Appendix 3. Modeled Wildlife Habitat Assessment

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1 INTRODUCTION

The Flathead National Forest (FNF) is engaged in a Land Management Plan (Forest Plan) revision effort. Ecosystem Research Group (ERG) was contracted by the U.S. Forest Service (USFS) to conduct an independent analysis of the effects of the FNF Forest Plan alternatives on 11 select wildlife species and one species guild, including federally listed species; Species of Conservation Concern (SCC); species of interest for trapping, hunting, subsistence, or observing; and species associated with riparian areas. In addition, ERG modeled habitat connectivity over a 50-year period for marten, a species known to be associated with patches of forest cover in relatively close juxtaposition to each other.

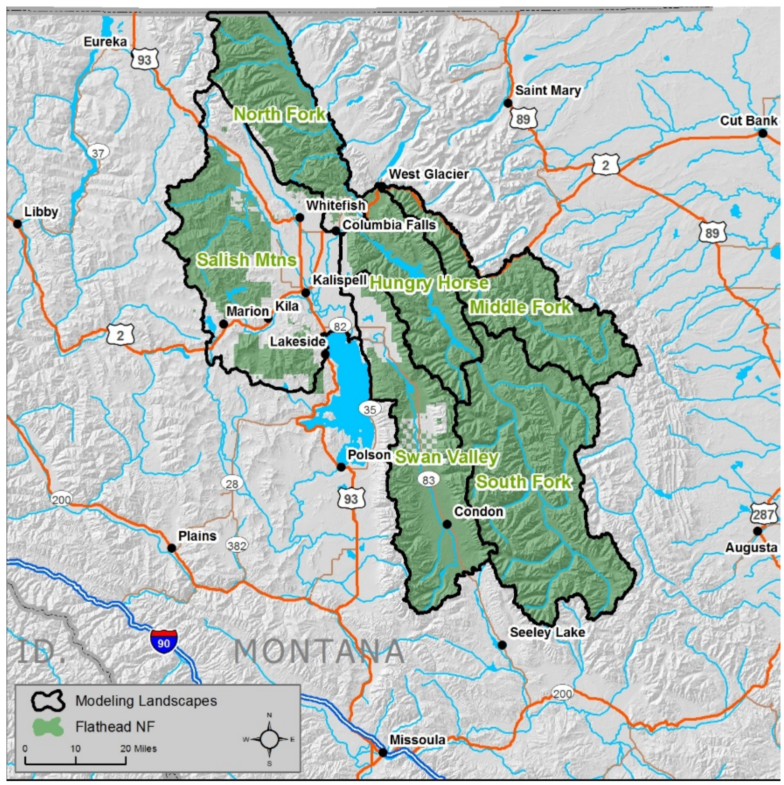

Figure 1. Flathead National Forest modeling area

ERG conducted the assessment using the USFS SIMPPLLE (SIMulating Patterns and Processes at Landscape scaLEs) model. The SIMPPLLE model is a spatially explicit model which uses logic pathways to predict how forests respond over time to succession, wildfires, and insect and disease risks based on cover types, size classes, crown closure, aspect, and slope (Chew et al. 2012). The SIMPPLLE model also allows the logic coefficients to be adjusted to reflect the potential that the future climate may become warmer and drier in the Northern Rockies as a result of global climate change impacts. In order to ensure the relevance of the modeled variables to a particular forest or landscape, they must be adjusted to fit local growing sites, insect risks, and fire behaviors. Adjustments to the SIMPPLLE model's system knowledge for the FNF were completed during the fall of 2015.

The SIMPPLLE model was used to evaluate how habitats change over a 50-year period by Forest Plan alternative. Modeling was performed assuming a trend to continued warmer, drier summer conditions using warmer and drier climate settings for years 30-50. The area modeled totaled 3.25 million acres, including all 2.27 million acres of the FNF (Figure 1).

The wildlife species selected are similar in that the literature suggests that key characteristics of vegetation habitat quality and availability that can be modeled are primary drivers and stressors. Furthermore, the species are comparable in that with the exception of elk and white-tailed deer, all are "specialists" rather than "generalists," which is notable because specialists require a narrow set of vegetative conditions for suitable habitat and are thus more likely to become at-risk from changes in habitat over time. Lastly, the 11 wildlife species occupy substantially different habitats across the FNF including large diameter, open-grown ponderosa pine (habitat for flammulated owls), very large diameter larch, ponderosa pine, black cottonwood and western red-cedar (*Thuja plicata)* snags (habitat for pileated woodpeckers), and mid-upper elevation interior, mature forests (habitat for American martens). Modeled habitat can be compared against the Natural Range of Variation (NRV) to identify major departures from historic conditions that might place a species at risk. The disturbances (wildfire, insects, disease, and human vegetation management) or lack thereof that created such departures can be identified from modeled results. The timeframe and duration of situations where habitat is limited can also be derived from modeled results.

Because the SIMPPLLE model is a spatially explicit model, it allows for the evaluation of available habitat over time and the arrangement of that habitat in terms of patch size. For example, the analysis for American marten includes a species-specific habitat assessment and an examination of general changes in patch size and habitat connectivity over time within designated areas.

1.1 Area Description

The FNF represents the portion of USFS Region One (R1) with moderate to high elevations, moderate to high precipitation, and relatively productive growing sites. Valley bottoms typically are forested with mixes of Douglas-fir, western larch, and grand fir. Less common are western red-cedar, lowland hemlock, black cottonwood, paper birch, quaking aspen, and white pine on mesic sites or ponderosa pine on drier sites. Mid-elevations and riparian areas are forested with stands of Douglas-fir, western larch, lodgepole pine, subalpine fir and Engelmann spruce. High elevations contain stands of subalpine fir and Engelmann spruce with lodgepole pine, mountain hemlock, and whitebark pine at the highest elevations (USDA 2011a; USDA 2011b). Nearly all of the mature whitebark pine has succumbed to white pine blister rust in the last half century.

The FNF is different from other national forests in western Montana (i.e. Lolo, Bitterroot, and Kootenai National Forests) in that valley bottoms and foothills generally lack the warm, dry habitat group that is characterized by open stands of ponderosa pine and frequent, low severity wildfires. Habitat for open forest-associated species such as flammulated owls, therefore, occurs at substantially lower levels than on other forests in western Montana. Another difference on the FNF is that low elevation valleys and south to west-facing slopes tend to have substantially higher snow depths than on comparable low elevation slopes on adjacent forests. This makes wintering conditions for wild ungulates (i.e. elk, white-tailed deer, and mule deer) more challenging than on adjacent forests. The FNF also has a higher percentage of Engelmann spruce-subalpine fir (e.g. ~80% of forest acres) than other western Montana forests, and occurs at the eastern periphery of the range of western red cedar, western hemlock, and western white pine.

1.2 Questions Addressed

The habitat assessment addresses the following questions:

- How does habitat for the modeled species change during the 50-year period by alternative?
- What combination of disturbances or lack thereof is responsible for those changes?
- Are projected long-term vegetation changes consistent with the recovery of federally listed species as mandated by the Endangered Species Act (USFWS 1973).

- Are projected long-term vegetation changes consistent with providing the ecological conditions necessary to maintain or restore a viable population of a species of conservation concern in the planning area, within the authority of the Forest Service and the inherent capability of the plan area, (36 CFR 219.9(b)(1))?
- How do FNF Forest Plan alternatives affect habitat availability over time, and are management activities that are included in the alternatives more or less important in influencing future wildlife habitats than are natural disturbances that are predicted to occur?
- For at-risk species, do the Forest Plan alternatives sustain or improve habitat over time?

Four forest plan alternatives are compared in this analysis. Table 1 outlines total acres of modelled mechanical treatments and prescribed burns over the 50 year model period, by alternative. Total human-generated disturbance including various types of logging and prescribed burning represents a modest percentage of the forest's 2.69 million acres. Acres treated over the 50 years range from 4 to 18% of total forest acres.

Table 1. Modeled vegetation management treatments by alternative

Alternative	Clearcut-with-Reserves	Commercial-Thinning	Ecosystem-Management-Broadcast-Burn	Ecosystem-Management-Underburn	Group-Selection-Cut
A2	73,087				25,985
B	76,233	161,214	200,777	45,093	
C	28,272	120,334	196,153	49,130	42,011
D	72,840	72,716	162,639	43,970	14,810

2 METHODS

2.1 How The SIMPPLLE Model Works and Modeling Assumptions Used

SIMPPLLE was initially developed for USFS R1 as a management tool to integrate disturbance processes and vegetation conditions at a range of spatial scales.

Specifically, SIMPPLLE's purpose is to provide the user with the ability to:

- Simulate ranges of conditions of plant communities and processes that can be expected for specific landscapes;
- Provide a basis for identifying the probability of disturbance processes and vegetation conditions;
- Simulate future vegetation changes caused by disturbance processes at multiple landscape scales;
- Simulate how changes in vegetation patterns influence the activity of fire, insect, and disease processes;
- Simulate management treatment alternatives for their impact on disturbance processes and the attainment of desired conditions at landscape scales and;
- Identify areas of high priority for treatments that can help achieve and sustain desired conditions at landscape scales.

The SIMPPLLE model was used in the FNF's Forest Plan revision for two purposes: to calculate NRV and to project the landscape conditions of the alternatives for analysis in the Environmental Impact Statement (EIS). This section discusses the use of SIMPPLLE to analyze NRV and to compare alternatives. The introduction describes the nature and utility of SIMPPLLE. This is followed by a discussion of data sources, calibration, and results specific to the FNF.

The SIMPPLLE model is a stochastic vegetation simulation model used to model vegetation conditions for the national forests. It takes a landscape condition at the beginning of a simulation (including past disturbances and treatments) and uses logic to grow the landscape through time, while simulating natural processes (growth, wildfire, insect damage, etc.) that might occur on that landscape during the simulation, accounting for the effects of those processes. Process occurrence in a timestep is dependent on many factors, including the vegetation's conditions at that timestep, the occurrence of past processes at a site, and proximity to other areas experiencing the outbreak of a particular process. Simulation timesteps are typically ten years, and simulations often are made for multiple timesteps. The logic assumptions in the model are set by the analyst, and come from a variety of sources, including expert opinion, empirical data, and modeled data from other forestry computer applications such as the Forest Vegetation Simulator.

One of the main utilities of the model is its stochastic nature. The model is typically run for multiple iterations to allow the manager to see a variety of possible projections, look for patterns, and adjust management response accordingly. Managers cannot know with precision the specific types, locations, and extents of natural disturbances that will occur on the landscape. Therefore, the SIMPPLLE model will randomly assign wildfire, insect, and disease processes on the landscape in a manner consistent with what is known about the nature of these disturbances (e.g., insect-prone stands have a higher hazard and probability of getting an infestation, especially in a dry climate cycle). As with fire, estimates of insect and disease activity are modeled, based on our best available information, but associated with a high level of uncertainty. Though it is reasonable to assume that there will be an increase in insect and disease activity over the next five decades, it is believed that the infested acres and length of the outbreak of Douglas-fir and spruce beetle in particular, are substantially overestimated in the model (see Flathead National Forest Revised Forest Plan Draft EIS appendix 2).

The other main utility of the SIMPPLLE model is its spatially interactive nature. A process occurring on one site is dependent, to an extent, on the processes that are occurring on adjacent sites. Consider a fire event, for example, SIMPPLLE simulates fire by assigning fire *starts* with a probability consistent with what historic records indicate for the area and climate. Each start is then given the opportunity to grow. The size the fire grows to is dependent on the surrounding vegetation as well as the historic probability that it will end with a weather event (or, if simulating fire suppression, whether or not there are enough resources to put the fire out). The *type* of fire that spreads (lethal, semi-lethal, and non-lethal) is dependent on the vegetation conditions of the site (including past disturbance or treatment), the climate assumption for the time step, its elevational position relative to the burning fire (uphill, downhill, etc.) and whether it is downwind or not. Again, the fire process will stop according to the probability of a weather ending event, successful fire suppression, or perhaps it runs up against a natural barrier such as the treeline or a lake. SIMPPLLE will then determine the *effect* of the fire by considering whether there are trees present capable of re-seeding/re-sprouting the site (in the case of a lethal fire), whether the stand's fuel conditions have been reduced (for semi- or non-lethal fires), and if there has been a change in size and/or species on the site.

2.2 SPECTRUM Model and Associated Uncertainties

Vegetation treatments for each alternative were determined with Spectrum, a software modeling system designed to assist decision makers in exploring and evaluating multiple resource management choices and objectives. Models constructed with Spectrum apply management actions to landscapes through a time horizon and display resulting outcomes. Management actions are selected to achieve desired goals (objectives) while complying with all identified management objectives and limitations (constraints).

Both the SIMPPLLE and SPECTRUM models use a given set of assumptions, including the amount of stand-replacing fire, insect or disease activity, and the rate of tree growth and stand structure change over time (succession). These assumptions are based on analysis and corroboration of actual data (such as fire history and historical vegetation information) and review of scientific literature, as well as professional judgement and experience of resource specialists familiar with the ecosystems and forest types of the FNF. Though best available information and knowledge is used to build these models, there is a high degree of variability and uncertainty associated with the results because of the ecological complexity and uncertainty of future events.

2.3 Identifying Natural Range of Variation

The 2012 Planning Rule directives (FSH 1909.12 Chapter 20) describe using the NRV as a basis from which to understand ecosystem integrity and establish desired future conditions that enhance the resiliency of the landscape. In the Zero Code of these directives is the definition of NRV, generally: "the variation of ecological characteristics and processes over scales of time and space that are appropriate for a given management application". The definition goes on to suggest that, "the pre-European influenced reference period considered should be sufficiently long, often several centuries…" and should "…include short-term variation and cycles in climate."

For the Flathead Plan revision, we chose to model vegetation conditions from AD 960 through 2000. This reference period allowed us to simulate the conditions associated with much of the time period known as the Medieval Climate Anomaly (MCA) as well as the other end of the climate spectrum known as the Little Ice Age. The inclusion of the MCA in the simulation is potentially valuable in that it might indicate conditions and processes that could occur in the modern climate regime (Calder et al. 2015).

Vegetation Conditions

The Region 1 VMAP product for the FNF was used to populate the landscape with dominance type, size and density information needed by the SIMPPLLE model. VMAP is a vegetation map derived mainly from remote sensed (satellite) data calibrated with on-the-ground sample data. The dominance type was supplemented with secondary species data using a combination of "looks like" data provided with the VMAP product and quantities of species presence indicated by Forest Inventory and Analysis (FIA) data. The "looks like" data is a similarity percentage to other polygons that are typed with a particular dominance type. For instance, a Douglas-fir VMAP polygon may have a "looks like" value for Ponderosa Pine of 20%. This might indicate there is Ponderosa Pine on the site, just not in sufficient quantity for it to dominate the site. If FIA indicates there is more Ponderosa Pine on the landscape than the VMAP has as a dominance type, we searched for the most likely sites to add Ponderosa Pine as a secondary component by searching for the appropriate "looks like" threshold for each species. For instance, a "looks like" threshold for Ponderosa Pine of 15% would mean the site in question would be classified as a Douglas-fir and Ponderosa Pine mix. Ultimately the data from this process is used to populate the grid of 150 m squares used in the SIMPPLLE simulation.

That said, we realize that pinning down an exact starting condition is not of much value for NRV (it is valuable for doing futuring and analyzing the Plan Alternatives, but that is another discussion). For one, it is a fallacy to assume that the conditions on the ground today are representative of vegetation conditions in the year 960. Secondly, the starting conditions for NRV are arguably not critical to the simulation. Other NRV studies, such as those conducted by LANDFIRE, use random starting conditions (LANDFIRE 2013). Therefore, to begin each simulation in the year 960, the current vegetation conditions derived from VMAP/FIA are simulated with the climate data from the past 15 decades, mainly to "wash" out the influences of modern vegetation management and fire suppression. Ultimately, the vegetation conditions resulting from this initial 150 year projection were used to approximate the landscape at year 960.

Initial Logic Assumptions in SIMPPLLE

The initial SIMPPLLE model logic used for the Flathead revision came from a long history of expert opinion, trial-and-error, and research that has been maintained and documented in logic files that are passed from forest to forest. These assumptions are documented in the model itself, through the Assumption Documentation screens. Before the Flathead planning team effort, the Nez Perce-Clearwater National Forests revised their logic in 2012 for an NRV run, and these assumptions were used as a basis for the Flathead analysis. However, there were several key points of logic updates made specific to the Flathead which are described next. Specifically, these were fire severity assumptions, fire size and start assumptions, and some pathway modifications that describe vegetation growth (AC).

Historic Climate

In consultation with the Rocky Mountain Research Station (RMRS) in Missoula Montana, we determined that the appropriate indicator of past climate was the Palmer Drought Severity Index (Anderson and Thompson 2013). Data for the Index is typically reconstructed for localized points, and the data point nearest the FNF was used to evaluate the climate for the area. Data is presented as a yearly indicator and therefore had to be generalized to a decadal average for simulations in the SIMPPLLE model. The data was smoothed using a 30 year third order “spline” function, which means that a curve was fitted for each year using a localized set of 30 data points. A random starting year within the first decade was then chosen to represent that decade, and points every 10 years from then were used to represent the full set of decadal index values. Finally, the points were categorized into three climate scenarios—wetter, dryer and normal—based on their quartile. The driest quartile indicated the dry decades of the simulation, the middle two were considered “normal” and the wettest represented the wet decades.

NRV Summaries by Species

NRVs are modeled for each wildlife species. For instance, the NRV for the flammulated owl represents the upper and lower range of flammulated owl habitat (i.e. open, large diameter ponderosa pine/Douglas-fir forest). Results of SIMPPLE-modeled habitat for each of the 12 species is “bracketed” by the NRV showing the degree to which current and future modeled levels of habitat compare with the NRV. This provides an indication of risk of long-term viability for each species. Habitat levels for a given species at or above the maximum NRV suggest the species is not at risk. Conversely, habitat levels near or below the minimum NRV suggest the species is at some potential risk of becoming non-viable over time.

2.4 Modeling to Compare Alternatives

Thirty replications of each scenario were run through SIMPPLLE to determine a range of possible outcomes. Results were compiled and analyzed across all 30 simulations to represent a realistic range of projected future conditions, keeping track of average levels as well as the maximum and minimum levels.

2.5 Wildlife Species and Habitat Query Designs

This analysis evaluates the level of currently available habitat and models potential future habitat in 10-year increments over fifty years for the following wildlife species: flammulated owl, fisher, American marten, Canada lynx (stand initiation foraging habitat), Canada lynx (multi-storied foraging habitat), black-backed woodpecker, olive-sided flycatcher, pileated woodpecker, moose/elk summer foraging habitat, white-tailed deer winter habitat, forested habitat connectivity, species associated with riparian areas, and the northern goshawk.

As discussed previously, habitats for wildlife species are correlated to vegetation parameters as affected by growth, forest succession and disturbances (i.e. fires, insects, disease, and human disturbances) over time. These parameters were captured in remotely sensed images and classified using R1-VMap polygons which were then used to create SIMPPLLE modeling landscapes. The literature was searched to find the best available science correlating vegetation characteristics to the species’ habitat requirements. This process was repeated, refinements were made, and concurrence was achieved with key USFS personnel.

The vegetative habitat components for each species were selected from the habitat group, cover type, size class, and density fields in the SIMPPLLE modeling files. SIMPPLLE simulations were used to determine changes to the habitats from wildfire, insects and diseases, or vegetation treatments on national forest system lands. The following sections describe the literature which helped determine necessary vegetation habitat components for the selected species and the vegetation parameter query used to model available habitat.

2.5.1 Flammulated Owl

Flammulated owls are strongly associated with mature xeric ponderosa pine/Douglas-fir stands in montane forests with snags (Hays and Rodrick 2003; Hayward and Verner 1994; Samson 2006b). While they prefer ponderosa pine forests, flammulated owls will also use open Douglas-fir forests (Marti 1997). Home ranges composed of at least 75 percent old ponderosa pine/Douglas-fir forest were occupied more continuously than home ranges consisting of less than 75 percent in this forest type (Linkhart et al. 1998; Reynolds and Linkhart 1992).

Flammulated owls prefer open canopy (less than 40% cover) (Samson 2006a) and avoid dense young stands of Douglas-fir (Wright et al. 1997). Flammulated owls also avoid clear-cuts and intensively cutover areas, but will use thinned or selectively logged stands.

Flammulated owls are secondary cavity nesters that often use abandoned pileated woodpecker (Dryocopus pileatus) or northern flicker (Colaptes auratus) cavities as nest sites. These may be reused for several years (McCallum 1994). These nest sites may have pockets of dense Douglas-fir near the nest that are used for roosting (Wright 1996). Some researchers suggest that this owl may be "semi-colonial," based on observations of clusters of calling owls with large "silent" areas between them (McCallum 1994); however, this may be a function of habitat patchiness (Howie and Ritcey 1987). Observations of clusters of breeding owls indicates that they may not reproduce if patches of suitable habitat are small and isolated, or if open patches for feeding and dense young patches for roosting are not in close proximity to large snags for nesting (Wright 1996).

Query Design

Ponderosa pine communities, used by flammulated owls, are extremely uncommon on the FNF and are at severe risk due to fire exclusion. This has caused open ponderosa pine stands to convert through succession to dense stands dominated by Douglas-fir. Early and mid-20th century logging removed many of the largest ponderosa pines. Forest Service monitoring often reports flammulated owls within relatively dense stands (>40% crown closure), yet the research (Hayward and Verner 1994; Wright 2000) suggests that flammulated owls require open understories to successfully forage for moths and grasshoppers. Since few existing mature ponderosa pine stands are open (15-39.9% crown closure) due to long-term fire exclusion, flammulated owls may be selecting dense stands simply because those are all that remain in most areas. The query for flammulated owls assumes that highly suitable nesting habitat is limited to forested stands with an average greater than 15-inches diameter at breast height (DBH) and crown closures of less than 40%. Based upon FIA data, forests with an average diameter greater than 15-inches DBH contain sufficient snags to provide habitat for the species that excavate nesting cavities used by flammulated owls (pileated woodpeckers and flickers). SIMPPLLE logic pathways show that dense stands of potential habitat (stands >40% canopy closure) will convert to highly suitable habitat (stands <40% crown closure) if treated by underburning, are burned by low-to-moderate severity wildfire, are attacked by Douglas-fir beetles, or are harvested or commercially thinned to remove understory and midstory trees. At a home range scale, timing of treatments would be designed to create a mosaic consisting of mature forest and dense understory patches of small trees, shrubs, and openings.

The query design for flammulated owl suitable habitat includes the following layers:

- Cover types: all cover types within the following habitat groups that include either ponderosa pine or Douglas-fir including mixed stands that contain western larch, grand fir, western white pine, western red-cedar, and lodgepole pine.
    - A2, warm and very dry
    - B1, warm and dry
    - B2, moderately warm and dry
- Tree size class: >15-inch DBH including:
    - 15–19.9-inch DBH
    - 20+-inch DBH
- Stands of 15–39.9% canopy cover

In addition, the following assumptions were made:

The SIMPPLLE model is dependent upon stand-level data (R1-VMap) and did not allow the incorporation of snag densities or understory composition. Thus we integrated FIA summary data to determine if snags for nesting exist at sufficient numbers within the larger size classes.

2.5.2 Fisher

Fishers (Martes pennanti) prefer dense, mesic, mature and late-seral coniferous stands in low to mid-elevation forests (Arthur et al. 1989; Jones and Garton 1994). Fishers require specific structural elements, particularly very large trees and coarse woody debris (CWD) (Ruggiero et al. 1994). Diverse structural components including fallen logs and stumps as well as some seedlings, shrubs, and herbaceous cover are important habitat characteristics (Meyer 2007). Earlier research suggests fishers are disproportionately tied to large, low to mid-elevation forested stream bottoms and high canopy cover (Jones and Garton 1994). In Montana, fisher habitat modeled by Olson et al. (2014) follows this pattern. In northern Idaho, however, habitat modeled by Olson et al. (2014) shows a pattern of large tracts of land independent of drainage patterns. In Montana, this spatial pattern may be associated with prevalence of stand replacing wildfires outside of stream bottoms and/or more precipitation falling as snow as elevations increase. Raine (1983) found that movements of fisher were restricted by the soft, thick snow cover that was present during midwinter whereas marten did not appear to be hindered by soft snow cover to the degree that fisher were.

Fishers prefer late-seral forests over other habitats (Ruggiero et al. 1994). Yet, studies have shown that in the Rocky Mountains, there are times of the year where young to medium-age stands of conifers are preferred (Jones 1991; Roy 1991). Fishers do not have as strong a habitat relationship to interior forests as do American martens. Yet fishers avoid large open areas with low canopy closure, an aversion that may limit population expansion (1994). At a landscape scale, Sauder and Rachlow (2014) found that the percentage of mature forest was not the best supported variable for predicting fisher occupancy, nor was the percentage of high canopy cover. Sauder and Rachlow (2014) found that fisher selected:

- Low to mid-elevation mesic, mixed conifer forests in more contiguous and complex shapes,
- Landscapes where mature forest (defined as greater than 65 feet tall) comprised greater than 50% of the landscape,
- Landscapes where openings (defined as areas with less than 10% canopy cover) comprised less than 5.4% of the landscape.

Accordingly, it has been concluded that fishers are at risk from large stand-replacing wildfires, insect outbreaks, and habitat modification that removes the structural components they need for denning and resting (USDI 2009). There has been an increase in large stand-replacing wildfires on portions of the FNF and adjacent Glacier National Park since the late 1980s.

Query Design

Olson et al. (2014) developed a coarse-scale land cover-based approach to determine the amounts and distribution of probable fisher habitat based on current vegetation and certain biophysical conditions. Sauder and Rachlow (2014) used a multi-scale product model to characterize both the configuration and composition of forest selected by fisher based on the monitoring of habitat use by individual animals. The Olson study determined the spatial probability of fisher habitat distribution was most influenced by several environmental variables such as tree canopy height, montane riparian vegetation, topographic position of habitat, and annual precipitation.

The query design for fisher habitat is based on the Olson model (Olson et al. 2014) and uses a combination of R1-VMap, Montana Natural Heritage Program, and FIA data. Denning and resting habitat was modeled as forests with an average DBH class greater than 10 inches, since trees in this class on the mesic habitats of the FNF generally have an average height greater than 65 feet tall. High elevation habitat types were excluded because annual precipitation falling as snow is too high for use by fisher. Forest with a canopy cover class less than 15% was excluded from fisher habitat based upon the definition of an opening by Sauder and Rachlow (2014). The following mapped fields are included in the mapped layer:

- Cover type: any dominance types in the habitat groups below with presence of western larch, Douglas-fir, western hemlock, western red-cedar, cottonwood which may provide cavities used for resting and denning.
- Habitat groups:
  - B3, moderately warm and moderately moist
  - C1, moderately warm and moist (grand fir)
  - C2, moderately warm and moist (western red cedar)
  - D1, moderately warm and moist (western red cedar)
  - D3A, lower elevation cool moist to moderately dry with white pine, (sub-alpine fir, spruce)
  - E1, moderately warm and moist to wet (western red cedar)
  - E2, cool moist to moderately dry (sub-alpine fir)
  - F1, cool moist to moderately dry (sub-alpine fir)

- Tree size class: >10-inch DBH for denning, resting in a mature landscape including:
  - 10–14.9-inch DBH
  - 15–19.9-inch DBH (denning/resting)
  - $\geq$20-inch DBH (denning/resting)
- Canopy cover > 15% including:
  - 15-39.9%
  - 40–69.9%
  - 70–100%

In addition, the following assumptions were made:

Fine scale habitat selection includes determining the presence of snags and CWD. VMap data does not provide information on these variables. Our query design uses FIA data to identify stands where the presence of snags and CWD is likely.

2.5.3 American Marten

American marten (*Martes americana)* prefer moist, mid- to late-seral coniferous forests with moderate- to high-canopy closure at mid-to-high elevations (Ruggiero et al. 1994). Martens are often labeled as an “interior forest species,” since they prefer large patches of late-seral forest (Ruggiero et al. 1994). Marten prefer high densities of snags and CWD (Buskirk et al. 1989) as complex physical structure near the ground provides refuge sites, access to prey, and a protective thermal environment (Buskirk and Ruggerio 1994). Martens are “subnivean” foragers (Ruggiero et al. 1994) and are thus well suited to deep snow conditions.

Query Design

On the FNF, all moist habitat groups from warm to cool (e.g. grand fir, western red-cedar, and subalpine-fir/spruce) were included as potential marten habitat, consistent with locations of published research as well as numerous marten observations (Montana Natural Heritage Program 2013; Tomson 1999a; Wasserman et al. 2010).

The query design for marten includes the following layers:

- Cover types: Douglas-fir through subalpine fir
- Habitat groups:
  - B3, warm and moderately moist
  - C1, moderately warm and moderately moist
  - C2, moderately warm and moist
  - D1, moderately cool and moist
  - D3A, lower elevation cool moist to moderately dry with white pine, (sub-alpine fir, and spruce)

  - D3B, higher elevation cool moist to moderately dry with whitebark pine (sub-alpine fir, mountain hemlock)
  - E1, moderately cool and wet
  - E2, cool and wet
  - F1, cool moist to moderately dry (sub-alpine fir)
  - F2, moderately cool and moderately dry
- Tree size class: >10-inch DBH including:
  - 10–14.9-inch DBH
  - 15–19.9-inch DBH
  - >20-inch DBH
- Stands > 40–100% canopy cover, including:
  - 40–69.9%
  - 70–100%

In addition, the following assumptions were made:

The SIMPPLLE model is dependent upon stand-level data (R1-VMap) and did not allow the incorporation of snag densities or CWD. FIA summary data are used to determine if snags and CWD exist in sufficient amounts within the larger tree size classes.

2.5.4 Canada Lynx

The Canada lynx (Lynx Canadensis) is listed as a threatened species under the ESA. Squires et al. (2013) described the distribution of lynx in Montana based on 81,523 telemetry points for resident lynx from 1998–2007. In Montana, lynx are primarily found in the northwestern portion of the state from the western border, through the Purcell Mountains and east to Glacier National Park, then south through the Swan and Mission Mountains and the Bob Marshall Wilderness Complex to Highway 200. In northwest Montana, reproducing populations are documented in the North Fork, Middle Fork, South Fork and Swan drainages of the FNF, in the Purcell Mountains on the Kootenai National Forest, and in the Swan and Mission Mountain areas on the Lolo National Forest. The FNF provides core habitat for the Canada lynx.

Potential lynx habitat is generally described as moist, boreal coniferous vegetation with cold, snowy winters that provide a prey base of snowshoe hares (Lepus americanus). Additionally, sites that typically have deep snow depths provide lynx, with their big feet, a competitive advantage (Koehler and Aubry 1994) over other mid-sized predators (e.g. coyotes, bobcats). Primary vegetation in the Northern Rockies that provides for snowshoe hares, and thus lynx, includes, subalpine fir and Engelmann spruce forest types as well as mesic lodgepole pine and aspen (Populus tremuloides) forests at mid to high elevations (Koehler and Aubry 1994).

Squires et al. (2006) found that the highest lynx densities are in extensive mesic, spruce/subalpine fir forests. Although Engelmann spruce and Sub-alpine fir were the dominant tree species in forests used by lynx, these forests also contained a mix of conifer species including Douglas-fir, western larch, and lodgepole pine. Lynx avoided dry conifer forests containing a high proportion of Douglas-fir trees, ponderosa pine trees, and grass in the understory (Squires et al. 2010). Extensive dry, cold lodgepole pine forests have few, if any lynx, which likely explains why cold, dry lodgepole-dominated forests east of the continental divide have no reproducing subpopulations (Squires et al. 2006).

Mature forests also provide concentrations of coarse woody debris for denning habitat although concentrations of woody debris in other situations (e.g. roadside slash) occasionally provide denning habitat (Butts 1992; Koehler and Aubry 1994). Squires, in his study of lynx in northwest Montana (2008; 2010), found that lynx located their dens in multi-storied stands, in generally concave or drainage-like topographies. Lynx generally denned in mature spruce–fir forests with high horizontal cover and abundant coarse woody debris. Eighty percent of dens were in mature forest stands and 13% in mid-seral, regenerating stands. Young stands that were either naturally sparse or mechanically thinned were seldom used for denning. Squires found that denning habitat is generally abundant across the coniferous forest landscape. Foraging habitat (stand initiation and multi-storied) is considered limiting, whereas denning habitat is likely not limiting.

Stand initiation hare habitat is made up of young, dense stands of saplings (and shrubs) that have regenerated after a disturbance such as a timber harvest or stand-replacing wildfire. These stands provide adequate cover and browse for reproduction and survival of snowshoe hares. On average, forest stands begin to provide winter habitat for snowshoe hares 15–20 years after disturbance (Koehler and Aubry 1994), once trees and shrubs are tall enough to extend above the snow (Koehler and Brittell 1990), and will often continue to provide habitat for another 20–25 years unless they are thinned. Denser stands appear to offer better habitat conditions for snowshoe hares; stands with less than 1,000 stems per acre are insufficiently dense to provide high quality habitat for hares (Griffin and Mills 2007).

Multi-storied hare habitat includes older forest stands that provide dense coniferous understories that maximize cover and browse for hares at varying snow depths throughout the winter. Only multi-storied stands in which tree limbs typically touch the snowline and in which the understory is dense provide winter habitat for snowshoe hares. Horizontal cover found in multistory forest stands is a major factor affecting winter hare densities.

Squires studied lynx resource selection in summer versus winter, including lynx success in capturing snowshoe hares (Squires et al. 2010). Lynx selected a mosaic of forest stages to meet their seasonal resource needs, with winter being the most constraining season for lynx in terms of resource use. During winter, lynx foraged primarily within a narrow elevation band composed of mature, large diameter trees (which Squires defined as greater than about 11inches DBH) with higher horizontal cover, more abundant hares, and deeper snow than available. These preferred forests included spruce-fir in the overstory and midstory forming a multistory structure with high horizontal cover from conifer boughs touching the snow surface. During winter, the primary component of horizontal cover was subalpine fir followed by other sapling and other tree density. Sapling and other tree densities in forests used by lynx during winter were about 1,000 stems/acre for saplings and about 280 stems per acre for other trees. During winter, the proportion of tree size classes in forests used by lynx averaged 0.05 saplings (less than 3 inches DBH), 0.19 pole (about 3–7 inches DBH), 0.42 mature (about 7–11 inches DBH), and 0.29 large (greater than 11 inches DBH) (Squires et al. 2010). Stands with dense understories or seedling-saplings providing multi-storied lynx habitat typically have moderate canopy closure or open patches in the canopy that allow dense seedling-saplings to re-develop. Where overstory canopies are too dense to allow understory development, thinning of the overstory by insect/disease or vegetation management may allow those understories to develop. Conversely, once multi-storied habitat is established, further thinning likely reduces the value of those stands for snowshoe hares and the suitability for lynx.

Squires found that lynx avoided openings in winter, and when they did use openings it was often within about 400 feet of cover (Squires et al. 2010). While cover is important to lynx while searching for food (Brand et al. 1976), lynx often hunt along edges (Mowat et al. 2000). The Northern Region Lynx Management Direction (USDA 2007) provides specific direction for vegetation management on national forest system lands within lynx habitat. The standards most applicable to long-term changes in vegetation conditions include: 1) limiting regeneration by timber management projects on national forest system lands within Lynx Analysis Units (LAUs) so that "unsuitable habitat" (stands too young to provide winter stand initiation hare habitat) does not exceed 15% of the lynx habitat in an LAU per decade, 2) limiting regeneration by vegetation management projects so that habitat in the stand initiation structural stage that does not yet provide winter snowshoe hare habitat cumulatively does not exceed 30% of the lynx habitat in an LAU in total; 3) limiting timber harvesting that would reduce multi-storied-hare habitat except under specified conditions (e.g. up to a specified number of acres in the Wildland Urban Interface); 4) limiting pre-commercial thinning that would reduce stand-initiation-hare habitat except under specified conditions; and 5) providing for linkage areas.

Query Design

We used mapped lynx habitat for the FNF, which is based on lynx telemetry locations and elevations with presence of deep fluffy snow, having boreal forest habitat types (Pfister et al. 1977) that are capable of producing snowshoe hare and lynx habitat. We conducted two analyses for lynx to assess their distinct habitat requirements: 1) a stand initiation habitat analysis and 2) a potential multi-storied habitat analysis. Additionally, all cover types with presence of subalpine fir/Engelmann spruce (which may be mixed with other species) were identified as potential habitat, to disclose how much of that potential habitat currently has sub-alpine fir or spruce and is in either a stand initiation or multi-storied condition. If potential habitat is currently forested with western larch (typical seral species on warmer subalpine fir habitat types) or is in a single-storied, dense stem exclusion condition, that habitat is considered "potential" but may not provide snowshoe hare habitat in its current condition. Modeled multi-storied habitat is limited to cover types that contain subalpine fir or Engelmann spruce (which may be mixed with other species) within subalpine fir/spruce habitat groups. Stand initiation hare habitat may be any cover types within grand-fir, subalpine fir/spruce (often mixed with other species) because grand-fir on the FNF (although not abundant) occurs in close juxtaposition to subalpine fir/spruce lynx habitat and is known to produce snowshoe hares. Once trees in the 0-5 inch DBH class reach a VMAP canopy cover class of 40% they are generally dense enough to provide summer and later winter hare habitat.

<u>Stand Initiation Hare Habitat</u>

The query design for lynx stand initiation hare habitat includes the following:

- Lynx habitat layer for the FNF
- Habitat group/cover type: subalpine fir series (excluding the E1 habitat group), including the following habitat groups:
    - C2, moderately warm and moist (grand fir)
    - D1, moderately cool and moist
    - D3A, lower elevation cool moist to moderately dry with white pine (sub-alpine fir, spruce)

  - D3B, higher elevation cool moist to moderately dry with whitebark pine (sub-alpine fir, mountain hemlock)
  - E2, cool moist to moderately dry
  - F1, cool and moderately dry
  - F2, moderately cool and moderately dry
  - G1, cold and moist
  - Since lynx primarily use spruce-fir forests (Squires et al. 2006; Squires et al. 2010), any cover type containing subalpine fir or Engelmann spruce was retained from within the habitat groups.
  - Lynx do not use dry habitats at low elevations or on southerly facing slopes such as ponderosa pine, dry Douglas-fir or dry Douglas-fir/western larch cover types.
  - Lynx do not use highly mesic habitats at low elevations such as western red-cedar; thus, habitat groups E1 was removed.
- Tree size class: 0–5-inch DBH seedling/sapling
- Canopy cover 40–100%; VMAP canopy cover classes greater than or equal to 40 percent accounted for eighty-five percent (5,515 of 6,505) of Squires' lynx telemetry locations on the FNF.
- At least 20 or more years since the previous stand replacing disturbance (high severity fire or regeneration logging) to model forest in the 0-5 inch DBH class that are above winter snow depths and thus available to snowshoe hares. Forest in the 0-5 inch DBH class and less than 20 years since the stand replacing disturbance are also summarized to model levels of lynx habitat in an unsuitable condition as identified in the Northern Rockies Lynx Management Direction (NRLMD). (2007).

<u>Multi-Storied Hare Habitat</u>

The query design for lynx multi-storied hare habitat includes the following:

- Lynx habitat layer for the FNF
- Habitat group/cover type: subalpine fir series (excluding the E1 habitat group), including the following habitat groups:
  - C2, moderately warm and moist
  - D1, moderately cool and moist
  - D3A, lower elevation cool moist to moderately dry with white pine, (sub-alpine fir, spruce
  - D3B, higher elevation cool moist to moderately dry with whitebark pine, (sub-alpine fir, mountain hemlock)
  - E2, cool moist to moderately dry
  - F1, cool and moderately dry
  - F2, moderately cool and moderately dry

  - G1, cold and moist
  - Since lynx primarily use spruce-fir forests (Squires et al. 2006; Squires et al. 2010), any cover type containing subalpine fir or Engelmann spruce was retained from within the habitat groups and modeled as suitable habitat.
  - Lynx do not use dry habitats at low elevations or on southerly facing slopes such as Ponderosa pine, dry Douglas-fir or dry Douglas-fir/western larch cover types.
  - Lynx do not use highly mesic habitats such as western red-cedar; thus, habitat group E1 was removed.
- Tree size class: >10-inch DBH including:
  - 10–14.9-inch DBH
  - 15–19.9-inch DBH
  - ≥20-inch DBH
  - Multi-storied lynx habitat is provided by forests with a high proportion of trees in the 7-11” and 11” + diameter class, so all diameter classes with an average above 10” were included
- Stands >40% canopy cover including:
  - 40–69.9%
  - 70–100%
  - VMAP canopy cover classes greater than or equal to 40 percent accounted for 85% (5,515 of 6,505) of lynx telemetry locations on the FNF.

In addition, the following assumptions were made:

While snowshoe hares require a dense understory, the SIMPPLLE model is dependent on R1-VMap classes and did not allow the incorporation of understory density. The Northern Region Lynx Management Direction is highly prescriptive and is incorporated into all FNF Forest Plan alternatives. Thus, this SIMPPLLE analysis identifies subtle differences in the amount and arrangement of possible stand initiation hare and multi-storied hare habitat over the 50-year time period.

2.5.5 Black-backed Woodpecker

Black-backed woodpeckers (*Picoides arcticus)* are associated with boreal and montane coniferous forests that have experienced recent burns. Black-backed woodpeckers are known to use three types of forested habitat: 1) post-fire areas that have burned within one to six years, 2) areas with extensive bark beetle outbreaks causing widespread tree mortality, and 3) areas of smaller disturbances scattered throughout the forest caused by wind throw, ice damage, or other occurrences that produce small patches of dead trees. These conditions all provide habitat for the black-backed woodpecker’s primary food source, woodborer beetles, and larvae. In an Oregon forest with a bark beetle epidemic, overall nesting success averaged 68.5 percent (Goggans et al. 1987). In contrast, nest success was 100 percent for nests monitored in burned forests of western Idaho (Saab and Dudley 1998).

Within those habitats, black-backed woodpeckers select a diverse mixture of conifer species, none of which is by itself essential to the species. These include ponderosa pine, spruce, western larch, mountain hemlock (*Tsuga mertensiana)*, Douglas-fir, and lodgepole pine (Dixon and Saab 2000).

Black-backed woodpeckers nest in snags at high densities in burned areas and can colonize very small, isolated burns (Hitchcox 1996). Black-backed woodpeckers in the Northern Rockies have a high degree of relatedness and can colonize burns across a wide geographic range (Pierson 2009). Hoyt and Hannon (Hoyt and Hannon 2002) concluded that black-backed woodpeckers can colonize new burns from up to 50 kilometers away.

High-severity stand-replacing wildfires may be particularly important for this species (Hutto 1995), though the woodpeckers may also select lower-intensity fires such as controlled burns (Russell et al. 2009). Black-backed woodpecker abundance was not correlated to burn size but best correlated to the number of small snags remaining after fire in the Northern Rockies (Hutto 1995). Forristal (2009) found that black-backed woodpeckers showed changing preferences for nest snag characteristics over time and recommended that the full range of snag species and diameters should be a component of maintaining black-backed nest habitat. At the plot scale, snag density was the most important predictor of nest-site occurrence, with increasing snag numbers >9 inches DBH associated with black-backed woodpecker nesting. In the Blue Mountains located in northeastern Oregon, mean DBH of nest trees was 37 cm (14.6 in) (n = 15), and trees were generally recently dead (<5 year) (Bull et al. 1986). Hejl et al. (2000) concluded that salvage logging eliminated black-backed woodpecker habitat, even when some unburned trees were left.

Query Design

The query design for black-backed woodpecker includes the following layers:

Habitat group/cover type: all habitat groups (excluding high elevation alpine cover types WB, WB-ES-AF, and AL-WB-AF) including:

- A2, warm and very dry
- B1, warm and dry
- B2, moderately warm and dry
- B3, warm and moderately moist
- C1, moderately warm and moderately moist
- C2, moderately warm and moist
- D1, moderately cool and moist
- D3A, lower elevation cool moist to moderately dry with white pine, sub-alpine fir, spruce
- D3B, higher elevation cool moist to moderately dry with whitebark pine (sub-alpine fir, mountain hemlock)
- E1, moderately cool and wet
- E2, cool and wet

- F1, cool and moderately dry
- F2, moderately cool and moderately dry
- G1, cold and moist

- Tree size class >10-inch DBH including:
  - 10–14.9-inch DBH
  - 15–19.9-inch DBH
  - ≥20-inch DBH
- Canopy cover > 15% including:
  - 15-39.9%
  - 40–69.9%
  - 70–100%
  - Canopy cover is of minor importance in predicting black-backed woodpecker habitat (Saracco et al. 2011), but we excluded the lowest canopy cover class to rule out forests with regeneration harvest prior to burning or salvage after burning.

For time step zero, a GIS layer including the locations of all severities of wildfire (low, moderate, and high severity) in the past ten years was used to select existing habitat. Most of the acreage burned on the FNF during this time period has been high severity. This 10-year time period incorporated Caton's (1996) six-year occurrence following fires and Hutto's (pers. comm.) finding that trees stressed by wildfire may continue to die over a 10-year period, prolonging the use of burned forests. For modeled future time steps, black-backed woodpecker habitat includes those stands meeting the habitat group and tree size class that are modeled to burn during those time steps. Since black-backed woodpecker nesting success was found to be lower in MPB-killed habitats compared to post-fire habitats, MPB-killed habitats are not considered high quality nesting habitat on the FNF, although black-backed woodpeckers may live there during intervals between fires.

In addition, the following assumptions were made:

The SIMPPLLE model is dependent upon stand-level data (R1-VMap) and thus is unable to incorporate snag densities. We assume that nest snags in burned forests exist in sufficient numbers for black-backed woodpeckers (Hitchcox 1996). Further, the availability of nest snags within burned forests has not been found to be limiting for black-backed woodpeckers.

2.5.6 Olive-sided Flycatcher

Olive-sided flycatchers (Contopus cooperi) are found in montane and northern coniferous forests, most often in forest openings, forest edges near natural openings (meadows, canyons, rivers) or human-made openings, and in open to semi-open forest stands (Altman and Sallabanks 2000). They can be found in dry to moist sites across a range of elevations. Occurrence of olive-sided flycatchers is influenced by relatively open canopies and the presence of tall trees for aerial fly-catching/foraging, and perches for singing (Altman and Sallabanks 2000).

In mixed conifer forests and in red-cedar-western hemlock forests in Idaho, they were found to be significantly more abundant in a matrix of clearcuts than in landscapes of old-growth forest (Evans and Finch 1994; Hejl and Paige 1994). Hutto and Young (1999) found Olive-sided Flycatchers were more abundant in early post-fire habitats than in any other major cover types, although they had similar occurrence in seed tree cover types, and were only slightly less common in clear-cut and shelterwood cover types, occurring more frequently in disturbed than in undisturbed forest in the Northern Rocky Mountains. Intermediate successional stages (e.g., dense even-aged sapling-pole or mature forests) are generally not suitable. Consequently, regional shifts in logging practices or decadal-scale fluctuations in fire occurrence could create local or regional variation in habitat availability, without necessarily leading to a net decline in habitat (Kotliar 2007).

Query Design

The query design for olive-sided flycatcher includes the following layers:

- Cover type: Douglas-fir through subalpine fir
- Habitat groups:
    - B1, warm and dry
    - B2, moderately warm and dry
    - B3, warm and moderately moist
    - C1, moderately warm and moderately moist
    - C2, moderately warm and moist
    - D1, moderately cool and moist
    - D3A, lower elevation cool moist to moderately dry with white pine (sub-alpine fir, Picea)
    - D3B, higher elevation cool moist to moderately dry with whitebark pine (sub-alpine fir, mountain hemlock)
    - E1, moderately cool and wet
    - E2, cool and wet
    - F1, cool and moderately dry
    - F2, moderately cool and moderately dry
- To determine both the mid-seral forest as well as openings that olive-sided flycatchers require, two distinct tree size classes are examined:
    - 0–5-inch DBH
    - ≥9-inch DBH including:
        - 9–14.9-inch DBH
        - 15–19.9-inch DBH
        - ≥20-inch DBH
- For the same reason as above, we examined two distinct canopy cover classes:
    - Within the 0–5-inch DBH size class: all canopy covers 15–100%

- Within the ≥9-inch DBH size class: 15% - 69.9% canopy cover including:
  - 15-39.9%
  - 40–69.9%

In addition, the following assumptions were made:

Olive-sided flycatchers require edges between openings and stands of mature forest. Analysis of seedling/sapling habitat (at all canopy cover levels) adequately represented openings in the landscape. The relative abundance of the seedling/sapling habitat and mature forest habitat was assessed in the time series modeling results.

We assume that if the ratio of seedling/sapling to mature forest stays within NRV (as defined by SIMPPLLe modeling (see 2.3) over the five-decade period, then olive-sided flycatchers will not be at risk. If either openings or mature forests drop to levels below NRV, then olive-sided flycatchers would be determined to be at risk. Some forest patches modeled as providing habitat for Black-backed woodpeckers may also provide habitat for Olive-sided flycatchers. Olive-sided flycatchers may be found to be at no risk at the planning unit scale, but will be at risk in certain landscapes for a given time period as a consequence of larger-than-normal wildfires.

2.5.7 Pileated Woodpecker

Pileated woodpecker (*Dryocopus pileatus)* are most often associated with mature forests (Ritter et al. 2000; Shackelford and Conner 1997). The species is a primary cavity excavator that nests in western larch, ponderosa pine, and black cottonwood (*Populus trichocarpa)* snags (Bull 1987; McClelland 1977). In Montana, pileated woodpeckers select larch for nesting more frequently than other tree species, followed by ponderosa pine, black cottonwood, aspen, western white pine, grand fir, and lastly, Douglas-fir (McClelland and McClelland 1999). Snags selected for nesting are very large diameter (≥20-inch DBH) and tall (≥40 feet) (Bull 1987; McClelland 1977). Bull and Holthausen (1993) found that pileated woodpecker abundance increased as the amount of forest without logging, >60% canopy closure, and old growth trees increased.

In recent decades, many forests inhabited by pileated woodpeckers have changed considerably from large continuous areas of mature and old forests with dense canopy cover (Bull and Holthausen 1993) to relatively open canopies (<30% closure) with an increasing number of snags and logs as a result of increased levels of insect infestation. Bull et al. (2007) studied the density of nesting pairs and traditional home ranges of pileated woodpeckers in two study areas over a 30-year period, and in five additional study areas over 15 years following extensive insect-caused tree mortality and timber harvest (during the 1990s). Although canopy closure declined due to tree mortality in five of the seven areas they studied and some of the forests were no longer classified as old growth, they continued to function as habitat for pileated woodpeckers because of the nesting, roosting, and foraging habitat provided. As a result, modeling included forests with average VMAP diameter classes greater than 15 inches DBH and greater than 15% canopy cover that are likely to include foraging habitat as well as some very large nest and roost trees.

Query Design

The query design for pileated woodpecker includes the following layers:

- Habitat Groups:
  - A2, warm and very dry
  - B1, warm and dry
  - B2, moderately warm and dry
  - B3, warm and moderately moist
  - C1, moderately warm and moderately moist
  - C2, moderately warm and moist
  - D1, moderately cool and moist
  - D3A, lower elevation cool moist to moderately dry with white pine (sub-alpine fir, Picea)
  - D3B, higher elevation cool moist to moderately dry with whitebark pine (sub-alpine fir, mountain hemlock)
  - E1, moderately cool and wet
  - E2, cool and wet
  - F1, cool and moderately dry

For nesting, pileated woodpeckers selectively prefer western larch, and ponderosa pine for nest sites, followed by black cottonwood, aspen, western white pine, grand fir, and lastly, Douglas-fir (McClelland and McClelland 1999). Thus, the following cover types were included for suitable habitat:

- 'CW', 'CW-ES-AF', 'DF', 'DF-AF', 'DF-C', 'DF-C-ES-AF', 'DF-ES', 'DF-ES-AF', 'DF-GF', 'DF-LP', 'DF-LP-AF', 'DF-LP-ES', 'DF-LP-ES-AF', 'DF-PP-GF', 'DF-PP-LP', 'DF-WP', 'DF-WP-AF', 'DF-WP-ES', 'DF-WP-ES-AF' ,'WB-DF-ES-AF', 'DF-WP-GF', 'L', 'L-C', 'L-C-ES-AF', 'L-DF', 'L-DF-AF', 'L-DF-C', 'L-DF-ES', 'L-DF-ES-AF', 'L-DF-GF', 'L-DF-LP', 'L-DF-PP', 'L-DF-WP', 'L-ES', 'L-ES-AF', 'L-GF', 'L-LP', 'L-LP-AF', 'L-LP-ES', 'L-LP-ES-AF', 'L-LP-GF', 'L-PP', 'L-PP-LP', 'L-WP', 'L-WP-C', 'L-WP-GF', 'PP', 'PP-DF'
- Tree size class: >15-inch DBH including:
  - 15–19.9-inch DBH
  - ≥20-inch DBH
- Stands > 15% canopy cover including:
  - 15–39.9%
  - 40–69.9%
  - 70–100%
  - Exclusion of the lowest canopy cover class to rule out forest with regeneration or salvage harvest.

In addition, the following assumptions were made:

Although pileated woodpeckers use very large-diameter snags and live trees with heart rot for nesting, the SIMPPLLE model is dependent upon R1-VMap and did not allow the incorporation of very large snag densities. The FNF used FIA summary data to determine the number of acres with at least 8 or 10 large

(15–19.9-inch DBH) and very large (>20-inch DBH) trees per acre (depending on habitat type group). A R1-VMAP texture file was then used to spatially map those acres. FIA data were also evaluated to ensure that sufficient large snags exist at the forest scale to provide nesting habitat, assuming random distribution.

2.5.8 Moose and Elk Forage

Forage for moose and elk was modeled due to changes in scientific knowledge that have occurred over the last few decades and a desire to model predicted changes in habitat in the future. A century of research on elk (Toweill and Thomas 2002) consistently concluded that the limiting factor on elk populations was access to winter ranges containing substantial amounts of forage. Forage availability on summer range was considered abundant under all combinations of disturbance (wildfire, logging, grazing) or lack thereof (wildfire suppression) and not limiting to populations. The first forest plans in Region 1 reflected that philosophy (USDA 1986b). Winter ranges were designated and targeted for periodic prescribed burning or logging designed to mimic low severity wildfires. Human disturbance was often precluded during the winter to avoid displacing wintering elk. Concerns regarding summer range were generally focused on retaining adequate security (Hillis et al. 1991) designed to slow the hunter harvest and retain branch-antlered bulls in the post-season population.

That model appeared to be adequate through the 20th century. Elk populations that were reestablished in the 1930s and 1940s (after near extirpation due to unregulated harvest and market hunting) increased through the 1960s and 1970s and were declared in many herd units to be at carrying capacity. Populations in western Montana continued to increase in the 1990s raising Montana Fish, Wildlife, & Parks (MTFWP) concerns about achieving sufficient harvest to minimize landowner conflicts.

In the 1970s, elk populations in the Selway herd unit of northern Idaho, an area characterized by dense coniferous forests mostly within a designated wilderness, began to decline. That decline has continued into the 2010s to the extent that populations today are only ~10% of what they were prior to the 1970s. Elk populations within other northern Idaho herd units have not shown declines; however, those herd units contained substantial amounts of natural openings, agricultural lands, or industrial forest lands. This suggested that within herd units dominated by dense forest and a lack of natural disturbance (e.g. wildfire, or human disturbance that mimicked wildfire), limited summer range forage could be the cause of population declines. While elk populations on the FNF have not suffered the declines that the Selway has, forest conditions on the FNF are similar in some areas in that natural openings are scarce and coniferous forests are dense unless maintained by fire or timber harvest.

Ongoing research (Proffitt et al. 2015) in the Bitterroot National Forest suggests forage availability on the summer range does affect elk populations, as much or greater than winter range forage availability. Other recent studies have also indicated that management can be improved by integrating nutritional ecology on elk summer range (Cook et al. 2001). For example, many of the important food plants, including shrubs such as red stem ceanothus, serviceberry, and Rocky Mountain maple, as well as grasses, grow only in forest openings or in forests with a more open canopy. Controlled burns or other vegetation management strategies aimed at creating a mosaic of forest conditions can be especially beneficial by providing abundant food resources in close proximity to cover. Furthermore, Hebblewhite and Profitt (2015) suggest that a lack of disturbance due to long-term wildfire suppression were largely responsible for population declines in some areas. Hebblewhite and Profitt (2015) also studied effects of elk calf survival from predation. Although wolf populations in the area were high, they found substantially greater predation from mountain lions.

Moose are more specialized than elk and tend to utilize more mesic sites with dense shrub communities. Since the 1990s, populations in Montana appear to have declined as evidenced by aerial survey trends and hunter harvest statistics, but much uncertainty about the significance and causes of apparent trends was unknown (Smucker et al. 2011). In 2013, MTFWP began a 10-year study designed to improve understanding of means to monitor the current status and trends of moose populations as well as the relative importance of factors limiting population growth (DeCesare et al. 2012).

Throughout northwest Montana moose populations increased and expanded in range through the early 1990s, which is believed to be due to prevalence of early successional forest created by fire and timber harvest (Brown 2006), and which is generally favorable to moose. Moose frequently use both logged and burned forest habitat in the first 10 to 30 years (Smucker et al. 2011; Telfer 1995); (Brown 2006). In the Yaak River drainage of northwest Montana, moose selected clearcut areas logged 15–30 years previously, as well as areas within 100 meters of a cutting unit (Matchett 1985). Across western Montana, sharp declines in timber harvest on national forest lands during the 1990s resulted in less early successional forest habitat than existed 50 years ago (Smucker et al. 2011). This trend is now being reversed in some areas of the FNF due to an increase in wildfires that have occurred since 2000. While shrub dominated habitats are used year-round, these areas are very important in winter because they provide much higher quantity and quality of forage compared to other available habitats (Van Dyke et al. 1995). Studies suggest that wildfire may be most beneficial to moose when a mosaic of burned and unburned forest patches is created at a landscape level. In many areas, moose forage in willow habitats until snow depth increases and then they move into conifer forests, where they forage on sub-alpine fir (Tyers 2003) and yew.

The query design for ungulate foraging habitat includes the following layers:

- Habitat group/cover type: subalpine fir series including the following habitat groups:
    - B1, warm and dry
    - B2, moderately warm and dry
    - B3, warm and moderately moist
    - C1, moderately warm and moderately moist
    - C2, moderately warm and moist
    - D1, moderately cool and moist
    - D3A, lower elevation cool moist to moderately dry with white pine (sub-alpine fir, Picea)
    - D3B, higher elevation cool moist to moderately dry with whitebark pine (sub-alpine fir, mountain hemlock)
    - E1, moderately cool and wet
    - E2, cool and wet
    - F1, cool and moderately dry
    - F2, moderately cool and moderately dry
    - G1, cold and moist

- The following habitat groups were included for elk only.
    - All non-forested grassland habitat groups (NF1, NF1A, etc.)
- Tree size class: 0–5-inch DBH seedling/sapling
- Canopy cover 0–100%, or combinations of:
- Tree size ≥15 inch diameter at breast height with:
    - Canopy cover 0-15%

In addition, the following assumptions were made:

While elk security habitat is important, the SIMPPLLE model is dependent upon R1-VMap and did not allow the incorporation of road management data. On the FNF, elk security habitat is modeled using other methods.

2.5.9 White-tailed Deer Winter Habitat Snow Intercept Cover

Snow intercept cover for white-tailed deer was modeled due to changes in scientific knowledge that have occurred over the last few decades and a desire to model predicted changes in habitat in the future. Research by Mundinger (1982; 1984) in the Swan Valley of Montana strongly tied white-tailed deer winter survival to mature conifers with dense canopy closure. Mundinger (1982; 1984) concluded that even though forage was limited under dense canopies, snow interception provided by dense canopies allowed white-tailed deer to move around and find limited winter forage and avoid the substantial caloric expenditure that would have been expended by plunging through deep snow within forest opening or under more open stands. MTFWP subsequently found that wintering white-tailed deer on the FNF foraged on arboreal lichens that were hanging on coniferous forest branches or had been blown to the ground by wind (Their pers. comm.). Other researchers (Toweill and Thomas 2002) acknowledge that of all native ungulates, white-tailed deer are the least capable of surviving deep snow. Current Forest Plan (USDA 1986a) measures accommodate wintering white-tailed deer based on those and other Montana Fish, Wildlife and Parks recommendations..

While Mundinger's (1982; 1984) findings are irrefutable based on the habitat and winter weather conditions he studied in the 1970s, changes in low elevation snowpack conditions associated with a changing climate may reduce the importance of snow intercept cover in the future. The severe winter conditions under which Mundinger did his research in the 1970s have become increasingly milder, especially at low elevations where white-tailed deer winter. While extreme winter weather conditions still occur (e.g. US Weather Service data indicates that the winter of 1996-97 stands as a fairly severe year in terms of total snowfall) the occurrence and duration of those severe events is becoming increasingly uncommon and of much shorter duration.

In addition, the 2012 Planning Rule (USDA 2012a) requires an ecosystem and biodiversity approach to national forest management. Mixed ponderosa pine, western larch, and Douglas-fir communities, which provide essential habitat for flammulated owls, require frequent disturbance resulting in relatively open canopies and open understories. Survival and continuous recruitment of very large ponderosa pine and western larch trees needed for nesting by pileated woodpeckers is increased where stand densities are lower and stand replacing fires are less frequent. Measures that would optimize cover for either wintering white-tailed deer or nesting flammulated owls and pileated woodpeckers are clearly opposed to each other at the scale of a forest stand. Measures to protect winter white-tailed deer habitat may be less important during the new “norm” of relatively warm, low-snow winters in the intermountain valleys. However, because there is uncertainty regarding winter precipitation in models of future climate, the FNF incorporated parameters into its modeling of alternatives at a landscape scale. Snow intercept cover is modeled as forests with an average diameter class of at least 10 inches and at least 40% canopy cover. Similar to fisher, forest with a canopy cover class less than 15% was defined as an opening for purposes of modeling future vegetation treatments. In landscape areas mapped as white-tailed winter habitat by MTFWP, no more than 30% of the habitat could be in an opening at any given time (see Spectrum Model Formulation for the FNF in the project record).

Query Design

The query design for white-tailed deer winter range includes the following:

- MTFWP winter white-tailed deer habitat layer
- Cover type: All, excluding high elevation alpine cover types WB, WB-ES-AF, and AL-WB-AF
- Habitat groups:
    - A2, warm and very dry
    - B1, warm and dry
    - B2, moderately warm and dry
    - B3, warm and moderately moist
    - C1, moderately warm and moderately moist
    - C2, moderately warm and moist
    - D1, moderately cool and moist
    - D3A, lower elevation cool moist to moderately dry with white pine (sub-alpine fir, Picea)
    - D3B, higher elevation cool moist to moderately dry with whitebark pine (sub-alpine fir, mountain hemlock)
    - E1, moderately cool and wet
    - E2, cool and wet
    - F1, cool and moderately dry
    - F2, moderately cool and moderately dry
- Tree size class > 10-inch DBH including:
    - 10–14.9-inch DBH
    - 15–19.9-inch DBH
    - 20+-inch DBH
- Stands > 40% canopy cover including:
    - 40–69.9%

- 70–100%

2.5.10 Habitat Connectivity

Connectivity, as coined in 1984 by Merriam (USDA 1997), refers both to the abundance and spatial patterning of habitat and to the ability of animals to move from patch to patch of similar habitat. Structural connectivity is the physical relationship between patches of habitat or other ecological units; functional connectivity is the degree to which landscapes actually facilitate or impede the movement of organisms and processes of ecosystems (Ament et al. 2014). Corridors are a means by which connectivity can be provided. They are strips or stepping stones of “hospitable territory traversing inhospitable territory providing access from one area to another” (USDA 1997). The effectiveness of a corridor depends upon the species using it, the type of movement, and the type of corridor (Hunter 1996). Animals need connectivity to forage within their home range, for dispersal to new home ranges, for migration between locations, and for genetic interaction between meta-populations. According to American Wildlands (2008), maintaining the ecological connections, or wildlife movement corridors, between major wildland habitats is one of the most pressing challenges for habitat and wildlife conservation in the Northern Rockies today.

Many connectivity or corridor studies focused on single species, but in recent years, there has been more emphasis considering connectivity for multiple species at a large landscape scale. In 2007, American Wildlands initiated a *Priority Linkage Assessment* which identified, cataloged and prioritized the threats to, and opportunities for, maintaining connectivity in the U.S. Northern Rockies. The outputs of the assessment included a GIS shapefile that contained polygons of major linkages, species of concern in each, priority of each linkage, and a field that distinguishes which linkages are used for seasonal movement (American Wildlands 2008). In 2015, the Nature Conservancy mapped the “penetrability” of the terrestrial landscape across the Pacific Northwest.

The availability and arrangement of vegetative cover may affect connectivity for some animals. Some species, such as marten, require moderate to high canopy cover (Ruggiero et al. 1994) with forest interior to conditions help them avoid predators, while other species prefer more open or mixed habitats (Tomson 1999b). Characteristics favorable for corridor/linkage zone functionality for most species, especially the large carnivores, include low road density, low concentrations of human occupancy, an abundance of productive foraging habitat, a robust mix of forested and non-forested habitats with abundant edge, and gentle to moderate terrain (Craighead and Vyse 1996; Servheen et al. 2003; Walker and Craighead 1997). In general, a variety of open habitats such as montane grasslands, wet meadows, shrublands, early-seral forest, riparian shrub associations, open-grown forest, talus slopes, and burns generously distributed amongst blocks of mature interior forest provide a favorable linkage environment that will accommodate a wider variety of species than unbroken forest alone (Costain 2009).

While there is no empirical evidence to support the concept of corridors (Rosenberg et al. 1997), many conceptual models have been built to project connectivity across landscapes (Noss et al. 1996; Walker and Craighead 1997). For example, the Northern Region Connectivity Protocol (USDA 1997) provides a framework for describing corridors and the effects of forest projects and other human activities. The aforementioned research suggests that sustaining historic mixes of vegetation in terms of cover types, size classes, and patch sizes and arrangement all contribute to sustaining well-distributed wildlife populations and avoiding genetically isolated populations. Much of the research focuses on habitat fragmentation and isolation caused by urbanization and residential development, which are prevalent in the Flathead Valley near Kalispell, but fortunately, are not a problem on large blocks of national forest land such as the FNF. Rather, barriers to animal movement are more likely to occur on adjacent private, developed lands.

The 2012 Planning Rule includes a requirement that plan components for ecosystem integrity (including connectivity) must take into account the interdependence of terrestrial and aquatic ecosystems (219.8(a)(1)). There is an additional requirement in the 2012 Planning Rule to maintain or restore the ecological integrity of riparian areas, "including plan components to maintain or restore structure, function, composition, and connectivity …" (219.8(a)). Public comments on forest plans, wilderness legislation, or individual projects often suggest that the establishment of large, permanent reserves of late seral forest be provided for habitat connectivity. Such permanent reserves may indeed provide long-term habitat when located within disturbance regimes where natural disturbances are infrequent or occur at very small scales. Within the Northern Rockies, however, natural, unavoidable disturbances like wildfire, insect outbreaks, or root disease make the benefits of permanent reserves more questionable. Recognition of the role of natural disturbance on the FNF necessitates an acceptance that connectivity provided by forest cover will change over time at a small or intermediate scale, and that most species are adapted to such changes, but that rapid succession will maintain connectivity at a large scale.

Query Design

Connectivity within the American Wildlands polygons, addressing multiple species, is used for the query below. Recognizing that connectivity for some species is affected by a lack of habitat components that take a long period of time to restore (Haber and Nelson 2015), connectivity across the FNF was modeled using the query design for marten because they are one of the species that is more limited by the amount and arrangement of mature tree cover. As a means of assessing long-term habitat connectivity, and as a means of assessing the benefits of permanent reserves, sample landscapes at year 2015 and 2065 were compared by acres of marten habitat, average patch size, and percent habitat occurring in 2015 against the modeled habitat that still remained at 2065. Figure 2 presents the American Wildlands polygons in the vicinity of the FNF and those selected for this analysis. Polygons were selected for analysis if they contained lands managed by the FNF. The percentage of FNF lands in each connectivity area is displayed in Table 2.

The query design for connectivity includes the following:

- American Wildlands selected polygon layer
- Cover types: cool Douglas-fir through subalpine fir
- Habitat groups:
    - B3, warm and moderately moist
    - C1, moderately warm and moderately moist
    - C2, moderately warm and moist
    - D1, moderately cool and moist
    - D3A, lower elevation cool moist to moderately dry with white pine (sub-alpine fir, Picea)
    - D3B, higher elevation cool moist to moderately dry with whitebark pine (sub-alpine fir, mountain hemlock)

  - E1, moderately cool and wet
  - E2, cool and wet
  - F1, cool and moderately dry
  - F2, moderately cool and moderately dry
  - G1, cold and moist
- Tree size class: >10-inch DBH including:
  - 10–14.9-inch DBH
  - 15–19.9-inch DBH
  - >20-inch DBH
- Stands > 40–100% canopy cover, including:
  - 40–69.9%
  - 70–100%

The query above is identified as *dense, mature tree cover*. While forest stands in the 5-9.9-inch DBH class provide cover for connectivity and will be used by many forest-associates, they may not have the structural complexity to be used by all species. Thus, the connectivity model provides a conservative model of landscape-level connectivity for forest interior species. Nonetheless, cover provided by even moderately dense pole or medium sized stands (5-9.9 and 10-15 inch diameter) stands likely contributes to the ability of wide-ranging carnivores to move across the landscape. For that reason, an additional query identified as *cover* will be applied to the aforementioned corridors identified by American Wildlands.

- Cover types:
  - All forested cover types
- Habitat groups:
  - All forested habitat
- Tree size class: >5-inch DBH including:
  - 5-9.9 inch DBH
  - 10–14.9-inch DBH
  - 15–19.9-inch DBH
  - >20-inch DBH
- Stands > 40–100% canopy cover, including:
  - 40–69.9%
  - 70–100%

In addition, the following assumptions were made:

American Wildlands connectivity polygons on the FNF do not include existing wilderness areas or the Jewel Basin Hiking Area, but these areas have relatively low levels of human influence. The specific effects of roads and human development on connectivity areas were not considered in this query, but is considered elsewhere (for example, see FNF grizzly bear secure core and elk security habitat analysis).

Table 2. Land management jurisdiction within the American Wildlands polygons

Connectivity Area Name	Forest Service		State		Other		Total
	Acres	%	Acres	%	Acres	%	Acres
Big Mountain	17,241	40.3%	4,528	10.6%	20,978	49.1%	42,748
Camas Creek	10,780	99.5%		0.0%	51	0.5%	10,831
Coram	68,775	85.5%		0.0%	11,676	14.5%	80,451
Essex	18,636	94.2%		0.0%	1,144	5.8%	19,780
Haskill Basin	39,797	41.1%	1,006	1.0%	56,141	57.9%	96,944
Idaho Hill	14,214	14.2%	5,565	5.6%	80,302	80.2%	100,081
Lost Trail - Kenelty	15,318	83.0%		0.0%	3,131	17.0%	18,449
North Fork	20,727	54.1%	5,634	14.7%	11,948	31.2%	38,308
North Whitefish Range	75,776	96.3%	611	0.8%	2,290	2.9%	78,676
Nyack Pinnacle	63,410	96.4%	344	0.5%	2,022	3.1%	65,776
Seeley-Clearwater	250,944	73.0%	52,202	15.2%	40,848	11.9%	343,993
South Glacier	40,104	97.2%		0.0%	1,166	2.8%	41,270
Swan Lake	15,123	76.3%	475	2.4%	4,226	21.3%	19,825
Swift Creek - Stillwater	130,901	64.0%	44,638	21.8%	29,150	14.2%	204,690
Total	781,746	67.3%	115,002	9.9%	265,073	22.8%	1,161,822

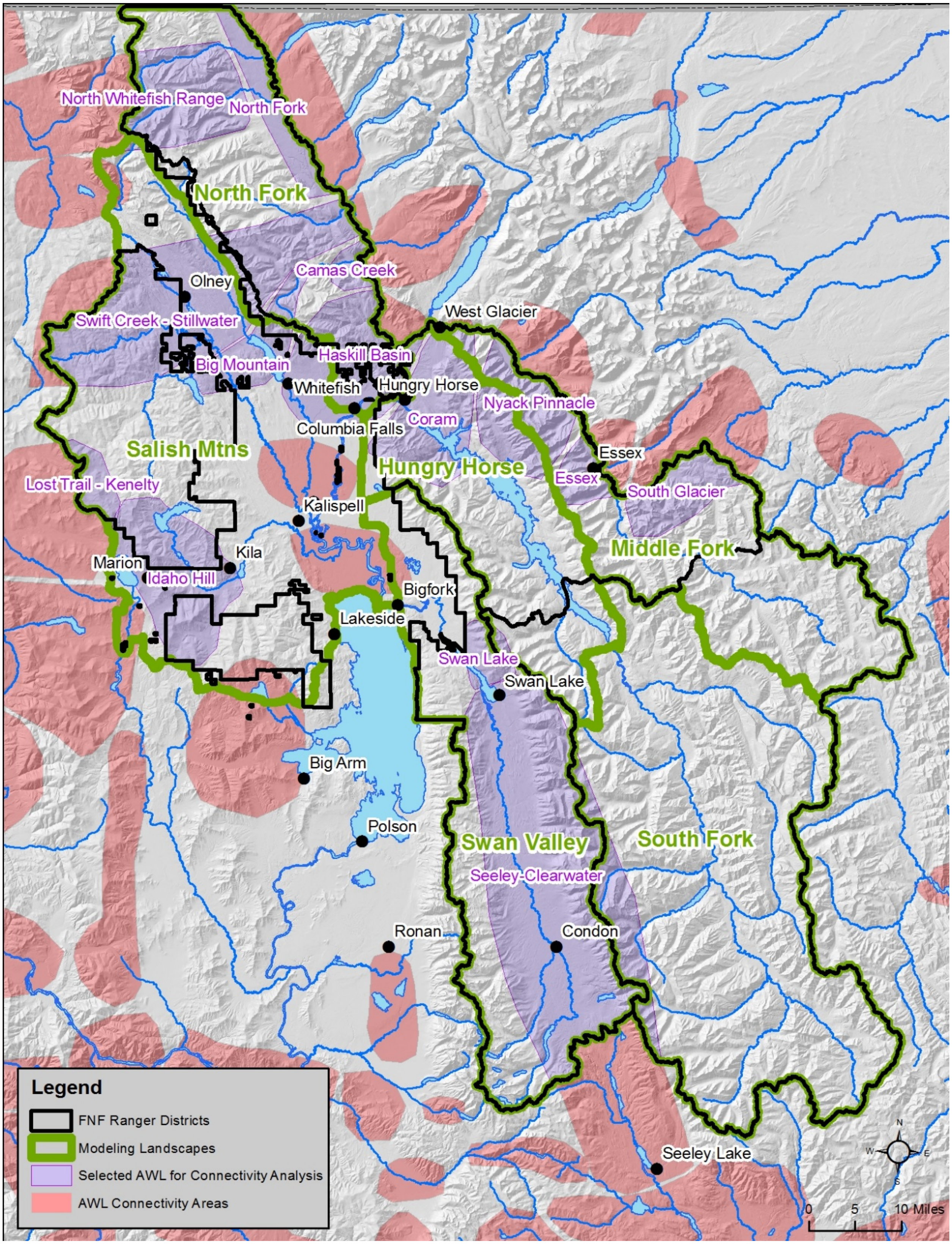

Figure 2. Flathead National Forests (FNF) selected American Wildlands polygons for the connectivity analysis

2.5.11 Riparian Habitat Conservation Area or Riparian Management Zone Species

In Region 1, riparian shrub and deciduous tree communities are generally considered to provide the highest levels of species diversity (Hutto and Young 1999). Avian species occupying riparian shrub and deciduous tree communities include species such as the American redstart, Wilson warbler, northern water-thrush, veery, catbird, and long-billed marsh wren. Several species of bats also forage at levels disproportionate to habitat availability above riparian shrub and deciduous tree communities.

In the mountainous West, riparian shrub and deciduous tree communities are disturbance-dependent. On wide, low gradient drainages (i.e. the Swan River), periodic flooding maintains a very highly convoluted pattern of meanders, sloughs, and oxbow lakes. Because this pattern is changing constantly due to periodic flooding, cottonwoods and shrubs are the predominant vegetation, whereas conifers are patchier and somewhat episodic since they only become established in the intervals between flooding events. Beaver activity also helps to maintain cottonwood/shrub communities and compliments the effects of flooding. In the West, impoundments have interrupted this cycle to the detriment of cottonwood/shrub communities. The only large impoundment affecting FNF lands is the Hungry Horse Reservoir, which was completed in 1953. The Hungry Horse dam inundated a segment of the South Fork of the Flathead River and flooded an estimated 6,867 acres of riparian/wetland wildlife habitats according to MTFWP.

Unlike low gradient streams, moderate or steep gradient streams (i.e. Bowman Creek) tend to be bedrock-controlled. Flooding generally has little effect on the amount of sinuosity. Conversely, wildfires, insect outbreaks, or human activities that mimic those natural disturbances limit conifer cover and allow dense communities of riparian shrubs to occupy riparian zones. Beavers occur within moderate and steep gradient streams, however, their influence upon the shrub community is much less than within low gradient streams. In the absence of disturbance, conifers will quickly re-occupy upland riparian zones and to varying degrees will shade out riparian shrubs.

Two human activities affecting natural disturbances in moderate and steep gradient streams include fire suppression and Riparian Habitat Conservation Area (RHCA) or Riparian Management Zone (RMZ) protective measures. Wildfire history data suggests wildfire-burned acreages in the 20th century declined during the mid-1900s until the 1980s, when fuel accumulations and warmer and drier weather began a trend of increasing acreage and severity of wildfires. Wildland fire burned approximately 1,230,000 acres from 1889 to 1929 in the vicinity of the FNF, about 40,000 acres between the 1930 and 1979, and about 575,000 acres burned in or adjacent to the FNF from 1980-2012 (USDA 2014), including some riparian areas.

Because deciduous trees and shrubs along low-gradient streams are maintained by periodic flooding, the query is designed to model those riparian deciduous communities that are maintained by other disturbance factors such as fires, insects, and disease. The query is designed to assess the availability of habitats that provide shrubs and deciduous trees within RHCAs/RMZs. For time step zero, a GIS layer including the locations of all VMAP polygons with cover types dominated by shrubs and deciduous trees was used, including VMAP DOM mid-40 shrub, MX-POTR5, and MX-POPUL. For purposes of modeling future vegetation treatments, there were minimal treatments in landscape areas mapped as RHCAs/RMZs because these areas are not suitable for timber production (see Spectrum Model Formulation for the FNF in the project record). Transitional forests resulting from moderate or high severity wildfires and insect/disease within 20 years following disturbance was used to model future forest openings containing riparian shrubs and hardwood trees. Since the VMAP cover class 0-14.9% may be lacking in trees but contain dense shrubs, it was included in the model. On the FNF, once mixed conifer stands in upland riparian areas reach an average DBH of 5 inches, the presence of deciduous trees and shrubs has often been greatly reduced or eliminated due to conifer competition and shading, so these forests were not included for purposes of future modelling of highly suitable habitat for species associated with riparian shrubs and deciduous trees.

Query Design

The query design for riparian species associated with shrubs and deciduous (hardwood) tree communities that are not maintained by flooding includes the following layers:

- the FNF RHCA layer (2013)
- Sloping, moderate and high gradient streams > 4% slope
- Habitat groups:
    - All that occur within the RHCA layer
- Tree size class < 5-inch DBH including:
    - 0–4.9-inch DBH
- Stands all canopy cover including:
    - 0-14.9%
    - 15-39.9%
    - 40–69.9%
    - 70–100%

2.5.12 Northern Goshawk

In their status review of northern goshawk (*Accipiter gentilis)*, the U.S. Fish and Wildlife Service (FWS) found that northern goshawks typically use mature forests or larger trees for nesting habitat (the nest area); however, they are considered a forest habitat generalist at larger spatial scales (USDI 1998b). Northern goshawks typically select nest sites in mature coniferous forests with relatively closed canopies (50–90%) and open, multi-storied stands (Brewer et al. 2007; Kennedy 2003; Reynolds et al. 1992; Reynolds et al. 2008) of at least 30 acres or greater (Reynolds et al. 1994). Northern goshawks are not limited to continuous old growth (USDI 1998a). Greenwald et al. (2005) reviewed all telemetry-based studies of Norther goshawks across North America, including a wide range of habitats across the U.S., and found that goshawks generally selected stands based on structure, but that selection varied by forest type. For example, in lodgepole pine stands, canopy closure ranged from a mean of 34-80% and a size of 9-15-inch DBH, whereas trees up to 20-inch DBH were selected in mixed species stands. Northern goshawks are adept at finding dense, multi-storied microsites suitable for nesting within dry, cold lodgepole pine-dominated stands that otherwise do not appear suitable for nesting (Squires and Ruggiero 1996). Fledgling success in Montana was higher in landscapes that contained a mix of open and dense forested stands than in landscapes with only dense stands (Clough 2000). Northern goshawks use all cover types and age classes for foraging habitat (Kennedy 2003).

Point data on northern goshawk nest locations are abundant across the Region (USDA 2006). Nest data for 154 northern goshawk nests on the adjacent Idaho Panhandle (IPNF) and Kootenai National Forests (KNF) were intersected with R1-VMap (Version 11) data to corroborate habitat queries as illustrated in Figure 3. The data points were overlaid on a digital elevation model and the minimum and maximum elevations were analyzed. The maximum elevation was used to determine an upper elevation limit of 7,000 feet for nesting habitat. Trees used as nest sites average 14-inch DBH in the USFS Northern Region (Samson 2006a).

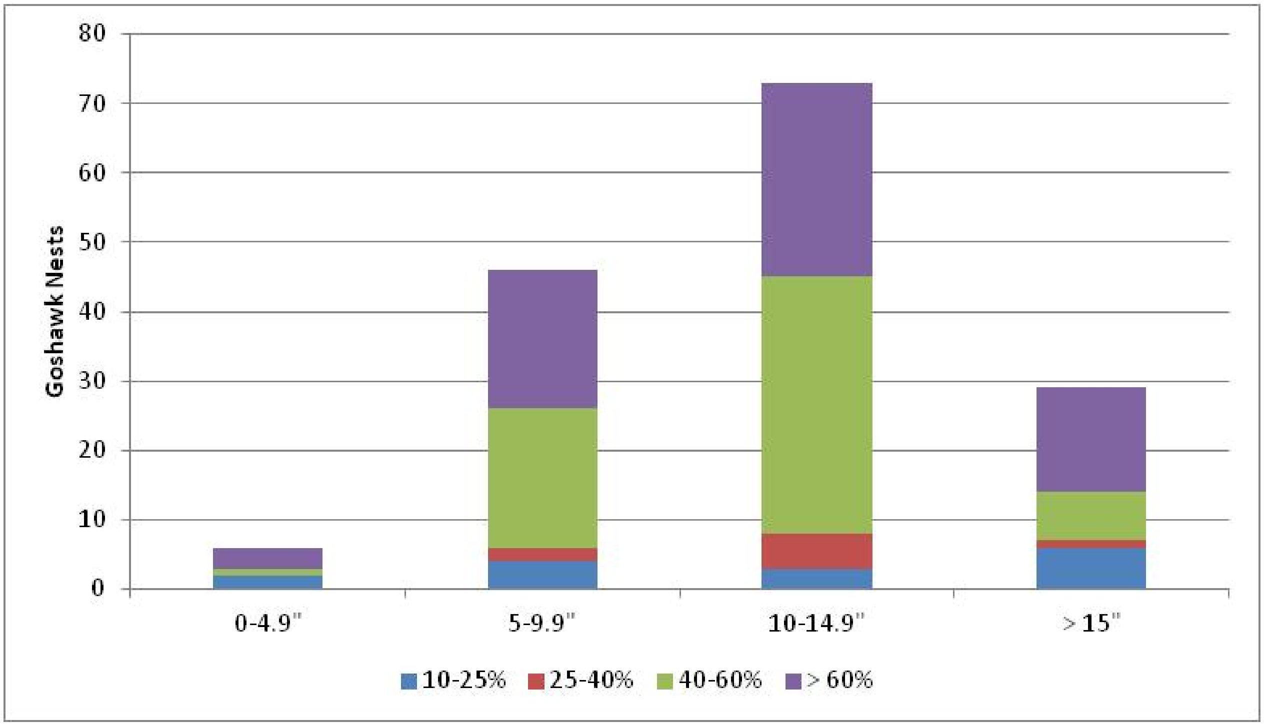

Figure 3. Northern goshawk nest location habitat characteristics within the IPNF and KNF

The data suggests that there is a preference for large (10–15-inch DBH and 15+-inch DBH) and a preference for moderately dense (40-60% crown closure) and dense (60% plus crown closures) stands. Interestingly, a substantial percentage of nests are in stands normally considered too small (<10-inch DBH), or in stands too open (<40% crown closure) for nesting northern goshawks. This phenomenon is typical for northern goshawk nest distribution and explains why McGrath et al. (2003) had difficulty in predicting suitable nest locations from random sites in a blind sample test. McGrath et al. (2003) concluded from data collected at the nest that such small stands (0–5-inch DBH), or very open stands (10–40% crown closure), often contain a microsite of large, dense trees that were undetectable at the stand scale. Squires and Ruggiero (1996) found similar nesting situations in Wyoming, where northern goshawks were nesting in dense, multi-storied microsites within lodgepole pine stands that were too small or open to typically support nesting goshawks, thus modeling provides a conservative estimate of goshawk nesting habitat.

Query Design

The query design for northern goshawk includes the following layers:

- Cover type: All, excluding high elevation alpine cover types WB, WB-ES-AF, and AL-WB-AF and pure ES-AF cover types that do not include other species such as western larch or Douglas-fir.
- Habitat groups:
    - A2, warm and very dry
    - B1, warm and dry
    - B2, moderately warm and dry
    - B3, warm and moderately moist
    - C1, moderately warm and moderately moist
    - C2, moderately warm and moist
    - D1, moderately cool and moist
    - D3A, lower elevation cool moist to moderately dry with white pine (sub-alpine fir, Picea)
    - D3B, higher elevation cool moist to moderately dry with whitebark pine (sub-alpine fir, mountain hemlock)
    - E1, moderately cool and wet
    - E2, cool and wet
    - F1, cool and moderately dry
    - F2, moderately cool and moderately dry
- Tree size class > 10-inch DBH including:
    - 10–14.9-inch DBH
    - 15–19.9-inch DBH
    - 20+-inch DBH
- Stands > 40% canopy cover including:
    - 40–69.9%
    - 70–100%

In addition, the following assumptions were made:

- Ponderosa pine stands may not have >40% crown cover, but ponderosa pine is a very minor component on the FNF.
- The northern goshawk habitat model is limited to nesting habitat. It is assumed that post-fledging and foraging habitat is non-limiting (Brewer et al. 2007; Kennedy 2003).

3 RESULTS AND DISCUSSION

3.1 Existing Vegetation

Since changes in vegetation over time directly affect the wildlife species assessed in this analysis, the mix of existing vegetation on the FNF provides a reference point for comparing future changes as affected by growth, succession, or disturbances. Existing vegetation conditions are categorized by the distribution of size classes and crown closures in Figure 4 (note: the FNF VMAP layer does not have a separate size class of very large trees, so this was modeled using other methods, as explained in the section on pileated woodpecker).

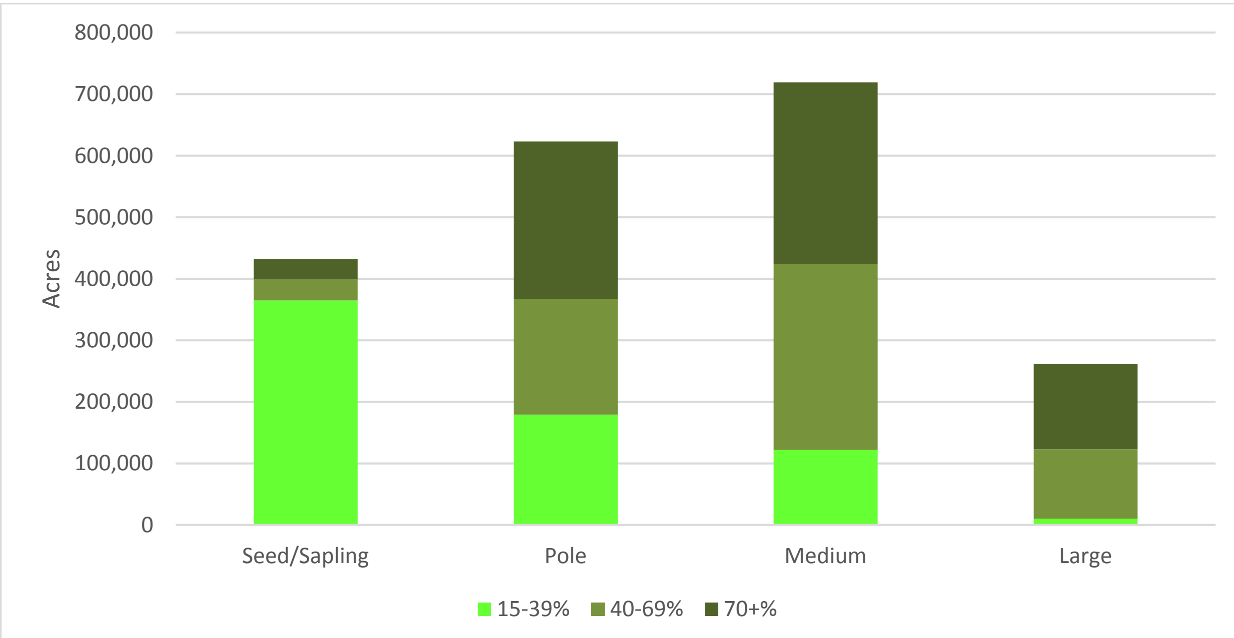

Figure 4. Distribution of existing VMAP size classes and crown closures

Seedling/sapling = 0-5-inch DBH trees, small = 5-10-inch DBH trees, medium = 10-15-icnh DBH trees, and large = greater than 15-inch DBH trees

3.2 Levels of Modeled Disturbance

Disturbances (wildfire, insects, and disease) directly affect the mix of vegetation on the FNF and subsequently the quantity of wildlife habitats available over time. Furthermore, disturbances or the lack thereof affect the magnitude and timing of other disturbances. For instance, areas that are burned by high severity wildfires may be fairly "fireproof" for decades. Conversely, areas that are missed by decades of fire may become vulnerable to insects or disease. The following sections show modeled changes in fire, insects, and disease over time.

Modeled levels of disturbances show the range of conditions that could occur over the next 50 years. High levels of modeled disturbance in decades 3, 4, and 5 are consistent with the trend of downscaled climate model projections and the assumption that the climate will be substantially warmer and drier in time steps 3, 4 and 5 (however, these conditions could occur sooner or could be more variable from decade to decade). High levels of modeled disturbance also reflect the vulnerability of forested stands that have accumulated fuels and/or are stocked at densities that makes them at risk for moderate and high severity wildfires and insect or disease outbreaks.

In the warm-dry and warm-moist biophysical settings that make up about 15% of the FNF, a high level of modeled disturbance is a logical consequence of successful, long-term fire suppression that corresponded with a period of cool, wet weather described in Morgan et al. (2008). In the cool-moist and cold biophysical settings that make up over 80% of the FNF, this high level of modeled disturbance is consistent with the mean fire return interval. Unlike the Bitterroot National Forest, the moist middle and upper elevation subalpine fir habitat types that are common on the FNF generally experience high intensity stand-replacing fires at intervals of 100 years or more. The Coram Experimental Forest on the FNF (western larch, Douglas-fir, lodgepole pine, and subalpine fir) has a mean fire return interval of 117-146 years (Sneck 1977). Although fire suppression has undoubtedly had some influence on fire frequency in these habitat types, the decadal running average of acres burned shows that the Forest is now in a similar pattern to that which occurred from 1890-1930. High levels of modeled future disturbance on the FNF are consistent with other broad-scale analyses (Hessburg et al. 1999).

Modeled levels of fire by time step and alternative (Figure 5) suggests that fires on the FNF will increase, especially at time steps 3, 4, and 5. These increases correspond with the warmer, drier climatic conditions modeled.

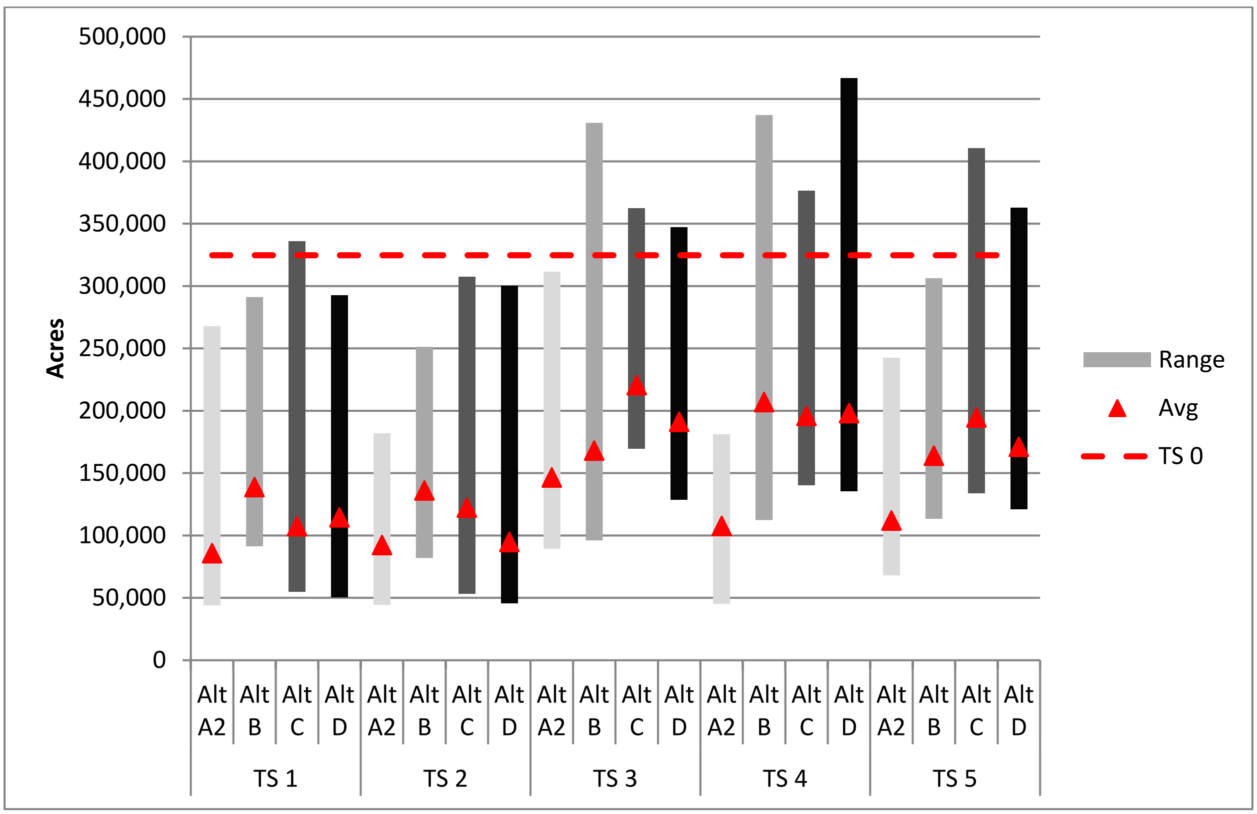

Figure 5. Modeled levels of wildfire by alternative

The range of acres burned by time step is substantial for all alternatives. Of all the variables that affect forest conditions including tree growth, succession, insects and disease, fire is the least predictable. The large range of acres burned, modeled over 30 simulations reflects the high level of variability due to wildfire. The dashed red line depicts the actual acres burned in the last decade, which is close to the upper end of the range of variability for all alternatives except A2 (which does not include modeling of prescribed fire). The average acres burned is much lower than the maximum of the range, indicating that there are many small fires reducing the average size, but that there are a few very large fires. The modeled 10-year average trends upward over the 5 decades, as expected with an anticipated trend for warmer, drier summer climatic conditions.

The SIMPPLLE model assumptions were that fire in wilderness was suppressed about 50% of the time, response time to fires varied from 0.5 hours (roadside) to 2 days (remote), Class A fires were not caught for wilderness or cool moist fires, and Class A fires in non-wilderness and non-Cool Moist were caught at about 35% of the time.

3.2.1 Insects and Disease

Modeled levels of insect and disease activity by time step and alternative are shown in Figure 6. Insects include both bark beetles (i.e. mountain pine beetles) and defoliators (i.e. spruce budworms). Diseases include both native (i.e. Armillaria root disease) and exotic (i.e. white pine blister rust) diseases.

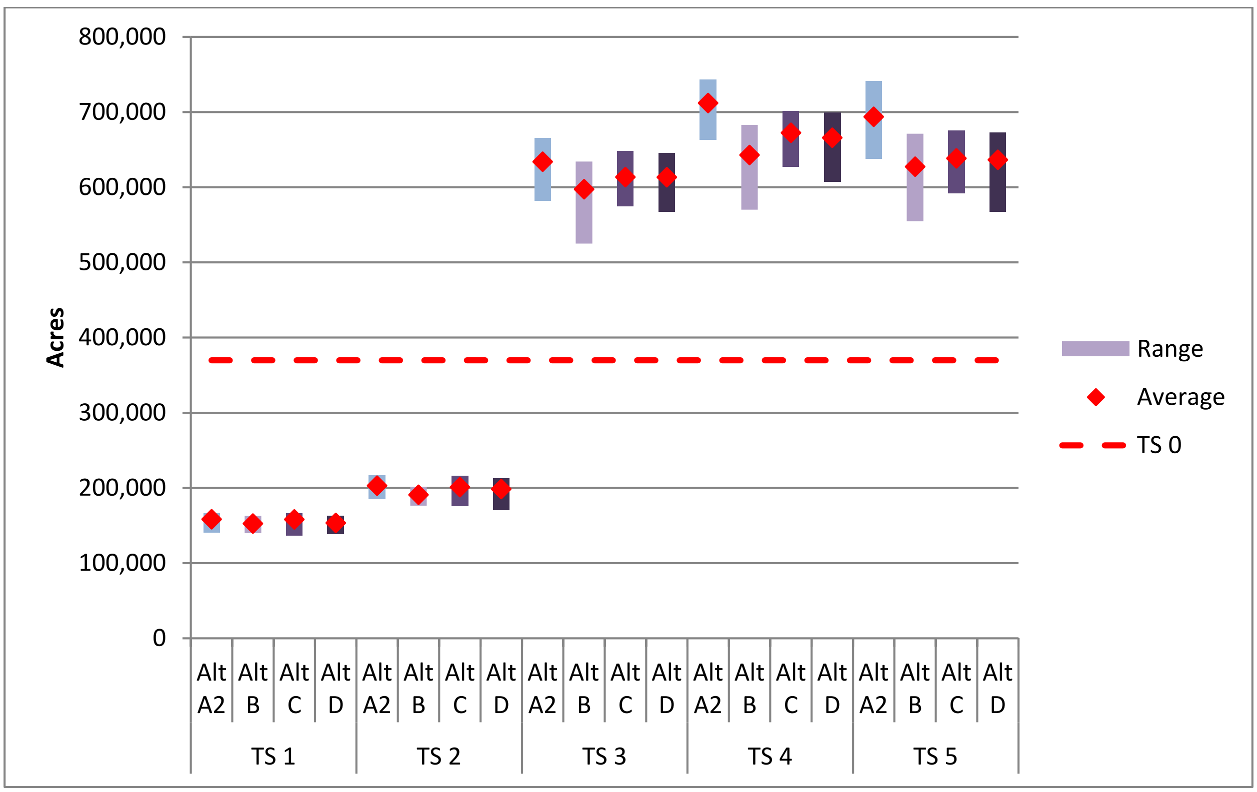

Figure 6. Modeled levels of insects and disease by alternative

The increases are consistent with high percentages of pole, large, and very large forested acres combined with high canopy closures, and presumed warmer, drier climatic conditions in decades 3 through 5. Modeled outcomes suggest the FNF is predisposed to large increases in insect and disease outbreaks.

3.2.2 Relationship of Wildfire to Insects and Disease

Modeled results suggest that levels of insect and disease are directly affected not only by warmer, drier climatic conditions, which makes stands more vulnerable to those disturbances, but also by the amount of wildfire. Existing levels of fire (shown in Figure 5) linked to severe fires that occurred from 2003 to 2012, resulted in a modeled decline in insect and disease activity in time steps 1 and 2 (shown in Figure 6). Time steps 3 through 5, however, show a steady increase in insects and disease, presumably due to the warmer, drier climatic conditions, species that are susceptible to insect and disease outbreaks (e.g. lodgepole pine), and by substantial percentages of relatively dense, medium, large, and very large forest size classes (Figure 7 and Figure 8). These results suggest that given the FNF's high proportion of large size classes, dense unburned stands combined with a warmer, drier climate, will likely succumb to insects and disease. Previously, it was stated that since mean modeled levels of fire are less than what burned in 2003 through 2012, then the model may be under-predicting fire and over-predicting insects and disease. Given the risk of insects and disease in stands that do not burn, the model suggests that vast acres of medium, large, and very large size class forests will succumb regardless of whether fires occur at mean, maximum, or higher-than-maximum-modeled levels.

Sections 3.3-3.5 summarize changes in vegetation as affected by disturbances (natural and human caused) which largely explain the changes in habitat for the wildlife species discussed in Section 3.6. The projected vegetation treatments resulting from the Spectrum model considered the lands suitable for timber production, vegetation desired condition, other multiple-use objectives, management requirements set forth in NFMA, and budget limitations. The Spectrum model was run with a mix of objective functions, based on the theme of the alternative. Alternative A2 is the no action alternative as modeled with SIMPPLLE, reflecting the existing 1986 Forest Plan. Alternative A2 is identified as alternative A in the FNF Draft Environmental Impact Statement (DEIS). Alternative A was run with an objective to maximize timber production while Alternatives B and C had objectives to move towards vegetation desired condition as quickly as possible, while meeting other resource objectives. Alternative D had an objective function to maximize timber and then to move towards vegetation desired condition.

3.3 Future Distribution of Size Classes

Figure 7 compares the current (decade 0) distribution of size classes between alternatives A and B through all 5 time steps. The changes in size class are not very dramatic. Seedling-sapling and large-sized stands increase somewhat. Very large stands decrease slightly. Pole-sized stands increase substantially in decades 1 and 2 then decline substantially in decades 3, 4, and 5 following major disturbances.

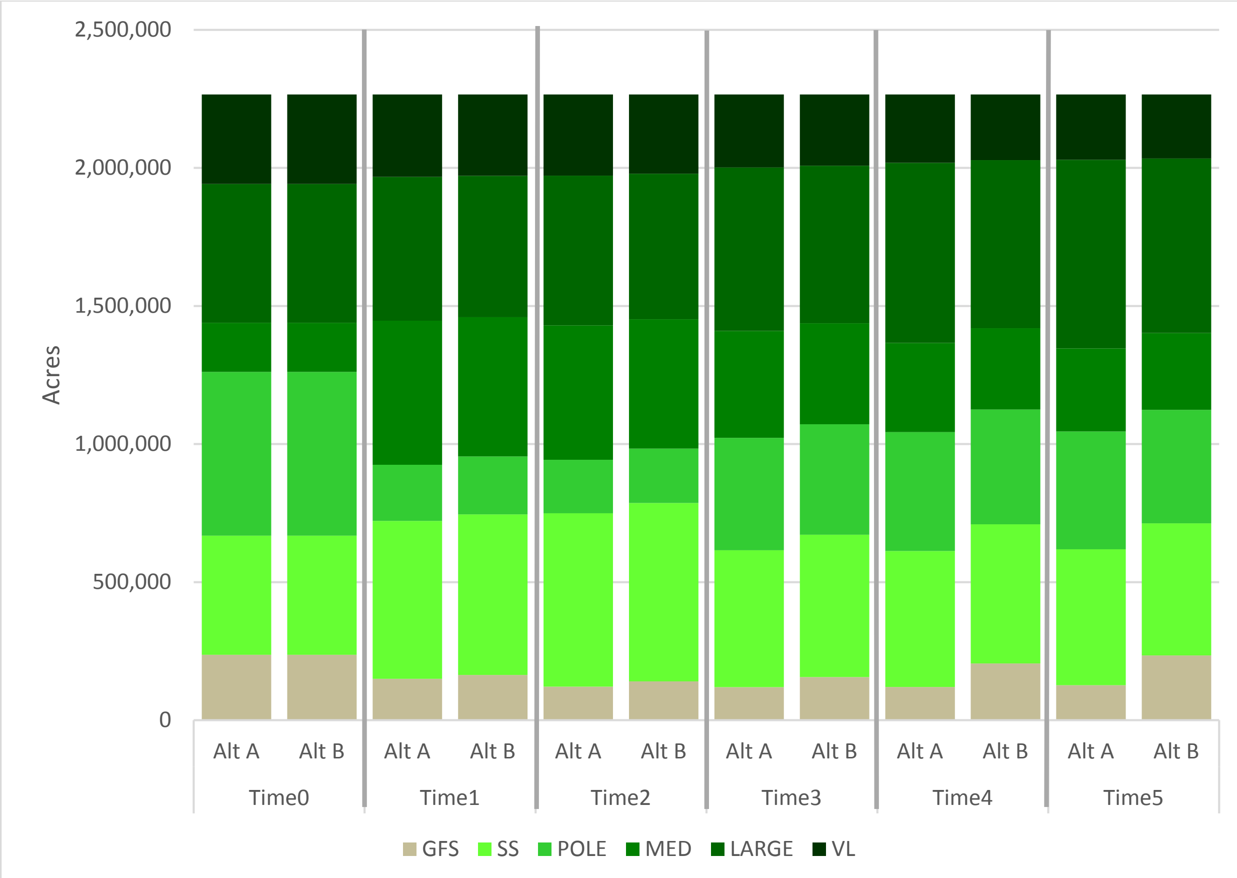

Figure 7. Current and modeled size class distribution for Alternatives A and B[1]

3.4 FUTURE DISTRIBUTION OF STAND DENSITIES

Changes in canopy closure for Alternative A, conversely, are much more dramatic over the 5-decade period (Figure 8). Very dense stands (70-100% canopy closure) decline substantially through the period. Low density, open stands (15-40% canopy closure) and moderately dense stands (40-70% canopy closure) increase substantially. These changes are consistent with substantial modeled increases in the amount of moderate-severity fire and insects and disease.

[1] Seedling-sapling (SS) <5”, Pole 5-8.9”, Medium 9-14.98”, Large 15-20.9”, and Very large >22”.

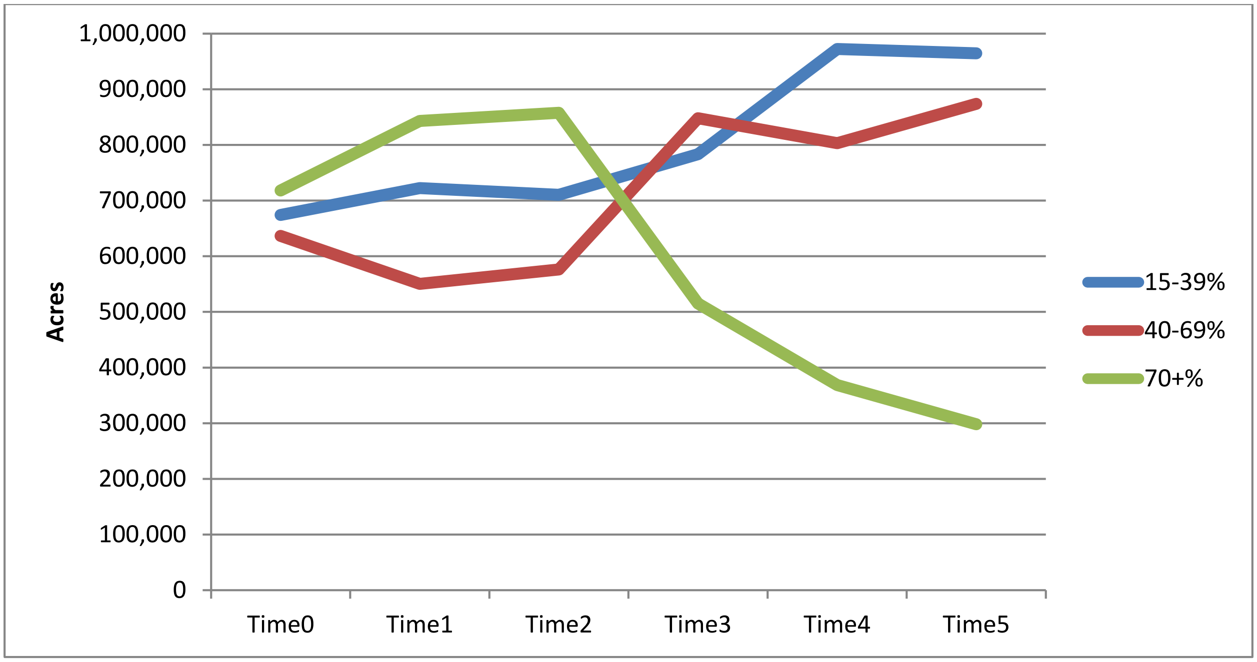

Figure 8. Current and modeled canopy density distribution for Alternative A

3.5 FUTURE DISTRIBUTION OF COVER TYPES

The aforementioned disturbances result in a slight modeled change in cover types for Alternative A as illustrated in Figure 9. Disturbance-dependent species like larch and ponderosa pine increase slightly by time step 5.

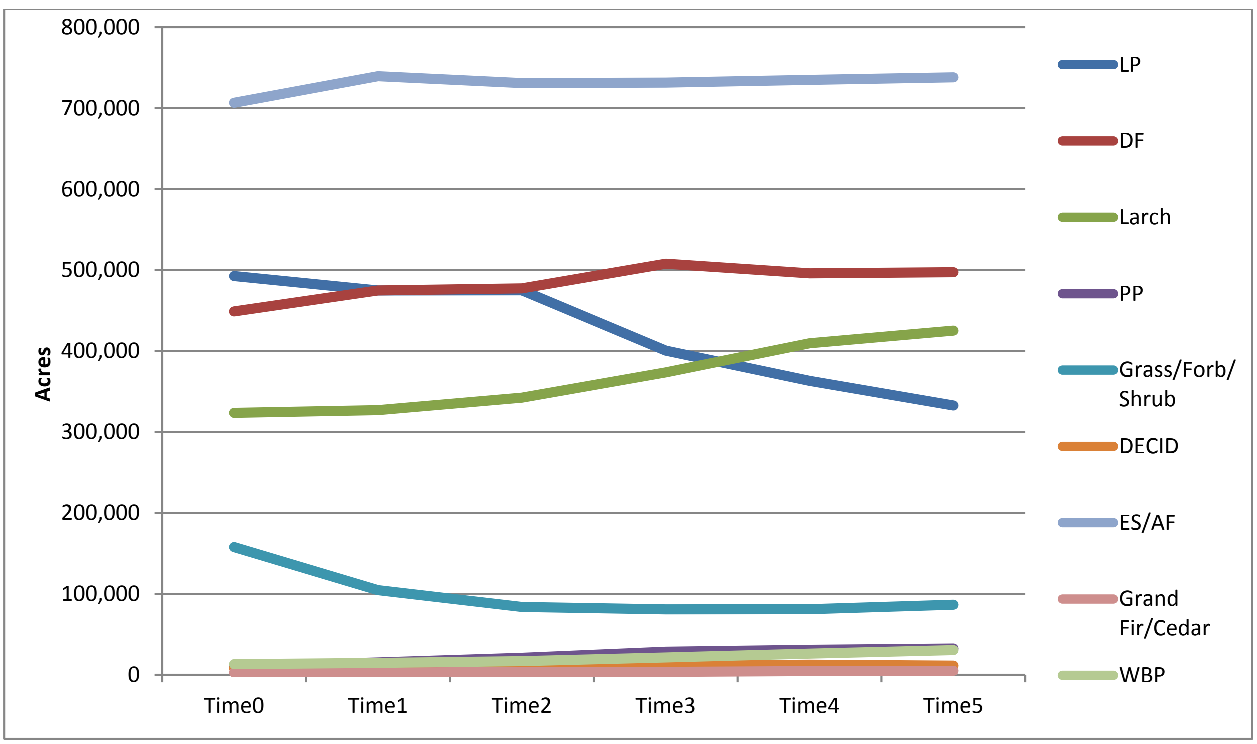

Figure 9. Current and modeled cover type distribution for Alternatives A

3.6 Wildlife Habitats

In this section acres of modeled habitat by alternative and time step are disclosed in a series of figures. In these figures the average level of habitat is represented by a red diamond. The filled boxes represent the second and third quartiles of the habitat results from the 30 simulations by the five decadal time steps. The black vertical lines extending above and below the filled boxes represent the range of maximum and minimum levels of habitat modeled over 30 simulations. The dashed red line shows the current (time step 0) level of habitat. The dashed black lines show the maximum and minimum levels of modeled NRV.

3.6.1 Caution When Comparing Current to Future Modeled Outcomes

Current levels of habitat (time step 0) represent *actual* on-the-ground conditions that meet the query for a given species, recognizing the potential limitations of VMap data. Future levels of habitat in time steps 1 through 5, represent *modeled* habitat based on a wide range of variables affecting tree growth and mortality from disturbances over time. Caution should be exercised when comparing current habitat at time step 0 against modeled habitat at time step 1 as this is an “apples to oranges” comparison. For instance, flammulated owl habitat shown in Figure 10 is currently at 15,000 acres. That acreage increases to 20,000 acres in time step 1 then maxes out at about 35,000 acres in time step 3. The current level of habitat (15,000 acres) is an accurate estimate of existing habitat. Increasing level of modeled habitat from time step 1 to 3 (20,000 acres to 35,000 acres) represents the modeled increase in habitat based on anticipated increases in fire, insects, disease, and vegetation management activities to move towards desired conditions. While this curve represents a highly probable change in available habitat, the modeled starting point at time step 1 (20,000 acres) may not be appreciably different from current levels of habitat (15,000 acres) at time step 0. Therefore, the appropriate way to interpret these outcomes is to consider time step 0 as the relative level of habitat within the 2.69 million acre FNF. Levels of habitat in time steps 1 through 5 reflect the trend over time. Comparisons to levels in time step 0 to time step 1 should be avoided.

3.6.2 Flammulated Owl

Acres of modeled habitat by alternative and time step are disclosed in Figure 10. Acres of existing habitat are slightly higher than the minimum NRV and increase to levels approximating the maximum NRV in time steps 3 through 5. The NRV of modeled habitat for flammulated owls ranges from roughly 12,000-37,000 acres (a small range of about 25,000 acres) out of approximately 2.4 million acres on the FNF. In the future, acres of habitat increases from current levels during all 5 decades for all four alternatives. The model predicts all alternatives but C maintain habitat between minimum and maximum NRV levels for the 5-decade time period. Alternative C exceeds the maximum NRV by the end of decade 5. For Alternatives B and D, acres of current habitat are slightly higher than the minimum NRV and increase to levels approximating the maximum NRV by the end of decade 5. Acres of current habitat increases by almost 200% by time step 3.

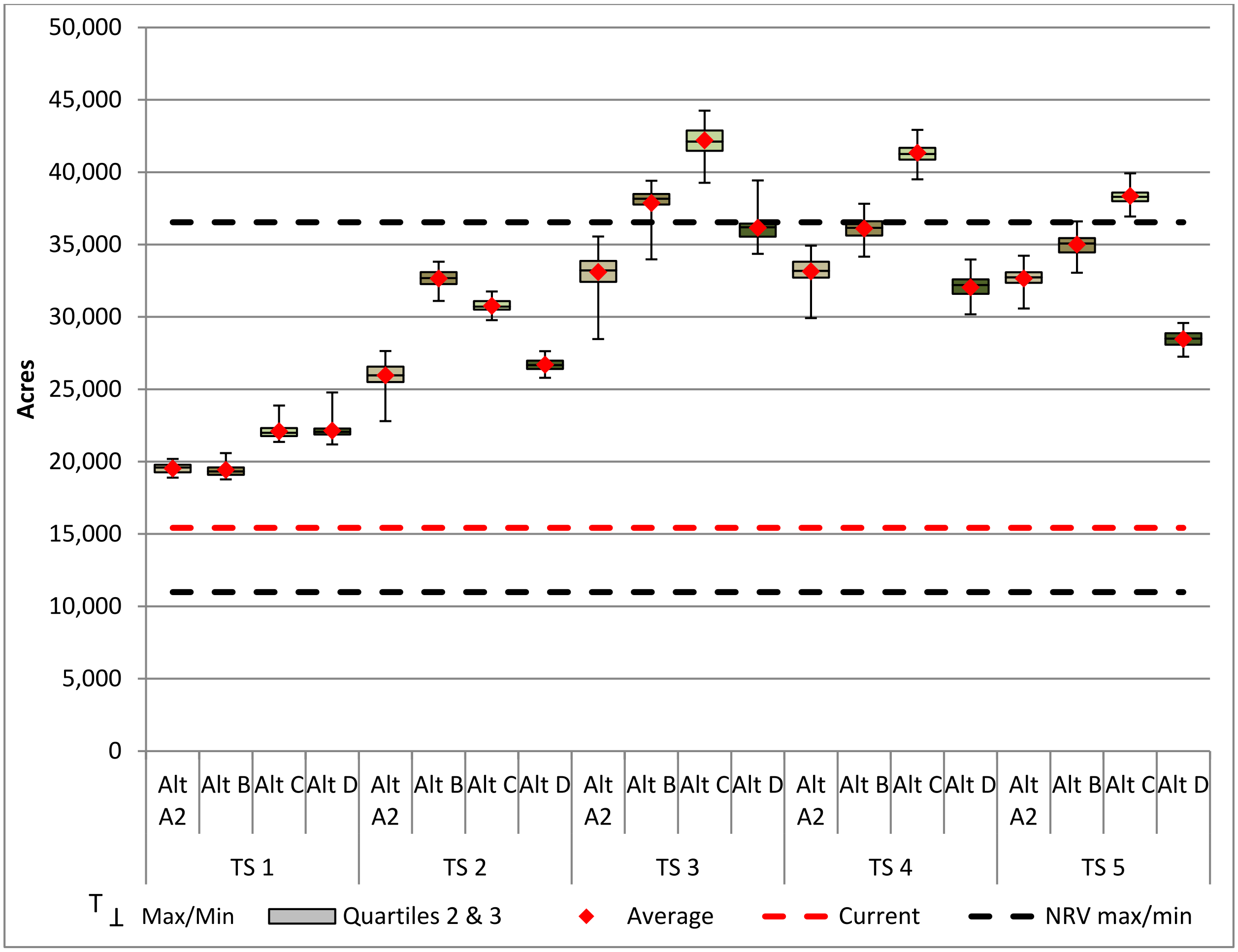

Figure 10. Current and modeled levels of flammulated owl habitat by alternative

Warm, dry and warm, moist habitat groups are uncommon on the FNF compared to adjacent national forests (i.e. Lolo, Bitterroot, and Kootenai National Forests) which explains the limited acres of habitat at both minimum and maximum ranges. Furthermore, habitat within those limited habitat groups tend to be on the "moist end" of the dry moisture regime, and often occur as smaller patches within the larger matrix of cool moist types which means they typically burn naturally at mixed or high severities rather than at low severities like typical warm, dry habitats on adjacent forests. Thus, natural wildfires on the FNF are less likely to create and perpetuate forests of large or very large trees in an open, park like structure with sparse understory trees when compared to adjacent forests.

In the past, dry, ponderosa pine-dominated forests of the FNF were largely located in the valley bottom and lower foothills of the main Flathead River valley. Many were kept in a more open condition by frequent Native American burning. The Flathead River valley is largely in private ownership. By the mid to late 1800s, settlement and development of the valleys by non-native Americans began, and wildfires were actively and effectively suppressed. Human disturbances, including Native American burning that was common historically and fuel treatments associated with Wildland Urban Interface areas (WUIs), often result in desired flammulated owl habitat consisting of large, open forest conditions.

Much of the FNF flammulated owl habitat is located in areas that contain a large acreage of WUI. Because most flammulated owl habitat is at low elevations and in the WUI, wildfires would be actively suppressed under all alternatives in most cases. Because flammulated owls prefer to nest in snags and feed in openings in less dense forests, it would be necessary to use timber harvest and prescribed burning as tools to achieve desired conditions.

Thus, the increases in flammulated owl habitat occurring with all alternatives in time steps 2 through 5 may be attributable as much to vegetation treatments as natural disturbances. Alternative C increases flammulated owl habitat to levels slightly above NRV in time step 3, likely as a result of climate changes as well as an increased level of prescribed burning to meet other resource objectives. Alternative A was modeled without prescribed burning because there is no objective for use of prescribed fire in the 1986 Forest Plan, which likely explains why it consistently produces less flammulated owl habitat through all time steps. Alternative B produces the most flammulated owl habitat by time step 2, likely as a result of modeled vegetation treatments that include timber harvest, pre-commercial thinning, and prescribed fire.

3.6.3 Fisher

Acres of modeled habitat by alternative and time step are disclosed in Figure 11. The model predicts all alternatives would stay within the minimum and maximum range of NRV over the 5-decade time period. There is a wide range of variation between maximum and minimum NRV; about 350,000 acres. Acres of habitat increase somewhat above the current condition in time step 1, likely due to forest succession outpacing fire, insects, disease, and vegetation management treatments. Then habitat declines and continues declining back to existing levels by time step 5, similar to the steady decline in very large trees shown in Figure 7.

Much of this decrease is likely attributable to wildfire and/or the high amount of both Douglas-fir and spruce beetle portrayed in the model, both of which would cause widespread mortality of trees in the very large size classes. Climate is expected to be warmer and drier by decade 3, resulting in more insect and disease. Modeled declines are clearly a function of reduced live trees in the very large size classes and reduced canopy cover, to levels below that which fishers require. Insect damage, disease, or fire produces snags and down woody material which increase fisher habitat quality—provided that canopy cover offered by live trees does not decrease considerably. Alternative B declines a little more than the other alternatives because this alternative treats more acres through regeneration harvest during the first decade to reduce stand densities in the warm, moist biophysical setting and does more commercial thinning in later decades. This modeled outcome identifies acres of habitat with no consideration for distribution of minimum sized areas across the landscape.

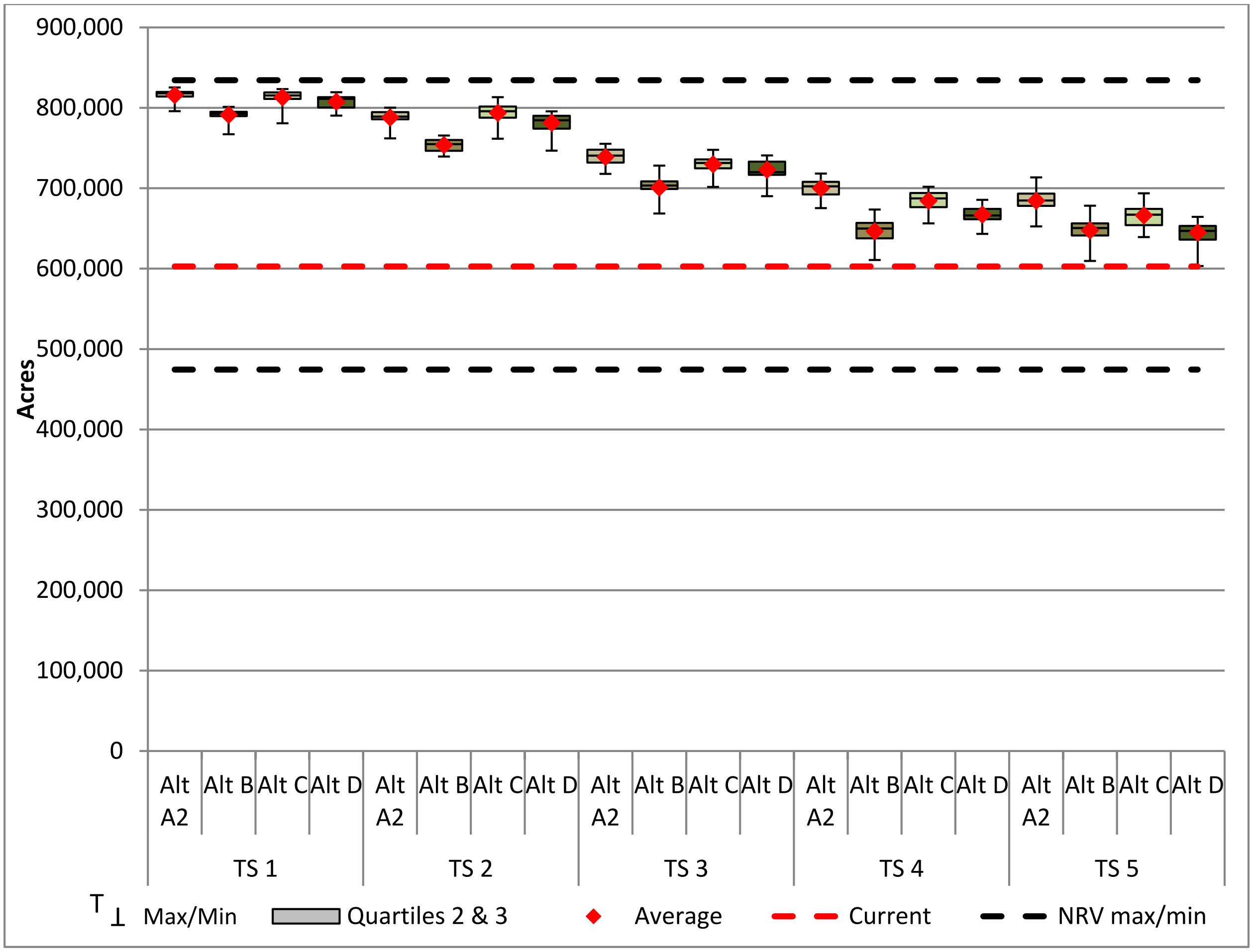

Figure 11. Current and modeled levels of fisher habitat by alternative

3.6.4 American Marten

Acres of modeled habitat by alternative and time step are disclosed in Figure 12. The model predicts all alternatives would stay within the minimum and maximum range of NRV over the 5-decade time period. There is a wide range of variation between maximum and minimum NRV; about 650,000 acres. Acres of habitat increases in time step 1, likely due to forest succession outpacing fire, insects, disease and vegetation management treatments. Then acres of modeled habitat declines substantially, returning to near current levels at time step 3 and continues declining through time step 5—ending up around 25% below current levels. Acres of habitat are near the maximum NRV in time steps 1 and 2, then decrease sharply to just the midpoint between current and minimum NRV in time steps 4 and 5.

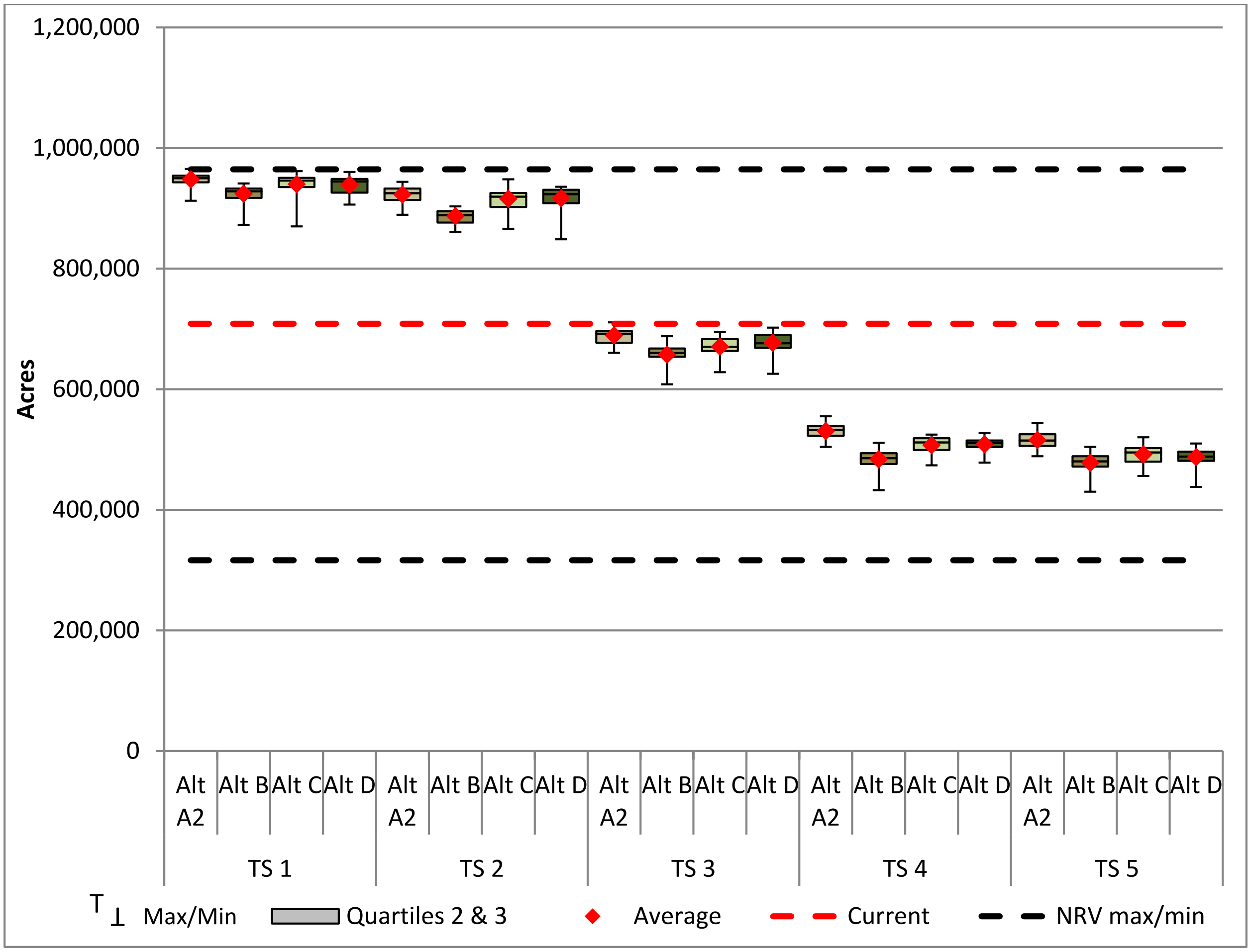

Figure 12. Current and modeled levels of American marten habitat by alternative

Like fishers, projected declines in marten habitat are clearly a function of modeled increases in fire, insects and disease which either reduce the large and very large size classes that martens require, or reduce the canopy closure to levels below that which martens require. The modeled decline in habitat is steeper than that for fishers. This is likely the result of martens occupying more upland habitats (including the cold potential vegetation group) than fisher. The model in this case is likely predicting that fires in upland habitats burn more acres at higher severities than lower elevation mesic habitats. Additionally, because martens require denser stands than fishers (≥40% versus ≥15% canopy closure), the combination of increased natural disturbance is resulting in a substantial overall decline in modeled canopy closure (which reduces marten habitat quality and quantity), as illustrated in Figure 8. Alternative B declines a little more than the other alternatives because this alternative treats more acres (including use of prescribed fire) during the first decade to reduce stand densities in the warm, moist biophysical setting and does more commercial thinning in later decades to meet other resource objectives.

3.6.5 Canada Lynx Stand Initiation Habitat

Acres of modeled habitat by alternative and time step are disclosed in Figure 13. The model predicts all alternatives would stay within the minimum and maximum range of NRV over the 5-decade time period. There is a wide range of variation between maximum and minimum NRV; about 180,000 acres. Existing habitat is slightly above the minimum NRV, then increases slightly in time steps 1 and 2, declines in time step 3, then increases again in time steps 4 and 5 to levels slightly above current levels by the 5th decade. Acres of habitat vary little between alternatives, with the greatest difference at 10% between Alternatives B and C in time step 5.

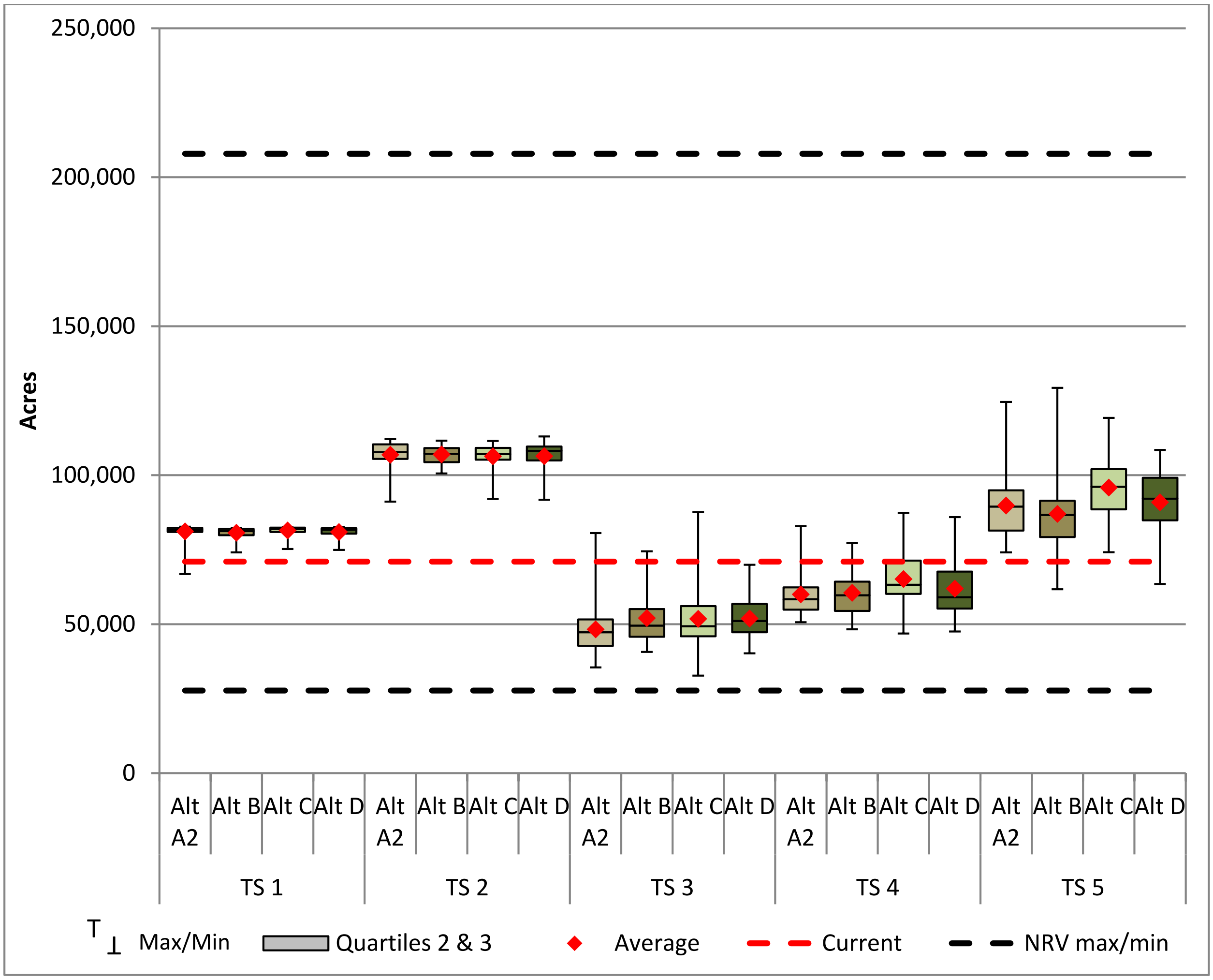

Figure 13. Current and modeled levels of Canada lynx stand initiation habitat by alternative

Stand initiation habitat occurs in a narrow "window" following major disturbances (stand-replacing fire, regeneration timber harvest, etc.) which typically begins once dense small trees and shrubs have regenerated (about 20 years after the disturbance on average) but may only last another decade or two until trees reach a stem exclusion condition. That is why the maximum range of the NRV (~225,000 acres) with naturally-occurring fires (without fire suppression) is only about 9% of all FNF acres. On forests like the FNF, where conifer growth is rapid in the moist habitats providing lynx habitat, if consistent levels of disturbance that re-initiate young forests are lacking, acres of stand initiation habitat will go up and down. Modeled acres of habitat by alternative represent only about half of the maximum NRV. All alternatives were modeled with fire suppression logic, which explains why modeled habitat is at the lower range of NRV. Stand initiation habitat at levels approaching maximum NRV would only occur if fires are not suppressed on most of lynx habitat. Furthermore, since all alternatives contain varying levels of regeneration timber harvest, it is clear that those levels of regeneration timber harvest do not replace the acres of disturbance that would have occurred naturally without fire suppression.

3.6.6 NRV for Canada Lynx Habitat in Unsuitable Habitat

Historically, fire, insects, and disease were the primary processes that affected forest vegetation in lynx habitat, reverting them to an early stage of succession or creating openings within the forest canopy. The NRLMD (2007) defines lynx habitat in an unsuitable condition as lynx habitat in the stand initiation structural stage where trees are generally less than 10 to 30 years old (e.g. current burned forest less than 20 years old) and have not grown tall enough to protrude above the snow in winter. As a result, these forests are too small or too open to provide dense, seedling-sapling winter forage for snowshoe hares, but trees will become taller and denser as forests go through vegetative succession. The SIMPPLLE model was used to model the levels of lynx habitat in an unsuitable condition in NRV. The model estimated that at a maximum level, 13.8% of FNF LAUs would have had more than 30% of the lynx habitat in an LAU in an unsuitable condition. At a minimum level, 4.0% of LAUs would have had more than 30% of lynx habitat in an unsuitable condition, and at a mean level, 8.6% of LAUs would have had more than 30% of the lynx habitat in an unsuitable condition. NRLMD standard VEG S1 infers that levels of unsuitable habitat greater than 30% at the LAU scale are undesirable for lynx, and should be avoided. This analysis, however, illustrates that due to periodic large, stand-replacing fires and insect and disease outbreaks, some large expanses of unsuitable habitat are inevitable and will exceed the 30% standard on a small percentage of LAUs. The following figure (figure 14) presents the natural range of variation going back about a 1000 years (NRV), for maximum, minimum, and average levels of lynx habitat in an unsuitable condition in the Flathead's LAUs, and compares that to current levels.

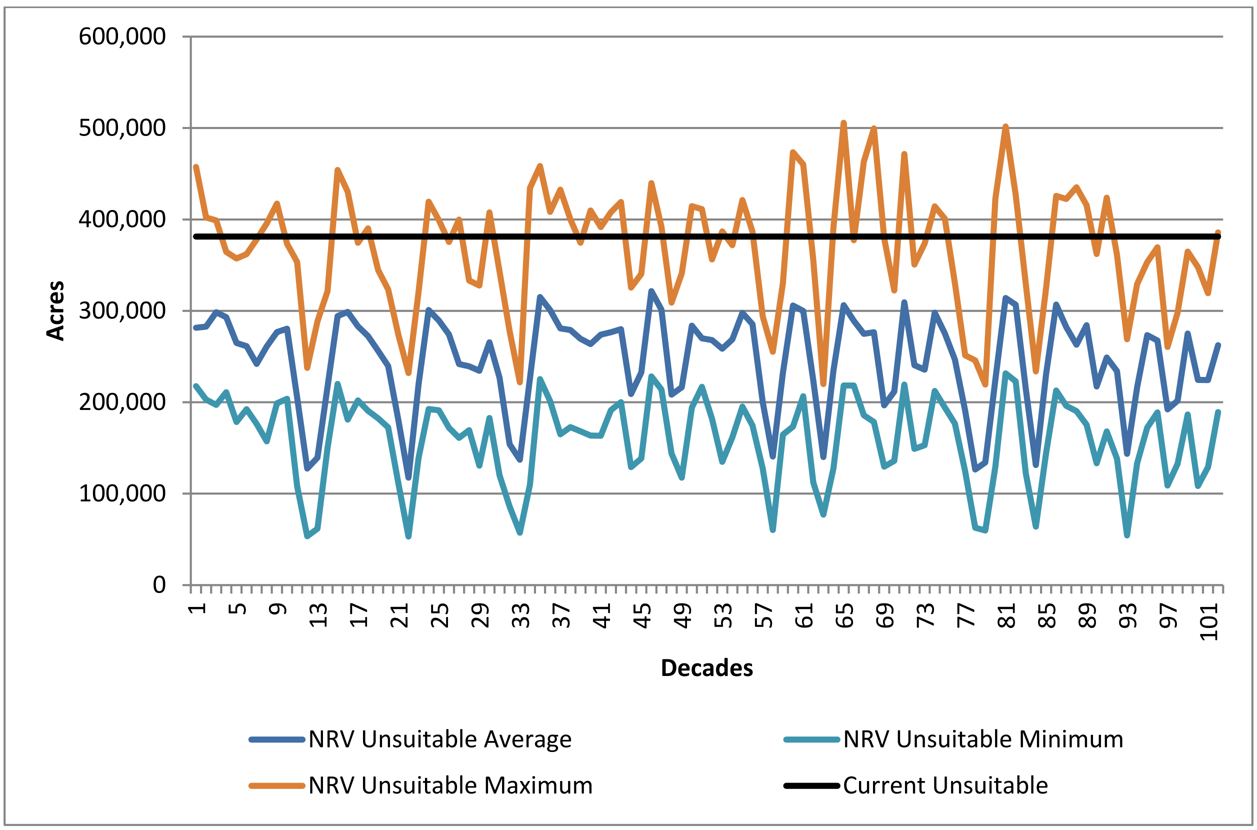

Figure 14 Average, Maximum, and Minimum Levels of Lynx Unsuitable Across 102 Decades within NRV and Current Levels

3.6.7 Canada Lynx Multi-Storied Habitat

Acres of modeled habitat by alternative and time step are disclosed in Figure 15. The model predicts that multi-storied habitat would initially increase to levels slightly above NRV and then decline to levels that hover around the midpoint of current and the minimum NRV. The range between maximum and minimum NRV is very large, almost 650,000 acres. There is uncertainty in the model results because although the model estimates canopy cover and canopy layers over time, it cannot discern whether there is a dense enough understory to provide winter snowshoe hare and lynx habitat. What the model depicts is the trend in forest stands that are most likely to have a multi-storied structure, high canopy closure, and presence of subalpine fir and spruce.

Acres of current habitat at time step 0 are above the midpoint of NRV. Modeled levels of habitat are slightly above the maximum NRV in time steps 1 and 2. Habitat declines in time step 3 back to current levels and then declines further in time steps 4 and 5 to levels above the minimum NRV.

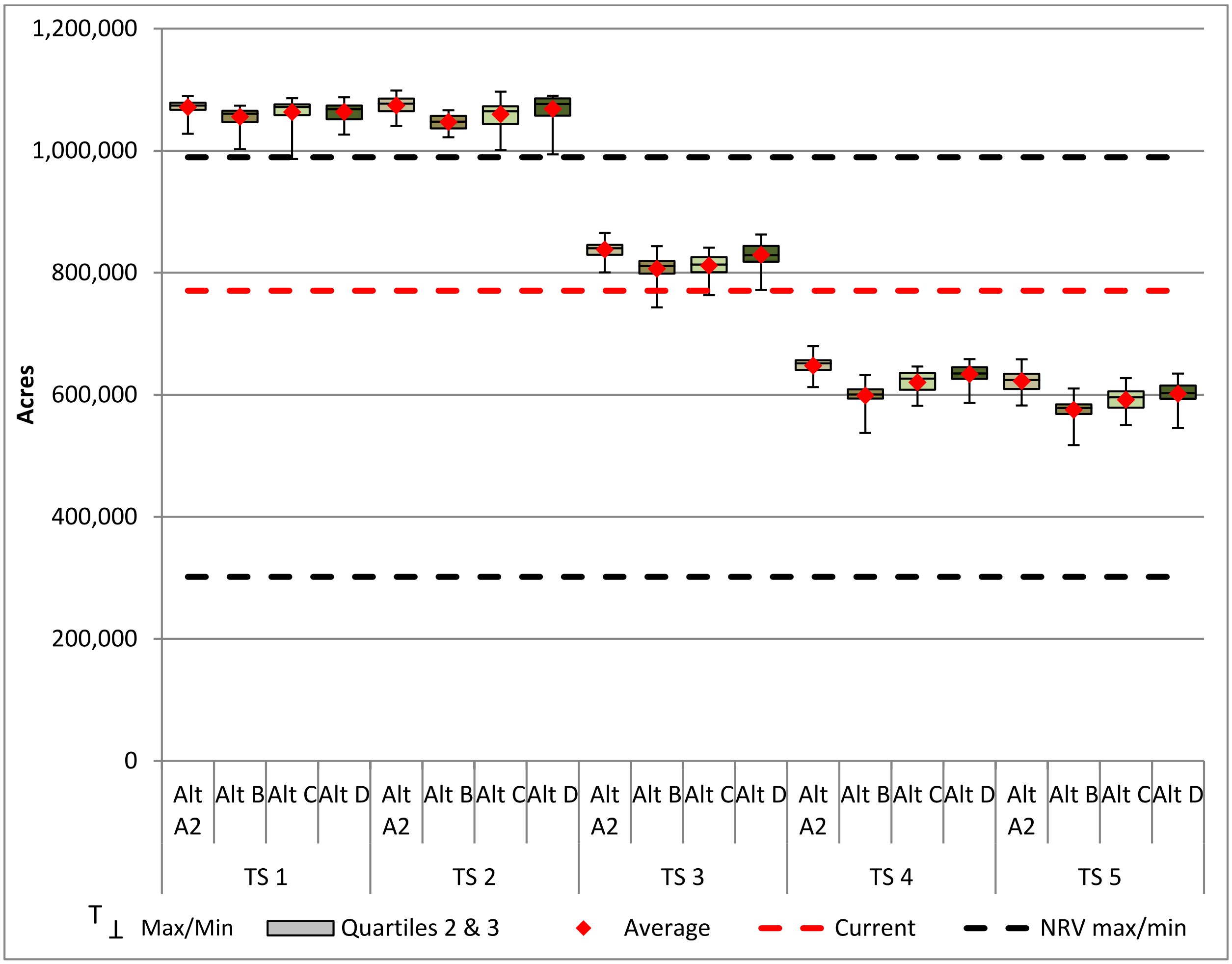

Figure 15. Current and modeled levels of Canada lynx multi-storied habitat by alternative

Since the model reduces harvest based upon lynx standard VEGS6 and applies fire suppression logic as well as forest succession for all alternatives, levels of modeled habitat slightly exceeds the maximum range of NRV at time steps 1 and 2. Like habitat for fishers and martens, modeled declines in lynx multi-storied habitat in time step 3 are clearly a function of substantial modeled increases in natural disturbances which either reduce the multi-storied, large and very large size classes that lynx require, or reduce the canopy closure to levels below that which lynx require by the end of the 5th decade.

Despite Forest Plan components to maintain or increase multi-storied hare and lynx habitat, modeled declines of about 200,000 acres below current levels are projected to occur at the end of five decades, regardless of alternative. This suggests that the current level of modeled multi-storied habitat may be unsustainable based on inevitable and unavoidable natural disturbances, which are projected to increase with a warmer, drier summer climate. These disturbances would return levels to within the modeled maximum NRV. If insects/disease kill scattered patches of trees in the overstory of multi-storied forests, it could increase the density of the understory, creating multi-storied stands after a lag time of a few decades provided the loss of canopy cover is not too great. In contrast, stand replacing wildfires would create more stand initiation habitat after a lag time of a few decades. According to modeling of NRV, fire cycles affecting the amount of multi-storied and stand initiation habitat have probably occurred in the past and are likely to occur in the future in the mid to high elevation subalpine fir and spruce forests of the FNF. Much still needs to be learned with respect to lynx response to wildfire over long periods of time, but lynx have persisted in the Northern Rocky Mountains with these fluctuations in historic levels of fire, insects, and disease.

3.6.8 Black-backed Woodpecker

Acres of modeled habitat by alternative and time step are disclosed in Figure 15. The model predicts all alternatives would stay within the minimum and maximum range of NRV over the 5-decade time period. The range between maximum and minimum levels of habitat is relatively large which parallel the maximum levels of modeled fire thorough the period—which is not surprising since this is a fire-dependent species. The NRV of modeled habitat for black-backed woodpeckers ranges from about 10,000 to 270,000 acres out of approximately 2.4 million acres on the FNF, a moderate range of about 260,000 acres. In the future, acres of habitat increases somewhat then declines back to current levels by decade five.

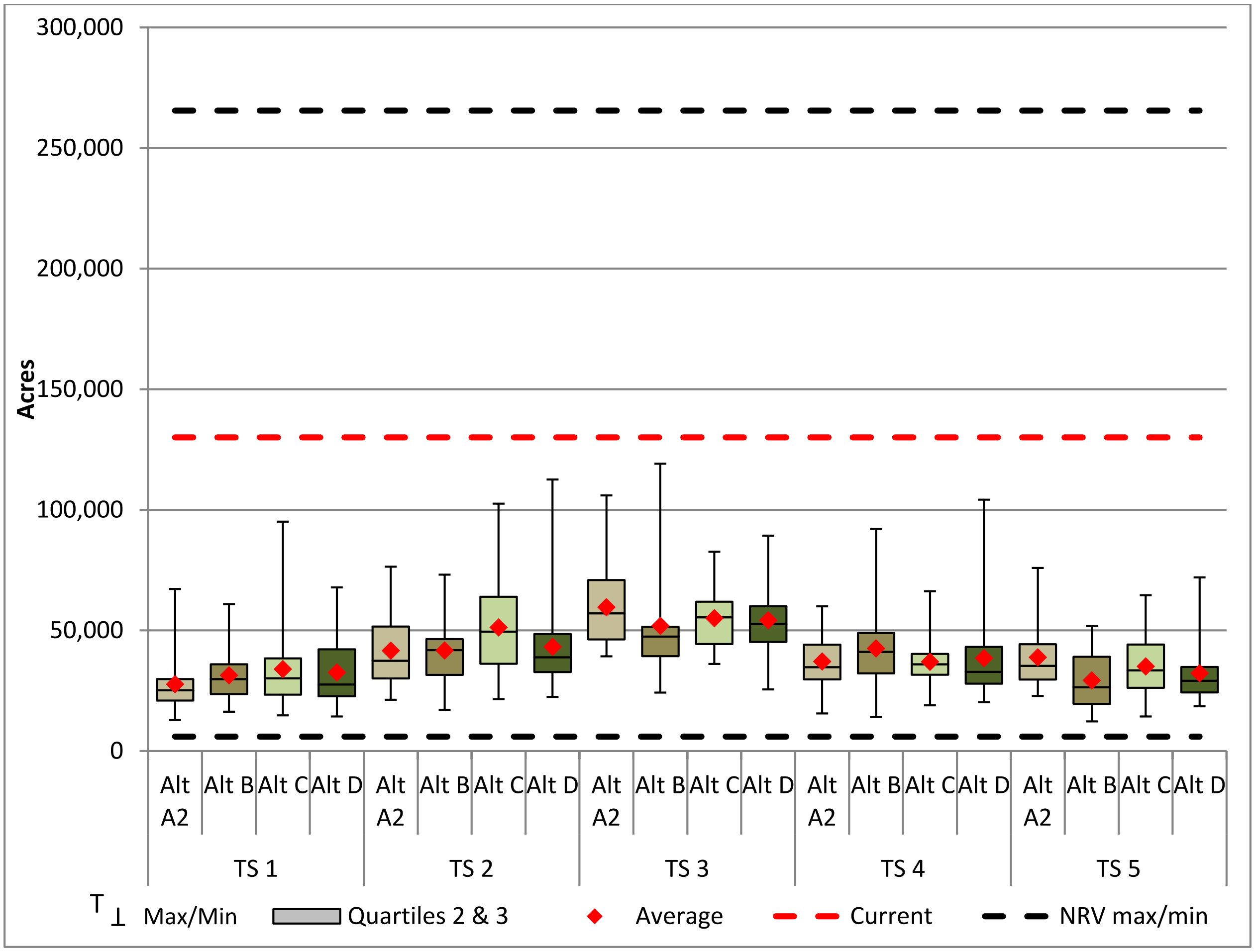

Figure 16. Current and modeled levels of black-backed woodpecker habitat by alternative

The current level of high-quality black-backed woodpecker habitat is the result of the large acreage burned with stand-replacing wildfires on the FNF in the last decade, but this habitat only lasts up to a decade. All alternatives were modeled with fire suppression logic for time steps 1-5. Thus, even though the mean acres of black-backed woodpecker habitat increases from about 25,000 acres up to 60,000 acres through the 5-decade period, that level of habitat never approaches the maximum range of NRV or even the acres burned in the 2003-2012 period that provided existing post-burn habitat. Clearly, the modeled fire suppression logic of the model is the single factor responsible for the relatively low level of black-backed woodpecker habitat resulting from stand-replacing wildfires in the 10-inch+ DBH size class on the FNF.

Black-backed woodpeckers readily cross forest boundaries to exploit far away burns (Hoyt 2000). Fires have been active on adjacent forests in the last two decades, despite continued fire suppression. Consequently, black-backed woodpeckers are not at risk on the FNF or in other adjacent forests in Region 1 (Samson 2006a) despite continuing fire suppression. In addition, although forests with insect and disease infestation do not provide the high-quality habitat that areas with stand replacing fires do, these acres are likely to increase after time step 2 and would sustain black-backed woodpecker populations at lower densities.

3.6.9 Olive-sided Flycatcher

Acres of modeled habitat by alternative and time step are disclosed in Figure 16. The model predicts all alternatives would stay within the minimum and maximum range of NRV over the 5-decade time period. Acres of habitat vary little between alternatives. The range between maximum and minimum levels of habitat is relatively large and parallel the maximum levels of modeled fire thorough the five-decadal period, which is not surprising since this is a fire-dependent species. The NRV of modeled habitat ranges from about 450,000 to 1.3 million acres out of approximately 2.4 million acres on the FNF, a large range of about 850,000 acres. In the future, acres of habitat increases continuously thru decade five. There are minor differences in alternatives, because wildfire, prescribed fire, commercial thinning, and timber harvest can all create the habitat conditions this species requires.

Because olive-sided flycatchers are edge-dependent, disturbances that create edges including moderate and high severity fires, insects and disease, can all contribute to olive-sided flycatcher habitat as long as sufficient mature forest remains following those disturbances. Consequently, even considering some uncertainty in the degree to which forests burn versus succumb to insects and disease, modeled habitat for olive-sided flycatchers is abundant on the FNF.

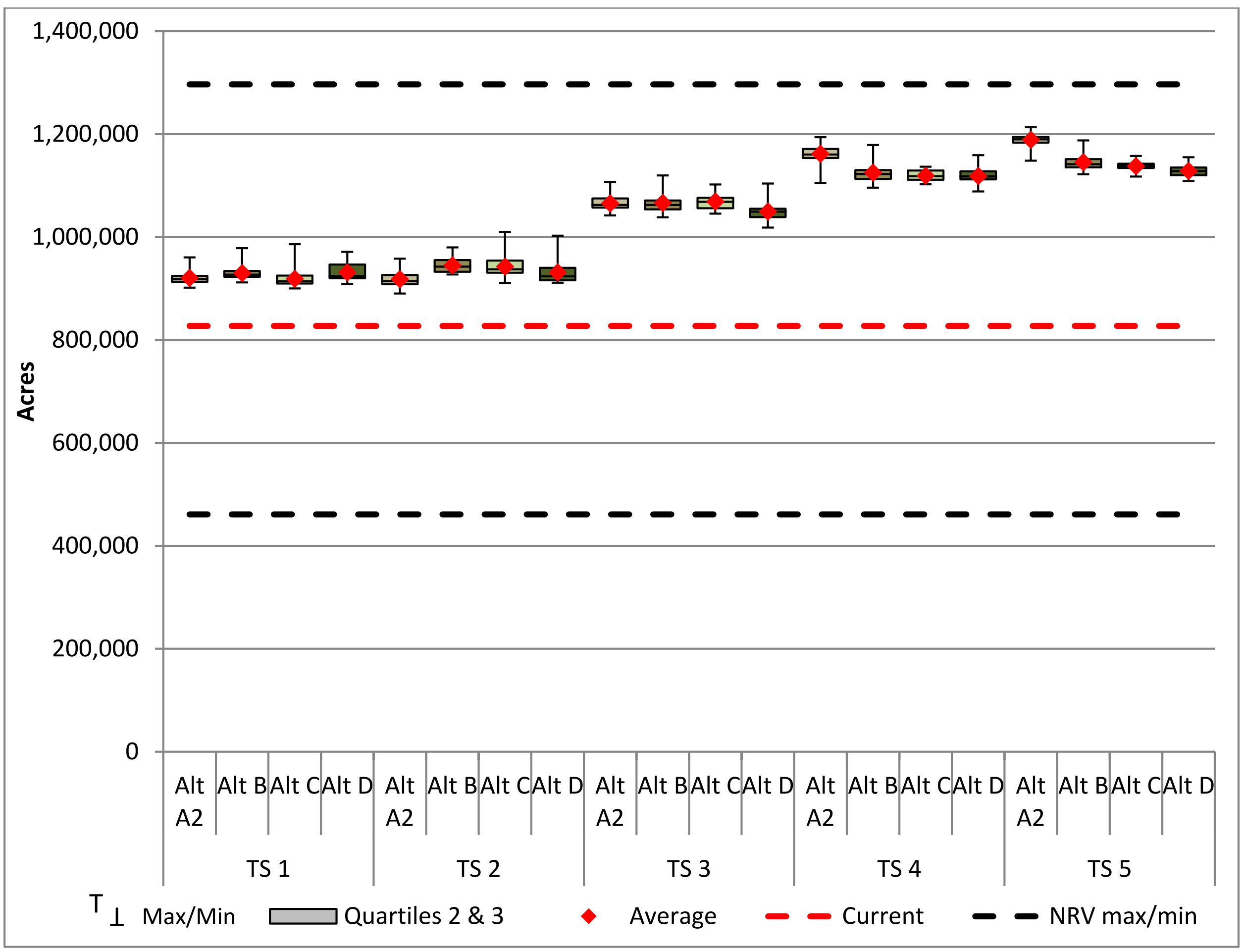

Figure 17. Current and modeled levels of olive-sided flycatcher habitat by alternative

3.6.10 Pileated Woodpecker

Acres of modeled habitat by alternative and time step are disclosed in Figure 17. The model predicts all alternatives would stay within the minimum and maximum range of NRV over the 5-decade time period. Future acres of modeled habitat varies little between alternatives and remains close to current levels which are at the middle of the range of NRV. Acres of habitat increase slightly and consistently through decade 5.

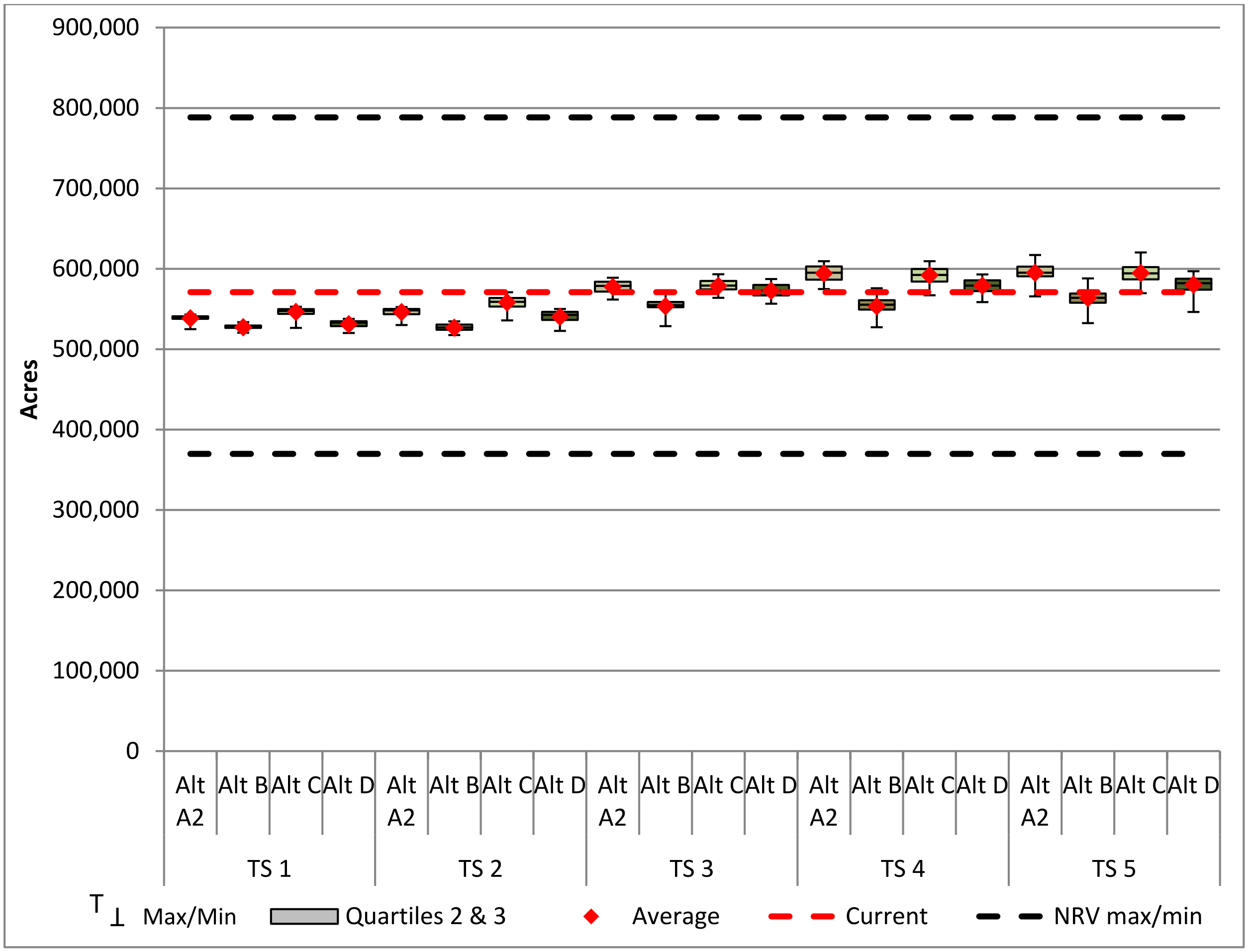

Figure 18. Current and modeled levels of pileated woodpecker habitat by alternative

Since pileated woodpeckers utilize forests that are relatively open (greater or equal to 15% canopy closure), moderate severity fires, insects, and disease have little negative effect as long as stands retain large trees and also contain a few very large trees for nesting and feeding. The combined modeled acreage of large and very large trees increases slightly through the 5-decade period (Figure 7), and parallels the slight modeled increase in pileated habitat through the same period, which explains the outcome. Changes in the distribution of cover types for suitable nest trees, which include western larch, ponderosa pine, Douglas-fir and western red-cedar, suggest those preferred nest trees will also increase slightly through the period (Figure 9). These multiple modeled variables all suggest that habitat for pileated woodpeckers will increase through the 5-decade period regardless of alternative selected.

The pileated woodpecker query design did not include the availability of nest snags or foraging habitat based on insect availability. The amount of modeled fire, insects and disease, however, will further contribute to both nesting snags and foraging snags that would increase habitat quality by the end of decade 5.

Since pileated woodpeckers are snag dependent and because remotely-sensed data does not detect snags, FIA data were reviewed to determine if snags occurred at sufficient densities within SIMPPLLE-modeled habitat to provide both nesting and foraging opportunities. FIA summary data (Flathead NF forest plan project file) suggests snags 15-20 inches DBH (used primarily for feeding) occur at approximately four per acre and snags >20 inches DBH (used primarily for nesting) occur at approximately one per acre. These densities suggest snags are not limiting pileated woodpeckers in the FNF.

3.6.11 Moose Forage

The NRV ranges from about 190,000 to 900,000 acres out of approximately 2.4 million acres on the FNF, a very large range of about 710,000 acres. Acres of modeled habitat vary somewhat between alternatives (Figure 18). The model predicts acres of habitat will increase slightly at time steps 1 and 2, then decline to current levels in times 3 through 5. Acres of habitat are approximately at the midpoint between the maximum and minimum NRV in all time steps.

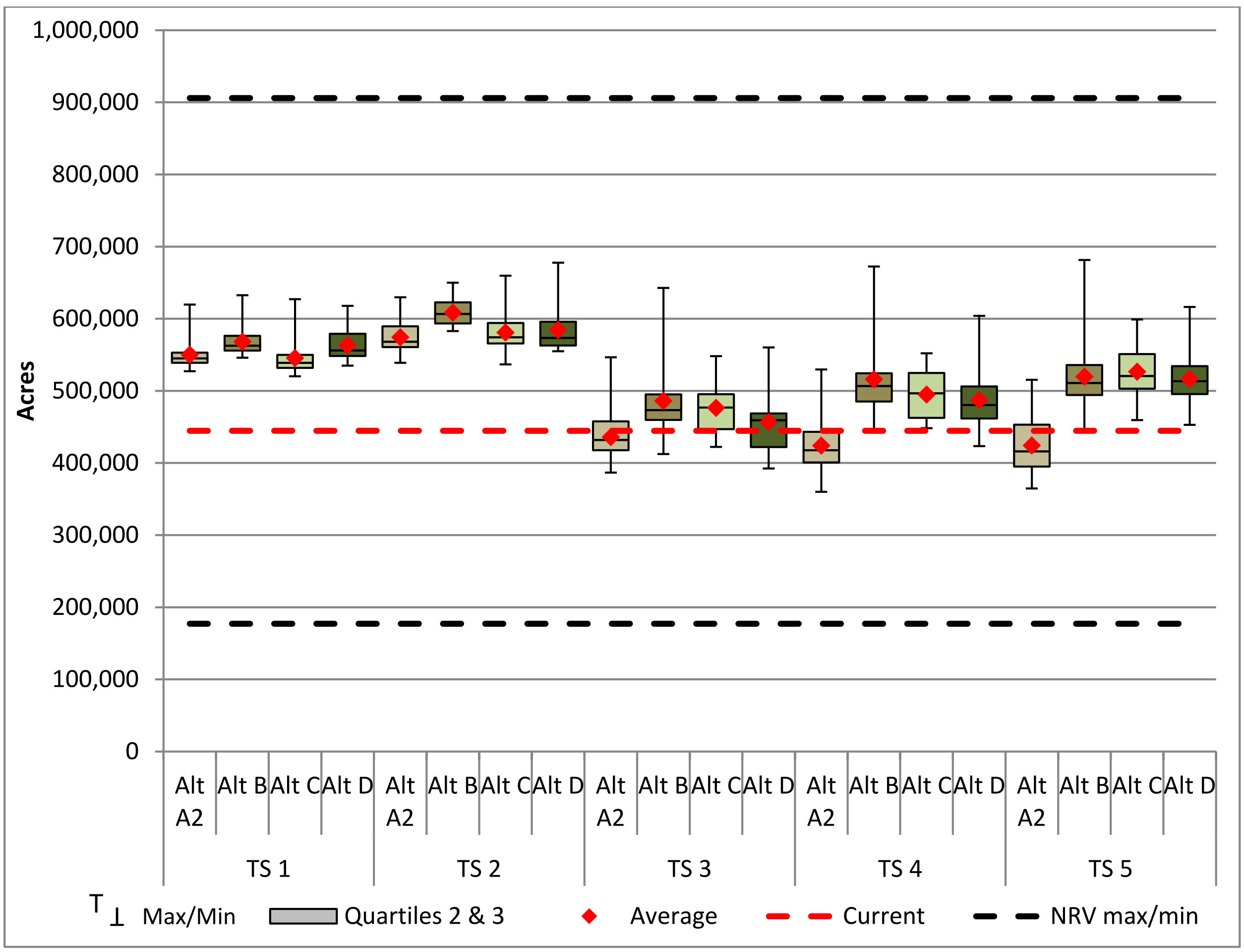

Figure 19. Current and modeled levels of moose habitat by alternative

Increased levels of habitat in decades 1 and 2 are clearly the result of increased disturbance from wildfires in the last decade as well as from management activities. Since moose habitat is a mesic subset of elk habitat, and mesic sites generally produce substantial levels of grass, forbs, and shrubs after any reduction in canopy, it may not matter much whether that loss in canopy occurs from fire, insects, disease, or vegetation management. Consequently, it is likely that moose habitat will stay at or above current levels and towards the midpoint of NRV assuming modeled increases in disturbances are highly probable. Alternative A is slightly lower than the other alternatives because that alternative does not include any prescribed burning.

3.6.12 Elk Forage

Acres of modeled habitat by alternative and time step are disclosed in Figure 19. The NRV of habitat for elk ranges from about 290,000 to 1,100,000 acres out of approximately 2.4 million acres on the FNF, a large range of about 720,000 acres. The model predicts all alternatives stay within the minimum and maximum range of NRV, hovering somewhere around the midpoint and current levels. Acres of habitat increase slightly in decades 1 and 2, then decline back to current levels in decades 3 through 5. In the future, acres of modeled habitat vary somewhat between alternatives, with Alternatives B and C slightly outperforming other alternatives, likely due to higher amounts of prescribed burning to meet multiple resource objectives. Alternative A is consistently outperformed by the other alternatives and this is most likely attributed to the lack of prescribed fire in Alternative A. With Alternative D, desired conditions would primarily be achieved by timber harvest which may be followed by prescribed burning.

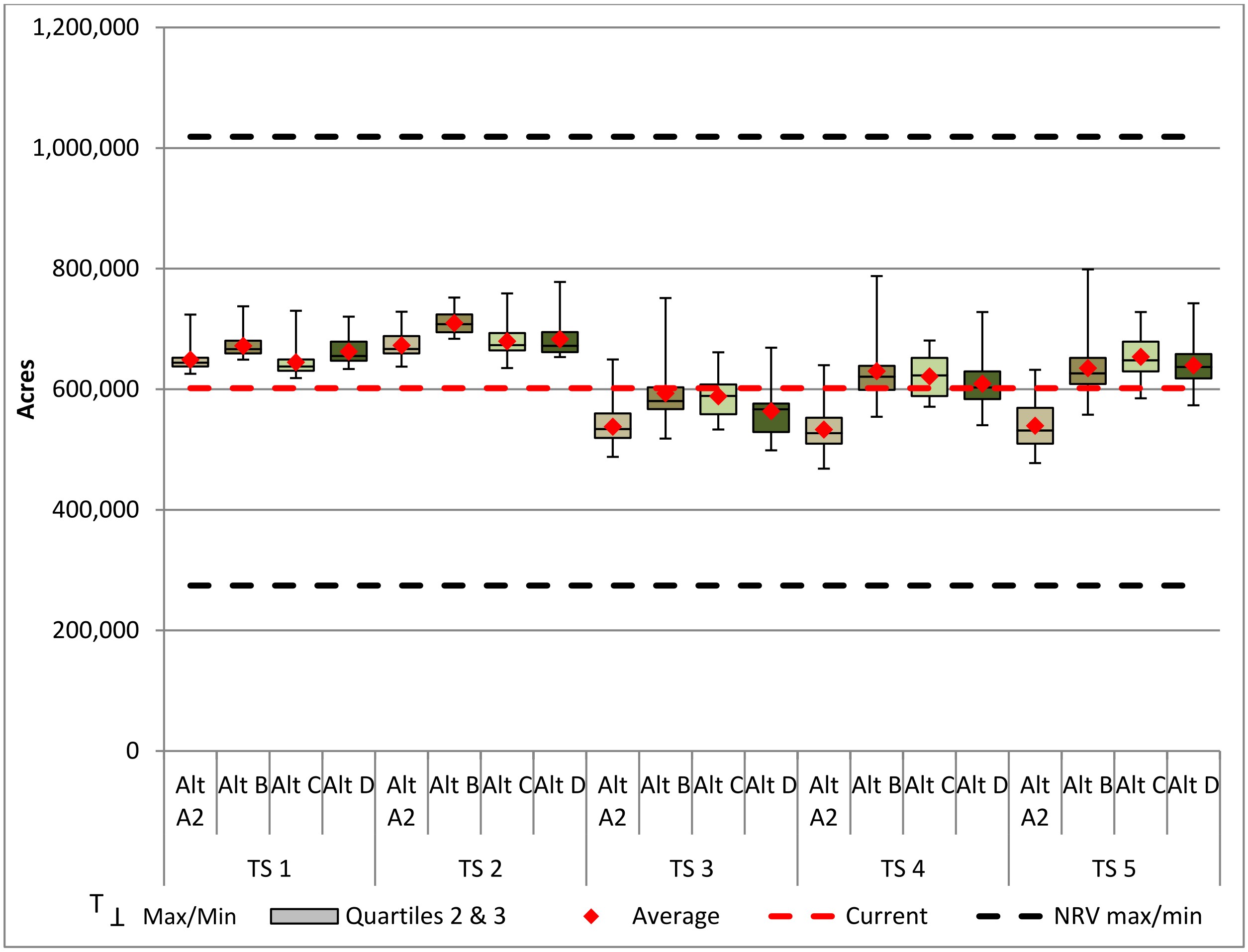

Figure 20. Current and modeled levels of elk summer forage habitat by alternative

Acres of habitat increase slightly at time steps 1 and 2, then decline back to current levels in time steps 3 through 5. Acres of habitat are within the NRV for all time steps, with a modest decline in time steps 3 and 4. The range of maximum and minimum habitat is substantial and similar to black-backed woodpecker habitat reflects the uncertainty with modeled acres of fire.

3.6.13 White-tailed Deer Winter Habitat

White-tailed deer winter range acres of modeled habitat by alternative and time step are disclosed in Figure 20. The model predicts all alternatives would stay within the minimum and maximum range of NRV over the five-decade time period. The NRV for snow intercept cover in areas mapped as white-tailed deer winter range ranged from about 29,518 to 110,721 acres out of approximately 325,491 acres of winter habitat on the FNF—a moderate range of about 81,203 acres. The current level of habitat is estimated to be at the midpoint of NRV at approximately 72,000 acres. Acres of habitat increase somewhat at time steps 1 and 2, then decline substantially from time steps 3 through 5. Acres of habitat are close to maximum NRV in time steps 1 and 2, then decline to a midpoint between minimum and maximum NRV in time step 3 and then drop closer to minimum NRV in time steps 4 and 5.

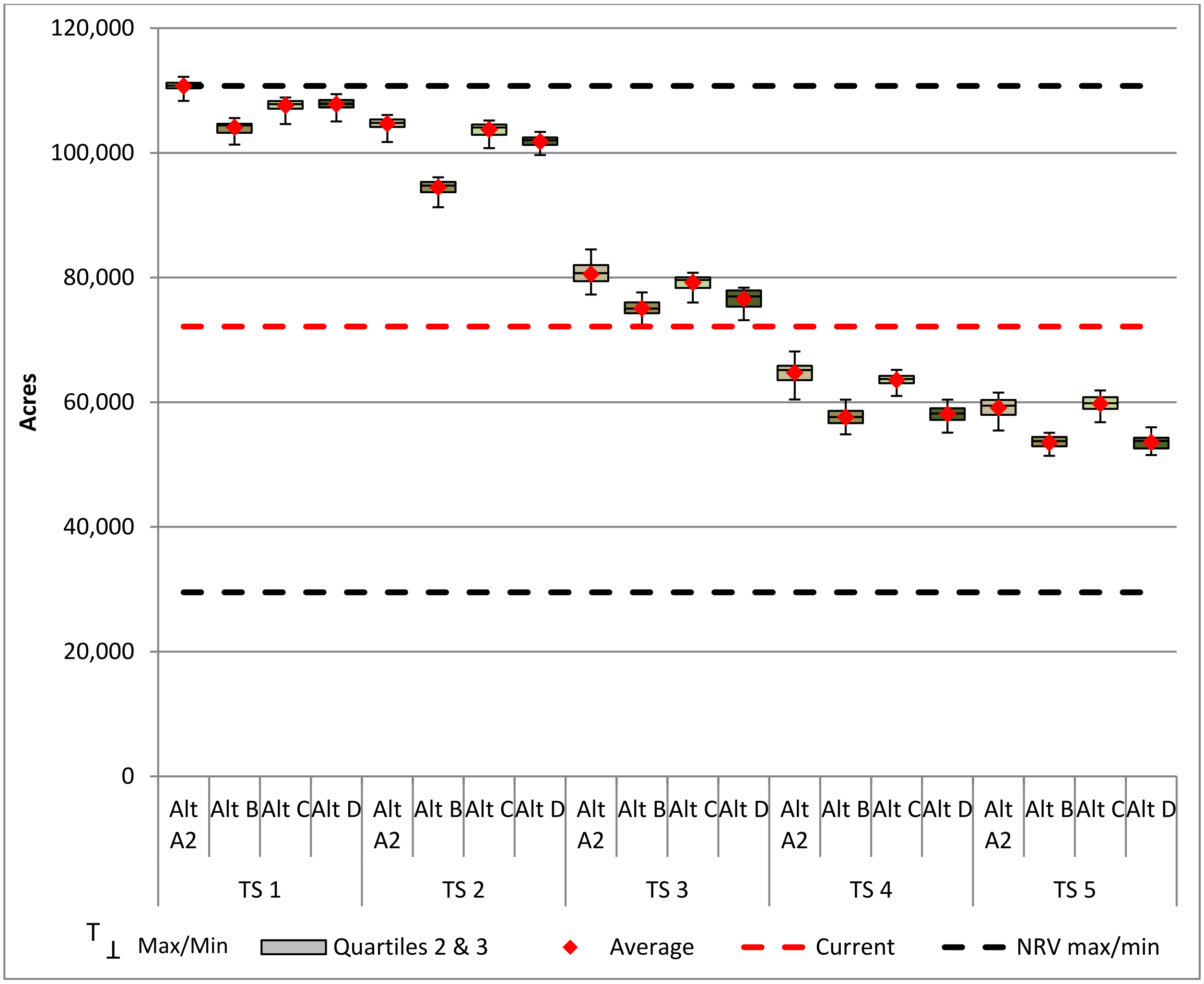

Figure 21. Current and modeled levels of white tailed deer habitat by alternative

Modeled habitat increases in the first and second decades, likely due to forest succession outpacing timber harvest, insects, disease, and wildfire. All alternatives decline to a level about 20,000 acres below current by decades 4 and 5, consistent with modeled increases in wildfire, insects and disease, which reduces canopy cover in some areas to the point that snow interception is no longer provided. Alternatives B and D provide slightly less snow intercept cover than A or C, likely due to vegetation treatments to meet other resource objectives in the warm-dry and warm-moist biophysical settings where the majority of the Forest's white-tailed deer winter habitat is located.

The steep modeled decline is clearly the result of increased disturbance and parallels similar declines in fisher, marten, and lynx multi-storied habitat. This change could be attributed to fire, insects, or disease since any of those disturbances would result in reduced canopy closure. Also, because of the increase in modeled disturbances, the decline in white-tailed winter range habitat is likely inevitable and unavoidable despite current fire suppression efforts. In the warm-moist biophysical setting, the moderate and high forest density class is currently a very high proportion of the total as a result of fire suppression. Vegetation modeling for the FNF shows that over the next 50 years all alternatives show a strong decrease in Douglas-fir and forest stand densities.

Winter climatic conditions have changed dramatically since the late 1970s and early 1980s when research suggested dense crown closure was essential for winter white-tailed deer survival. The current pattern of winter weather seldom results in the prolonged combination deep snow and severe cold that characterized conditions from the late 1970s. Consequently, it's unlikely that white-tailed deer populations will actually parallel the modeled decline in habitat and populations may actually remain stable or increase. With all alternatives, white-tailed deer are likely to do well during most winters, but the lack of snow interception provided by a canopy of full-crowned mature trees could cause higher levels of mortality due to predation during harsh winters.

3.6.14 Habitat Connectivity

Levels of cover (stands greater than 5 inches DBH and greater than 40% canopy closure), and levels of dense, mature forest (marten habitat) were modeled within the American Wildlands-designated polygons (Figure 2) to represent changes by alternative by time step within areas important for habitat connectivity. Those polygons represent 1.16 million acres. Additionally, changes in mean patch size were modeled to show how treatment and natural disturbances might affect the size of those patches over time.

Levels of dense, mature forest (marten habitat) within the aforementioned connectivity areas (National Forest lands only) are disclosed in Figure 21 by alternative and time step. Levels of existing dense, mature forest within those connectivity areas is displayed by the dashed red line. The mean level of habitat is represented by the boxes on the black vertical lines. Habitat declines by about 75,000 acres through times 3 through 5, but with little difference evident between alternatives.

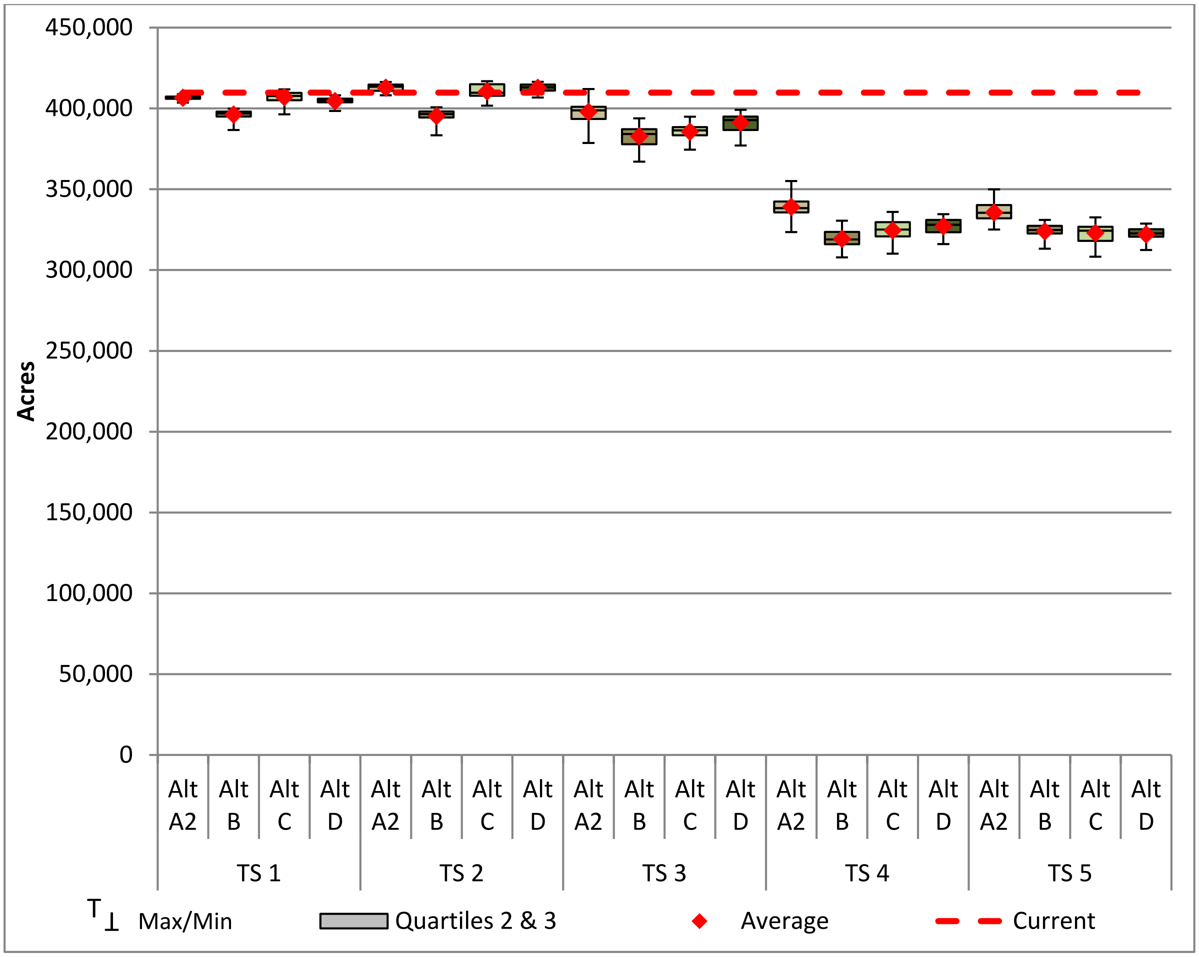

Figure 22. Current and modeled levels of mature forest habitat within the connectivity polygons by alternative

National Forest System lands within the selected connectivity areas total about 782,000 acres, representing 33% of the FNF total acreage. Moreover, 34% of the connectivity areas are within the WUI, which is approximately twice the percentage (17%) of WUI acres within the entire FNF. Mature forest is currently present on about 35% of the selected connectivity polygons and is estimated to drop to 28% by time step 5. The modeled decline in dense, mature forest habitat within the corridors parallels a modeled decline in marten habitat at the forest scale. The alternatives provide approximately the same levels of habitat in all time steps. Because a large percentage (34%) of the connectivity area acreage is in the WUI, all alternatives are modeled to meet the desired condition of reducing stand density and making forests more resilient. All alternatives would meet this objective by using different types of stand treatments. For example, Alternative A has no prescribed burning, Alternative B has a mix of regeneration harvest, commercial thinning, and prescribed burning, Alternative C places the most emphasis on prescribed burning, and Alternative D places the most emphasis on timber production. This suggests that all vegetation management activities have a similar end result, added to the inevitable and unavoidable natural disturbances that are causing the decline in dense, mature forest habitat within the American Wildlands corridors. While the connectivity areas contain more WUI acres than the FNF has a whole (34% versus 17% respectively), the modeled decline in dense, mature forest habitat is comparable between the connectivity areas and FNF acres. This suggests that WUI treatments which may be intensive at the project scale are still relatively insignificant compared to natural disturbances from fire, insects, and disease.

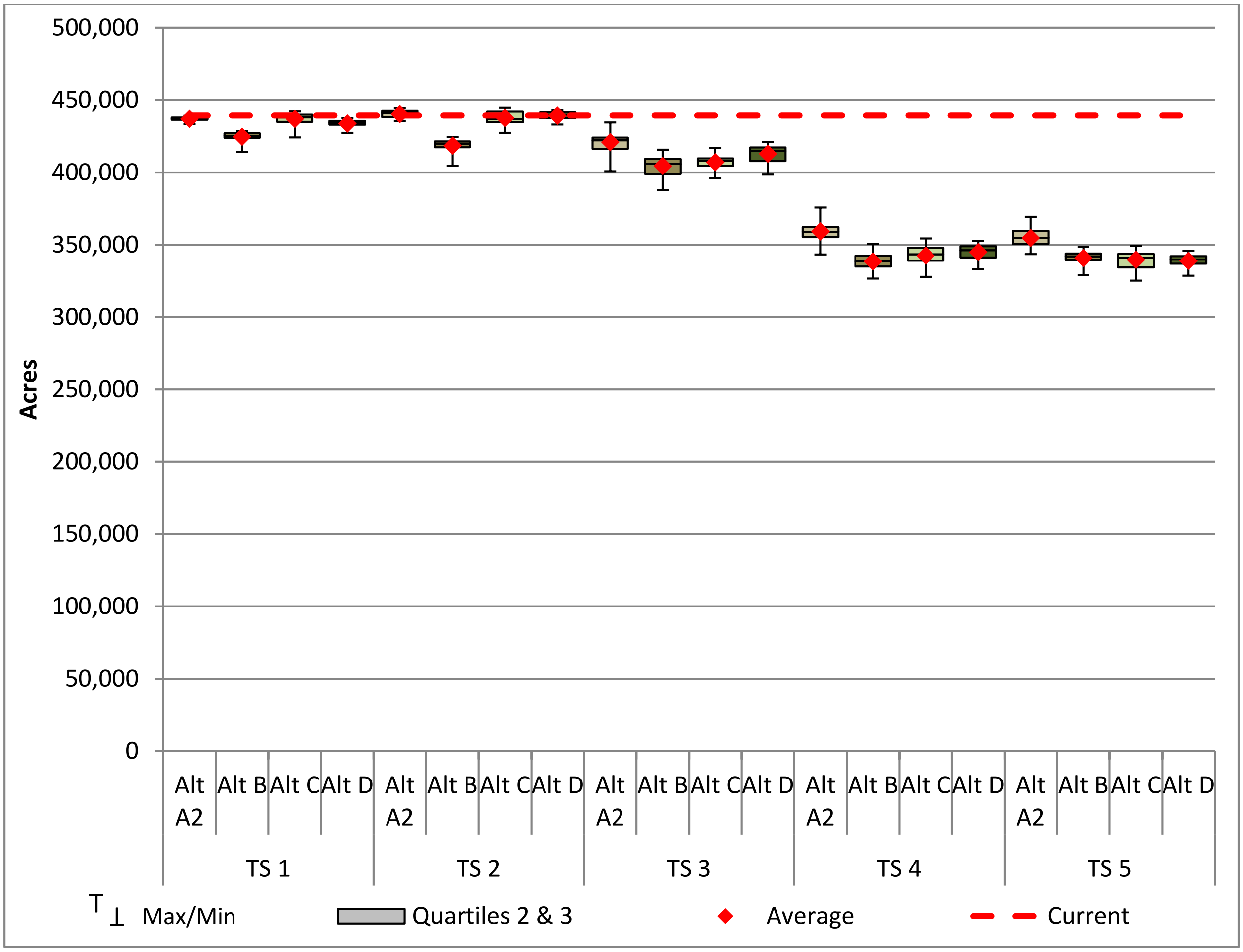

Figure 23. Current and modeled levels of forest cover habitat within the connectivity polygons by alternative

Changes in Connectivity Habitat

Levels of dense pole-and larger forest (cover) within the aforementioned American Wildlands polygons (National Forest lands only) are disclosed in Figure 22 by alternative and time step. Existing dense, pole-and larger forests within those polygons are displayed by the dashed red line. The mean level of habitat is represented by the boxes on the black vertical lines. Habitat declines by about 100,000 acres through time steps 3 through 5, but with little difference evident between alternatives

Changes in Mean Patch Size for Mature Forest by Alternative and Time Step

The modeled number of mature forest patches, and the mean patch size within the aforementioned connectivity areas, are disclosed in Figure 23 and Figure 24 by alternative and time step. Mean patch size declines substantially, especially in time steps 3 through 5 with a corresponding increase in the number of patches.

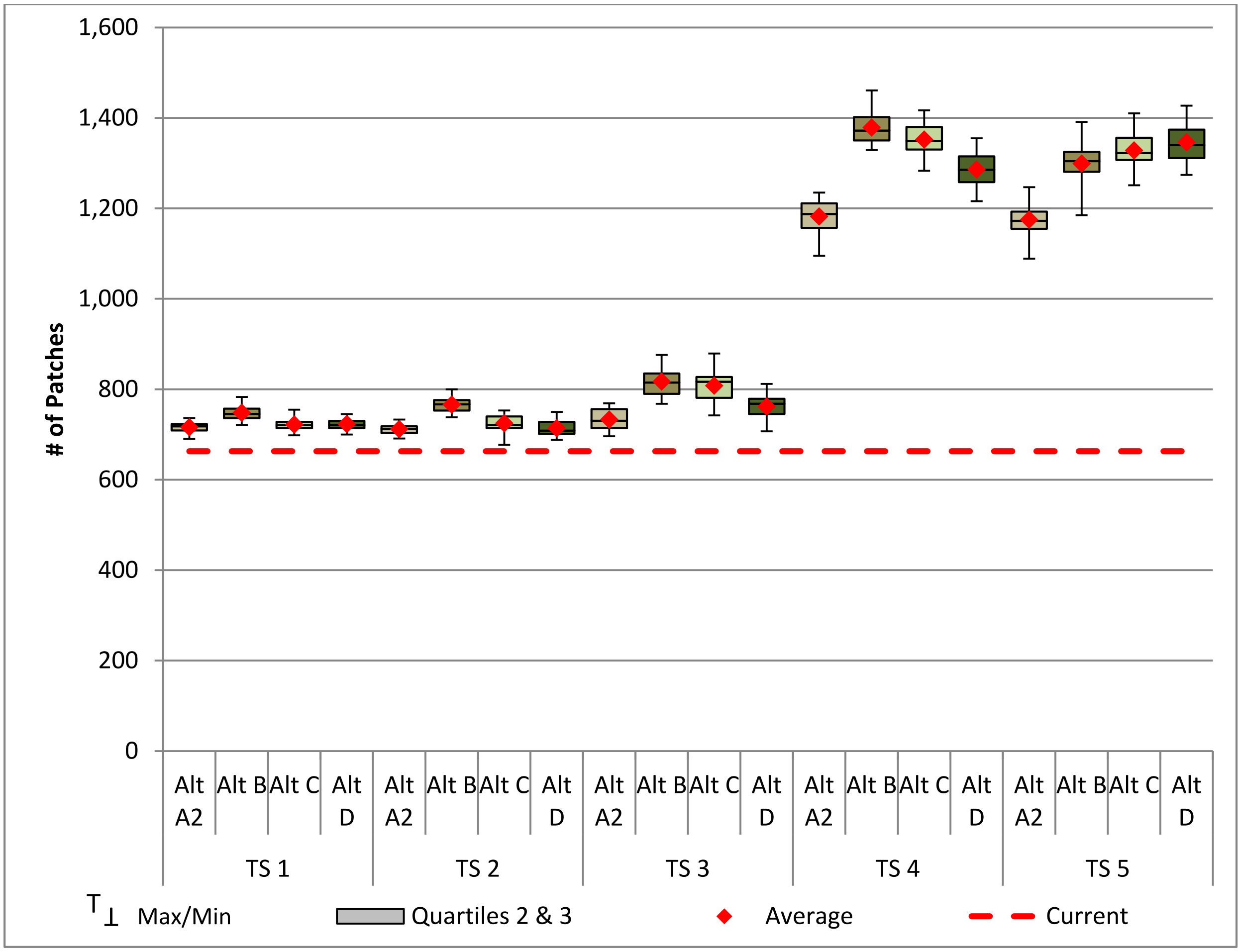

Figure 24. Number of patches current and modeled of mature forest habitat within the connectivity polygons by alternative

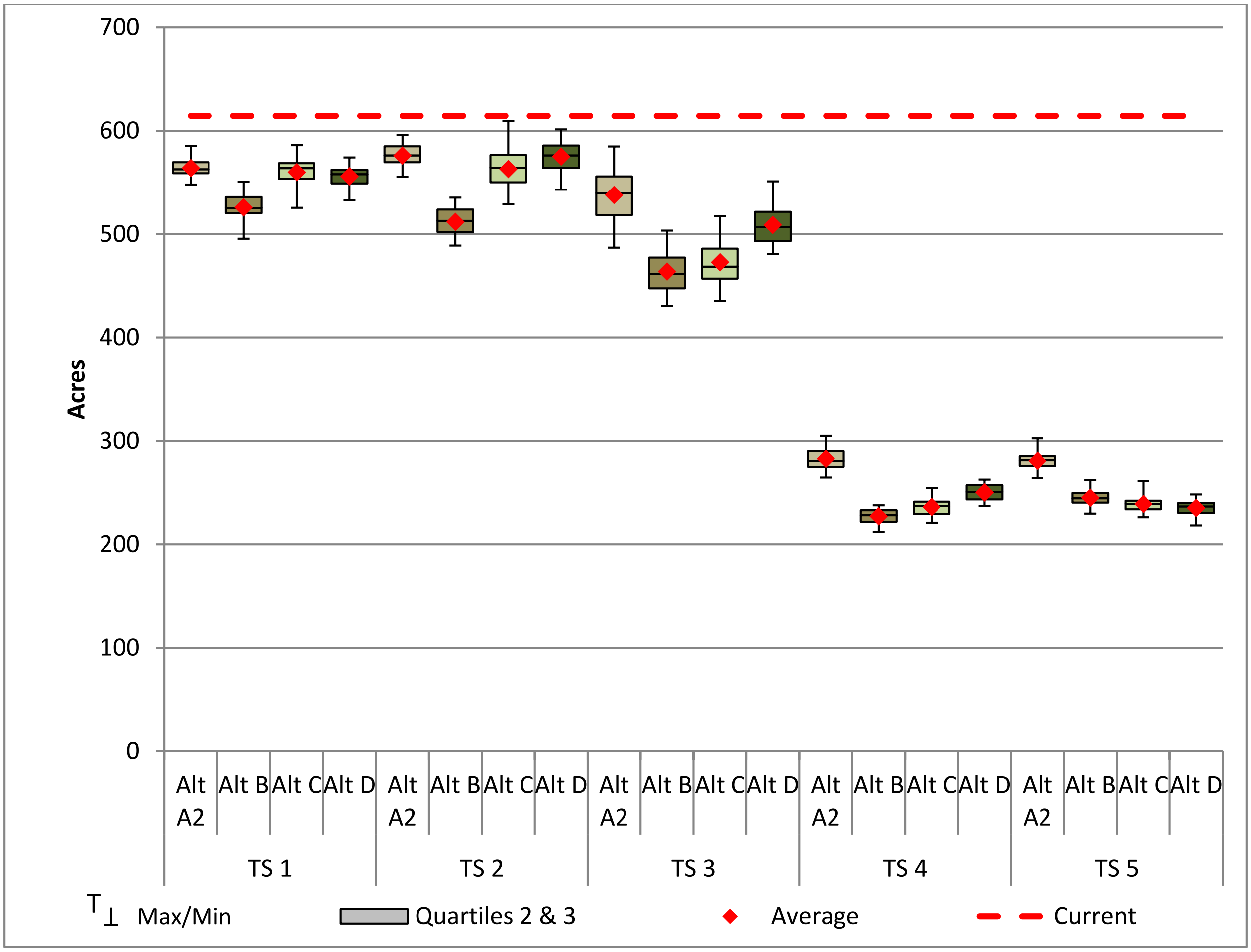

Figure 25. Average current and modeled patch size current of mature forest habitat within the connectivity polygons by alternative

Declines in mature forest patch size, accompanied by an increase in the number of patches, are presumed to have negative effects on interior forest species (i.e. martens, fishers). Mature forest patch sizes in Alternatives B, C, and D show little difference between alternatives by the end of the fifth decade. Alternative A shows slightly less of a decline in mature forest patch size, presumably because Alternative A was modeled without prescribed burning to match the original 1986 forest plan.

A substantial portion (34%) of the area in the American Wildlands polygons is in the WUI where people live. The WUI is where vegetation management would be emphasized and where wildfires would be most aggressively suppressed. Even if fires are suppressed, the model estimates that disease and insect infestations will increase with expected warmer, drier climates. Insects and disease within mixed species forests tend to create numerous small patches.

Larger, more severe stand-replacing fires could result in some very large, even-aged, early-seral patches and reduce the size of mature forest patches, especially in the cool-moist and cold biophysical settings. Modeling suggests that fire coverage and severity, as affected by slope, aspect, and fire suppression, often cumulatively results in a small patch mosaic, especially in the warm-dry and warm-moist biophysical settings. Modeling over several decades generally predicts that disturbances tend to reoccur on previously disturbed acres, which further add complexity to existing patterns of forest cover. For instance, severe burns are often followed by re-burns 15-25 years later, after forest debris accumulates on the forest floor.

Moderate severity burns are often followed by bark beetle attacks on weakened, surviving trees which may add to the patchiness of forest patterns.

These modeled results suggest that the current mix of patch sizes is likely due to a century-long absence of stand-replacing fire, which has allowed stands to reach large or very large size classes and high densities where the boundaries between them become relatively indiscernible. A return to smaller patch sizes is not only likely inevitable and unavoidable, but perhaps more normal when we consider the effects of natural disturbances.

3.6.15 Species Associated with Riparian Habitat Conservation Areas or Riparian Management Zones

As illustrated in Figure 25, there is a high degree of variation in modeled riparian habitat between alternatives. The model predicts all alternatives would stay within the minimum and maximum range of NRV over the five-decade time period. Acres of riparian habitat in an early succession condition that provide dense shrubs and deciduous trees decline slightly at time steps 1 and then more substantially at time step 2, followed by increasing habitat that returns to near current levels for Alternatives B and D at time steps 3 through 5.

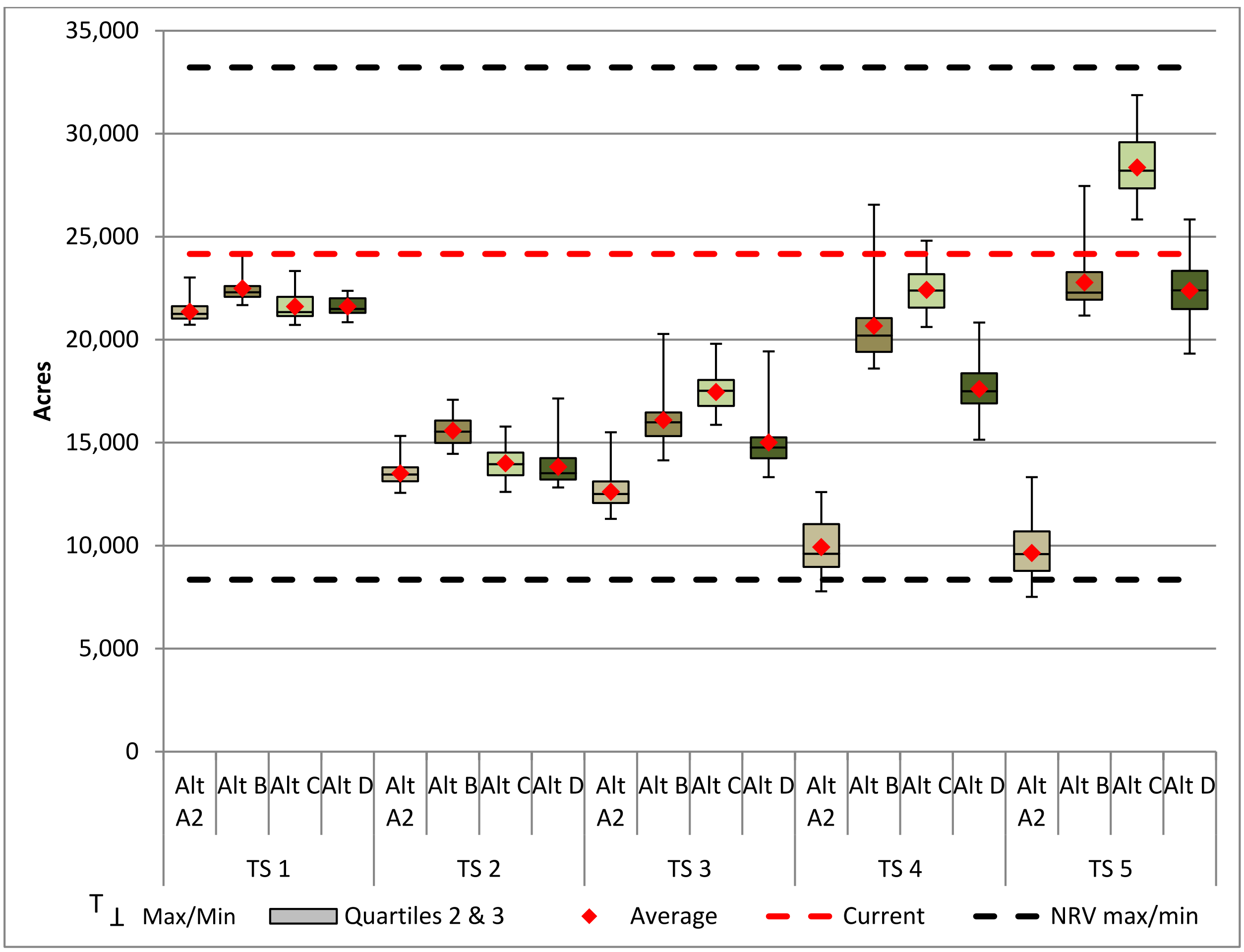

Figure 26. Current and modeled levels of RHCA associated species habitat by alternative

Since upland riparian areas generally produce substantially higher levels of shrubs after a reduction in canopy closure, it may not matter much whether that loss in canopy occurs from fire, insects, disease, or vegetation management. Consequently, it is likely that habitat for riparian species associated with shrub and hardwood habitats will stay at or above current levels assuming that modeled increases in natural disturbances are highly probable by the end of decade 5. RHCAs are not suitable for timber production, so there is a minimal amount of tree removal modeled in RHCAs under all alternatives. Alternative A stays well below current levels, probably because wildfires are suppressed and there is no prescribed burning. Alternative C slightly exceeds current levels by decade 5 likely because this alternative has the most recommended wilderness and prescribed burning to meet desired conditions.

3.6.16 Northern Goshawk

Acres of modeled habitat by alternative and time step are disclosed in Figure 26. The model predicts all alternatives would stay within the minimum and maximum range of NRV over the five-decade time period. There is little variation between alternatives. Acres of habitat increase slightly at time steps 1 and 2, then decline substantially at time steps 3 through 5. Current levels of habitat are at the maximum NRV, then habitat declines steadily to near the minimum NRV by time step 5.

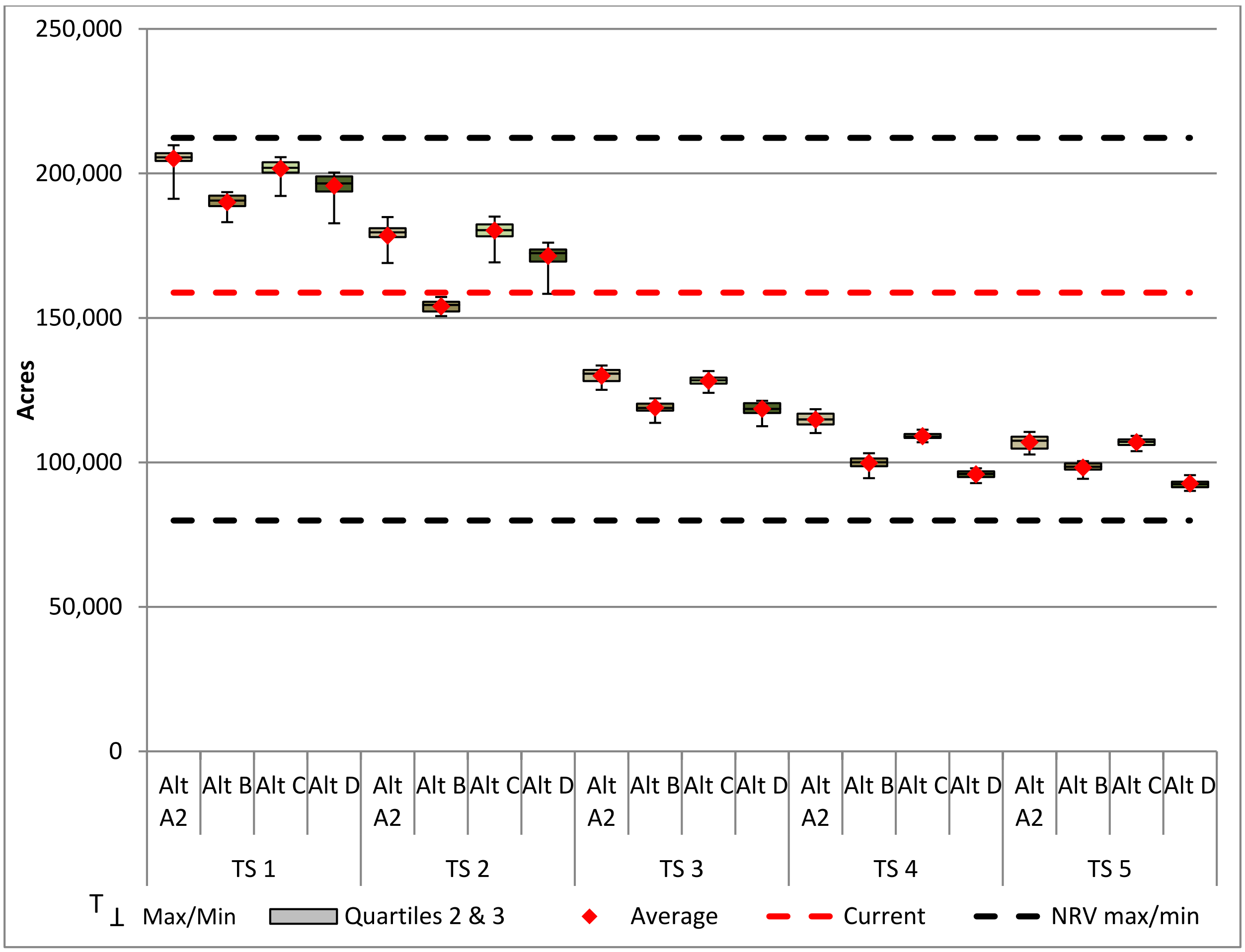

Figure 27. Current and modeled levels of northern goshawk habitat by alternative

Vegetation modeling results suggest that there would be an upward trend in the large tree size class, but a downward trend over the next five decades in the very large forest size class in all biophysical settings except the warm dry. The combined acreage of large and very large trees used to model northern goshawk nesting habitat increases slightly through the time period, therefore, the decline is not because large trees are limited, but rather because modeled stands will become too open to provide nesting habitat (i.e. less than 40% canopy closure). The combination of increased fire, insects, and disease is resulting in a substantial overall decline in modeled canopy closure—which reduces nesting habitat quality and quantity but may increase foraging habitat quality and quantity. Because Alternatives B and D provide slightly less modeled nesting habitat (10,000 acres) than Alternatives A and C, timber harvest also likely plays a role in reduced canopy closure.

This modeled outcome identifies acres of nesting habitat with no consideration for distribution across the landscape. For that reason, modeled levels of nesting habitat may have little relationship to the actual density of nesting northern goshawks. Northern goshawks are highly territorial and can nest in relatively small, isolated parcels of nest habitat (Squires and Ruggiero 1996). Research (Clough 2000) has shown that landscapes fragmented by timber harvest support nest densities comparable to un-fragmented landscapes as long as nest habitat persists at levels sufficient to support northern goshawks at maximum densities based on territoriality. Consequently, while the modeled nesting habitat declines over the five decades, it remains within the NRV, suggesting no risk to northern goshawk sustainability regardless of alternative selected and the actual nesting population may change little over time.

4 CONCLUSIONS

4.1 INCREASE IN FUTURE DISTURBANCE

In the last two decades there has been a substantial increase in wildfires, insect outbreaks, and root disease across Region 1 and several factors suggest that trend will continue. Given that the past two decades *were warmer and drier* based on National Weather Service data this is a very conservative modeling assumption. For those reasons, the modeled outcome for increased disturbance from fire, insect, and disease has a relatively high level of certainty. What is uncertain is the exact timing or magnitude of changes.

4.2 REDUCTION IN VERY DENSE STANDS

The SIMPPLLE-modeled results suggest that very dense stands will decline substantially with a corresponding increase in open stands. Disturbances that will likely create open stands include moderate severity fires, bark beetle outbreaks within mixed stands of lodgepole pine and other species, and root disease. High severity fires and bark beetle outbreaks within pure stands of lodgepole pine will continue to recruit grass/forb and seedling-sapling stands. For species and habitats that are disturbance dependent (i.e. black-backed woodpeckers, elk summer range forage), the preceding decade of very active fires (2003-2012) recruited a lot of habitat that, had those fires not occurred, would have likely resulted in habitat at below minimum NRV levels. If fires occur at higher-than-modeled levels, we could expect more stand-replacing events with a higher-than-modeled loss of dense stands and an increase in burned forest.

4.3 DEPARTURES FROM NATURAL RANGE OF VARIATION

Other broad-scale analyses (Hessburg et al. 1999) conducted for the Northwest have concluded that some forested habitats, particularly warm, dry habitats dominated by ponderosa pine, are currently below the minimum of NRV. The findings in this analysis indicate current habitat levels for all wildlife species modeled were above the minimum NRV and in one case higher than the maximum NRV. We suggest that this is due to the area's mix of fire regimes that predominately burn with stand-replacing or mixed severities. The FNF has a virtually no frequent fire/low severity fire regime. Consequently, whereas, ponderosa pine-dominated landscapes on the Bitterroot National Forest have missed five or six fire return intervals in the last century, and thus have suffered massive shifts in species composition, size class distribution, and canopy closure, there are few comparable situations on the FNF. Because of inherent long fire return intervals on most of the FNF landscape, such as the moist, mid to high elevation subalpine fire habitat types, *current* habitat levels are within the maximum and minimum range of NRV for all species.

4.4 DECLINES IN MARTEN, FISHER, NORTHERN GOSHAWK, WHITE-TAILED DEER WINTER HABITAT AND LYNX MULTI-STORIED HABITAT

While these habitats declined by the end of five decades, all remained above the minimum NRV and fisher habitat remains above current levels. Habitat for these species reaches levels near the maximum range of NRV for time steps 1 and 2 because of modeled forest succession and because the SIMPPLLE model applies fire suppression logic that would increase the availability of dense, large, or very large stands so that they reach maximum levels that would have occurred historically. However, numerous research findings provide conclusive evidence that such stand conditions predispose those stands to fire, insect, or disease. Those stand conditions, combined with the assumption that time steps 3 through 5 would have warmer and drier climatic conditions, account for the decline in modeled habitats. A high percentage of road-less and wilderness lands in the FNF preclude most options to reduce the severity of future natural disturbances. Mechanical restoration treatments on timber suitable lands or prescribed burning could reduce the severity of those disturbances in some portions of the Forest, in some situations. Those options, however, are limited due to budget limitations and protective measures for particular species. Those limitations are included in the SPECTRUM model and apply to all alternatives. Because of those limitations, the SIMPPLLE-modeled outcomes generally show little difference in habitat between alternatives.

4.5 Increases in Flammulated Owl Habitat

SIMPPLLE-modeled outcomes for flammulated owl habitat were much different than outcomes for other forests and constituted a surprise for the modeling team. A comparable modeling analysis on the Kootenai and Idaho National Forests (USDA 2012b) concluded that flammulated owl habitat was below the minimum NRV and only increased to above minimum NRV levels in alternatives that emphasized vegetation treatments. That outcome was consistent with results reported by Hessburg et al. (1999), who concluded that warm, dry ponderosa pine habitats had suffered severe departures from historical conditions. Conversely, modeled results on the FNF suggest existing habitat is above minimum NRV and will increase near maximum NRV by time step 3.

In retrospect, ponderosa pine are very uncommon on the FNF compared to adjacent national forests (i.e. Lolo, Bitterroot, Kootenai National Forests) which explains the limited acres of habitat at both minimum and maximum ranges. Furthermore, habitat within those limited acres of ponderosa pine are on the “moist end” of the dry moisture regime which means they typically burn naturally at mixed or high severities rather than at low severities like typical warm, dry habitats on adjacent forests. Thus, natural wildfires on the FNF are less likely to create and perpetuate large, open forests than on adjacent forests. Conversely, human disturbances including Native American burning that occurred historically and fuel treatments associated with WUIs often result in desired flammulated owl habitat consisting of large, open forest conditions. Much of the flammulated owl habitat is located in the Swan Valley which contains a high amount of WUI. Thus, the increase in flammulated owl habitat occurring in time steps 2 through 5 may be attributable as much to vegetation treatments as natural disturbances.

4.6 Increases in Black-backed Woodpecker, Moose, Elk, and Riparian Habitat in the Early Successional Stage

Moose and elk summer habitat is currently at the NRV midpoint. This is clearly the result of large wildfires in the preceding decade (2003-2012). Future SIMPPLLE-modeled habitat is near the midpoint of NRV as a result of future disturbances. Based on previous discussions as to the likelihood of those disturbances, this outcome has a high level of certainty.

Black-backed woodpeckers, although disturbance-dependent like elk or moose, only benefit from fire for a short period (i.e. up to 10 years) after the event. Although the level of existing habitat is high and near maximum NRV resulting from the preceding decade of active fires, future habitat is expected to decline to near minimum NRV as a result of modelled levels of fire suppression, in spite of substantial future modeled fires. Acres of riparian habitat in an early succession condition that provide dense shrubs and deciduous trees decline slightly at time steps 1 and then more substantially at time step 2, followed by increasing habitat that returns to near current levels for Alternatives B and D at time steps 3 through 5. This is likely a result of increasing levels of modeled fire, insects and disease. Despite these variations, overall levels stay within NRV.

4.7 INCREASES IN OLIVE-SIDED FLYCATCHER AND PILEATED WOODPECKER HABITAT

Olive-sided flycatchers and pileated woodpeckers both require medium, large, and very large trees that are projected to remain at or near current levels over five time steps. Very dense stands will decline substantially, and moderately dense and open stands will increase as a result of mixed severity fires, insects, and disease. Olive-sided flycatchers require moderately dense stands adjacent to openings. Pileated woodpeckers require open to dense stands with abundant snags. The combination of medium, large and very large trees, distributed across landscapes that have a mosaic of fire, insect, and disease-caused mortality should provide excellent habitat for both species. Based on previous discussions as to the likelihood of future disturbances, this outcome has a high level of certainty. FIA data provide further assurance that current snag densities are sufficient for pileated woodpeckers. Modeled habitat for moose and elk (i.e. seedling-sapling stands) suggests that openings will be sufficient to provide adequate edge habitat for olive-sided flycatchers.

4.8 CHANGES IN HABITAT CONNECTIVITY AND MATURE FOREST PATCH SIZE

Modeled mean mature forest patch sizes within the American Wildlands connectivity areas (Figure 2) decline substantially, especially in time steps 3 through 5, with a corresponding increase in the number of patches. Declines in mature forest patch size, accompanied by an increase in the number of patches, are presumed to have negative effects on interior forest species (i.e. martens, fishers). Patch sizes in Alternatives B, C, and D show little difference between alternatives, suggesting that the mix of vegetation management activities to meet desired conditions, along with disturbances (fire, insect, and disease) are causing the decline in patch sizes of dense, mature forest habitat within these corridors. Alternative A shows slightly less decline in mature forest patch size, presumably because Alternative A was modeled without prescribed burning to match the original 1986 Forest Plan.

The connectivity areas contain proportionally more WUI acres than the FNF as a whole (34% versus 17% respectively). The modeled decline in dense, mature forest habitat, however, is comparable between the connectivity areas and FNF acres. This suggests that WUI treatments (which may be intensive at the project scale) are still relatively insignificant compared to natural disturbances from fire, insects, and disease.

Arguably, a return to larger, more severe fires (as predicted in time steps 3 through 5), could result in some very large early seral patches. Modeling, however, suggests that fire coverage and severity, as affected by slope, aspect, and fire suppression, often results in a “small patch mosaic” across the landscape. Modeling over several decades generally shows that disturbances often reoccur on previously disturbed acres, which add further complexity to existing patterns of forest cover. For instance, severe burns are often followed by re-burns 15-25 years later after forest debris accumulates on the forest floor. Moderate severity burns are often followed by bark beetle attacks on weakened, surviving trees that may add to the patchiness of forest patterns.

4.9 Do These Results Suggest Any Species Are at Risk?

All species analyzed have habitat that remains above minimum NRV levels throughout the five-time step period, suggesting none of those species, including the federally-listed Canada lynx, are at risk. We attribute this to the FNF's inherently long fire return intervals, which suggest that some FNF landscapes have only missed one or two fire events and most have not missed any. Initial increases in modeled lynx multi-storied habitat, which we attribute to the operation of the succession and fire suppression logic of the model, is followed by a modeled decline in time steps 3 thorough 5 to near mid-NRV levels, due to inevitable and unavoidable natural disturbances. Some reviewers may interpret the decline in lynx multi-storied habitat in time steps 3 through 5 to be a cause for alarm based on the lynx's federally-listed status and the relative importance of multi-storied habitat to lynx survival. We suggest, instead, that the modeled changes in lynx multi-storied habitat reflect limitations in the carrying capacity of lynx habitat as affected by current conditions, climate, and natural disturbances. Lynx are a wide-ranging species capable of moving long distances, including to and from Canada, as changes in habitat occur. While multi-storied habitat might be protected or recruited at a project scale, based on modeled results, those actions would only be significant at the project scale and not at the forest scale. In addition, although there is a time lag between losses of multi-storied habitat and development of stand initiation habitat, snowshoe hares and lynx have persisted with these habitat cycles in the past.

4.10 Fine Scale Management Recommendations Versus Broad Scale Comparisons to NRV

The wildlife research papers citied in this analysis are all based on the habitat preferences of radioed or observed individual animals. They generally show that habitat selection for highly specialized species (e.g. pileated woodpeckers) is strongly correlated to a certain combination of vegetative species, size, density or structure, and/or topographic characteristics at a home range scale. The literature typically includes recommendations for creating or sustaining that desired mix of habitat components with the intent of benefitting that single species. Not surprisingly, some of those recommendations end up as Regional direction or forest plan standards applied at the project scale. As an example, the NRLMD (2007) limits unsuitable habitat to no more than 30% of lynx habitat in each individual LAU. However, the analysis of NRV demonstrated that at a Forest scale, natural processes such as fire, insects, and disease (over which managers have little control) resulted in some LAUs exceeding the 30% standard. This analysis of NRV, current conditions, and modeled future conditions suggests that the scale at which habitat findings are applied should strongly consider the scale at which natural and man-made disturbances occur. SIMPPLLE model-based analyses such as this analysis provide a useful tool for testing different scales (e.g. home range, project, national forest, larger landscape).

4.11 How Do the SIMPPLLE-modeled NRVs Compare with Other Published Historical Range of Variability Estimates?

Comparisons of existing and future habitat to the NRV are given a lot of emphasis in this report. SIMPPLLE-modeled NRVs were compared against published information on NRV (USDA 2012b) to determine to how similar or dissimilar those results are. HRV calculations (Hessburg et al. 1999) were made for four different ecological subdivisions on the FNF. Conversely, this analysis treats the FNF as one vegetation unit. Hessburg et al.(1999) categorized old growth as trees greater than 25 inches DBH, whereas this analysis categorized very large trees as greater than 20 inches DBH. Other examples of dissimilar categories are prevalent in this document and Hessburg et al. (1999). Nonetheless, there are striking similarities between Hessburg et al. (1999) HRV estimates and the modeled NRV outcomes in this report. For instance, Hessburg et al. (1999) concluded that the availability of existing stand initiation stands (seedling-sapling stands) was substantially below the HRV. This report found that seedling-sapling stands were within the range of NRV, but only because of the high level of wildfires that occurred between 2003 and 2012 (disturbances that occurred after the Hessburg et al. (1999). Hessburg et al. (1999) concluded that the current availability of large diameter and old growth stands exceeded the HRV. This report found that habitat for fisher and marten were near the maximum NRV and lynx multi-storied habitat exceeded the maximum NRV, in spite of the wildfires that occurred between 2003 and 2012. Other comparisons with Hessburg et al. (1999) were similar.

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