humans.

Bighorn Sheep (Ovis canadensis)

Distribution and Population Trend

Bighorn sheep occur throughout western North America, extending northward into southern and central British Columbia and Alberta, and southward into Mexico. In Montana, in 45 distinct populations or herd units are either isolated or exist in a metapopulation structure, with very limited exchange of individuals among herds. There are bighorn sheep herd units on the Elkhorns, Big Belts, and Rocky Mountain Range GAs (see map 43 in appendix A, Bighorn Sheep and Mountain Goat Distribution).

Prior to 2009, there were approximately 5,700 bighorn sheep in Montana (MTFWP2010). Sheep numbers declined dramatically statewide beginning in late 2009, by as much as 10% to 20% by 2011, due to pneumonia-associated die-offs and subsequent poor to nonexistent lamb recruitment in herds that had experienced disease (MTFWP 2010, Butler et al. 2013). Information on herd units and their population status is from MTFWP (2010). The population in the Elkhorns GA was established in the mid-1990s with sheep transplanted from elsewhere, and was increasing in number before experiencing a severe disease-related die-off in 2008. The population was reduced to fewer than 20 sheep, below a threshold from which it is likely to recover. The Beartooth Wildlife Management Area (WMA)-Gates of the Mountains Wilderness Area herd unit is at the north end of the Big Belts, using some NFS land along with a sizeable area of other public and private lands to the north. This herd appears to have been generally stable to increasing in recent years. There are four herd units on the south end of the Rocky Mountain Range GA, collectively referred to as the Southern Rocky Mountain Front-Teton River Complex. These sheep occur on extensive areas of NFS land, and range onto BLM and private lands to the east during winter. This herd group has traditionally been large and robust, and has served as a source population for transplants to other areas in Montana as well as to other states (Picton and Lonner 2008). These herds experienced disease-related die-offs in 1984 and 2010, the most recent one apparently reducing lamb recruitment for at least 2 years following the die-off (Butler et al. 2013). Another herd unit, the North Fork Birch-Teton herd occurs on the north half of the Rocky Mountain Range GA, and has been stable to increasing in recent years.

Historically, bighorn sheep occurred in the Little Belts and Big Snowy Mountains, but disappeared by the early 1900s (USDA 2011d). After transplants into the Big Belts and Little Belts, sheep were found in the Little Belts in the 1970s, but have since disappeared from there (Picton and Lonner 2008).

Food Habits and Habitat Use and Status

Bighorn sheep are adapted to a wide variety of habitats, but require certain key elements, described in the MT Bighorn Sheep Conservation Strategy (MTFWP 2010), which summarizes the best available current science on bighorn sheep. Escape cover or terrain, comprised of open slopes of 60% or greater and usually having rocky outcrops, is found in all seasonal habitats. Escape terrain is generally found in close proximity to open foraging areas. Sheep tend to avoid areas with dense timber or high amounts of horizontal cover, favoring areas with high visibility to avoid predation, facilitate use of foraging habitat, and maintain social cohesion. Winter ranges tend to be at low elevation or on south-facing slopes with low snow levels in proximity to escape terrain. Bighorn sheep forage on forbs early in the year, switching to grasses and shrubs as summer progresses and into fall and winter (MTNHP 2014b), depending on availability. In some areas, such as on the Rocky Mountain Range GA, sheep may migrate in excess of 20 miles from summer to winter ranges (USDA 2011d), whereas in other areas sheep may remain year-round in the same general area. Snow depth may be an important driver of sheep movement to winter ranges.

Consideration of system drivers and stressors for bighorn sheep

A number of factors may influence bighorn sheep population dynamics and distribution. Residential, resort, and industrial/energy development may encroach on sheep habitats particularly winter ranges, in some areas where winter range occurs largely on private lands. Livestock may compete for forage, so range management particularly on winter ranges is important for maintaining sheep habitat.

Forest succession that results in understory development in open woodlands near escape terrain, or that results in encroachment of confers into grasslands near escape terrain, can render bighorn sheep habitat unsuitable. Fire can be a useful tool in maintaining openings and removing horizontal cover that inhibits sheep use of some habitats. Timing of disturbance may be important; fires that impact winter forage without adequate time for re-growth may create crowding on remaining range, or nutritional stress during winter. Bighorn sheep inhabit a wide range of climates, suggesting that any effects of climate change will not be uniform across Montana and possibly not even within eco-regions (Butler et al. 2013).

The most important influence on bighorn sheep populations in Montana appears to be disease-related die-offs (e.g. Tomassini et al. 2009; Wehausen et al. 2011; WSWG 2012). In addition to the direct mortality experienced in a die-off event, lamb:ewe ratios may remain chronically low for years after disease-related die-offs (Butler et al. 2013). A group of biologists known as the Wild Sheep Working Group (WSWG) under the auspices of the Western Association of Fish and Wildlife Agencies conducted an exhaustive review of the literature and recent available data regarding known wild bighorn sheep die-offs, and concluded that domestic sheep and goats were the source of most or all disease resulting in those die-offs (WSWG 2012a). The group coined the term ‘effective separation’, defined as “spatial or temporal separation between wild sheep and domestic sheep or goats to minimize the potential for association and the probability of transmission of diseases between species” (WSWG 2012a). Based on the body of evidence regarding the relationship between bighorn sheep-domestic sheep/goat contact and bighorn sheep disease-related die-offs, the group stated that “efforts toward achieving effective separation are necessary and warranted” (WSGG 2012a). MTFWP has attempted to establish buffer zones of up to nine miles between domestic sheep and goats and bighorn sheep populations (USDI 1998a, MTFWP 2010) but this strategy has not always been successful. As some bighorn sheep herds expand in numbers and distribution, the established buffer zone may break down and they may come in contact with domestic sheep or goats, as it appears happened in the Elkhorns GA in the mid-2000s (MTFWP 2010).

In 2012, the FS carried out the first steps of a Bighorn Sheep Viability Analysis, identifying and mapping areas where occupied bighorn sheep habitat and domestic grazing allotments occurred on NFS lands (Weldon 2012). These maps, updated annually, display for each state both active and vacant domestic sheep and goat grazing allotments, along with occupied bighorn sheep habitat (WSWG 2012b). Currently, there are four active sheep grazing allotments on the HLC NFs: two on the Upper Blackfoot GA and two on the Big Belts GA. Over ten air miles currently separate the boundaries of the grazing allotments from the areas known to be occupied by bighorn sheep. Sheep in allotments on the Lincoln Ranger District (Upper Blackfoot GA) only graze during the day, and are returned to private land at night due to concerns about predation by grizzly bears. This management practice likely also further minimized potential for contact between those domestic sheep and any wild sheep that may use the area. Overall, there is relatively minimal potential for contact and disease transmission between bighorn sheep and domestic sheep and goats on the HLC NFs. Careful planning using available tools (e.g., those outlined in Weldon 2012) will be critical to maintaining 'effective separation'.

Mountain Goat (Oreamnos americanus)

Distribution and Population Trend

Mountain goats occur only in western North America, in Montana, Idaho, and Washington and extending northward in Alberta, through British Columbia and into Yukon, Northwest Territories, and southeast Alaska. Mountain goats in Montana occur naturally west of and along the Continental Divide, with some introduced populations in central and southwestern Montana. In the plan area, mountain goats are found in the Rocky Mountain Range and Upper Blackfoot GAs, which are part of their historic distribution, and in the Big Belts, Elkhorns, Crazy Mountains, Highwoods, and Snowies GAs, where they exist as introduced populations (see map 43 in appendix A, Bighorn Sheep and Mountain Goat Distribution). Mountain goats on the Rocky Mountain Range GA are contiguous with the population on the Flathead National Forest, and may be connected to mountain goat populations in Glacier National Park. Populations in the other GAs within the planning area are individually isolated by large expanses of unsuitable low elevation land.

Mountain goats are hunted in a number of areas on the HLC NFs, including the Crazies, Rocky Mountain Range, Big Belts, and Highwoods GAs. Mountain goat numbers have remained relatively stable in recent years.

Food Habits and Habitat Use and Status

Mountain goats prefer high, rugged, and rocky upper mountains and peaks, and seldom venture far from cliffs and broken terrain that provide escape cover from predators. Unlike bighorn sheep, mountain goats may use dense timber types and creek bottoms in proximity to escape terrain, for security and thermal cover both in summer and winter (MTFWP 2014b). Winter and summer ranges often strongly overlap, with goats changing aspect or elevation to feed on forage exposed by wind in winter or on very steep slopes where snow cannot accumulate. They rely primarily on herbaceous and woody vegetation in close proximity to escape terrain, and in winter may use grasses as available (Foresman 2012). Although mountain goat and bighorn sheep ranges overlap, mountain goats may be found in steeper, higher elevations that are in association with more mesic, closed forest types than those used by bighorn sheep. Goats require more sodium in summer and fall than occurs in their diet, so they may travel several miles to use natural salt licks or those established for grazing domestic livestock (Foresman 2012). Some natural licks on the HLC NFs are known.

Consideration of system drivers and stressors for bighorn sheep

Mountain goat populations and distribution are limited by the amount and distribution of high elevation habitat that includes steep escape terrain. They appear to have one of the highest natural mortality rates of big game animals, due to the terrain and climate where they live (Chadwick 1973). In some areas, such as Glacier National Park and the Headquarters Pass/Our Lake area on the Rocky Mountain Range GA, mountain goats appear to be habituated to human presence and even to large volumes of traffic. Throughout much of their range, however, mountain goats occur in remote areas, often wilderness, where human activity is less common. Unexpected or unpredictable disturbance in these areas, such as helicopter tours or seismic exploration activity can cause disturbance and stress to goats, as can some vehicle traffic (e.g. Joslin 1985). Disturbances such as logging may cause abandonment of some traditional areas (Chadwick 1973; Joslin 1985). Because goats experience low productivity and relatively high natural mortality rates, they may be particularly vulnerable to excessive harvest (Burleigh 1978, MTNHP 2014b).

Moose (Alces alces)

Distribution

Moose occur throughout Alaska, Canada, portions of New England, the northern portion of some central states, and the mountainous western United States including portions of Montana, Idaho, Washington and Wyoming. In Montana, moose occur primarily in the western third of the state, extending east into the island mountain ranges of central Montana. Moose range has been mapped on portions of all GAs except the Highwoods GA (see map 37 in appendix A, Elk and Moose Distribution), although there have been at least two observations of moose in the Highwoods GA within the past 20 years (MTHNP data). Although individual moose may make extremely long-distance forays into seemingly unsuitable habitats, their functional, year-round distribution is likely limited by both habitat needs and temperature. Moose are generally not found in areas where mean summer temperature exceeds 59 degrees Fahrenheit (Renecker and Hudson 1986; Franzmann and Schwartz 2007).

Population Trend

Surveys of moose have been intermittent and vary by MTFWP Region, generally occurring more regularly in Regions 1 and 3, which historically have supported higher densities of moose (Smucker et al. 2011). Efforts by MTFWP to understand moose population trend combined information from surveys, hunter effort and success, and other factors point toward the likelihood that the moose population in MT is declining (DeCesare and Newby, 2013). Research is currently underway to determine factors influencing moose population trend in Montana (DeCesare and Newby 2013).

Food Habits and Habitat Status

Moose are broadly associated with boreal forest habitat types. They are primarily browsers, feeding on willow, shrub species, and sometimes conifer saplings, and foraging on forbs and aquatic vegetation commonly as well.

Moose appear to use habitats in the Rocky Mountain region where elevation, terrain, and vegetative cover may mediate high temperatures (Smucker et al. 2011). These include a variety of forested habitats occurring at mid-high elevation that are interspersed with wetlands or openings that provide browse species for forage. In summer, access to aspen or conifer stands that provide relief from heat stress may be important (Renecker and Hudson 1986; Lenarz et al. 2009). Moose are capable of using shrub and willow dominated openings at snow depths much greater than other ungulates, but ultimately increasing snow depth may cause them to seek areas of conifer cover where they may forage on subalpine fir or other conifers. Moose may select areas of early successional forest created by timber harvest or fire.

Consideration of system drivers and stressors for moose

Vegetation Management and Fire

Changes in timber harvest from large-scale clearcuts prior to the 1990s, to smaller, more focused vegetation management treatments have resulted in an overall decrease in early successional forest resulting from timber harvest. Conversely, the increased number of large fires in the region, along with increasing use of fire as a management tool may have contributed to moose habitat.

Climate and Climate Change

Moose in Montana are at the southern edge of their distribution, and climate may play a role in their distribution and population dynamics. Moose are well adapted to cold temperatures, but begin to experience heat stress above about 23 degrees Fahrenheit in winter, and above about 60 degrees Fahrenheit in summer (Reneker and Hudson 1986). Although moose appear to alter their habitat use to relieve heat stress, seeking conifer cover or aquatic environments in summer, some activities, such as moving through deep snow in winter, may elevate body temperature and reduce the effectiveness of attempts to thermoregulate. Heat stress may cause physiological stress, increasing moose vulnerability to disease, parasites, and other sources of mortality, as well as potentially decreasing reproductive success. If average annual temperatures increase in Montana, maintaining habitat that provides foraging opportunities (willow and other browse species, or forest openings) that is in close proximity to habitat that provides thermal relief, such as closed canopy conifer or aspen stands, and wetlands, may be important to sustaining moose populations.

Predation

Although moose are the largest ungulate in North America, they are vulnerable to predators. Their solitary habits and to some extent the habitats they use may provide predators with more opportunity than exists for preying on elk, for example, because of the latter's gregarious nature and habit of frequenting open areas where predator presence may be more readily detected. Deep snow habitats used by moose may also make them more vulnerable to predators that are able to travel on top of crusted snow. Wolves have been known to prey on moose; in an area of the North Fork of the Flathead River where moose were relatively abundant, wolf diets shifted to include more moose in winter, when other prey such as elk and white-tailed deer became less available (Kunkel et al. 1999). Grizzly bears may prey on moose calves in areas where grizzlies are relatively abundant, such as the Rocky Mountain Front (DeCesare and Newby 2013).

Species of Interest for Viewing or Management

Wolverine (Gulo Gulo)

Research and literature on wolverine ecology was comprehensively reviewed in the 12-Month Finding on a Petition to List the North American Wolverine as Endangered or Threatened (USDI 2014e), the source for the information presented here.

Distribution

Wolverine are found in the northern portion of the western hemisphere, largely in northern Canada and Alaska but extending southward in the mountainous western portion of North America into Montana, Idaho, and the northern portion of Wyoming. Wolverine have been documented in all GAs in the plan area except the Highwoods, Snowies and Castles. There is a single trapping record from the Crazies from over 40 years ago.

Population Trend

Wolverines were nearly extinct in Montana during the early 1900s, but have been increasing in numbers and range since. Wolverines likely exist as a metapopulation, with intermittent exchange of individuals among semi-isolated subpopulations that maintains genetic diversity and possibly demographic function. Because of their food and space requirements (see below), wolverines appear to exist at naturally low densities.

Food Habits and Habitat Use and Trend

Research and literature on wolverine ecology was comprehensively reviewed and information about the wolverine's life history and requirements are summarized in the proposed rule for listing them as threatened or endangered (USDI 2013b), the source for much of the information presented here. Wolverines use a wide variety of habitats, apparently not specializing in specific vegetation or geologic habitat features, but requiring areas with enough winter precipitation to reliably maintain deep, persistent snow into late spring and early summer, during the denning period (Copeland et al. 2010). Therefore in Montana, at the southern periphery of their range, wolverines are generally restricted to high elevations where deep snow persists, resulting in the semi-fragmented, metapopulation structure described above. Wolverines appear to choose areas of high structural diversity for dens, including components such as logs or boulders.

Wolverines are food generalists, preying on small animals and birds, scavenging carrion, and consuming fruits, berries, and insects (Hornocker and Hash 1981; Banci 1994). Wolverines require a great deal of space, with home ranges in Montana (Glacier NP) and northern Wyoming (Yellowstone NP) estimated at 55 to 128 square miles for females, and 193 to 311 square miles for males.

Two separate models were developed to map wolverine habitat in Region One. The first, based on information and methods described by Inman et al. (2013), uses resource selection functions derived from studies of radio-collared wolverine in the Greater Yellowstone Ecosystem (Inman et al. 2012) to map categories of wolverine habitat, including primary habitat (suitable for use by resident adults), maternal habitat (suitable for use by reproductive females), and dispersal habitat for males and females (see map 44 in appendix A titled Wolverine Primary and Maternal Habitat). The second method is derived from methods outlined by Copeland et al. (2010) and uses remote imagery to identify areas where snow cover persists until at least May 15 for periods of 1-7 years. Maps using the Copeland method identify areas where snow has persisted for only one year during the past 7 years, for 2 of the past 7 years, and so on up through areas where snow has persisted through May 15 for all 7 years of data (see map 45 in appendix A, titled Persistent Spring Snow/Potential Wolverine Denning Habitat). We used both methods to estimate the amount of potential wolverine habitat in the plan area, by GA, as shown in Table 2.68. For the persistent snow map, data from 2000-2006 were used.

Table 2.68 Acres of potential wolverine habitat by Geographic Area using two methods of estimation. Blank cells indicate where there was no habitat in that category.

Geographic Area	Inman Method		Copeland Method *Acres Persistent Snow by Total Years Persisting*						
	Acres Primary Habitat	*Acres Maternal Habitat*	*7 Years*	*6 Years*	*5 Years*	*4 Years*	*3 Years*	*2 Years*	*1 Year*
Big Belts	51,129	12,910		1,078	2,569	5,012	8,203	10,637	11,835
Castles	2,760				207	1,533	2,818	2,735	6,878
Crazies	18,131	148				675	14,698	11,289	12,121
Divide	26,726	704			1,485	2,602	6,966	18,421	28,029
Elkhorns	44,199	6,247		1,746	3,449	4,861	9,590	9,672	14,651
Highwoods	334						41,035		
Little Belts	203,484	20,810		1,356	7,112	31,262	75,832	45,487	115,078
Rocky Mountain Range	496,303	247,921	35,355	34,429	41,634	49,115	17,608	93,959	167,424
Snowies	31,514	4,933		742	2,515	2,515	17,880	12,163	14,611
Upper Blackfoot	146,086	64,839	11,314	10,127	10,772	11,601	41,035	11,492	36,644

These two methods of mapping wolverine habitat give a combined picture of the potential for each GA to support wolverine. Primary habitat, as described by Inman et al. (2013), is area “suitable for survival/use by resident adults”. Maternal habitats are “those of high enough quality that female wolverines are capable of locating natal dens and rendezvous sites within”. Primary habitat provides a broader picture of overall potential wolverine habitat; not surprisingly, the largest acreage of potential primary wolverine habitat is on the Rocky Mountains GA, which is the northernmost GA and the western boundary of that GA, running along the Continental Divide.

Maternal habitat, which requires structure for denning along with characteristics that would favor retention of late spring snow (Inman 2013) is much less available and may limit wolverine distribution throughout the plan area.

Although the map produced using methods developed by Inman et al. (2013) indicates primary habitat available in all GAs, although the amounts in the Highwoods and Castles may not be sufficient to support even a single male wolverine, the map made using the Copeland (2010) method paints a slightly different picture. For the period 2000-2007, only the Rocky Mountain Range and Upper Blackfoot GAs showed snow cover that persisted into May during each year analyzed. Although use of a longer data set might be informative, the Copeland-based map seems to indicate that denning habitat may only be reliably available on an annual basis in a very limited portion of the plan area. That may mean that GAs where snow does not reliably persist through May are not capable of supporting reproduction annually or regularly, which casts some doubt on their ability to contribute to the overall wolverine population. Meanwhile, the Rocky Mountain Range and Upper Blackfoot GAs likely do not contain enough habitat to sustain a separate wolverine population, but by virtue of their connectedness to the Flathead NF and Glacier NP they likely contribute to the overall population of wolverines in the northern Rocky Mountains.

Consideration of system drivers and stressors for wolverine
According to the proposed listing rule (USDI 2013b), much of wolverine habitat in the contiguous United States is in a management status, such as designated wilderness, inventoried roadless area, or national park, that provides some protection from management, industrial, and certain recreational activities (USDI 2013b). Furthermore, wolverine apparently are not dependent on specific vegetation or habitat features that may be altered by land management activities, nor are they particularly vulnerable to disturbance by most recreational activity (USDI 2013b), with the possible exception of snowmobiling in high elevation denning areas. Therefore, land management as practiced by the FS is unlikely to have much if any impact on wolverine population dynamics or distribution.

Climate change has been discussed as the greatest potential impact to wolverine numbers and distribution, because of the apparent requirement for deep, persistent snow in order for females to den and reproduce successfully. Wolverines' need for relatively cold average temperatures and for persistent snow explains their occurrence largely in the upper elevations of mountains in this part of their range, where they occur at lower elevations, and even at sea level, in the more northern portion of their range (USDI 2013b). Although wolverine have been observed at lower elevations in Montana and elsewhere in the Northern Rockies, it appears that low elevation and valley bottom habitat is used only for dispersal and not for foraging or reproduction (Inman et al. 2009). Therefore, if climate change affects montane habitats, and particularly the timing, depth, or duration of snowpack, it could impact wolverine numbers and distribution. In the proposal to list wolverine as threatened or endangered, the USDI (2013) suggested that wolverine habitat is "projected to decrease in area and become more fragmented within the foreseeable future as a result of climate changes." After additional review, however the USFWS concluded that there was a great deal of uncertainty regarding what the impacts of climate change might be at higher elevations. They acknowledged that "great difficulty still exists in predicting changes in precipitation with climate models" (USDI 2014e), and that some newer models suggest that higher elevations could maintain more snow than previously thought (USDI 2014). In summary, if climate change results in substantially reduced snowpack or timing of melt, wolverine habitat could be diminished and fragmented. There is a great deal of uncertainty, however, as to whether that will occur. Forest management activity appears to have little impact on wolverines, and the majority of wolverine habitat on the HLC NFs is in wilderness, inventoried roadless, or lands otherwise relatively unavailable for development or other potentially impactive management activity.

Northern Goshawk (Accipiter gentilis)

Distribution
The northern goshawk is widespread in North America, with its breeding range in northern and eastern Canada and the mountainous western United States and Mexico. It is present throughout the western two-thirds of

Montana as a year-round resident, and in eastern Montana as a migratory, over-wintering population. Goshawks are found throughout the HLC NFs, with occurrences and known or suspected nesting territories on all GAs.

Population Trend

Montana's state rank for the northern goshawk is S3, which is defined as "Potentially at risk because of limited and/or declining numbers, range, and/or habitat, even though it may be abundant in some areas" (MTHNP field guide). An independent panel reviewing the status of goshawks in the western United States, however, concluded that existing data were not adequate for assessing population trends. Currently available data on goshawk nesting activity on the HLC NFs is also not suitable for use in making inferences about population trend. Although the data follows established protocols, the protocols are not designed for making inferences regarding population status or trend. Also, only known nesting territories are monitored, so the full extent of goshawk distribution in the plan area is unknown, and therefore population estimates are not possible. However, goshawks appear well-distributed across the plan area where suitable habitat exists. Samson (2006) concluded, after conducting an exhaustive review of goshawk ecology, habitat availability, and monitoring in Region One that "No scientific evidence exists that the northern goshawk is decreasing in numbers".

Food Habits, Habitat Status and Trend

Goshawks are foraging generalists, foraging in both dense and open forest stands as well as in forest-grassland and forest-shrub ecotones. They prey on a wide variety of small mammal and avian species, including grouse, hares and rabbits, squirrels, and others. During winter, many birds make seasonal shifts to lower elevation grasslands, shrublands, and riparian corridors feeding on pheasants, grouse, small mammals, and other available prey. Diet likely varies with prey availability (MTNHP field guide).

Forest structure used for nesting appears to be an important component of goshawk habitat, and the availability of suitable nesting habitat may influence distribution and population dynamics. In the past, goshawks were thought to be dependent on old growth, and were identified as a Management Indicator Species (MIS) on both the LCNF and the HNF. A great deal of research, including data collection on the HNF, LCNF, and other east-side forests has shown that goshawks are not, in fact, an old-growth dependent species (Bush et al. 2012; USDI 1998b; Samson 2006, and others). Post-fledging habitat has also been the focus of research and discussion, and described extensively in the published literature.

Samson (2006) characterized nesting and post-fledging habitat based on several studies from Region One, for the purposes of estimating and mapping the abundance and distribution of goshawk habitat throughout the region. He characterized nesting habitat region-wide, and also by ecological province. The parameters used by Samson (2006) to map goshawk nesting habitat are described in detail in his report, but include stands of specific tree dominance groups, with moderate to high cover, two or three-story structure class, and relatively large trees. He used data from those studies along with forest inventory analysis (FIA) data to estimate available goshawk nesting and post-fledging habitat throughout Region One. His estimates, updated by Bush and Lundberg (2008) to correct some errors in the original model, predicted that there are approximately 25,000 acres of goshawk nesting habitat on the HNF, and approximately 24,000 on the LCNF. Samson (2006) as updated (Bush and Lundberg 2008) also estimated that there are 121,600 acres of post-fledging habitat on the HNF, and 163,900 acres on the LCNF. Based on these and other findings, Samson (2006) concluded that habitat for the goshawk is well distributed across Region One and by Forest, and that there is likely one interacting population of goshawks throughout the Region. These conclusions suggest that there is a healthy level of gene flow and demographic resiliency within the Region One goshawk population (see also Bayard de Volo et al. 2013).

Biologists working on the East-Side Assessment evaluated nesting habitat data collected during extensive monitoring of goshawk territories over several years on the east-side forests. They examined the data to determine whether the predictions made by Samson (2006) apply to the generally much drier east-side national forests (Helena, Lewis and Clark, Custer, and Gallatin NFs), and if not, to develop more accurate mapping tools and a more accurate assessment of northern goshawk habitat availability and distribution on NFs east of the Continental

Divide. The group analyzed results of goshawk monitoring and stand analysis in goshawk nesting territories, and came to the conclusions (Bush et al. 2012) that goshawks do not extensively use old growth (refer to Terrestrial Vegetation- Special Ecosystem Components for information regarding old growth on the HLC NFs) for nesting despite their status as an MIS for old growth, and that data from east-side stand exam inventories and from geospatial analysis on existing vegetation around known nests are not well-described by the regional nest model developed by Samson (2006). Furthermore, the group found that "goshawk nests occur in very diverse settings and vary by geographic area" (Bush et al. 2012). Bush et al. (2012) proposed a revised goshawk nest model to be used for inventory estimates as well as for analysis for the four east-side forests included in the effort. This model includes lodgepole pine, Douglas-fir and ponderosa pine types with greater than 25% canopy cover depending on the tree dominance type, and tree size of 5-10 inches dbh, depending on tree dominance type. This model reflects actual data collected from goshawk nest territories on these forests, and estimates more goshawk nesting habitat than previously reported. This model was applied to the most updated vegetation layer available (2014 VMap; refer to appendix B), to arrive at the most current estimates possible of goshawk nesting habitat on the HLC. The results are displayed on map 46, Goshawk Nest Habitat, in appendix A and shown in Table 2.69. The map and table display 'Existing Habitat' (which is assumed to be currently available), 'Affected Habitat' (which includes habitat types that are expected to produce suitable nesting habitat but have been affected by fire, insect, or management activity within the past 15-20 years), and 'Possibly Recovered Habitat' (which is habitat that appears in the vegetation data image to have been affected by disturbance, but that may have recovered into suitable habitat in the time since the image was made).

Table 2.69 Acres of goshawk nesting habitat by GA, estimated by the East-Side Assessment goshawk nest model (Bush et al. 2012).

Geographic Area	Acres Existing Nest Habitat	Acres Affected Nest Habitat	Acres Possibly Recovered Habitat
Big Belts	193,561	1,599	4,015
Castles	45,065	0	273
Crazies	29,282	32	438
Divide	159,427	3	1,843
Elkhorns	81,406	24	1,337
Highwoods	27,301	0	0
Little Belts	522,757	1,268	8,306
Rocky Mountains	162,426	1,985	3,997
Snowies	47,164	0	377
Upper Blackfoot	182,978	963	5,255

Goshawks use overlapping home ranges, but the post-fledging area (PFA) around each active nest is thought to be a relatively exclusive, defended territory. Therefore, saturation of available habitat is likely limited by the number of defended PFAs that can occur in a given area. Given the estimated average size of a PFA, it appears that all GAs are capable of supporting anywhere from 60-1000 goshawk nesting territories. The actual number is likely to be less, as nesting territories are also influenced by the configuration of suitable habitat, prey availability, topography, presence of other goshawks or of other raptors such as red-tailed hawks or great-horned owls, etc. It is clear, however, that goshawk nesting habitat on the HLC NFs is abundant and well-distributed, and that the HLC NFs contribute to sustaining the region-wide northern goshawk population.

Vegetation characteristics have also been described at the scale of the PFA; PFAs appear to be fairly heterogeneous, and vary widely by geographic region (Brewer et al. 2009). Hargis et al. (1994) stated that at the scale of the foraging area or territory, goshawks mainly require vegetation diversity and a variety of successional stages that support a variety of small prey.

Consideration of system drivers and stressors for northern goshawk

Vegetation Management and Fire

Samson (2006) summarized the factors that influence northern goshawk habitat availability and population dynamics. He noted that suppression of natural processes, such as fire, has benefitted northern goshawks by increasing the abundance and distribution of forested habitats. Furthermore, increases in the extent and connectivity of forested habitat have occurred since European settlement.

Timber harvest has the potential to impact goshawks by removing suitable nesting habitat. However, the level of timber harvest in the Northern Region has not been sufficient to impact goshawk habitat (Samson 2006). Furthermore, timber harvest levels have generally declined, and focus has shifted in recent years away from large harvest units producing large volumes, to smaller units focused on reducing fuels and removing hazard trees. This is particularly true on the east-side forests, which are drier and generally less productive from a timber volume standpoint.

Similar to timber, fire may impact goshawk habitat through removal of habitat types used for nesting. Large, stand-replacing fires have the greatest impact, while smaller, low-severity fires that maintain large trees and canopy may, in fact, benefit goshawks. Large portions of the HLC NFs are in designated wilderness, where fire has increasingly been allowed to play a more natural role, and managed fire is used increasingly to reduce fuels in non-wilderness areas. Allowing a diversity of forest successional stages on the landscape may create a small reduction in goshawk habitat at the largest scale, but will contribute to maintaining the mix of open, relatively mature forest required for nesting while creating openings important for goshawk foraging.

Climate Change

To the extent that climate change influences fire frequency and severity in the plan area and the Region, it may also impact the abundance and availability of goshawk nesting habitat. Likewise, if climate change alters the abundance and spatial pattern of forest types used by goshawks, their distribution and population dynamics may be altered as well. Goshawks appear to be relatively versatile, however, apparently using forest types as available, as illustrated by the differences in east-side goshawk nesting habitat versus that used on the west side, as discussed above. Therefore, where forests with timber meeting the size and canopy closure, and relatively open understories used by goshawks continues to exist, goshawks will likely persist.

Weather and Predation

Local weather and predators also play key roles in goshawk productivity in a given year, and may influence goshawk distribution over time. Cold, wet spring weather occurring at key points in the nesting period may result in nest failure for the year; this has occurred in at least two years during which goshawk nest monitoring was carried out on the LCNF and resulted in near-total nest failure throughout the Forest. Other raptors, such as red-tailed hawks may prey on goshawk nestlings. Great horned owls may occupy existing goshawk nests, making them unavailable to goshawks due to the earlier nesting season of owls.

Food Availability

Some studies have found that goshawk reproductive success may be influenced by prey availability (Salafsky et al. 2007; Wiens et al. 2006), which may in turn be influenced by vegetation management, wildland fire, weather, and climate change.

Species Summary

Goshawks appear to be abundant and well distributed in the plan area and in the region, although estimates of population size and trend are not currently possible using existing monitoring protocols and data. All GAs appear to have sufficient nesting habitat to support goshawks and contribute to the regional population. Goshawks in the plan area use somewhat smaller diameter trees and more open canopy for nesting than do goshawks west of the

Continental Divide, likely based on availability. Certain vegetation management activities, high severity wildland fire, and insect infestations all have the potential to reduce nesting habitat where those disturbances occur.

Information Needs

An assessment is defined by the 2012 Planning Rule as a rapid evaluation of existing information (36 CFR 219.5 (a)(1) and FSH 1909.12, Chapter 10, section 11), and is therefore comprehensive without necessarily being exhaustive, and does not include generation of new information. Information gaps or uncertainties were identified and discussed as appropriate for each species.

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