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DRAFT Ecological Impacts Analysis Report

for the Draft EIS for Amendments to LMPs to Address Old-Growth Forests Across the NFS

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Cover Photo: A sequoia seedling sprouts after fire. Photo Credit: photographer unknown; Pacific Southwest Forest Service.

This report is incorporated by reference in full for the Draft EIS for Amendments to LMPs to Address Old-Growth Forests Across the NFS

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List of Abbreviations

CFR	Code of Federal Regulations
EIS	environmental impact statement
FIA	Forest Inventory and Analysis
LMP	Land management plan
NRM	Natural Resources Manager
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
NFS	National Forest System
NOGA	National Old Growth Amendment
USDA	United States Department of Agriculture
USFS	United States Forest Service

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1. Introduction

A primary purpose of the 2012 Planning Rule (planning rule) is to promote the ecological integrity of national forests and grasslands and other National Forest System administrative units. Ecological integrity – a substantive requirement of the planning rule – is designed to support Ecological Sustainability (36 CFR 219.8), Diversity of Plant and Animal Communities (36 CFR 219.9), and Multiple Uses (36 CFR 219.10).

Regulatory Framework

- **National Environmental Policy Act of 1969:** Mandates consideration of the consequences to the quality of the human environment from proposed management actions. The agency must examine the potential impacts to physical and biological resources as well as potential socioeconomic impacts (40 CFR § 1508.14).
- **National Forest Management Act of 1976:** Mandates development of land management plans and requires public notification of a significant change in a land management plan (such as through an amendment) and to provide for public participation in development and review.

When proposing a land management plan amendment, the planning regulations (36 CFR 219), as amended, require the responsible official to identify the substantive requirements (219.8 through 219.11) of the 2012 planning rule that are directly related to the amendment based on its purpose or effects (36 CFR 219.13(b)(5)). (See the substantive requirements discussion in the Draft EIS, Section 1.9.1.) The Secretary determined that the following substantive requirements, as they relate to the Ecological Impacts Analysis, are within the scope and scale of the proposed amendment for land management plan direction for old-growth forests across the National Forest System:

- 36 CFR 219.8(a)(1)—Terrestrial and aquatic ecosystem integrity (including associated analytical considerations in 219.8(a)(1) (i through vi).
- 36 CFR 219.8(a)(1 and 2)—Watershed integrity, water quality, and soils.
- 36 CFR 219.8(a)(3)—Riparian areas.
- 39 CFR 219.9(a)(2) Ecosystem diversity.
- 36 CFR 219.9(b) Ecological conditions for species (including threatened, endangered, proposed or candidate species and potential species-of-conservation-concern). (Also see the Draft EIS, Chapter 3, sections for *Endangered Species* and *Sensitive Species*.)

The old-growth amendment is directly relevant to the requirement for ecological integrity because one of its primary purposes is "to foster the long-term resilience of old-growth forest and their *contributions to ecological integrity* across the National Forest System" (NOI, Fed Reg 88042, emphasis added). It's important to note that application of this requirement is tailored to the scope and scale of the amendment and that amendments may differ in their analytical processes than land management plan (LMP) revisions. Notably, LMP revisions require an assessment of ecological, economic, and social conditions, trends, and sustainability and their relationship to the LMP within the context of the broader landscape. By contrast, amendments are more targeted. They address changed conditions and/ or specific circumstances needing change by adding, modifying, or removing plan components and/ or changing how and where on the unit (or plan area) plan components apply. The associated analysis for amendments is therefore also targeted and limited.

As discussed in Chapter 1 of the Draft EIS, the proposed action is part of the Secretary's response to Executive Order 14072. While old-growth forests are not specifically mentioned in the National Forest Management Act (NFMA) or associated regulations, they do have a distinct composition, structure, and function representing a unique stage in forest development and therefore meet the definition of an ecosystem as defined in the NFMA regulations at 36 CFR 219.19. At the same time, ecosystems can be thought of as being nested in other ecosystems, and old-growth can be thought of as a successional or developmental stage in a dynamic system within a vegetative type. Regardless, whether old-growth is treated as an ecosystem itself, or as a distinct component in a larger ecosystem, this analysis focuses on the NFMA requirement as applied to the scope of the amendment as discussed in Chapter 1 of the Draft EIS. The analysis focuses solely on old-growth and not broader ecosystems. As such, old-growth forests are covered by the general requirements to provide for the sustainability and integrity of ecosystems:

> *The plan must include plan components, including standards or guidelines, to maintain or restore the ecological integrity of terrestrial and aquatic ecosystems and watersheds in the plan area, including plan components to maintain or restore structure, function, composition, and connectivity, taking into account: (i) Interdependence of terrestrial and aquatic ecosystems in the plan area. (ii) Contributions of the plan area to ecological conditions within the broader landscape influenced by the plan area. (iii) Conditions in the broader landscape that may influence the sustainability of resources and ecosystems within the plan area. (iv) System drivers, including dominant ecological processes, disturbance regimes, and stressors, such as natural succession, wildland fire, invasive species, and climate change; and the ability of terrestrial and aquatic ecosystems on the plan area to adapt to change. (v) Wildland fire and opportunities to restore fire adapted ecosystems. (vi) Opportunities for landscape scale restoration.* (36 CFR 219.8(a)(1)).

Ecological integrity is further defined in the regulations as:

> "*[T]he quality or condition of an ecosystem when its dominant ecological characteristics (for example, composition, structure, function, connectivity, and species composition and diversity) occur within the natural range of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence.*" (36 CFR 219.19)

Notably, natural range of variation is only part of the definition of ecological integrity. By specifically capturing the ability of ecosystems to, "withstand and recover from most perturbations," resilience is identified as a fundamental component.

The concept of ecological integrity as applied to forest planning has received attention based on several factors. First, the natural range of variation (NRV) does not necessarily represent a management target or desired condition and a description of the NRV alone is not sufficient to determine whether there is ecological integrity (FSH 1909_10, Hayward et al. 2012, Romme et al. 2012). Rather, descriptions of NRV provide contextual information to support development of plan components (Wiens et al. 2012).

Second, there is some debate as to how well NRV analyses capture climate change factors, particularly when using historical ecological information and modeling processes (Safford et al 2012). The planning directives offer an operational perspective on this matter:

> *"In light of possible changes in species composition under the effects of climate change and with a focus on restoration, the Agency designs plan components to provide ecological conditions to sustain functional ecosystems based on a future viewpoint. Functional ecosystems are those that sustain critical ecological functions over time to provide ecosystem services"* (FSH 1909.12_20).

Ecological integrity thus functions as a key component of ecological sustainability, restoration, and adaptation to climate change (Suding et al. 2015) and as a useful framework to guide management of terrestrial ecosystems (Carter et al. 2019).

Although NRV remains a cornerstone of analyses for ecosystem restoration, it has its constraints due to limitations of the reference period examined (Hayward et al. 2012, Nowaki et al. 2012) and in an age of climate change (Millar 2014). Directional environmental changes, especially intensifying climate change and associated droughts, wildfires, and insect outbreaks, are fundamentally transforming ecosystems, including old-growth forests, within management-relevant timeframes through persistent changes in ecological characteristics such as species composition, structure, function, and diversity (i.e., ecological integrity) (Steffen et al. 2018, NAS 2019, Coop et al. 2020, Williams et al. 2020, Guiterman et al. 2022). Ecological transformations are often exemplified by a shift in dominance among organisms with different life forms (e.g., forest to grassland, Scheffer et al. 2001. Guiterman et al. 2022), may represent novel ecosystems (Hobbs et al. 2009), and will likely alter ecological function and provision of services such as carbon storage and water quality (e.g., Kodero et al. 2024). A contemporary approach to ecological integrity integrates the development of ecological reference models with an understanding of disturbance ecology to account for the rates and magnitudes of modern ecological change and therefore the consequences for sustaining ecological functions and ecosystem services (Draft EIS, Appendix D, Adaptive Strategy for Old-Growth Conservation Framework).

2. Information sources

In accordance with 36 CFR 219.3, this analysis uses the best available scientific information found to be relevant to National Forest System old-growth forests and ecosystems. The accurate, reliable, and relevant sources used for the analysis are cited throughout; uncertainty and/or conflicting sources of information are acknowledged and interpreted where applicable. Key types of sources used for this report include:

2.1 FIA data and methods

Forest Inventory and Analysis (FIA) data were used to quantify the extent of old-growth forest across different administrative units and land use allocations. FIA data are collected nationwide and provide nationally consistent, unbiased estimates of forest area and characteristics at broad- and mid-levels (Bechtold and Patterson 2005, Westfall et al. 2022). Data were downloaded from USDA Forest Inventory and Analysis DataMart on July 25, 2023 and classified as old-growth forest using the definitions and criteria applied in the *Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management* technical report (USDA and USDI 2023). The planning unit and National Forest System region of each inventory plot were identified based on the administrative forest code attribute in the FIA database, while presence in a wilderness, roadless area, national monument, grazing allotment, or the wildland urban interface was determined based on a spatial overlay, using data obtained from the Forest Service's Enterprise Data Warehouse. Because wilderness and inventoried roadless areas overlap, estimates of MOG in inventoried roadless areas were based only on the portions of inventoried roadless areas that are outside designated wilderness. For grazing allotments, only active allotments were used.

2.2 LANDFIRE

The LANDFIRE data resource integrates various geospatial technologies, including biophysical gradient analyses, remote sensing, vegetation modeling, ecological simulation, and landscape disturbance and successional modeling (Rollins, 2009). The LANDFIRE framework provides nationally consistent vegetation classification, wildland fire, and fuels assessment, to inform assessment of ecosystem integrity at broad scales. LANDFIRE's Biophysical Settings estimate reference conditions for the vegetation patterns that may have been dominant prior to Euro-American settlement and are based on both the current biophysical environment and an approximation of the historical disturbance regime. Historical disturbance regimes are derived from this information, where areas with historic fire return intervals that are 35 years or less are described as 'Frequent' (i.e., FRG I and II) and 'Not Frequent' for fire return intervals greater than 35 years (i.e., FRG III, IV, and V). Data for Alaska also has a class of 'Indeterminate Fire Regime,' as information for this location could not be derived by LANDFIRE. The degree to which knowledge of historical Indigenous stewardship informs the estimates varies geographically. Furthermore, the empirical basis for modeling varies by vegetation type. LANDFIRE uses Fire Regime Groups that describe presumed historic fire regimes based on vegetation dynamics, fire spread, fire effects, and spatial context.

2.3 USDA and USDI 2024 Threat Analysis

Executive Order (EO) 14072 – *Strengthening the Nation's Forests, Communities, and Local Economies* – instructed the U.S. Department of the Interior (USDI), Bureau of Land Management and U.S. Department of Agriculture (USDA), Forest Service to implement a set of actions focused on the status of the Nation's forests. Section 2.c.(ii) directed the agencies to analyze the threats to mature and old-growth forests on Federal lands, including from wildfires and climate change. To fulfill this direction, the agencies wrote a full report (*Mature and Old-Growth Forests: Analysis of Threats on Lands Managed by the Forest Service and Bureau of Land Management*) (USDA and USDI 2024) and an introductory report currently available online. These reports include information about the impacts of fire, fire exclusion, insects and disease, tree cutting, mill infrastructure, and climate change on old-growth forests, as well as future projections of old-growth forests from the Forest Service's Resources Planning Act Assessment (2023 USDA Forest Service).

2.4 Tribal Information

Forest Service line officers at the local or unit level who consult directly with Tribal leaders are among the primary[1] sources of Tribal information used for this analysis. Secondary Tribal information for the

[1] *Primary* sources of information are first-hand accounts, letters, feedback, comments, etc. shared from Federally recognized Tribes who have a direct connection on a topic pertaining to this effort. *Secondary* sources of information are one step removed from primary sources. They may have been acquired from previously published agency policy, directives, or guidance pertaining to Federally recognized Tribal Indigenous Knowledge (IK) or other concerns that relate to this topic; they would have relied on primary sources but may have an added layer of interpretation or analysis.

analysis includes existing, published Forest Service land management plans (see Current Management Direction section); Forest Service Research and Development publications; and the Natural Resources Manager (NRM) Heritage Web/Mobile – an official agency system of record for spatial and tabular information on Tribal Sacred Sites. The Forest Service also relies on NRM natural database for information shared with Tribal permission about Treaty Rights, but this information is limited to resources of Tribal concern or places of Tribal Importance. Information from Forest Service Tribal Relations specialists (e.g., at the Forest Service Washington Office and at the local, unit-level), who collaborate with tribal members directly, are additional sources of information. The information available at a national scale is incomplete and the old-growth amendment requires additional, official Tribal consultation with line officers at the unit level to identify Treaty Rights resources, sacred sites, and Places of Tribal Importance that may be affected by the proposed action.

The Forest Service is not aware of all sites, interests, or areas of Tribal Importance. The Forest Service relies on its relationships and consultation with federally recognized Tribes and Alaska Native Corporations to be informed of where and what interests may be impacted by Forest Service proposed actions. The consultation process affords both Tribes and the Forest Service opportunities to identify sites, interests, and values of Tribal importance, as well as to identify mitigation and/or opportunities for avoidance, as well as protective measures to preserve Tribal interests.

3. Eco-cultural Resources

Because Tribal worldviews emphasize that humans are an integral part of the natural world and dependent upon reciprocal relationships with its inhabitants, there is a need to identify and consider interconnections among tribal communities and their environment within a larger socioecological system (Anderson 2005, Heyd and Brooks 2009, Long et al 2018). The term “eco-cultural” recognizes the need for ecological and cultural integration in restoration, characterizing interactions between tribal people and their environment (Harris and Harper 2000, Lake et al. 2010, Rogers-Martinez 1992, Tomblin 2009).

Tribes regard many plants, fungi, animals, and other items as important for material use as foods, medicines, and ceremony, but also for nonmaterial values, including sense of place, sacredness, and other dimensions of cultural significance (Burger et al. 2008). Phrases such as “ecosystem services,” “cultural ecosystem services,” or “Eco-Cultural Resources Management Plan” encompass both subsistence values and nonmaterial values important to native peoples (Burger et al. 2008, Long et al 2018, Schröter et al. 2014). In many Tribal Communities, plants and other resources such as water, are also valued as sovereign persons and not just as commodities (Kimmerer 2021:32).

Cultural Keystone species and Tribal legally protected species can also serve as Indigenous Knowledge measurement indicators. Tribes have identified Keystone (also referred to as Cultural Keystone) species that are important for cultural identity, as a Treaty resource, or reinforce Tribal sovereignty. Cultural Keystone species are plants or animals that contribute to the contextual foundation of a culture. These species have fundamental roles in Indigenous food systems, diet, and medicine. Cultural Keystone species feature prominently in the language, ceremonies, and narratives of native peoples and can be considered cultural icons (Garibaldi and Turner 2004). Some examples of Cultural Keystone species for Native American cultures of North America may include western red-cedar (*Thuja plicata*), juniper (*Juniperus occidentalis*), paper birch (*Betula papyrifera*), wild blueberry (*Vaccinium angustfolium*), or river cane (*Arundinaria gigantea*). Tribes have concerns about the quantity, health, and sustainability of Cultural Keystone species or species (beings) that are associated with older forest. There is a desire to have further cooperation between Tribes and the Forest Service to identify and protect Tribally-important keystone species.

4. Defining Old-growth

The National Forest System stewards approximately 149 million acres of woodlands and forests from Alaska to Florida (Oswalt et al. 2019). These forests look dramatically different from coast to coast, from region to region, and from forest to forest. Furthermore, they provide vastly different ecosystem services and values. Echoing the vast variation in forest types, older forests vary across the United States. Consider the dissimilarity between old-growth sequoias in California that can be over a thousand years old and upwards of 250-feet tall with a 30-foot diameter trunk and an old-growth stand of dwarf pitch pine in New Jersey that may be hundreds of years old, roughly 14-feet tall and only several inches in diameter. This variation underscores the complexity of both nationally defining old-growth and setting criteria for identifying where old-growth forests occur.

Throughout this document, we make a distinction between old-growth *definitions* and old-growth *criteria*. Old-growth definitions refer to the narrative frameworks that describe how old-growth differs from earlier stages of forest development. Old-growth definitions are generally qualitative, nuanced, and honor the multi-dimensional nature of old-growth forests. Definitions can capture both structural and functional characteristics of old-growth forests and illustrate the meaningful differences between old-growth and other forest development stages, as well as differences among old-growth types. Old-growth criteria – also referred to as “working definitions” in the *Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management* technical report (USDA and USDI 2023) – on the other hand, are the quantitative elements of the definition necessary to distill the complexity of old-growth definitions into straightforward, unambiguous, operational terms. Old-growth criteria generally consist of a minimum tree size and a minimum stand age and may include other metrics like a minimum density. The simplification of old-growth definitions into criteria is necessary to provide both unit managers and the public a shared understanding of exactly which stands should be managed as old-growth forest. The use of simplified criteria is also necessary to effectively inventory and monitor old-growth forest. However, old-growth criteria – like any categorical simplification of a complex ecological phenomenon – have limitations. Systematic application of the criteria will sometimes include areas that do not “feel” like old-growth and also exclude areas that effectively function as old-growth forest. While the narrative definitions provide a comprehensive and nuanced view of what constitutes old-growth forest, criteria offer a simplified and quantifiable approach for practical management and monitoring purposes. Both aspects are essential for ensuring the conservation and sustainable management of old-growth forests.

In addition to unique ecological attributes, old-growth forests are distinguished by ecosystem services such as water quality enhancement and provisioning; carbon storage; and social, cultural, and economic values. Old-growth forests have relationship-based meanings tied to cultural identity and heritage; local economies and ways of life; traditional and subsistence uses; aesthetic, spiritual, and recreational experiences; and Tribal and Indigenous histories, cultures, and practices. These varied values add to the complexity of establishing both a general definition of old-growth forest and criteria necessary for mindful stewardship (Helms 2004, Wirth et al. 2009, Pesklevits et al. 2011, Gray et al. 2023).

Early attempts at defining old-growth date back to the 1940s when the term was used to differentiate slower-growing older forests from apparently faster-growing younger forests (Andrews and Cowlin

1940). By the late 1980s, Thomas et al. (1988), working with an interagency group, concluded that old-growth forest was best perceived as "a stage of forest development characterized by more diversity of structure and function than that found in younger successional stages." There is a scientific consensus that a single definition or set of inventory criteria for old-growth is not desirable because the specific features that set old-growth forest apart from earlier developmental stages differ by forest type and even across the geographic range of individual forest types (USDA and USDI 2023).

In 1989, former Forest Service Chief Dale Robertson established a narrative definition for old-growth forest and directed the National Forest System and Research and Development (RD) to identify criteria to identify old-growth forest for each major forest type in each Forest Service region. The generic definition of old-growth forest in Chief Robertson's 1989 memo read:

> *Old-growth forests are ecosystems distinguished by old trees and related structural attributes. Old-growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics which may include tree size, accumulations of large dead woody material, number of canopy layers, species composition, and ecosystem function" (U.S. Department of Agriculture, Forest Service 1989).*

Building from the 1989 memo, RD published a series of General Technical Reports (GTRs) or similar publications (e.g., Region 5 developed several white papers) documenting more detailed old-growth definitions and associated criteria for dominant forest types in each National Forest System region. These publications formed the basis for management and public dialogue as old-growth definitions and criteria were frequently incorporated into land management plans or associated analysis documents.

4.1 Old-growth forest types

Forest and grassland managers, whether within the National Forest System or another organization, employ a wide range of classification schemes to differentiate forest types. The effectiveness of a particular classification scheme depends on the application. The spatial extent of consideration, relevance of existing versus potential vegetation, audience for the classification, and local traditions all inform the system for naming forest types. Regional definitions for old-growth forest (Table 1) use a variety of approaches to classify forests. For instance, Region 1 uses existing and potential vegetation groupings differentiated by geographic zones (Green et al. 1992), while Region 2 classifies old-growth forests by existing vegetation (Mehl 1992). Differences among regions reflect pragmatic choices to apply forest classification systems based on those used by local land managers and the public. The nine Forest Service regions have identified approximately 200 old-growth forest types. These 200 types were further classified into 80 groups with at least ten records per group to allow for more robust estimates (USDA Forest Service 2023; Woodall et al. 2023). The original 200 vegetation types and subsequent groupings can be found in Appendix 1. Both Pelz et al. (2023: Appendix A Supplementary data) and the *Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management* technical report (USDA and USDI 2023: Appendix 1) provide summaries of the old-growth forest types (and definitions and criteria) used at the initiation of Executive Order 14072.

Table 1. Joint National Forest System and Research and Development products developed in response to Forest Service Chief Robertson's directive to develop old-growth forest definitions and criteria. This set of citations represents the initial products developed for each Region. Some Regions subsequently developed new guidance during forest plan revision, particularly the Southwestern, Pacific Southwest, Pacific Northwest, and Alaska Regions.

Region	Citation
1 - Northern Region	Green (1992)
2 - Rocky Mountain Region	Mehl (1992)
3 - Southwestern Region	Popp et al. (1992), USDA Forest Service (2019, 2022)[2]
4 - Intermountain Region	Hamilton (1993)
5 - Pacific Southwest Region	Beardsley and Warbington (1996)
6 - Pacific Northwest Region	USDA Forest Service (1993), Davis et al. (2022)[1]
8 - Southern Region	Gaines (1997), Tyrell (1998)
9 - Eastern Region	Tyrell (1998)
10 - Alaska	Boughton (1992a), Boughton (1992b, Suring (2011)[3]

4.2 Old-growth forest definitions and criteria

Regional old-growth criteria use structural characteristics and include an attribute that captures the abundance of large trees, specifically, minimum live trees per acre of a minimum size and/or minimum basal area of live trees. Many regional criteria also set a minimum stand age or tree age, and some include standing snags or downed wood. Each region recognizes important ecological variation by defining unique old-growth criteria for different vegetation types. Pelz et al. (2023: Table 2) provide a summary of old-growth forest structural criteria used in each region, reflecting forest structure in April 2023 (Table 2).

Table 2. Elements of National Forest System regional old-growth forest criteria, by region, applied to FIA data (USDA and USDI 2023). Region 6 has two sets of 'old forest' definitions: one for the Northwest Forest Plan (NWFP) area and another for other lands. All elements shown are applied as minimum criteria. (Quadratic Mean Diameter = QMD; Stand Density Index = SDI.)

NFS Region	Old and large tree density	Large tree density	Tree or stand age	Stand basal area	Dead tree density (of a certain size)	Density of trees with decay	% total SDI from trees ≥ 45.7 cm diameter	QMD of trees ≥ 25.4 cm diameter	Down wood cover	Diameter diversity
Northern	X	X*	X*	X						
Rocky Mountain	X	X*	X*		X	X				
Southwestern							X	X		
Intermountain	X	X*	X*							
Pacific Southwest		X	X							
Pacific Northwest (NWFP)		X			X				X	X

[2] Sources used to revise old-growth forest criteria.
[3] Description of old-growth classification.

NFS Region	Old and large tree density	Large tree density	Tree or stand age	Stand basal area	Dead tree density (of a certain size)	Density of trees with decay	% total SDI from trees ≥ 45.7 cm diameter	QMD of trees ≥ 25.4 cm diameter	Down wood cover	Diameter diversity
Pacific Northwest (other)		X	X							
Southern		X	X	X	X					
Eastern		X	X							
Alaska		X	X		X					

*As part of the 'density of trees that are old and large' element

Regional and planning unit old-growth definitions exhibit broad variation in criteria and these differ among forest types and for the same forest type across regions or planning units. Old-growth forest criteria differ geographically for the same forest type, as described below, because of fundamental differences in developmental processes between forests. Forests we observe as old-growth forest are the outcome of ecosystem development and aging. The pattern of aging differs based on forest type, site productivity, and disturbance regime. Site productivity is influenced by soil conditions, precipitation amount and variability, length of growing season, and disturbance history. Each of these factors influence the characteristic pattern of forest development and interact with one another, resulting in multiple patterns of forest development (aging) and tree growth, even within a forest type. For instance, interior Douglas-fir on the front range of Colorado grows slowly (poor granitic soils, dry climate with a short growing season) and experiences relatively infrequent fire (Visty 2005). In contrast, maritime Douglas-fir forest in northern Idaho experiences modest moisture, a long growing season, and more variable fire frequency resulting in very different structural characteristics when it transitions from stem-exclusion (mature) to old-growth forest (Green et al. 2011).

Hence, the variety of criteria reflects dramatic differences in the forest structure expected among old-growth types. For instance, Western Hemlock/Alaska Yellow Cedar ecosystems (*stand age over 150 years, 26 trees/acre greater than 15 inches diameter at breast height*) versus Limber pine in Utah (*stand age over 500 years, 16 trees/acre greater than 10 inches diameter at breast height*) (USDA and USDI 2023). The regional criteria to identify old-growth forests across North America reflect the application of extensive scientific investigation (Table 1; USDA and USDI 2023). These criteria echo the methodical synthesis of extensive field measurements and summary of plot data published in over a dozen scientific reports (Table 2).

4.3 National old-growth forest inventory definitions and criteria

In response to Executive Order 14072, the *Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management* technical report (USDA and USDI 2023, Pelz et al. 2023) used old-growth forest definitions from 1989 and regional criteria documented in the GTRs as the foundation for the first, nationally consistent inventory of old-growth forest on all National Forest System lands (Table 1). The objective of the old-growth inventory report (link above) was to provide a consistent, national-scale estimate of old-growth forest extent across all National Forest System and Bureau of Land Management lands. To do so, the national inventory estimates were based on FIA plot data – a peer-reviewed and widely accepted sampling protocol (Bechtold et al. 2005, Burril et al. 2021, Westfall et al. 2022). Using FIA data allowed the national inventory to provide a measure of uncertainty in the estimates. The national inventory team worked with Forest Service regional staff to determine how to apply regional definition criteria to FIA field-plot data for this initial national-scale inventory. Wherever possible, the national inventory applied existing regional criteria (citations in Table 6.1); in some cases, the regional criteria were adjusted to accommodate use of the FIA data.

Pelz et al. (2023) and USDA and USDI (2023) outline the definition framework and criteria applied to FIA plot data to estimate the extent of mature and old-growth forest on National Forest System and Bureau of Land Management lands. Tables listing the old-growth definitions and criteria applied to FIA data by region can be found in Appendix 1 of the *Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management* technical report (USDA and USDI 2023) and in Pelz et al. (2023: Appendix A Supplementary data). The same definitions, criteria, and methods used in the published national inventory form the basis for analysis of the proposed action and alternatives in this EIS. Currently, as described in the Current management direction section, old-growth definitions vary by unit within regions, as previously discussed.

4.4 Influence of patch size on identifying old-growth forest

The minimum patch size of an "old-growth forest" must be sufficient to function as an ecological unit consisting of many trees recognized as sufficiently similar at a broad spatial extent to be a forest. Consequently, given the extreme variation among forest types in horizontal patterning of stands, a minimum patch size for old-growth forest will differ by forest type. This variation in the spatial extent at which old-growth forest features manifest is a consequence of ecological scaling, which is strongly influenced by disturbance regime (intensity, extent, frequency), intra- and between-patch heterogeneity (consider the variation in tree species, tree size, and other structural or composition features along a horizontal transect), and even the size of individual trees (see definition of forest) (e.g., Wiens 1989). Hence, the minimum patch size for old-growth in a longleaf pine forest will differ from a mesic hardwood or cypress-tupelo forest ecosystem. Given the infrequency of canopy-removing disturbance and lower horizontal structural diversity, the mesic hardwood and cypress-tupelo old-growth forest manifest characteristics old-growth features at a smaller spatial scale than longleaf pine, which experiences frequent fire and exhibits substantial horizontal structural diversity. A recreationist walking through similar size patches of these different forests would likely recognize the difference in extent needed to exhibit old-growth characteristics.

Spatial simulation of historical landscape patterns has demonstrated the importance of large old-growth patches as crucial habitat for species such as the northern spotted owl and as refugia for disturbance-sensitive species (Wimberly 2002). The structure and microclimate of old-growth forests are altered along edges, highlighting the importance of maintaining large interior old-growth habitat. However, the definition of the size of old-growth patches has been suggested to be reduced to a scale of an individual large old tree, emphasizing the importance of fine-scale features within old-growth forests (Lindenmayer and Taylor 2020). Additionally, despite their small size and isolation, small patches of old-growth can serve as refugia for biodiversity and provide multiple ecosystem services, highlighting the ecological significance of small patches.

Because of the difficulty in identifying minimum patch size for different old-growth forest types, no national criteria are available to set minima for this analysis. Therefore, this analysis will not attempt to set minimum patch size, although we acknowledge that a handful of old trees in an area do not make an old-growth forest. Developing objective protocols to identify minimum patch size during development of adaptive strategies will be critical (see Appendix D, Adaptive Strategy for Old-Growth Conservation Framework, for the Draft EIS,). The process requires local information and will benefit from input from Indigenous communities and other participants.

5. Ecosystem Services

5.1 Biodiversity

Old-growth forests contain a diverse array of plant and animal communities, including many that are rare or absent in younger forests. This diversity plays a key role in maintaining ecosystem function, resilience, and the ability of old-growth to deliver other ecosystem services. Old-growth forests support high levels of biodiversity due to complex structure, with features like large trees, diverse understory vegetation, and abundant dead wood creating a wide range of ecological niches and microhabitats (Brockerhoff et al. 2017).

Tree cavities, generally carved by woodpeckers, are one example of a key habitat for a variety of forest species and are generally found in greater numbers in old-growth forests. The number and diversity of cavity formation agents and cavity users increase as forests age, leading to increases in both taxonomic and functional diversity (Cadieux et al. 2023).

Lichen diversity is also often significantly higher in old-growth forests (Esseen et al. 1996). The temporal continuity of high-quality ecological conditions for the maintenance of lichen communities, including epiphytic lichens, is well-established. For instance, it has been extensively documented that old-growth forests, as well as mature forests, host significantly higher diversity and more rare lichen species compared to younger and more disturbed forests (Lesica et al. 1991; Sillett et al. 2000 McMullin and Wiersma 2019). Lichens play important roles in nutrient cycling and provide food and habitat for other species. Some species such as *Lobaria oregana* (a canopy lichen) spread slowly and may take centuries to recolonize a forest (Marcot et al. 2018).

Fungi, including mycorrhizae, are also key components of old-growth forest biodiversity, contributing to nutrient cycling, decomposition of organic matter, and providing food for other organisms. Old-growth forests are recognized as an important reserve of fungal diversity for several fungal functional guilds, with a very large number of ectomycorrhizal species hosted in old-growth stands (Tomao et al. 2020). The diversity of fungi increases as forests age, with many species unique to old-growth stands. By maintaining high fungal diversity and higher microbial biomass (Zak et al. 1994), old-growth forests help sustain ecosystem integrity and contribute to nutrient cycling.

Old-growth develops along a wide variety of successional pathways, including trajectories following minor and some major disturbances. As a result, old-growth forests on National Forest System lands show regional differences in biodiversity related to differences in climate, disturbance history, site productivity, and species composition. These multiple pathways are significant because each leads to a unique diversity of plant and animal communities, which maintain ecosystem function, sustain higher broad-scale diversity, and foster resilience. In turn, this diversity contributes to maintaining processes like nutrient cycling, carbon uptake and storage, and water regulation – as discussed below.

Riparian areas are ecotones between terrestrial and aquatic ecosystems. Despite their somewhat limited extent, riparian areas often contribute disproportionately to overall watershed biodiversity, productivity, and water quality. Old-growth riparian forests have been identified as biodiversity hotspots and are capable of rapid carbon uptake and storage, making them particularly valuable ecosystems for conservation and restoration efforts (Dybala et al., 2018). They provide in-stream habitat features such as large natural dams that are not widely found in younger forests but are critical for aquatic insects and other invertebrates (Keeton et al. 2007, Franklin et al. 2001). Some old-growth riparian areas require active management to restore species composition and structure to reference conditions (Goebel et al. 2012, Keeton et al. 2007).

Forests that contain early-, mid- and late-seral vegetation stages also provide a wide range of biodiversity conditions that may not be found in, or provided by, old-growth forests. Many species rely on a combination of different seral vegetation stages for different parts of their lifecycle and the use of each seral stage differs based on the species. Therefore, maintaining a mosaic of old-growth forests and forests of different ages (stages in forest development) and seral stages is crucial for preserving a broad spectrum of plant and animal communities and associated ecological integrity across broad areas.

5.2 Water Resources

Water is one of the most important natural resources flowing from forestlands. Water yield (i.e., quantity) from a forest is determined by the amount of precipitation minus evapotranspiration and water stored in the soil. Water yield specifically from old-growth forests on National Forest System lands is largely unknown and highly variable but general principles apply. For example, tree root channels created by trees can serve as flow paths for water infiltration, enhancing soil permeability and promoting groundwater recharge. Old-growth forests can also intercept and transpire precipitation, influence snowmelt timing, and modulate the quantity and timing of stream flow. In certain forest types such as coast redwood and pine forests from central California and Oregon, fog drip can be a significant contributor to soil moisture (Dawson, 1998, Ingwersen 1985). Perry and Jones (2016) found daily streamflow from basins within young plantations of Douglas-fir was 50 percent lower than streamflow originating from reference basins with older forests.

Old-growth forests also contribute to water quality. Forested watersheds provide the highest quality and most stable water supplies compared to other land uses in North America (Caldwell et al. 2023, Brown et al. 2008, Liu et al. 2021, Murphy et al. 2020). In general, the greater the forest coverage in a watershed, the higher the water quality (Brogna et al. 2017, Duffy et al. 2020). Overland flow and stream channel erosion rates are typically lower in forested watersheds (Neary et al., 2009), resulting in lower sediment concentrations in streams and lower concentrations of other pollutants associated with developed or agricultural lands (Lockaby et al. 2013). Undisturbed forest, which is a common condition in old-growth, often has the highest water quality (Fredriksen, 1971) since old-growth forests are highly retentive of nutrients in both living biomass and dead organic material. The release of nutrients from dead organic materials is typically slow; nutrients are tightly retained within the old-growth forest ecosystem. Fredriksen (1972) and Sollins et al. (1980) noted that, in old-growth contexts, only small amounts of nutrients leach into groundwater and are subsequently delivered to streams. They attribute this to the nutrient-conservative condition of old-growth forests.

There is also a Tribal concern for sufficient quantity and improved water quality associated with old-growth. For example, Great Lakes Indian Fish and Wildlife Commission identified and shared older forest characteristics important to water, water bodies, and watersheds that include, "High level of water retention, groundwater recharge, high water quality and watershed resiliency due to: 1) Thick organic duff; 2) Dense root mat; 3) Well-developed soil A horizon; and 4) Multi-layered canopy (Jason Schlender, Executive Administrator, May 24, 2024).

5.3 Carbon

Biogenic carbon uptake and storage are among the essential ecosystem services that our nation's forests and grasslands provide (2012 Planning Rule, 36 CFR Part 219). Mature and old-growth forests provide a nature-based climate solution by storing large amounts of biogenic carbon over long time periods (Executive Order 14072). Carbon stewardship involves the intentional consideration of carbon uptake, storage, or stability. Careful stewardship of carbon uptake and its long-term storage and stability in ecosystems contributes to maintaining ecological integrity and fostering climate resilience. Older forests take up carbon more slowly than younger forests, but longer periods of carbon accumulation (increased carbon stability) mean that these forests have higher carbon stocks, especially in forest floor and downed woody debris components (Hoover et al. 2012; Hoover and Smith, 2023; Gray et al. 2016). Mature and old-growth soils in most temperate forest ecosystems also contain a high proportion of the total biogenic carbon. The soil organic carbon pool may be relatively stable even with disturbance (Nave et al. 2010; Nave et al. 2021; Nave et al. 2022) and this can contribute to natural climate solutions (Bossio et al. 2020).

5.3.1 Background

Regulatory Considerations

The Council on Environmental Quality (CEQ) *National Environmental Policy Act (NEPA) Guidance on Consideration of Greenhouse Gas (GHG) Emissions and Climate Change* (published January 9, 2023) provides recommendations that pertain to land and resource management plans and projects, including associated environmental analysis documentation. This guidance includes the recommendation that agencies consider the projected GHG emissions or reductions for proposed actions and their reasonable alternatives (Section IV) and use this information to assess potential climate change effects (Section V). The CEQ guidance and regulations also advises agencies to assess the potential future state of the affected environment in NEPA analyses (Section VI), including considering the impacts of climate change on project actions and alternatives (for more information on incorporating climate change into NEPA Environmental Analysis, see Brandt and Schultz 2016). To do so, it recommends the use of the best available information and science, including relevant data and quantification tools where appropriate, to guide these analyses. The CEQ advises that agencies should be guided by a rule of reason and the concept of proportionality in determining the appropriate depth of analysis. This includes recognition of the inherent complexities and uncertainties associated with analyzing projected fluctuations in biogenic carbon associated with land and resource management plans and actions under uncertain future climate conditions – and this would include carbon in old-growth forest ecosystems. Several components of this guidance were codified within the National Environmental Policy Act Implementing Regulations Revisions Phase 2 on May 1, 2024 as required directives, while all other regulatory considerations related to climate and carbon remain recommended.

Carbon Considerations in Forest Ecosystems

Forests are dynamic ecosystems that undergo fluctuations in biogenic carbon as they establish, grow, die, and regenerate. Forest plants remove carbon dioxide from the atmosphere and store some of it as biomass. Forest managers, policymakers, and scientists typically consider 50 percent of wood biomass by dry weight in trees as carbon. Carbon uptake and storage from the atmosphere help to modulate greenhouse gas concentrations. The rate of carbon uptake by plants from the atmosphere is influenced by many factors, including natural disturbance, management, forest age, successional pathways, climate, environmental factors, and availability of water and nutrients.

The long-term capacity of forest ecosystems to sequester and store carbon depends in large part on their health, productivity, resilience, and adaptability to changing conditions. Major factors influencing the long-term capacity of forest ecosystems to sequester and store carbon include: 1) forest age: younger forests generally have higher rates of carbon uptake and storage, while older forests have greater carbon stocks; 2) forest structure and diversity: forests with more complex structure are generally more resilient and better able to acclimate and adapt to changing conditions; 3) disturbance regimes: disturbance intensity and frequency vary across forest ecosystems, from individual tree-based gap dynamics to landscapes characterized by large, high severity, stand-replacing wildfires at low to high frequencies; a forest's disturbance dynamics will affect its carbon uptake and storage rates and total carbon stocks over time; and 4) land cover type changes: across all ownerships in the conterminous United States, within the land sector, forest land has the greatest capacity to gain and store carbon. Conversion of forest land to non-forest land is the largest source of carbon losses (Vance 2018).

Forest Aging

Trends in aging of forest stands impact future carbon trends. As stands age, growth rates tend to decline, resulting in declining rates of carbon uptake. However, although live biomass may be approaching peak levels in mid-aged stands, ecosystem carbon stocks typically continue to increase with increasing stand age, as dead organic matter and soil carbon stocks accumulate (Pregitzer and Euskirchen 2004). Some forest types remain carbon sinks for many decades. The trajectory of carbon stocks depends on the balance of net primary productivity with respiration. Past and present aging trends can inform future conditions; however, their applicability may be limited, because potential changes in management activities, disturbance, and future climate are likely to affect future stand age distributions and forest growth rates (Davis et al. 2009; Keyser & Zarnoch, 2012).

5.3.2 Current Forest Carbon Status and Recent Dynamics

Old-growth forest has not typically been singled out for analysis of broad-scale carbon stocks and dynamics. In recent decades, carbon stocks in forests in the United States have increased greatly (Domke et al. 2023b). There are indications, however, that this carbon sink strength, or the rate of carbon uptake, may be reduced in the future, via deforestation from land use conversion, insects and disease (Quirion et al. 2021), wildfire, and climate change effects (Domke et al. 2023a, Hogan et al. 2024). Although there is high variability across landscapes and forest types, and uncertainty in estimates, rates of carbon capture tend to be higher for younger stand ages, with older forests having lower rates of uptake but the highest carbon stock amounts, from relatively long time periods of uptake and storage (Figure 1).

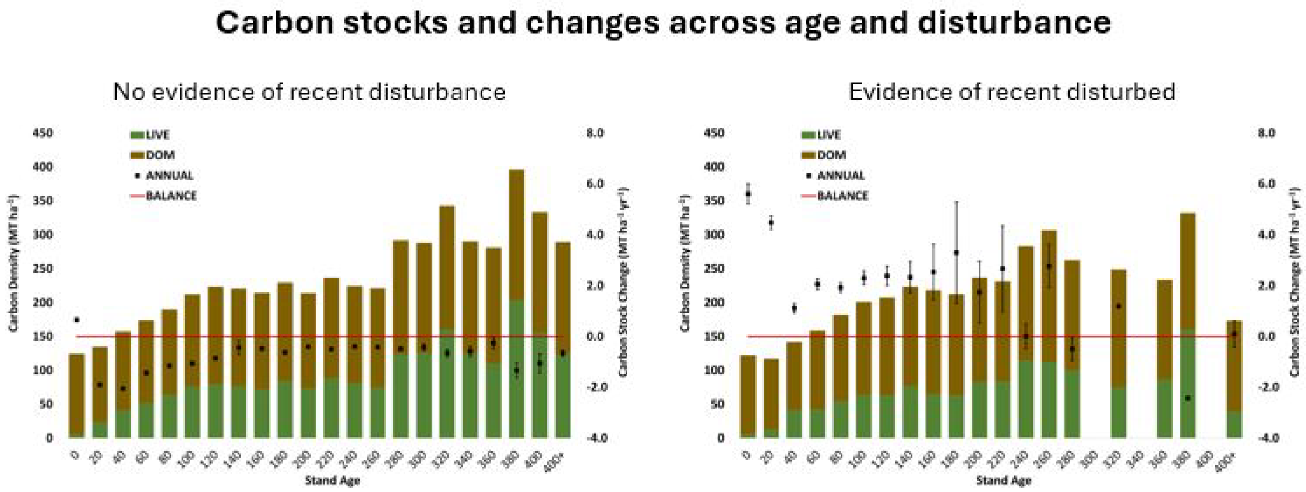

Figure 1: Carbon stocks and changes across stand ages without and with evidence of disturbance (Domke et al. in prep a, b)

Science and modeling efforts are underway to reduce uncertainties in these estimates in the context of carbon stewardship, carbon resilience, and carbon stability. Forest carbon stocks have increased over 5 billion metric tons over the reporting period, even while the forest land base is relatively stable (Domke et al. 2023b), indicating U.S. forests are denser. Estimates indicate that the rate of change in net carbon uptake was greater in 1990 than more recently, thereby suggesting slowing in the carbon sink. In the United States, warming temperatures and changing precipitation patterns combined with increased disturbances put at risk the capacity of forests to store carbon and provide ecosystem benefits, such as water and wildlife habitat (Stanke et al. 2021, Domke et al. 2023a, Hogan et al. 2024).

The Forest Inventory and Analysis program (FIA) includes a variable known as stand age (STDAGE) in the publicly available database (USDA Forest Service, 2023), which allows for examination of carbon stocks and changes in those stocks, in the context of stand development. Even with uncertainties inherent in the variable in uneven-aged stands, the stand age attribute may be used as an indicator of time since the largest disturbance in a system. Increases in time since large disturbance are associated with increases in tree size and associated biomass and related carbon, as well as carbon accrual in soils and dead wood pools. Carbon density continues to increase with stand age beyond 300 years (Figure 1, Domke et al. in prep a). Net uptake is stronger for younger forests, but net uptake continues in stands of advanced ages, well past 300 years. Without recent disturbance carbon accrual continues, but with recently disturbed forests, the annual balance of carbon shifts from live to dead pools, and forests above 60-80 years can become net emitters of carbon (Figure 1).

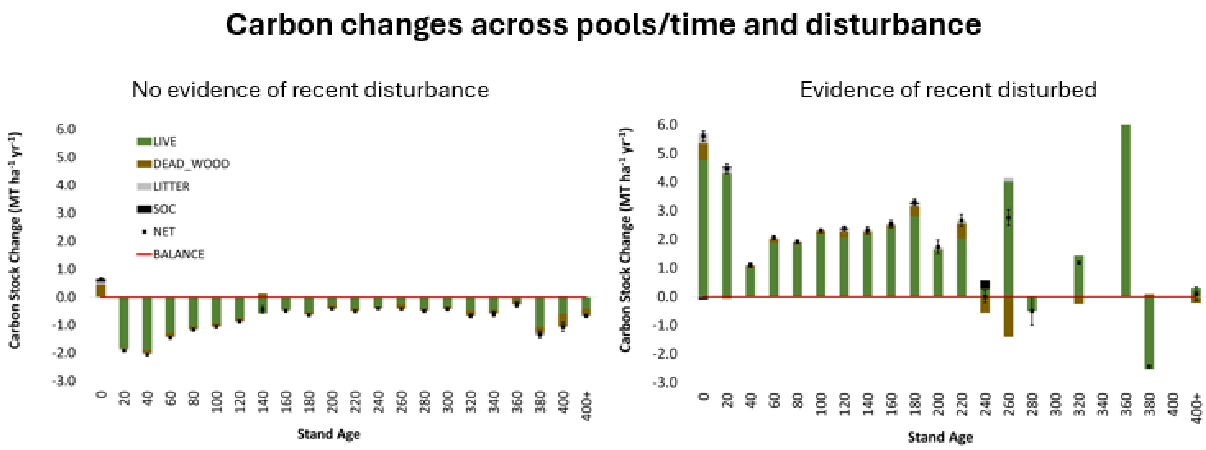

Figure 2: Carbon changes across pools/time and disturbance (Domke et al. in prep a, b)

Disturbance causes a shift from live to dead pools. In the absence of recent disturbance carbon accrues in live pools (Figure 2a). As stand ages advance, dead wood begins to accrue resulting from stand developmental processes. With natural disturbance, live organic material transfers to dead wood pools (Figure 2b). With climate change-related stressors such as drought, vapor pressure deficit, increased temperature, wind, wildfire, and insect outbreaks, demographic rates may shift, leading to changes in forest composition and shifts to eventual older forests that are comprised by novel ecosystem types (Domke et al. in prep a, b; McDowell et al. 2020), that may alter rates of carbon uptake and the associated capacity for long-term carbon storage.

5.3.3 Climate Change and Environmental Effects on Potential Future Old-growth Carbon Dynamics

Climate change introduces additional uncertainty about how forests—including the stability of old-growth forest carbon uptake and storage—may change in the future due to climate-exacerbated risks from stress, insects, and fire (Anderegg et al. 2022; Wu et al. 2023). Climate change results in many direct changes to the local environment, such as changes in temperature and precipitation (Matthews et al. 2018) and indirect changes to many ecosystem processes (Vose et al. 2012). The uncertain level of resilience of individual tree species in response to climate change (Baker et al. 2023; Clark et al. 2023) and expected disturbance rate increases also make it challenging to use past trends to project the effects of disturbance, aging, and tree regeneration on forest carbon dynamics (Anderegg et al. 2020, 2022; Davis et al. 2023), including old-growth forests.

The myriad effects of disturbance, aging, climate change, nitrogen deposition, and CO_2 fertilization are likely to affect carbon uptake and storage amounts of forest carbon and may also modify the rate of change in carbon stocks. Temperature and precipitation fluctuations also impact carbon stocks and fluxes. Warmer temperatures can increase forest carbon emissions through enhanced soil microbial activity and higher respiration (Ju et al. 2007; Melillo et al. 2017). However, warming temperatures may reduce soil moisture via increased evapotranspiration, leading to slower carbon uptake and storage (Ju et al. 2007; Melillo et al. 2017, especially in semi-arid and low elevation forests (Xu et al. 2013). Forest ecosystems, including old-growth forest ecosystems, may initially respond to increased atmospheric CO2 with higher carbon uptake rates related to increased productivity and growth; the effect, however, may be greatly diminished or lost within five years (Zhu et al. 2016), can be limited by nitrogen and other nutrient availability (Norby et al. 2010) and requires additional research (Körner et al. 2005; Norby et al. 2010; Zhu et al. 2016). Warmer temperatures can increase carbon emissions via increased respiration and soil microbial activity; soil moisture decreases via increased evapotranspiration, especially in semi-arid and low-elevation forests, may result in slower forest growth and carbon uptake; drought-stressed trees may be more susceptible to insects and pathogens (Dukes et al. 2009), which can both reduce carbon uptake (Kurz et al. 2008; D'Amato et al. 2011) and increase emissions. Forest regeneration failure associated with climate change, and warming temperatures may also reduce soil carbon stocks (Nave et al. 2022). Changes in temperature and precipitation may impact soil organic carbon as well by affecting organic matter inputs and decomposition rates (Clark et al. 2016; D'Amore and Kane 2016). Soil microbial activity, which contributes to soil organic carbon formation, may alter via shifts in soil temperature and moisture, especially in water-limited ecosystems (Alster et al. 2016; Lybrand et al. 2016). The effects that temperature and precipitation impose on soil carbon vary (Nave et al. 2021b) and depend on local and regional soil type and vegetation composition (Nave et al. 2021a). All these factors have implications for the potential for instabilities in old-growth forest carbon stores and dynamics.

6. Status and trend of old-growth ecosystems

In this section, we discuss the current status and recent trends of old-growth forests. We focus on the following key characteristics and questions:

1. **Extent** – How much old-growth is there currently at the national, regional and unit scales for National Forest System lands?
2. **Ecosystem Diversity** – How well represented are different ecological types of old-growth?
3. **Structure and Composition** – What is the current ecological condition of old-growth forests?
4. **Spatial Distribution** – What is known about the configuration of old-growth and how does it relate to ecological integrity?
5. **Recent Change** – How has the amount of old-growth changed in the last 10-20 years and why? and;
6. **Future Projections** – How is the extent of old-growth forest expected to change in the coming decades?

6.1 Extent

In response to Executive Order 14072, '*Strengthening the Nation's Forests, Communities, and Local Economies*,' the USDA Forest Service conducted the Agency's first consistent inventory of old-growth forests on National Forest System lands (see *Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management* technical report) (USDA and USDI 2023). This national old-growth inventory relied on the forest inventory plot network collected by the Forest Inventory and Analysis (FIA) program, which is the primary source of information about the extent, condition, status, and trends of forest resources across the United States (Oswalt et al. 2019).

The national old-growth inventory estimates that there are approximately 24.7 million acres of old-growth forest on National Forest System (NFS) lands, comprising approximately 17 percent of total forested NFS lands. Notably, other recent studies offer lower estimates of old-growth forest extent than the USDA and USDI (2023) national inventory, based on different assumptions and methodologies. For example, Barnett et al. (2023) modeled forest carbon accumulation over time using saturating, non-linear growth models and DellaSalla et al. (2022) used data derived from remotely sensed biomass, tree height, and tree density information, while the national inventory relies on forest structural criteria on FIA plots. These differences underscore the importance of clearly articulating the assumptions made and methods used when defining and inventorying old-growth forests.

The national inventory found the amount of old-growth is highly uneven both within and among National Forest System regions (Figure 3). For example, approximately half of all old-growth occurs in just two of the nine regions: the Pacific Northwest and Alaska Regions. As noted by Pelz et al. (2023), the inventory underestimated the amount of old-growth in Alaska, where approximately 3.5 million acres of forested land was not included in the old-growth forest inventory due to challenges with access precluding effective application of FIA. In contrast, combined, the Southern and Eastern Regions contain only about five percent of the old-growth on National Forest System lands. Across regions, the extent of old-growth ranges from approximately three percent of the forested area in the Eastern Region to 27 percent of the forested area in the Pacific Northwest Region and 76 percent of the Alaska Region. Approximately 10–15 percent of forested lands in all other regions are classified as old-growth.

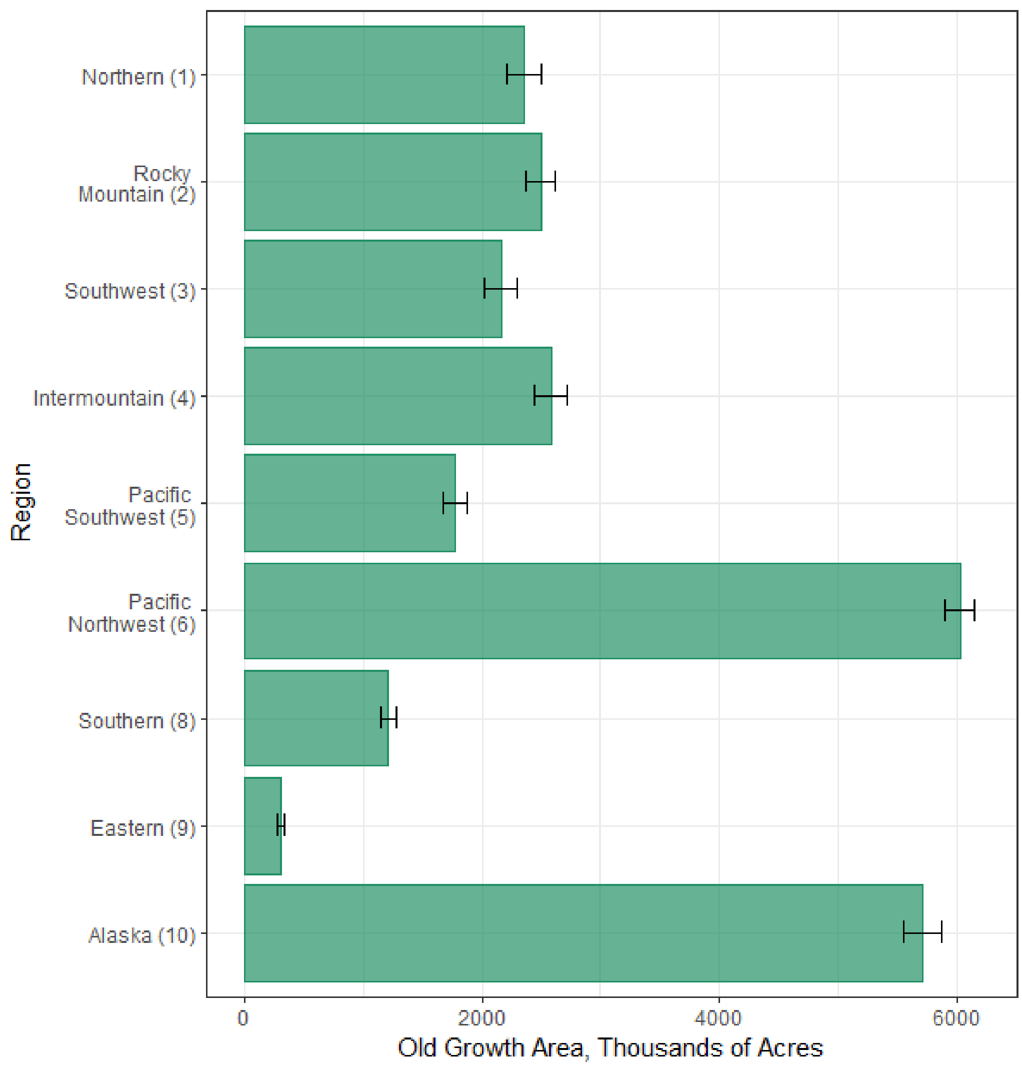

Figure 3. Estimated old-growth forest area (estimate and ±1 standard error) by Forest Service region

At the scale of individual National Forest System units, the national inventory data indicate a wide range of old-growth abundance, ranging from 83 percent of the forested area on the Chugach National Forest to less than one percent of several forests, including the Green Mountain and White Mountain National Forests of the Eastern Region. This wide range reflects numerous factors, including the diversity in ecosystems and history of land use of what are now National Forest System units. Overall, for approximately half of National Forest System units, less than 10 percent of forested land is classified as old-growth; 38 units contain 11–20 percent old-growth; 21 units include 21–50 percent old-growth and two units, the Tongass and Chugach National Forests in Alaska, include greater than 50 percent old-growth. Appendix 2 shows the estimated proportion of forested land classified as old-growth forest for each National Forest System unit.

Comparing the current and historical extent of an ecosystem is a common step in evaluating ecological integrity (Keith et al. 2013; Maes et al. 2020). This provides context for managing ecological systems and for identifying biodiversity values at risk when implementing forest management strategies (Wiens et al. 2012). Over the last 400 years, the extent of old-growth forests in the United States have experienced significant declines due to widespread timber harvest and land use changes (USDA and USDI 2023, DellaSala et al. 2022). In the United States, excluding Alaska, some studies estimate that old-growth has been reduced to less than 10 percent of its extent circa 1600 (Thomas et al. 1988; Spies and Franklin 1996). These studies suggest that the extent of old-growth has declined dramatically and, as such, its contribution to ecological integrity has diminished.

6.2 Ecosystem diversity

The Planning regulations (36 CFR 219.8) emphasize the importance of ensuring ecosystem diversity to conserve ecological integrity and biodiversity. Old-growth forests, often viewed as a single forest type, host a diverse array of plant and animal communities and develop along various pathways. Recognizing and stewarding this diversity of old-growth forests contributes to ecosystem stability, resilience, and the delivery of ecosystem services. Here we consider the representation of old-growth across two broad classifications: 1) forests with different disturbance regimes (i.e. frequent vs non-frequent fire); and 2) vegetation types (i.e. forests dominated by different species assemblages such as pinyon-juniper versus spruce-fir).

6.2.1 Disturbance regimes

One of the most important distinctions of forest ecosystems, including old-growth forests, is between forests that characteristically experience frequent, low-severity fires (with return intervals of 35 years or less, on average, i.e., FRG 1 and 2) and infrequent-fire forests (with average intervals greater than 35 years). Here, we group old-growth forest types into frequent-fire forests and infrequent-fire forests based on LANDFIRE Fire Regime Groups that describe presumed historic fire regimes based on vegetation dynamics, fire spread, fire effects, and spatial context.

Based on FIA data, forest types with frequent-fire regimes comprise just over half of National Forest System lands but include only 37 percent of the total old-growth. Specifically, across all National Forest System lands, approximately 72 million acres are classified as frequent-fire forests (Table 3), 13 percent of which is classified as old-growth. At the regional level, the proportion of old-growth in frequent-fire forests ranges from four percent in the Eastern Region to 18 percent in the Rocky Mountain Region.

By contrast, approximately 67 million acres of National Forest System forested land are infrequent fire regimes with approximately 23 percent classified as old-growth. Of the approximately 149,000 acres of land in infrequent fire regimes in the Eastern Region, only two percent is classified as old-growth. By contrast, 100 percent of the Alaska Region is classified as infrequent fire regime and 76 percent of the region is classified as old-growth. Table 3 shows the proportion of each region classified as frequent- versus infrequent-fire regime and the proportion of the area classified as old-growth.

Table 3. Proportion of frequent-fire versus infrequent-fire land by Forest Service region. Data source: Forest Inventory and Analysis (FIA) database, downloaded 7/25/2023. The classification of FIA plots as frequent- or infrequent-fire regime is based on the old-growth vegetation type.

Region	Total Forest Land: Frequent Fire Regime (1,000 acres)	Total Old Growth: Frequent Fire Regime (1,000 acres)	Precent of Frequent Fire Regime as Old Growth	Total Forest Land: Infrequent Fire Regime (1,000 acres)	Total Old Growth: Infrequent Fire Regime (1,000 acres)	Percent of Infrequent Fire Regime as Old Growth
All NFS Lands	72,102	9,172	13%	67,329	15,483	23%
Northern Region	6,819	504	7%	13,841	1,992	14%
Rocky Mountain Region	6,298	1,151	18%	8,132	1,327	16%
Southwestern Region	11,003	1,474	13%	4,223	629	15%
Intermountain Region	7,079	895	13%	13,156	1,733	13%
Pacific Southwest Region	12,697	1,610	13%	1,551	82	5%
Pacific Northwest Region	10,778	2,224	21%	11,421	3.809	33%
Southern Region	13,098	1,161	9%	-	-	-
Eastern Region	4,330	152	4%	7,459	149	2%
Alaska Region	-	-	-	7,547	5,764	76%

6.2.2 Vegetation types

To evaluate the representation of old-growth forests across different vegetation types, we utilized existing regional classifications of old-growth vegetation types, which were then applied to field plot data from FIA (USDA and USDI 2023; Pelz et al. 2023). The national inventory identified more than 200 unique forest vegetation types across all National Forest System regions. These types were further grouped into 80 categories, each containing at least 10 FIA plots to ensure robust estimates (USDA and USDI 2023; Woodall et al. 2023). The original 200 vegetation types and subsequent groupings can be found in the *Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management* technical report (USDA and USDI 2023: Appendix 1, Old-growth Vegetation Types). For detailed ecological descriptions of different types of old-growth forest refer to *20240603BASIRegionalOldGrowthSummary* in Miscellaneous Supporting Documents. Appendix 3 (in this report; Estimated Amount of Old-Growth Forest by Vegetation Type) shows the estimated amount of old-growth by vegetation type grouping based on FIA data.

Based on FIA data, the most common old-growth vegetation types are Mountain Hemlock and Sitka Spruce (Figure 4).

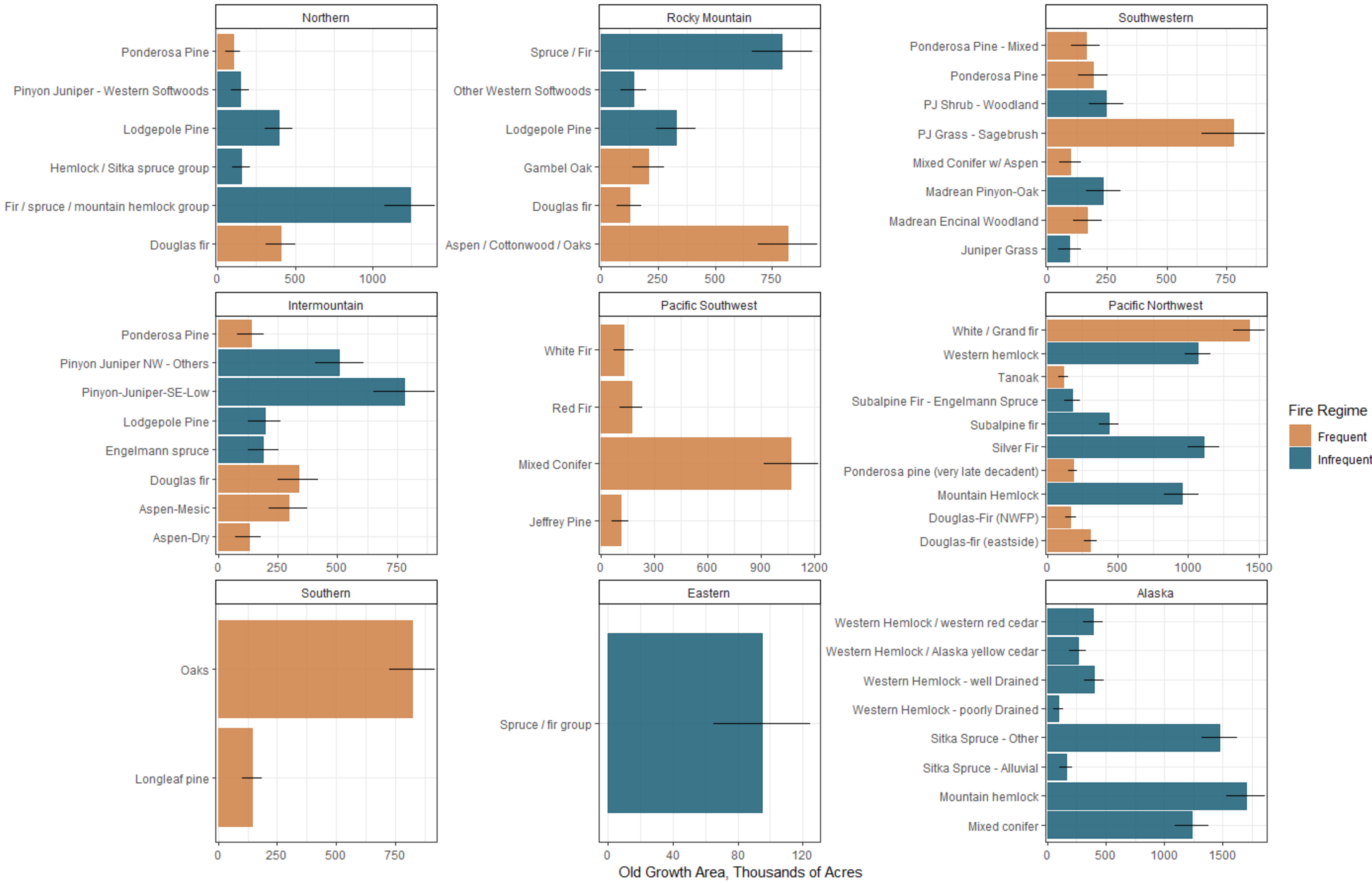

Figure 4. Thousands of acres of old-growth on National Forest System lands, by old-growth forest type grouping (see Appendix 1). Data source: FIA. Only forest types that had a total of at least 90,000 acres of old-growth are included.

Together, these two types include over three million acres of old-growth, which represents more than 70 percent of the extent of these types on National Forest System lands. Outside of Alaska, the White/Grand fir type in the Pacific Northwest and the Spruce/fir/mountain hemlock type in the Northern Region are also relatively abundant, representing approximately 1.4 million acres (26 percent of the forest type) and 1.2 million acres (17 percent of the forest type), respectively. The oak and longleaf pine forests in the Southern Region are also reasonably well represented with 822,000 acres (17 percent of the forest type) and 145,000 acres (20 percent of the forest type), respectively. Overall, approximately 30 of the 80 forest type groups contained at least 20 percent old-growth, as shown in Appendix 3. Estimated Amount of Old-growth Forest by Vegetation Type.

By contrast, 17 of the 80 vegetation types contained five percent or less old-growth forest, based on the FIA data. Some vegetation types, such as hardwood forests in the western United States, are naturally rare and, as such, national-scale data such as FIA are unlikely to detect old-growth in these systems. For other types, such as the Northern Hardwoods of the Eastern Region, FIA identified nearly six million acres of the forest type on National Forest System lands but only 54,000 acres of old-growth, or less than one percent. Similarly, out of an estimated four million acres of conifer forests (excluding longleaf pine) in the Southern Region, less than one percent was classified as old-growth. Conserving rare ecosystems, which often contain unique and vulnerable ecological elements and are frequently of special interest to local communities, presents a particularly important opportunity for conservation efforts in the United States.

6.3 Structure and composition

Forest structure encompasses the physical arrangement and organization of components within a forest ecosystem, including the spatial distribution of trees, canopy cover, tree height, understory vegetation, and the presence of dead wood. Assessing forest structure involves considering various indicators, such as tree size, canopy cover and tree density. Species composition of ecosystems refers to the identity and relative abundance of different species present. It encompasses the variety of species and their distribution patterns, which play a crucial role in shaping ecosystem structure and function. Together, structure and composition influence various ecological processes, such as nutrient cycling, energy flow, and the provision of ecosystem services. The interplay between structure, function, and composition is crucial for maintaining ecosystem integrity, biodiversity, and functionality.

The majority of research shows that the prolonged absence of frequent low- to moderate-severity fires has led to widespread changes in the structure and composition of frequent-fire forests in North America (Eisenburg et al. 2024, USDA and USDI 2024, Hagmann et al. 2021, Hanberry et al. 2018). These changes, generally characterized by increased forest density and abundance of fire-sensitive and shade-tolerant tree species, have made forests more susceptible to large-scale disturbances such as drought and wildfires, a situation exacerbated by the rapid warming of the climate. Based on LANDFIRE, in frequent-fire forests, the structure of old forests has shifted from a generally open-canopy structure that would maintain low severity fires to a closed canopy structure that is highly vulnerable to stand-replacing fires (Figure 5).

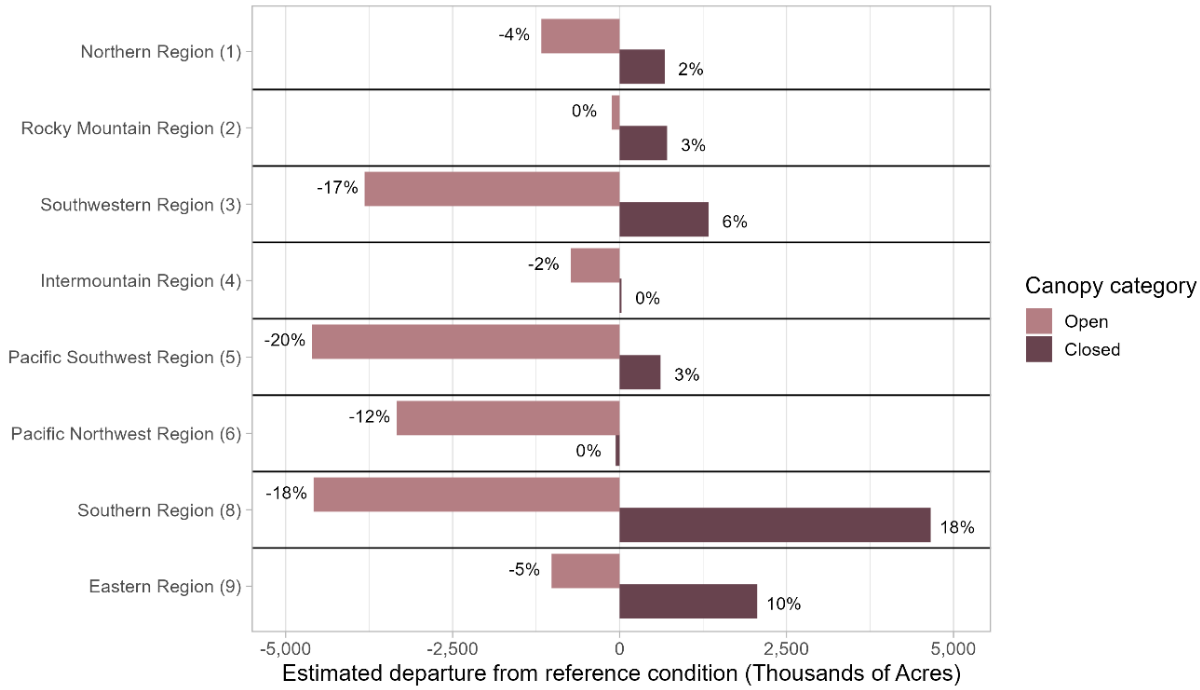

Figure 5. Estimated difference between current (2020) and pre-settlement extent of late-successional frequent-fire forest with open or closed canopy structure across National Forest System regions. Late succession forest area during the pre-settlement period is estimated from the LANDFIRE dataset by applying its estimated forest succession class proportions to the forested land area of the corresponding biophysical setting, region and canopy category.

In the interior montane forests of the western United States, historically, dry mixed-conifer forests supported frequent fires, with mean fire return intervals ranging from 5-25 years (see review by Hagmann et al. 2021). Frequent burning in pine and dry mixed-conifer forests contributed to the sustainability of old forests and trees, with ponderosa pine, western larch, Douglas-fir and other fire-resistant conifers commonly exceeding 300-400 years in age. The disruption of this frequent-fire regime has led to a decrease in these fire-adapted species and an increase in shade-tolerant and fire-sensitive species like grand fir and white fir. Traditional cultural burning in pine and mixed-conifer forests also promoted open canopy conditions that supported diverse understories of native grasses and herbs providing foods and medicines for people as well as forage conditions for hunted animals (Eisenburg et al. 2024). For example, under open canopies of fire-maintained forests, understories generally consisted of a diversity of bunchgrasses, edible herbs, berries such as serviceberry and huckleberry, and nut-producing shrubs like hazelnut (Eisenburg et al. 2024).

Significant changes in species composition have taken place in pine oak region of Southeastern forests, as uplands that were often dominated by one or two pine and/or oak species dramatically increased in hardwood dominance with fire exclusion and elimination of cultural burning (Varner et al. 2005). Hardwoods, particularly oaks (e.g., water oak and laurel oak), sweetgum, tulip-tree, black gum, and red maple, representing the current “southern mixed hardwood forest” were once rare but are now abundant (USDA and USDI 2024, Varner et al. 2005; Ware et al. 1993). These now closed-canopy forests dramatically reduce understory biodiversity and alter structure and processes in what were historically open, grass- and pine-dominated systems. These transformations in vegetation have had cascading impacts on herbaceous diversity, vertebrates, and invertebrates throughout these regions. Particularly noteworthy is the decline in vertebrate populations, including the endangered red-cockaded woodpecker, which relies on open pine forests and savannas for habitat, as well as a range of grassland-associated birds, gopher tortoises, pine snakes, and Northern bobwhite quails (Eisenburg et al. 2024). They also alter wildland fire environments by creating more mesic understories and litter layers that are less receptive to frequent understory burning (Nowacki and Abrams 2008; Kreye et al. 2013).

Old-growth forests in the eastern United States are threatened by mesophication, a process characterized by the transition of oak, hickory, and other frequent-fire deciduous forests to shade-tolerant, late successional species-dominated forests. This phenomenon has been exacerbated by elimination of cultural burning and the suppression of fires, leading to a shift in plant communities towards more mesic species (Abrams and Nowacki (2020), Abrams et al. 2022, Hutchinson, 2024). The ongoing mesophication in forests is expected to persist, creating a climate disequilibrium in these ecosystems (Nowacki and Abrams, 2014). Chronic water stress associated with mesophication has been shown to reduce tree growth and the carbon sink capacity of deciduous hardwood forests, contributing to additional carbon emissions annually (Brzostek et al., 2014). Furthermore, the process of mesophication has been linked to litter flammability gradients across the Southeast, indicating a widespread impact beyond oak forests in the eastern United States (Varner et al., 2021). The stability of secondary forest cover replacing old-growth forests underscores the importance of effective restoration and conservation efforts to reduce the vulnerability of these old-growth forests.

In addition to disrupted fire regimes, loss of native foundation tree species to introduced pests and pathogens has profoundly altered the structure and function of many forest ecosystems. In certain cases, nonnative pests and pathogens have been the strongest driver of change, dramatically altering forest structure and composition and key ecosystem functions (Kane et al. 2018). For example, in eastern forests the loss of eastern hemlock and American chestnut and declines in ash, elm, and beech have fundamentally altered ecosystem composition structure and related processes such as hydrology, food webs, and the transfer or energy and nutrients (Ellison et al. 2005). In the West, whitebark pine has experienced a severe population decline largely due to a fungal disease introduced from Europe. The structure and composition of high elevation forests in the West have been fundamentally altered with the loss of this long-lived, foundational species with cascading effects on ecosystem services.

At finer spatial scales, the presence of old trees, both within and outside of old-growth forests, represents a critical structural element that provides essential habitats for a diverse array of species and significantly contributes to carbon sequestration, biodiversity, and overall ecosystem resilience. The rarity of old trees in comparison to historical conditions, as well as their keystone ecological functions and services, highlight their conservation value (Manning et al., 2006). For example, large old trees exert a significant influence on the spatial distribution and abundance of various plant and animal species (Lindenmayer and Laurance, 2016) and recent studies underscore the importance of managing and conserving old trees to ensure the persistence of tree-related microhabitats, such as insect galleries and exposed sapwoods (Kozak et al., 2023). Physiologically, old trees exhibit age-related changes in growth efficiency, with reversible growth declines observed when relieved from competition (Martínez-Vilalta et al., 2006). In forests prone to frequent fires, old trees have evolved characteristics such as thick, fire-resistant bark, deep root systems, complex crown architecture, high heartwood to sapwood ratios, and they provide unique habitats for wildlife (Kolb et al., 2007). Finally, the biomass of old trees continuously increases with age, emphasizing their important role in carbon stock accumulation.

The presence of old trees outside of old-growth forests, which are often biological legacies resulting from intermediate disturbances, support particular ecosystem processes and biodiversity (Franklin et al. 2003). However, the conservation of old trees is crucial not only for maintaining biodiversity and ecosystem functions but also for preserving cultural heritage, traditional practices, and social values. Old trees are deeply rooted in human culture, carrying various cultural and aesthetic values and symbolic significance (Liu et al. 2019). They are often referred to as heritage trees due to their natural and cultural significance, providing humans with aesthetic, symbolic, religious, and historic values (Thirumurugan et al. 2021; Blicharska and Mikusiński 2014). Acknowledging the environmental, ecological, and socio-cultural benefits of old trees, strengthens efforts to prevent the decline of old-growth forests (Gilhen-Baker et al. 2022).

6.4 Spatial distribution

The spatial distribution of old-growth ecosystems has important implications for their ecological integrity, potential for restoration, and long-term persistence. The location and relative configuration of old-growth patches across a landscape are recognized as fundamental properties of resilience because spatial attributes influence exposure to threats and responses to disturbances (Chambers et al. 2019). Moreover, adequate spatial distribution contributes to maintaining connectivity which, in turn, influences key ecological processes, such as foraging movements, seasonal migrations, gene flow, and range shifts in response to environmental change (Bennett 1999); the 2012 Planning Rule includes requirements to evaluate, protect, and/ or restore ecological connectivity.

Maps in Appendix 4 show the spatial distribution of old-growth forest across firesheds (areas of about 25,000 acres each) within National Forest System (NFS) units. Each region contains two maps derived from FIA plot data as outlined in the *Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management* technical report (USDA and USDI 2023): (1) percent old-growth of total forested NFS land within a fireshed and (2) extent of old-growth within a fireshed.

The spatial distribution and configuration of old-growth forests at finer scales has been recognized as an important consideration for sustaining biodiversity, carbon storage, and ecosystem functions in the face of changing environmental conditions. For example, at relatively fine spatial scales, recent research has underscored how climate refugia – small areas that are relatively buffered from contemporary climate change – play a disproportionately large role in the long-term persistence of species and ecosystems (Pradhan et al. 2023, Morrelli et al. 2016). Similarly, fire refugia, or areas that burn less severely or less often than the surrounding landscape, have been shown to promote persistence or expansion of old-growth forests (Krawchuk et al. 2020). Because they are less vulnerable to severe wildfire or climate change, old-growth forest located in refugia may disproportionally sustain biodiversity, improve carbon stewardship and ecosystem functions over upcoming decades (Krawchuk et al., 2020; Morelli et al., 2020). The location of refugia is influenced by both topo-climatic factors and current vegetation, which can vary at fine geographic scales in biologically and topographically diverse landscapes.

Currently, reliable information about the location of old-growth forests relative to fire refugia across the National Forest System (NFS) is lacking. However, a cooperative effort between Forest Service NFS and RD provides estimates of the distribution of climate refugia within NFS lands (Table 4). This analysis was based on Thorne et al. (2020) and adapted to produce results for the contiguous United States according to the following levels of agreement: areas where all ten models agreed are represented in the "Very likely refugia" class, where seven to nine models agreed are "Likely refugia," and where only four to six models agreed is considered "Uncertain refugia." "Unlikely refugia" and "Very unlikely refugia" were assigned when one to three or no (zero) models agreed, respectively.

Table 4. Percent of contiguous United States NFS lands in each climate refugia likeliness category, based on model outputs, for two future periods under the RCP 8.5 climate scenario, as well as the current extent of old-growth for each category.

Climate Refugia Likeliness Category	Mid-century (2035-2064)	Estimated area of current old-growth in mid-century refugia areas and 90% C.I. (1,000s Acres)	End of century (2070-2099)	Estimate of current old-growth in end-of-century refugia areas and 90% C.I. (1,000s Acres)
Very likely refugia	25%	5,550 (5,281 - 5,819)	4%	1,029 (904 - 1,154)
Likely refugia	25%	4,873 (4,620 - 5,127)	23%	5,315 (5,049 - 5,582)
Uncertain refugia	14%	2,482 (2,302 - 2,662)	22%	3,909 (3,686 - 4,131)
Unlikely refugia	17%	2,886 (2,698 - 3,074)	29%	4,841 (4,597 - 5,084)
Very unlikely refugia	20%	3,169 (2,978 - 3,361)	23%	3,867 (3,655 - 4,079)

6.5 Recent change

FIA plot data were analyzed to estimate the recent net change in old-growth forest extent. This analysis used FIA plots that were measured more than once between 2000 and 2020 (measurement year and remeasurement intervals vary by state; see USDA and USDI 2024). Figure 6 shows the results of the FIA data analysis at the national and regional scales. Nationally, the amount of old-growth has remained steady at approximately 25 million acres during the most recent FIA remeasurement cycle. However, at the regional level, there is important variation in net change of old-growth forest. Some regions, such as the Northern Region and the Intermountain Region, have seen declines of more than 400 thousand acres during this period. The Pacific Northwest and Eastern Regions, on the other hand, experienced an increase of approximately 400,000 acres of old-growth. This represents approximately a seven percent increase for the Pacific Northwest Region and approximately 50 percent increase for the Eastern Region.

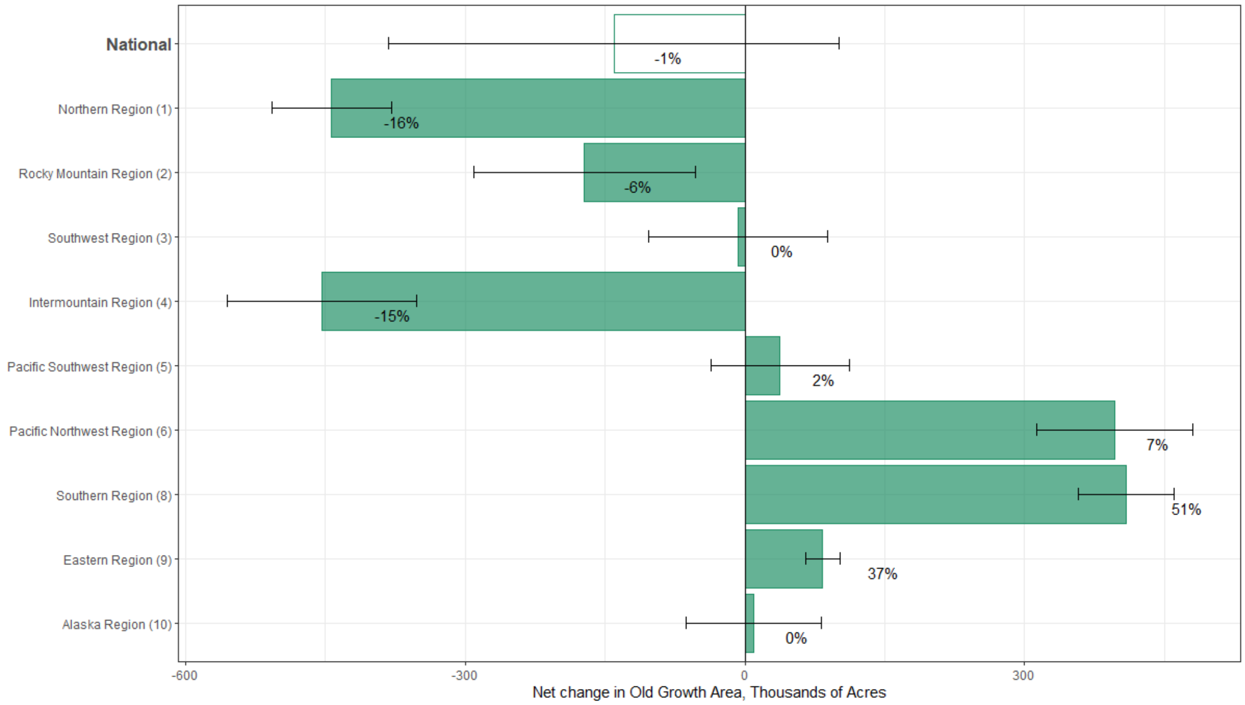

Figure 6. Net change in old-growth area. Error bars represent ±1 standard error.

To understand factors contributing to recent change in old-growth forest, methods from the *Mature and Old-Growth Forests: Analysis of Threats on Lands Managed by the Forest Service and Bureau of Land Management* report (USDA and USDI 2024) were repeated exclusively for NFS lands. The relative contribution of disturbance to change in the amount of old-growth varied widely across regions (Figure 7). Nationally, disturbance from fire and insect and disease were the most common disturbances in old-growth forest. An estimated 1.02 million acres of old-growth forest were disturbed by fire (approximately 60 thousand acres per year). Approximately 30 percent of fire in old-growth forest was in the low basal area loss category (less than 25 percent basal area loss). Forests that experienced low basal area loss showed net gains in old-growth forest, demonstrating that low-severity fire does not necessarily threaten old-growth. An estimated 5.1 million acres of old-growth forest were disturbed by insects and disease (both native and non-native species). In forests disturbed by insects and disease, there was a 273 thousand-acre decrease in old-growth forest extent. Results of the FIA re-measurement analysis showed that tree cutting was not a major threat to old-growth during the most recent remeasurement period (USDA and USDI 2024).

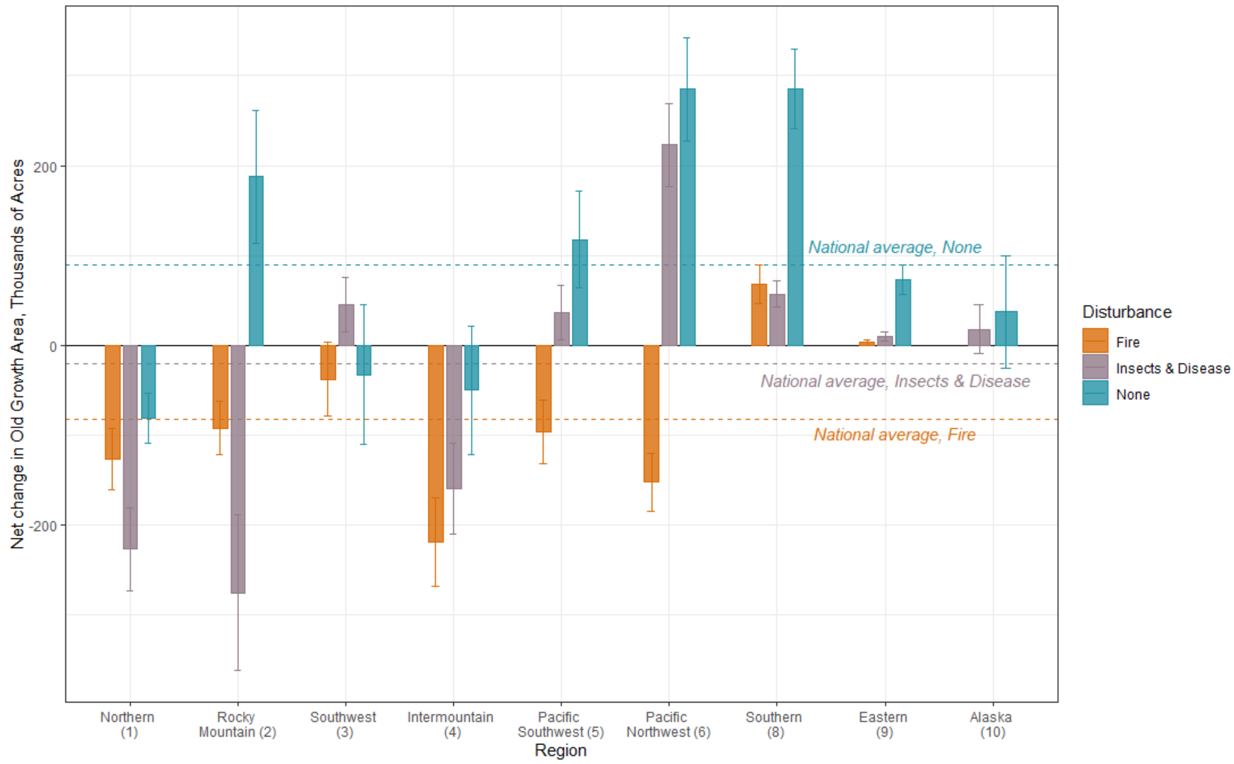

Figure 7. Relative contribution of disturbance to change in the amount of old-growth. Error bars represent a ±1 standard error.

6.6 Future Projections

For this analysis, the national forest dynamics model projections from the [2020 Resources Planning Act (RPA) Assessment] were summarized specifically for old-growth forests on National Forest System lands across the contiguous U.S. The RPA Forest Dynamics Model is a stochastic modeling system that projects future FIA plot (condition) level data using an imputation approach (Coulston et al. 2023). The Forest Dynamics Model is informed by climate, timber prices, human population, and income, as well as by a set of sub-models representing harvest choices, forest disturbance, growth, aging, regeneration, and forest type transitions over time. It is important to note that model outputs shown here reflect little change in the volume of old-growth forests on Forest Service lands killed by fire from now until mid-century (see the *Mature and Old-Growth Forests: Analysis of Threats on Lands Managed by the Forest Service and Bureau of Land Management* report, USDA and USDI 2024). However, for all forests across the conterminous U.S., the Forest Dynamics Model projects an increase in severe fires and as much as a doubling of fire-killed volume across all U.S. forests between 2020 and 2070 (Costanza et al. 2023). Likewise, other research has shown an increase in fire in U.S. forests, particularly more large and severe fires is more likely over the coming decades (Abatzoglou and Williams 2016, Brown et. al. 2020, Donovan et. al. 2023, Dye et. al 2024, Ellis et. al. 2021, Westerling 2018). For detail about methods and assumptions underlying the Forest Dynamics Model, see the Threat Analysis Report (link above) (USDA and USDI 2024), and Coulston et al. (2023a, b).

As Figure 8 shows, RPA projections show little net change in mature and old-growth forest area on Forest Service lands across the contiguous U.S. Losses from mature and old-growth due to disturbance are offset by growth and succession that transform younger forests into mature and old-growth. Younger, mature, and old-growth trends from these projections were consistent with the overall forest succession and aging trends projected for all forests in the contiguous U.S. in the 2020 RPA Assessment (Coulston et al. 2023). Regional differences are shown in Appendix 7 of the *Mature and Old-Growth Forests: Analysis of Threats on Lands Managed by the Forest Service and Bureau of Land Management* report (USDA and USDI 2024).

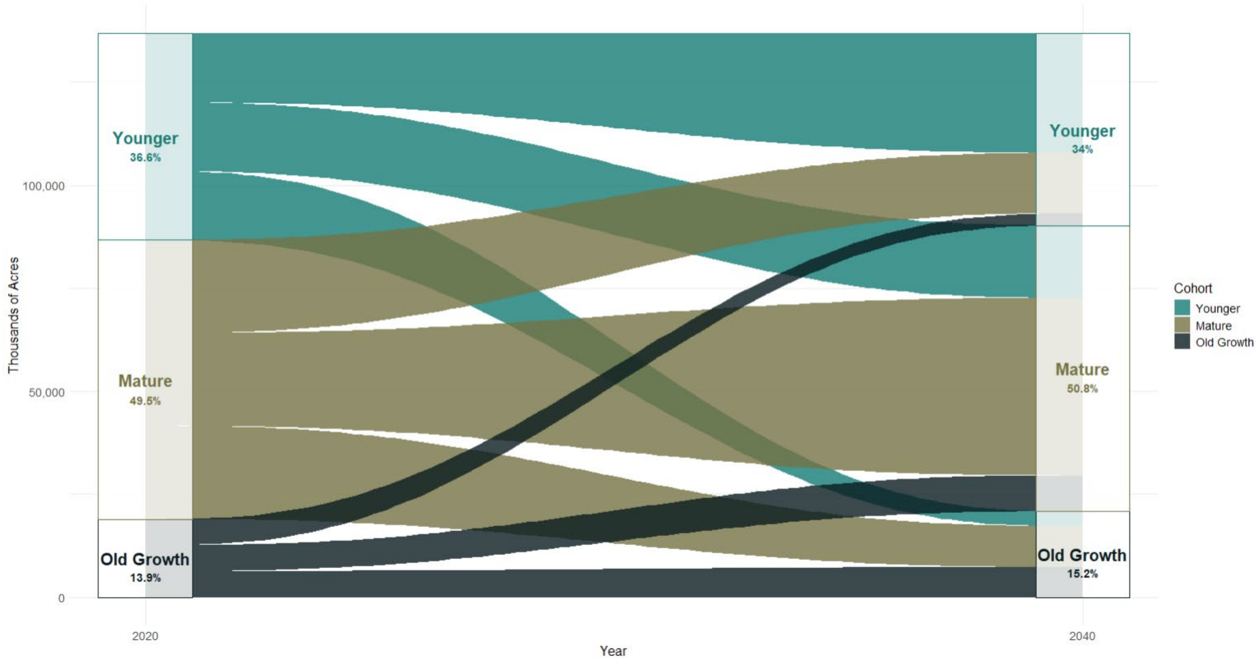

Figure 8. The modeled transition between younger, mature, and old-growth forest classes from 2020 to 2040. Percentages in the labels represent the relative proportion of each forest class compared to total forest area at the time point. Flows are colored based on the forest class in 2020.

7. Drivers and stressors

In this section, we present an overview of the major drivers and stressors affecting old-growth forest. Stressors are factors that may directly or indirectly degrade or impair ecosystem composition, structure, or ecological processes and thereby negatively affect ecological integrity (36 CFR 219.19). Drivers may be considered synonymous with stressors, although they do not necessarily impair ecological integrity; in fact, some drivers are necessary to support ecosystem integrity. Some drivers may become stressors when they occur outside of their expected frequency, severity, or extent. Many drivers and stressors that impact old-growth are related to natural disturbances or influences, while others are anthropogenic in nature. Drivers and stressors may interact with each other to create complex effects and feedback loops and can impact social and economic sustainability, as well as ecological sustainability. For example, the interaction of climate change and past forest management practices has amplified the frequency, scale and severity of disturbance events leading to more extreme wildfire and declining forest conditions (Eisenberg et al. 2024, Hessburg et al. 2021, Domke et al. 2023). The *20240603BASIRegionalOldGrowthSummary* in Miscellaneous Supporting Documents details the major drivers and stressors for different types of old-growth; see also the *Mature and Old-Growth Forests: Analysis of Threats on Lands Managed by the*

Forest Service and Bureau of Land Management report (USDA and USDI 2024) for additional context and analysis of old-growth stressors.

7.1 Fire

Fire, whether wildfire, cultural burning, or prescribed, is a dominant ecological disturbance in many old-growth forest ecosystems. Fire can be a requirement to drive ecosystem integrity (Clark et. al. 2024, Costanza et. al. 2023) or behave as a stressor to ecosystem integrity (Hessburg et. al. 2021). Fire frequency, size, intensity, and seasonality are directly influenced by climate and weather conditions. Effects from fire depend on initial forest condition, fire severity (measure of vegetation loss or soil exposure) and size, and forest condition following the fire. (USDA and USDI 2024).

Across the nation, FIA data estimated that 1.7 million acres or 6.8 percent of old-growth forest on National Forest System lands experienced fire between 2000-2020, resulting in 0.7 million fewer acres of old-growth forest, a 2.6 percent decrease. No fires were recorded on plots in Alaska (USDA and USDI 2024).

Of these fire-disturbed old-growth forests, 32 percent experienced low fire severity, 18 percent moderate fire, 18 percent moderately severe fire, and 33 percent severe fire (Figure 9). Forests with low severity fire showed net gains in old-growth forest acreage (7.8 percent), while there was significant net loss in old-growth forest experiencing severe fire (30.4 percent). Old-growth that experienced moderate and moderately severe fire also had net loss in acreage, 5.5 percent, and 10.8 percent respectively.

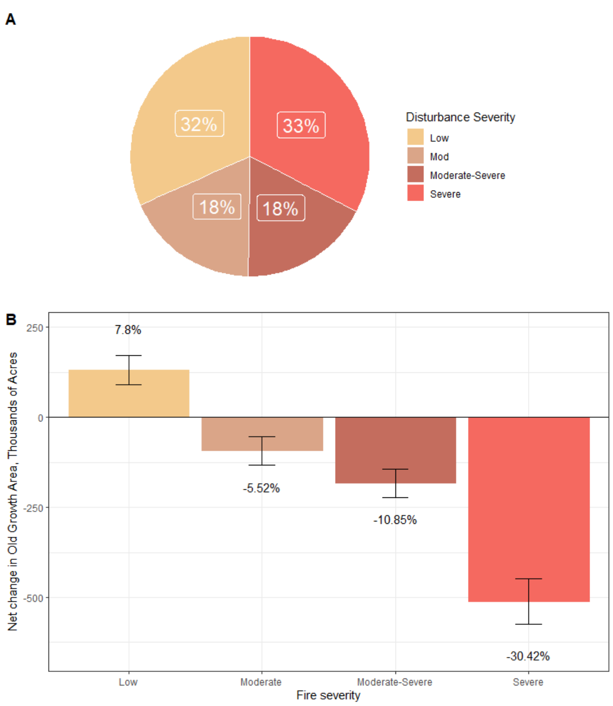

Figure 9. A) Fire severity by effects level in fire-disturbed old-growth forest. B) Net changes in area of old-growth forest that experienced fire disturbance calculated from re-measured FIA plots ±1 standard error. Percent change is calculated by acres of net change/acres of total old-growth disturbed by fire. (Severity class: Low = less than 25% basal area loss; Moderate = 25-59% basal area loss, Moderate-severe = 60-90% basal area loss, and Severe = greater than 90% basal area loss.

Monitoring Trends in Burn Severity data showed that the area burned by moderate- to high-severity wildfire on National Forest System and Bureau of Land Management land has increased by four-times; from 0.6 million acres during 1980-1999 to 2.5 million acres from 2000-2019 (Table 2 from USDA and USDI 2024). These results are consistent with Anderegg et al. (2022) which projected that average future fire risk as compared to historical values will increase by more than four times throughout the 21st century.

The Wildfire Hazard Potential maps the relative potential for high-intensity wildfire (energy released by a fire) that could be difficult to manage and cause harm (Dillon et. al. 2015). Results by region can be seen in Table 5.

Table 5. The proportion (%) of NFS lands in Wildfire Hazard Potential (WHP) index categories. Areas with higher WHP values represent fuel with a higher probability of experiencing torching, crowning, and other forms of extreme fire behavior under conducive weather conditions. The data are intended for use as a long-term planning tool (Dillon et. al. 2015).

NFS Region	Very high	High	Moderate	Low	Very low
1: Northern	20.7	34.4	23.3	12.8	8.7
2: Rocky Mountain	5.2	15.9	20.8	29.4	28.6
3: Southwestern	28	37.3	21.6	10.2	2.9
4: Intermountain	11.1	23.6	25	23.3	17
5: Pacific Southwest	34.8	27.6	26.4	9	2.3
6: Pacific Northwest	16.5	29.6	33.3	16.7	4
8: Southern	1.3	15.4	24.7	27.8	30.8
9: Eastern	2.3	5.2	10.8	28.2	53.5

7.1.1 Fire Exposure

Nation-wide analysis shows a growing risk of exposure to moderate and high severity fire over time. From 1980–1999, less than half of mature and old-growth forests had exposure to high risk. From 2000–2019, 70–80 percent were exposed. By the end of this century (2080–2099), climate change projections predict an increase in this exposure to 95–100 percent of old-growth forests (USDA and USDI 2024).

Inventory data (USDA and USDI 2024) shows the largest percent change in area of old-growth affected by fire occurred in California mixed conifer (-6.9%), closely followed by lodgepole pine (-6.7%). The largest absolute changes occurred in fir/spruce/mountain hemlock, Douglas-fir, lodgepole pine, ponderosa pine, California mixed conifer and pinyon/juniper where wildfire-related mortality is a persistent future stressor (Table 6).

Table 6. Forest type groups with net change (positive or negative) greater than 5,500 acres in area of old-growth forest that experienced fire disturbance over a 9-year average remeasurement period. Area and confidence interval are in thousands of acres (from FIA plot data, USDA and USDI 2024).

Forest Type Group	Old-growth Change Estimate (1,000 acres)	Low 95% Confidence Interval (1,000 acres)	High 95% Confidence Interval (1,000 acres)	Percent Change
Fir/Spruce/Mountain Hemlock	-248	-337	-160	-3.5%
Douglas-fir	-147	-227	-67	-5.0%
Lodgepole Pine	-112	-181	-42	-6.7%
Ponderosa Pine	-81	-154	-8	-6.0%
California Mixed Conifer	-64	-122	-6	-6.9%
Pinyon/Juniper	-41	-94	13	-1.4%
Other Western Softwoods	-28	-54	-1	-4.4%
Loblolly/Shortleaf Pine	6	-5	16	20.0%
Oak/Hickory	26	-1	53	4.0%
Longleaf/Slash Pine	39	10	68	44.4%

Threat from moderate to high severity wildfire primarily occurs in the West during the early part of this century. By the end of the century, predicted climate change and increased exposure to high-risk fire expands risk of severe wildfire from the West to most of the East (Figure 3 in USDA and USDI 2024). Oak/hickory, loblolly/shortleaf, and maple/beech/birch groups see the largest relative increase of exposure. Absolute risk changes tend to be low in eastern forest, with forests in the far Northeast maintaining the lowest exposure risk to severe fire throughout. Escalating fire exposure over the next century means that a progressively higher proportion of old-growth forests will likely experience adverse effects from fire (USDA and USDI 2024). A similar FIA analysis found fire was the most frequent disturbance agent in the Southeast. The most impacted forest types were longleaf–slash pine, loblolly–shortleaf pine, oak–gum–cypress, oak–pine and oak–hickory (Ojha et. al. 2020).

Based on data developed for the Resources Planning Act (RPA) Assessment (Costanza et al. 2023), the proportion of old-growth forest burned annually at moderate to high severity will trend upward by then end of the century (Figure 4 from USDA and USDI 2024). The largest future increase is projected to occur in the West among Douglas-fir, ponderosa pine, and piñon/juniper forests, as well as woodland hardwoods. Most of the East will have moderate increase, except for fire-related mortality in the oak/hickory forest type group which is projected to at least double in volume by 2070. In the South, the extent is projected to remain relatively steady or decrease and it will decrease under all climate models on the Pacific Coast. (Costanza et al. 2023, USDA and USDI 2024)

7.1.2 Fire Exclusion

Fire exclusion, also known as a fire deficit, refers to the suppression or absence of natural fire regimes in an ecosystem due to human intervention or land management practices that aim to prevent wildfires. This disruption of the natural fire cycle can lead to an accumulation of vegetation, dead organic matter, and fuel loads, increasing the risk of uncharacteristically severe fires when wildfires do occur. Fire exclusion began centuries ago, long before wildfire suppression policies emerged in the late 19th century (USDA and USDI 2024). For thousands of years, Indigenous communities in North America have used fire to intentionally manage the ecosystems they live in (Dovetail 2021a) including old-growth forest (USDA and USDI 2024). This cultural burning serves to connect people to the landscape and transmit cultural practices, ceremony, language, and understanding of place, in addition to maintaining important habitats (Dovetail 2021a). The arrival of Europeans and disease in the 15th century killed up to 80–90 percent of the Indigenous population, displaced remaining communities, and interrupted traditional use of fire across much of the landscape (Eisenberg et. al. 2024, Dovetail 2021a, Clark et. al. 2024). Suppression and the absence of frequent cultural burning and other Indigenous stewardship practices have led to dense forests of today that are vulnerable to drought, forest insects and diseases, and wildfires (Eisenberg et. al. 2024, Clark et. al. 2024). Attitudes towards indigenous cultural burning and fire suppression policy have shaped and continues to shape modern attitudes and management responses to fire and has had long-lasting cultural impacts (Dovetail 2021b).

Results of the mature and old-growth condition assessment (MOGCA) analysis (USDA and USDI 2024) reveal about 37 percent of old-growth forests currently have very low exposure to the threat of fire deficit, 18 percent have low exposure, 20 percent have moderate exposure, 14 percent have high exposure, and 11 percent have very high exposure. Forest types with the highest threat of fire deficit were loblolly/shortleaf pine (95 percent), oak/hickory (87 percent), ponderosa pine (68 percent), Douglas-fir (37 percent), and piñon-juniper (31 percent) (USDA and USDI 2024).

Estimates of percent area of the landscape exposed to wildfire exclusion can quantify areas of deficient fire; areas that are burning less frequently than they did in the past (USDA and USDI 2024). Results can be seen in Table 7.

Table 7. Percent area of NFS managed land exposed to wildfire exclusion was estimated by comparing observed fire frequencies to historic mean fire return intervals (USDA and USDI 2024).

NFS Region	Insufficient Fire	Excessive Fire	Sufficient Fire
1: Northern	43.7	2.7	53.6
2: Rocky Mountain	56.8	0.2	43
3: Southwestern	58.7	4.7	36.7
4: Intermountain	45.5	2.9	51.6
5: Pacific Southwest	49	4.2	46.8
6: Pacific Northwest	49.2	2.8	47.9
8: Southern	88.2	0.6	11.1
9: Eastern	51.3	0	48.6

7.2 Insects and disease

Similar to other ecological disturbances, low to modest levels of tree-killing insects and pathogens in forests can increase ecological diversity, species diversity, and structural diversity, as many organisms have evolved along with their plant hosts. However, non-native insects and disease have almost eliminated certain dominant overstory trees. “No other disturbance agent has effectively eliminated forest tree species, or even genera, from forests in the United States as quickly as forest pests" (Potter et. al. 2019).

Across the nation, approximately 22 percent of old-growth forest on Forest Service managed land was disturbed by insects and disease (native and non-native species) between the years 2000-2020. This represented 5.4 million acres of old-growth forest and resulted in 0.3 million acres (1.1 percent) less old-growth forest (USDA and USDI 2024). Most areas (72 percent) experienced a low severity event, i.e. low tree mortality and these areas showed a net gain in extent of old-growth. However, old-growth exhibiting moderate to severe disturbance effects (28 percent total) showed significant net loss in extent of old-growth forest. These net changes by severity are seen in Figure 10.

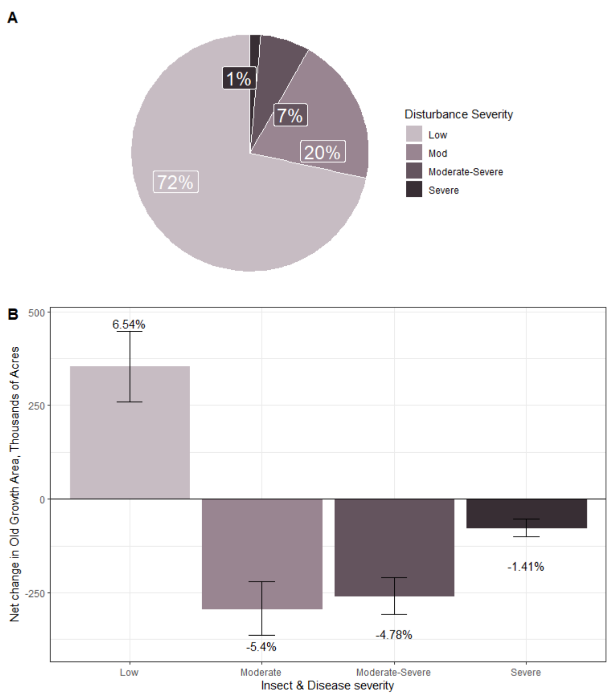

Figure 10. A) Insects and disease impacts by effects levels in insects- and fire-disturbed old-growth forest. B) Net changes in area of old-growth forest that experienced insect and disease disturbance calculated from remeasured FIA plots ±1 standard error. Percent change is calculated by acres of net change/acres of total old-growth disturbed by insects and disease. (Severity class: Low = less than 25% basal area loss; Moderate = 25-59% basal area loss, Moderate-severe = 60-90% basal area loss, and Severe = greater than 90% basal area loss).

Regional FIA inventory data show that outcomes from insects and disease outbreaks varies across the U.S. In the Rocky Mountain and Pacific Northwest regions, the net gain after low severity events was significant. The Northern region had significant loss after moderate effects, the Intermountain after moderate and moderately severe effects, and the Rocky Mountain after moderate through severe effects (USDA and USDI 2024). The largest percent change in area of old-growth occurred in lodgepole pine forests, followed by other western softwoods and oak/hickory forest type groups as a result of insects and disease disturbance. The largest absolute changes occurred in lodgepole pine, fir/spruce/mountain hemlock and Douglas-fir forest type groups (Table 8).

Table 8. Forest type groups with the most change in area of old-growth forest that experienced insect and disease disturbance over a 9-year average remeasurement period. Area and confidence interval are in thousands of acres (from FIA plot data USDA and USDI 2024).

Forest Type Group	Net Area Change Estimate	Confidence Interval (95%)	Percent Change
Lodgepole Pine	-303	+\- 121	-18.2
Fir/Spruce/Mountain Hemlock	-96	+\- 159	-1.4
Douglas-fir	-85	+\- 87	2.9
Other Western Softwoods	-71	+\- 60	-11.1
Oak/Hickory	-52	+\- 28	-8.0
Aspen/Birch	-51	+\- 87	-4.3

USDA and USDI (2024) also used national maps to identify forests with environmental characteristics and conditions that indicate they are uncharacteristically vulnerable to insect and disease outbreaks. Forest Health Assessment and Applied Sciences Team (FHAAST 2024) data was used to identify the percent of NFS forest lands that experienced light defoliation to mortality events from insects and disease for the years between the years 2013 and 2022. Summary data (USDA and USDI 2024) show that forested lands in western NFS regions had a larger proportion of their area impacted by insects and disease events than NFS regions in the eastern U.S. (Table 9). The Pacific Southwest region had the highest occurrence of defoliation and mortality events (31 percent of area) and the Southern region had the lowest presence of events, at less than one percent of its area.

National Insect and Disease Risk Map (NIDRM 2024) data was used to identify areas where forests are stressed and susceptible to outbreaks of native and non-native insects and diseases. These include forests with overly high stand densities and where soil site conditions contribute to drought (Krist et al. 2015). Summary data (USDA and USDI 2024) provided the percent of the NFS region that could potentially lose at least 25% of basal area due to mortality driven by insect and disease stress between 2013 and 2027 (Table 9; Krist et al. 2015). On average, eastern regions had more area at risk (89.7 percent) than western regions (71.7 percent), though all regions had more than 60 percent of their extent at risk due to forest conditions promoting uncharacteristic mortality from insects and disease. Note that basal area loss from insects and disease should not necessarily be considered an ecological risk in all old-growth forests (USDA and USDI 2024).

Table 9. Proportion of NFS region vulnerable to insect and disease outbreaks based on FHAAST and NIDRM data. Insects and Disease Incidence: Percent of NFS area by region that experienced defoliation and mortality events between 2013 and 2022. Mortality Hazard: Percent of NFS area by region that, without remediation, is expected to lose at least 25 percent of standing live basal area between 2013 and 2027.

NFS Region	Insect and Pathogen Incidence (% of NFS region)	Mortality Hazard (% of NFS region)
1: Northern	9.3	73.1
2: Rocky Mountain	10.7	80.9
3: Southwestern	8	62.2
4: Intermountain	6.1	66.2

NFS Region	Insect and Pathogen Incidence (% of NFS region)	Mortality Hazard (% of NFS region)
5: Pacific Southwest	31	67.2
6: Pacific Northwest	14.2	80.3
8: Southern	0.6	88.4
9: Eastern	3.4	90.9

USDA and USDI (2024) also identified exposure to insect and disease outbreaks. For this analysis, the term exposure is defined as the magnitude or degree of change in climate or other factors a species or system is likely to experience. Results indicate about 85 percent of old-growth forests had very low exposure to insect and disease hazard, nine percent had low exposure, four percent moderate exposure, and both high and very high exposure had one percent each. Old-growth forest type groups with the highest exposure were fir/spruce/mountain hemlock, followed by Douglas-fir, and ponderosa pine (USDA and USDI 2024).

Western Spruce Budworm, Douglas-fir Tussock Moth, and Balsam Woolly Adelgid have the potential to impact both Engelmann spruce and subalpine fir trees in the western U.S. Highly productive sites that can sustain high densities of large older trees generally have the highest hazard rating for all three of these insects (USDA and USDI 2024).

While native insects are most threatening to pine and spruce forests, non-native insects and pathogens threaten both deciduous and coniferous old-growth forests and the threat is rarely associated specifically with stand structure. Recent insect-caused mortality appears to be far outside what has been documented since Euro-American settlement and is likely related to climate change (Vose et al. 2018). With non-native insects, it’s more than just climate change. Increased global trade and transportation of infected vectors has increased the likelihood of them finding novel suitable environments (Hulme 2009) (USDA and USDI 2024).

Most western coniferous forests experience bark-beetle (for example, Douglas-fir beetle, mountain pine beetle, spruce beetle) outbreaks that threaten mature and old-growth forests. Mountain pine beetle outbreaks have affected millions of acres of forest throughout the West in Oregon, Colorado, Montana, and Wyoming over multiple decades. Uncharacteristically high tree density and homogeneity combined with drought and repeated mild winters (which are increasingly likely with climate change) represent conditions that lead bark beetles from endemic to threatening (USDA and USDI 2024).

Non-native pathogens can also lead to oak loss in the southern United States. Oak forests that become uncharacteristically dense with shade-tolerant species such as maple in the absence of intermediate disturbance such as fire are also vulnerable to oak decline, a complex set of factors that kill large oak and can threaten old-growth forests (USDA and USDI 2024).

7.3 Extreme Weather

Extreme weather events (e.g. droughts, flooding, hurricanes, tornadoes, severe thunderstorms) are occurrences of weather phenomena that fall along the periphery of historical measurements for a particular place and/or time. Extreme weather events are a natural component of forest ecosystems across the nation, typically producing disturbances in small patches and killing limited numbers of large trees. Based on FIA plot remeasurements since the start of this century, extreme weather events have not accounted for much change in the extent of old-growth forests (USDA and USDI 2024; and Figure 11, Figure 12). However, the frequency, intensity, duration, and/or extent of extreme weather events are increasing as well as the interactions among these disturbances (USGCRP 2018, Domke et al. 2023). The overall exposure and sensitivity to these disturbances will vary across the nation, but these increasing trends may present localized challenges as weather-related changes in old-growth forest structure and function may increase susceptibility to other threats (Vose et al. 2018).

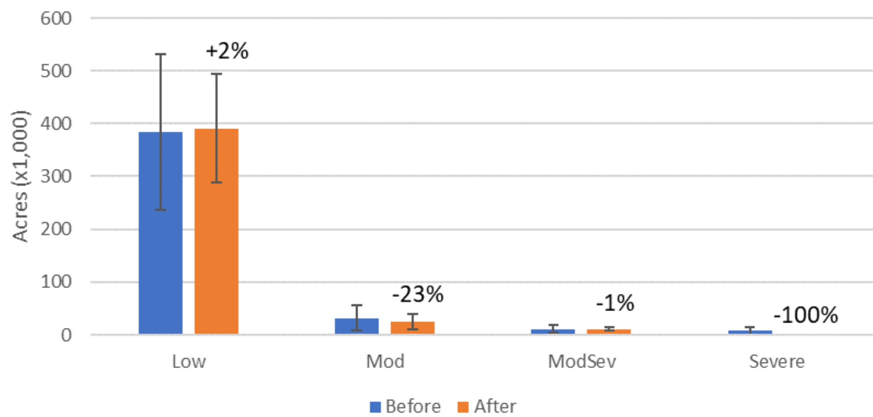

Figure 11. Net changes (and 95% confidence intervals) in old-growth forest extent on National Forest System lands that experienced weather disturbance over an average of 9 years from remeasured FIA plots (mostly 2000s to 2010s). Percentages represent net change by severity class.

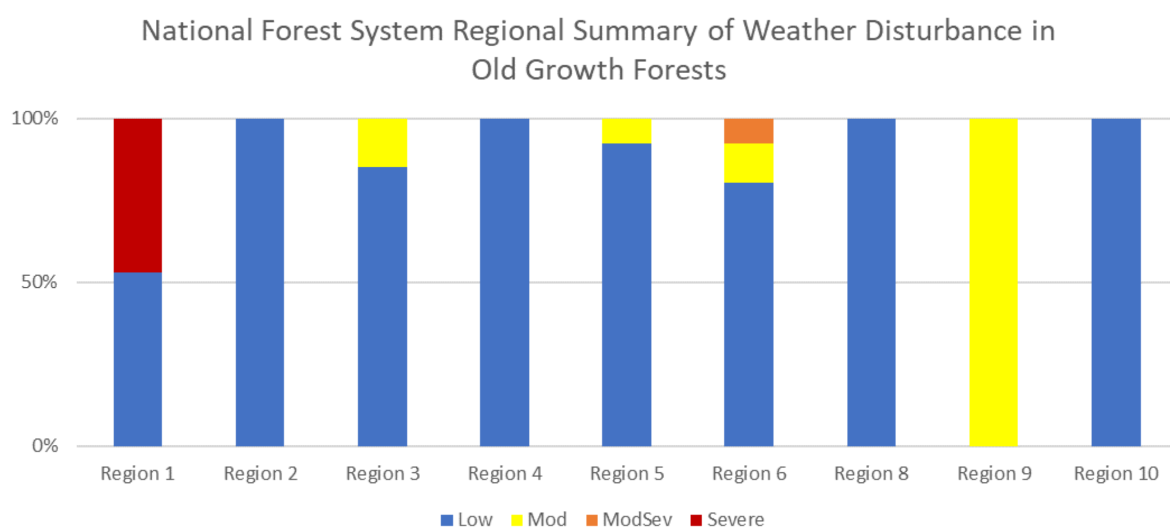

Figure 12. Regional variations in weather disturbance severity (basal area mortality) for old-growth forests from 2000s to 2010s. Low (<25% basal area mortality), Mod (25-60% basal area mortality), ModSev (60-90% basal area mortality), Severe (>90% basal area mortality).

Hurricanes, tornadoes, and severe thunderstorms represent extreme weather events most commonly associated with or relegated to eastern forests. The Atlantic and Gulf coasts of the United States, as well as Puerto Rico in the Caribbean, are areas of regular hurricane activity. Winds from these events can affect both forest-level (e.g., structure, function, composition) and tree-level dynamics with geographically distinct impacts (Cannon et al. 2023). Like all extreme weather events, hurricanes experience varying periods of activity through time, with active phases punctuated by calmer phases. Since 1970, however, hurricane activity has increased and some individual events (e.g., Harvey, Irma, Jose, and Maria) have reached and sustained very high intensity conditions that have been described as anomalous (USGCRP 2018). Such storms have extended over broad areas with the ability to rapidly transform old-growth forests where present. Tornadoes and severe thunderstorms, on the other hand, exert a more localized effect on forest ecosystems compared to hurricanes, and their occurrence over shorter time periods and small areas makes it difficult to detect trends. Over the beginning of the 21st century, the eastern United States has experienced more variable tornado activity with a decrease in the number of days per year with tornadoes coupled with an increase in the number of tornadoes. When it comes to severe thunderstorms, while several significant events have occurred in recent years, there is an insufficient number of observations to determine long-term trends in frequency or intensity (USGCRP 2018).

Extreme precipitation and associated flooding events are not limited to a single part of the country, but how these events play out – timing and intensity – vary from east to west. Since the beginning of the last century, the annual precipitation across most of the northern and eastern United States has increased in association with other extreme weather events, e.g. hurricanes (Easterling et al. 2017; USGCRP 2018). The number of intense (i.e., >2 inches of precipitation within a 24-hour period) precipitation events across the Southeast increased by 22 percent (McNulty et al. 2015). In the western US, atmospheric rivers play a critical role in replenishing water supplies. However, the frequency and severity of these atmospheric rivers has been on the rise and accounts for increases in heavy and extreme precipitation (Gershunov et al. 2019). Overall, these higher intensity rainfalls lead to greater soil erosion and flooding. Such events can create conditions of instability that can put old-growth forests at increased blowdown risk.

Drought is another extreme weather event that occurs from coast to coast. In recent times, the Nation's forests have experienced relatively even proportions of dry and wet conditions. However there has been more variation from year to year at a regional scale. Generally, though, periods of drought have been on the rise across all regions with the southwestern United States expected to experience the most substantial increases (USDA Forest Service 2023). Drought causes hydraulic damage in the water transport system of trees, and the legacy of drought can lead to slower growth rates and increased susceptibility to mortality in future droughts in some tree species (Anderegg et al. 2013; Bose et al. 2024). From a forest-level scale, exposure and the concomitant sensitivity of a forest type may identify potential ecological impacts from severe and prolonged drought conditions. For example, the longleaf pine/slash pine forest type of the southeastern United States is dominated by the drought-tolerant longleaf pine (*Pinus palustris*), therefore restoring and maintaining this component represents an ecosystem resilience strategy for climate adaptation (Clark et al 2018). Pinyon-juniper forests of the western US, on the other hand, have experienced widespread mortality and growth declines from recent severe droughts in combination with other stressors. Mortality was highest on areas with deep soils and high stand density as well as drier sites (Flake and Weisberg 2019). To increase the adaptive capacity of these pinyon-juniper sites, proactive stewardship may be necessary to reduce density (Bradford and Bell 2017).

7.4 Vegetation management

Vegetation management can be a stressor in old-growth forests, but it can also be an important driver of restoration and positive transformation (USDA and USDI 2024). Interactions among climate, disturbance, and vegetation have always been complex and can create or worsen threats (Loehman et al. 2020, Sample et al. 2022). Cultural burning and other examples of indigenous stewardship have shaped these ecosystems for thousands of years (Hankins 2021). Many old-growth forests have been lost or degraded through historical logging, land use practices, and fire suppression policy (Bragg et al. 2008, Hanberry et al. 2018a, Hanberry et al. 2020). These past practices and ongoing climate change have caused shifts in natural disturbance regimes, increased forest density, altered tree species composition, and transitioned forests to non-forest (Coop et al. 2020, Davis et al. 2020, Hanberry et al. 2020). However, resource managers can respond to threats to ecosystem composition, structure and function through vegetation management strategies designed to address ecosystem integrity. Whereas high-grade logging preferentially removed large, old ponderosa and Jeffrey pine, western larch, and Douglas-fir trees from historically fire-maintained forests and savannas, today, ecological silviculture can be a valuable tool, alongside prescribed fire and cultural burning, to maintain and restore resiliency in old-growth (Hagmann et al. 2021, Davis et al. 2024, Hanberry et al. 2020, Eisenberg et al. 2024).

Silvicultural approaches can aid in restoring old-growth attributes by mimicking natural forest dynamics and promoting structural complexity and biodiversity (Ducey et al. 2013, Bauhaus et al. 2009). Thinning can accelerate individual tree growth, aiding in the restoration of large trees and old forest structures (Case et al. 2023). Prescribed fire and cultural burning can reintroduce fire as a natural modifier of vegetation that can help reduce vulnerability in fire-dependent old-growth forest ecosystems. (Davis et al. 2024, Hanberry et al. 2020, USDA and USDI 2024). Vegetation management can also accelerate the restoration process and promote the development of old-growth-like characteristics (Spies et al. 2013, Bragg et al. 2008). Using the best available scientific information, including Indigenous Knowledge, as guidance, approaches will vary based on the forest type, existing condition, and site characteristics (Bragg et al. 2008, Clark et al. 2024, Loehman et al. 2020, Sample et al. 2022, USDA and USDI 2024). Often a combination of practices may be necessary for success and repeated treatments may be important to maintain resiliency after initial activities have been completed (Reinhardt et al. 2008, Fulé et al. 2012, Stephens et al. 2012b, Kalies and Yocom Kent 2016, Davis et al. 2024).

7.4.1 Variability of treatments and management activities across broad vegetation types

In northern hardwood-conifer forests, uneven-aged silviculture has been highlighted as a beneficial approach for creating habitats that support species dependent on old-growth conditions with deadwood and contributing to the conservation of old-growth forest attributes (Keeton 2006). Uneven-aged management can recruit old-growth forest structure by enhancing age and size class diversity and increasing snags and large downed logs (D'Amato and Catanzaro 2009). Using methods that create gaps in the canopy, favor larger trees that may become snags, build multiple canopy layers, and encourage regeneration, vegetation management can move even-aged, uniformly spaced forests of today, a remnant of past timber harvest practices, towards a more complex forest structure.

The goal to develop complex and denser forest structure may be ill-suited to historically open single stratum forest ecosystems, such as southeastern mixed forests, which have a simple structure of overstory trees and limited woody development in the midstory and understory (Hanberry et al. 2018a). Vegetation management practices that favor techniques focused on overstory maintenance, prevention of tree regeneration, and midstory development can restore characteristics of open old-growth forests. For example, during the past 100 years mixed oak-shortleaf pine forests originally comprised of large-diameter overstory trees with an open midstory, have transitioned to primarily younger, closed broadleaf forests of red maple and eastern red cedar (Hanberry et al. 2018a, Nowacki and Abrams 2008). These forests historically evolved with a frequent fire regime that regularly consumed shade-tolerant understory plants and other biomass. Cultural burning removed woody debris while rejuvenating diverse fire-maintained herbaceous and shrub species and associated fauna (Nowacki and Abrams 2008). This also allowed space for overstory trees that need sunlight, like oaks, to maintain vigorous growth. (Hanberry et al. 2018a). Silvicultural methods that balance overstory retention with pine regeneration and canopy recruitment are important to restoration success (Bragg et al. 2008).

Prescribed fire and cultural burning can also address the conversion to fire-sensitive understory species (mesophication) in central hardwood and oak-pine-hickory forests as frequent low intensity fires can remove non-oak species that contribute to decreased oak and hickory dominance (Burton et. al 2010, Harper et. al. 2016, Nowacki and Abrams 2008). Prior to European settlement, the mosaic of canopy gaps and tree sizes and ages characteristic of old-growth forests was reinforced by cultural burning and beaver activity. Restoration activities like prescribed fire and cultural burning mimic a frequent low severity fire regime to help restore more historically accurate open canopies and encourage the recruitment of certain plant species, including oak and pine (D'Amato and Catanzaro 2022).

In the Coastal Plain, longleaf pine is a critically endangered ecosystem due to past logging practices which left few seed trees and fire exclusion that prevented longleaf pine re-establishment. (Hanberry et al. 2018b, Wahlenberg 1946). As Wahlenberg (1946) noted, old-growth longleaf timber was almost entirely depleted by 1945. Vegetation management to restore old-growth longleaf pine includes silvicultural methods focused on retention of larger older trees, creation of an open canopy, adjusting species composition, and the careful reintroduction of low severity frequent surface fire to facilitate natural ecological processes and longleaf pine regeneration (Brockway et al. 2005, Hanberry et al. 2018b, Johnson et al. 2018, Mitchell et al. 2009).

As in the eastern US, silvicultural treatments can be used in western forests to restore historical forest structures and modify fire behavior in degraded forests. In 1994, a timber sale screening process named Eastside Screens was developed by the Forest Service in response to concerns about loss of old trees on the eastside of the Cascades in Oregon and Washington (USDA 1995). In 2021, an assessment of the amendment and subsequent decision determined the 21-inch standard that prohibits harvest of larger trees was no longer adequate to support landscape restoration and resiliency efforts. The proposal determined that management policy should align with current best available science and expertise to emphasize the recruitment of old and large fire tolerant tree species meaning that young but large shade tolerant tree species competing with larch and pine for resources may be removed (USDA 2021a, USDA 2021b).

Franklin et al. (2008) also describes how the removal of smaller trees to reduce fuel ladders and thinning to disrupt crown continuity in dry eastside forests of Washington state can reduce the risk of crown fire that may kill even large old trees, though historic evidence of high severity fire in these dry forests suggests a variable-severity fire regime may be a natural ecological process contributing to ecological integrity (Williams and Baker 2012). Retention of these larger fire- and insect and disease resistant tree species can provide anchors in older forests. Other activities to restore and maintain old forest attributes include reduction of stand densities and ground fuel loadings and the shifting species composition to more drought and fire tolerant species (Franklin et al. 2008).

For intensively managed Douglas-fir forests in the Pacific Northwest, Case et al. (2023) provides empirical evidence that restoration treatments like commercial thinning of mature stands and pre-commercial thinning in young stands accelerated the development of characteristics of old-growth forests resulting in larger trees, more complex forest structure, reduced tree density and increased understory diversity (Case et al. 2023).

In ponderosa pine-Douglas-fir forests in the Northern Rocky Mountains, tree density reduction helped to shift species composition back towards fire resistant tree species and increase ecosystem resilience to insects and future fire (Hood et al. 2016). Hood et al. (2020) also found mortality from mountain pine beetle attacks increased in areas of higher tree density with long intervals between vegetation management treatments.

Davis et al. (2024) found significant variability in efficacy in mitigating wildfire severity among treatment types across five western conifer dominated forest types. For all types, prescribed or pile burning led to reduced wildfire severity, with the largest reduction in effects occurred where stands were also thinned. This combination of treatments reduced tree density, ladder fuels, and surface fuels which can reduce crown fire and fire intensity and severity. Thinning without prescribed fire was less effective at reducing fire effects and in some cases increased effects, most likely due to higher fuel loads from slash left on site. Without prescribed fire, other ecological benefits of burning, such as increased resistance to bark beetle, may be missed. Prescribed fire alone often resulted in higher tree densities and fire severity than harvested stands even though surface fuels have been reduced. (Figure 13; Davis et al. 2024).

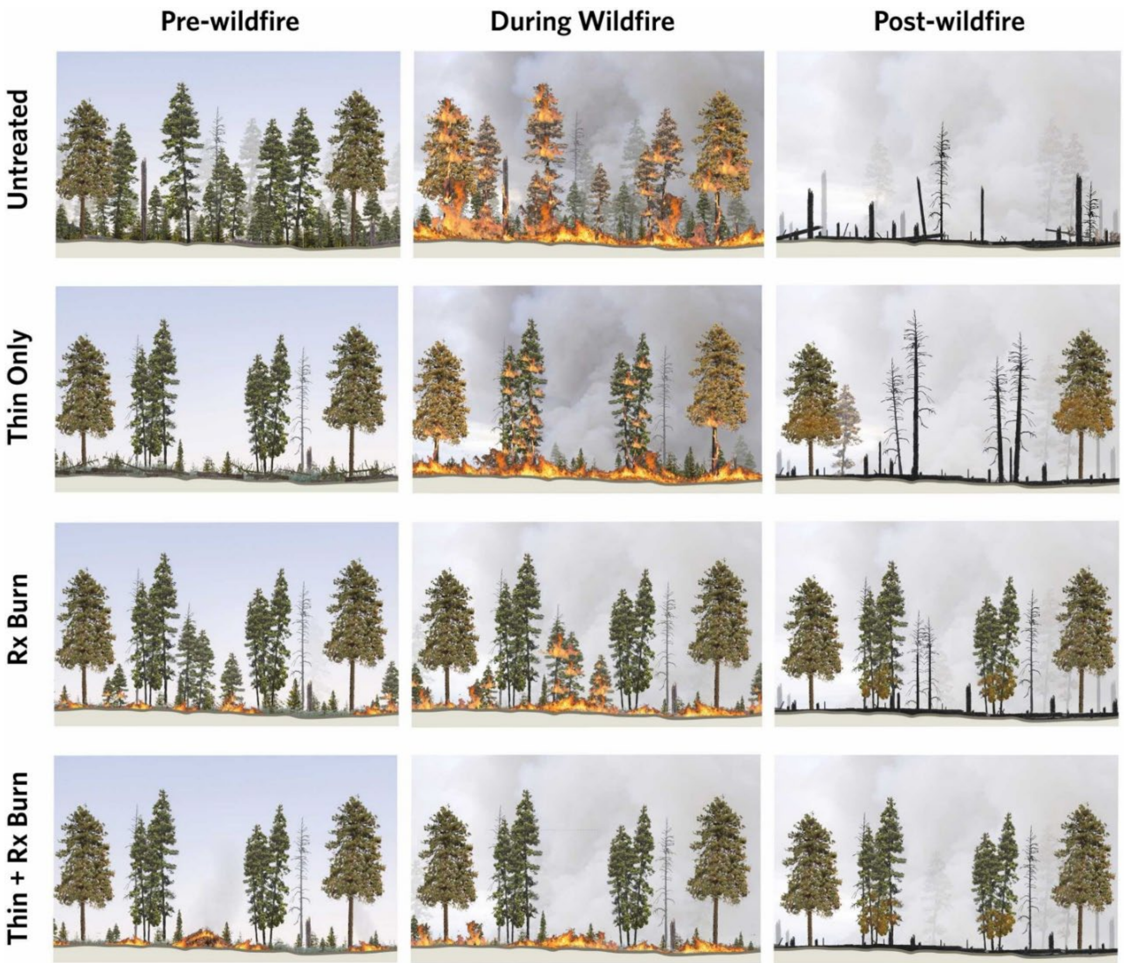

Figure 13. Diagram demonstrating potential treatment effects on forest stand structure (pre-wildfire), fire behavior (during wildfire), and fire severity (post-wildfire). Figure by Erica Sloniker, in Davis et al. 2024, reproduced with permission.

As with most forest types, pinyon and juniper woodland ecosystems that stretch across much of the southwestern U.S. have varying and distinct challenges for old-growth resiliency that have implications for management strategies. In areas where pinyon and juniper woodlands are expanding, vegetation may be managed to improve rangeland conditions for sagebrush dependent species. For example, mechanical thinning can open the canopy to benefit understory vegetation while leaving larger old-growth trees as a source of seed and for wildlife habitat (USDI 2023, Tausch et al. 2009). Where natural fire regimes have been disrupted and led to increasingly dense forests, fuel reduction projects using thinning and burning are conducted to reduce the risk of severe wildfire and advance a more balanced and robust plant assemblage of grasses, forbs, and shrubs (USDI 2023, Tausch et al. 2009). Where pinyon and juniper has experienced extensive tree die-off, priority is given to adaptive management strategies that enhance drought resilience, reduce fire risk, and maintain social and ecocultural value (Eisenberg et al. 2023, Redmond et al. 2023). These include selective thinning to reduce water stress but retain juvenile trees, snag and log retention to facilitate native vegetation establishment alongside seed and seedling planting, and grazing management to improve understory composition (Redmond et al. 2023).

The latest remeasurement of FIA plots show approximately 367,000 acres of old-growth experienced tree cutting over a mean period of 9 years between 2000 and 2020. This equated to approximately 1.5 percent of old-growth forests experiencing tree cutting. In the context of tree cutting in old-growth, it does not necessarily refer to large diameter trees being cut, nor does it identify the intent and purpose; rather it refers to the presence of cut trees within the FIA plot. (USDA and USDI 2024).

Based on Forest Service FACTS data, the amount and type of timber harvest treatment types have varied from 1980–2002 (Figure 14). Before 2000, even-aged treatments consisted of 35 percent of all timber treatments. After 2000, even-aged treatments decreased to ten percent. Intermediate and other treatments are relatively the same proportion between 1983-2022 approximately, 31 percent of all timber treatments. Before 2000, stand improvement/tending treatments consisted of 27 percent of all treatments. After 2000, stand improvement/tending treatments increased to 50 percent. Uneven-aged treatments are relatively the same proportion between 1983-2022 totaling four percent of all timber treatments.

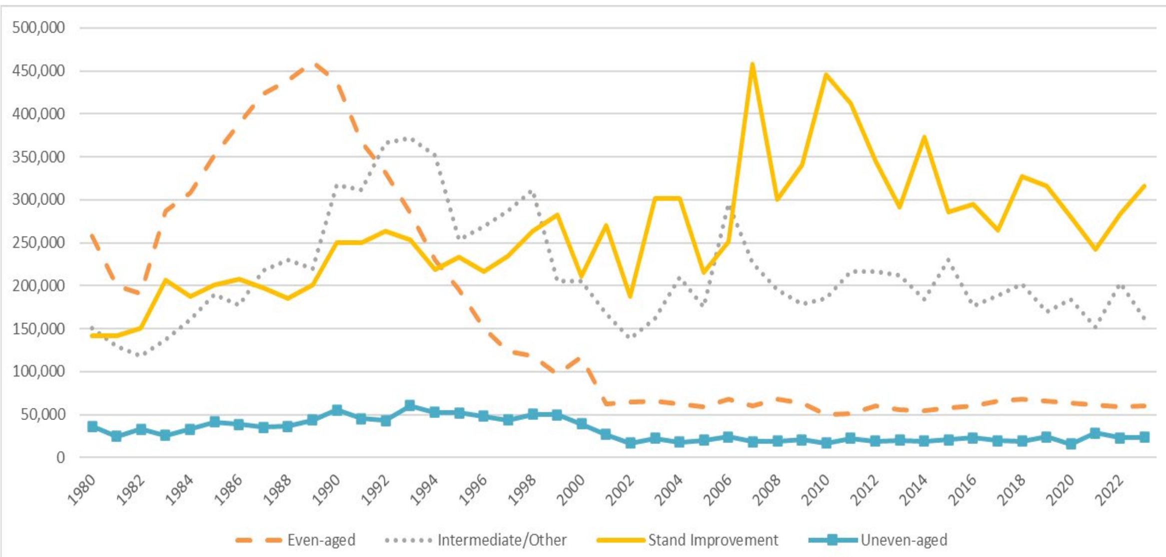

Figure 14. Timber cutting treatments from 1980-2022. Data source: FACTS NRM

Since December 2023, when the Forest Service first announced the old-growth amendment, any project proposing vegetation management activities in old-growth forests (based on regional old-growth definitions) has been required to be reviewed by the Deputy Chief of the National Forest System. A primary purpose of the review is to contribute to a greater understanding of the amount and types of activities proposed in old-growth forests. This review process has revealed that vegetation management activities in old-growth forests make up a small proportion of the Forest Service's treatment footprint. This is consistent with the analysis of remeasured FIA plots that found very little tree cutting in old-growth (USDA and USDI 2024).

Between December 18, 2023, and April 23, 2024, the Deputy Chief of the National Forest System has approved 31 projects totaling approximately 116,460 acres of proposed vegetation management within old-growth forest. This represents about nine percent of the total acres proposed for treatment within these projects. Another 18 projects representing 29,786 acres of treatments in old-growth forests had been received and are under review. The primary purpose and need of most projects are to restore forest vegetation to create more resilient conditions or to reduce hazardous fuels to project values at risk and communities. Treatments proposed include prescribed broadcast burning, mechanical or manual surface fuel treatments, commercial and noncommercial thinning, shaded fuel breaks, intermediate harvests, hazard tree removal, riparian area enhancement, and hardwood stand enhancement. Other project purpose and needs include fiber optic line installation to expand broadband services, protection of old-growth sequoia stands, to provide Alaska resident forest products, and to address public safety from hazardous trees. Other treatments have been designed to keep stands as old-growth and include permanent and temporary road construction, road reconstruction, herbicide application, tree planting, and a fiber optic line installation. Of note, 6,500 acres of regeneration harvests have been proposed in seral old-growth lodgepole pine stands. Projects currently under review also include the purposes of wildlife habitat improvement and to transfer land to the Bureau of Indian Affairs to be held in trust to the Leech Lake Band of Ojibwe in Minnesota.

7.4.2 Forest Management for Carbon Optimization

Forest management for carbon optimization can help mitigate increasing atmospheric carbon dioxide concentrations while aligning with forest resilience and adaptability objectives (Ontl et al. 2020 and Kaarakka et al. 2021). Management actions can address vulnerabilities of forest ecosystems to climate change, chronic stressors, or other disturbances such as insect outbreaks or drought (Goodwin et al. 2020) that put sustained forest productivity at risk of decline, with consequences to carbon stewardship and stability. Management can also address effects of previous land uses, such as past clearing with subsequent forest regrowth or fire suppression resulting in dense stands. These past actions may reduce carbon stability via simplified species composition or structural diversity, as well as modified disturbance regimes.

Many management activities may have short-term carbon emissions but yield long-term carbon benefits through enhancing forest resiliency and therefore carbon stabilization. For example, timber harvest aimed at removing hazardous fuels and reducing live tree density can yield short-term carbon emissions but ultimately reduce risk of high severity wildfire, yielding long-term increases to carbon stability (Krofcheck et al. 2019). For projects involving forest harvest, some removed carbon can be stored for long time periods if converted to harvested wood products (HWP). Woody biomass for energy production can also decrease greenhouse gas emissions if it is substituted for more fossil fuel-intensive energy sources (Sathre and O’Connor 2010, D’Amato et al. 2011, Oliver et al. 2014). Management activities enhancing species, structural, or age-class diversity can also result in long-term carbon stabilization (Puhlick et al. 2020; Crockett et al. 2023). The use of silvicultural tools such as removing hazardous fuels and reducing live tree density in stands outside the natural range of variability can increase resiliency to disturbance. Timber harvest initially reduces the amount of carbon in a forest stand, but carbon may be transferred to HWP or used for energy production, while increasing longer-term forest productivity and health (Sathre and O’Connor 2010, D’Amato et al. 2011, Oliver et al. 2014). Treatments may have benefits such as reducing the risk of wildfire and tree mortality, thereby contributing to long-term carbon stewardship (Krofcheck et al. 2019). While National Forests (or Administrative Units) tend to remain in the forest land cover type, and thus may provide a buffer against land use change and subsequent carbon losses. Factors such as atmospheric carbon dioxide concentrations, climatic variability, and the availability of growth-limiting forest nutrients such as nitrogen can also influence carbon dynamics (Caspersen et al. 2000; Pan et al. 2009).

Little research has addressed management or natural disturbance impacts on soil carbon stocks. Recent evidence suggests that typical disturbances related to harvest operations have little to no effect on soil carbon (Curzon et al. 2022). Other recent research in some ecosystems shows a range of soil carbon responses to harvest and fire. This research points to natural factors, such as soil texture and parent material, forest type, and climate, as more significant drivers of soil carbon stocks than disturbances such as fire or harvest (Nave et al. 2021b).

7.4.3 Carbon in Harvested Wood Products

Moving carbon stored in forests to forest products storage may result in lower net GHG emissions relative to unmanaged forests, if carbon stored in harvested wood products (HWP), substitution effects, and forest regrowth are considered (Lippke et al. 2011; McKinley et al. 2011; Skog et al. 2014; Dugan et al. 2018). The Intergovernmental Panel on Climate Change (IPCC) recognizes wood as a renewable resource that when sustainably managed can mitigate climate change (IPCC, 2022b). Assessing impacts of harvest on GHGs thus should include carbon storage estimates from wood products.

The duration of carbon persistence in harvested wood products (HWP) depends on the commodity type. For example, paper, pulp, or small-piece biomass will not retain carbon as long as timber. Carbon stored in HWP increases with HWP commodity production. Landfills (also known as solid waste disposal sites) also store discarded forest products and may continue to store carbon for many decades, as decomposition is slowed under oxygen-poor conditions. Wood products used in place of steel or concrete, as well as wood-derived biomass used in energy production in place of coal and natural gas, may reduce net GHG emissions as well (Gustavsson et al. 2006; Lippke et al. 2011).

7.5 Succession

Old-growth forests currently face numerous threats and stressors, which are expected to be exacerbated by climate change into the future. However, analysis of FIA plot projections developed as part of the 2020 RPA Assessment projects old-growth forest extent to increase over the next five decades despite increasing disturbances, with a slowing rate of increase over each decade. While this suggests that natural ecosystem succession will yield resilient old-growth forests that are characteristic for the local site conditions, a deeper analysis of the same FIA plot data yields important nuance. There is evidence that some of the identified old-growth includes areas where long-term fire suppression has allowed some forest group types to expand from fire refugium as well as includes forests that have developed compositional and structural characteristics outside the normal fire regime. Thus, these do not represent ecological old-growth forests and instead represent uncharacteristic conditions (USDA and USDI 2024).

Some forest group types of the eastern United States have been undergoing mesophication as a result of long-term fire suppression and multiple interacting factors. For example, red maple (*Acer rubrum*) is a fire-sensitive, shade-tolerant species that has experienced a rapid spread into significant portions of the oak-pine and oak-dominated ecosystems. The high proportions of maple in conjunction with an increasing density of trees have resulted in a lack of regeneration of oak across large landscapes, putting these systems at risk of conversion to an uncharacteristic system (Nowacki and Abrams 2008; Iverson et al. 2017; Hanberry et al. 2020a; Hale and Peterson 2024). Under a changing climate, the drought- and fire-adapted species associated with the oak forest types exhibit moderate to high adaptive capacity. However, areas that are converting or are at-risk of converting to a maple-dominated forest do not display the same resiliency to the projected altered climatic patterns (USDA Forest Service 2015).

In a parallel situation, some historical ponderosa pine (*Pinus ponderosa*) forests of the western United States are experiencing an ingrowth of Douglas-fir (*Pseudotsuga menziesii*). Small diameter Douglas-fir are creating a dense understory that suppresses pine regeneration (Hessberg et al. 2016; Battaglia et al.

2018; Hanberry et al. 2020b). The high density leads to uncharacteristic fire behavior and a subsequent loss of larger old trees (USDA and USDI 2024). If fire frequency and intensity remain high, established regeneration may not be able to develop and old-growth ponderosa pine trees that are currently serving as seed sources may be eliminated (Halofsky et al. 2018).

7.6 Climate change

7.6.1 Climate trends and projections: broad regional patterns

Forests in the United States are increasingly affected by climate changes, including warming temperatures, changing precipitation patterns, and increasing frequency and scale of some disturbances, as well as the interactions between these changing factors. The continental United States has been warming about 60 percent faster than the planet as a whole since 1970; during this time period, temperatures in the contiguous United States have risen by 2.5°F and temperatures in Alaska by 4.2°F (USGCRP 2023). This reflects a general worldwide pattern of northern latitudes warming more quickly on average. Regions are experiencing climate change differently and will continue to do so as the planet warms (Kunkel et al. 2022, USGCRP 2023, USDA Climate Risk Viewer 2024, Climate Toolbox 2024). There is also substantial seasonal variation in observed changes. For example, in many northern states, average winter temperatures are warming more quickly than summer temperatures (Kunkel et al. 2022, USGCRP 2023). Precipitation patterns and characteristics are changing across the country, with variation both regionally and seasonally. Comparing the period 2002-2021 to 1901-1960, many areas in the eastern United States are getting wetter on average, while Hawaii and the southwestern United States are getting drier (USGCRP 2023). However, average summer precipitation has decreased across much of the West and in the Southeast (USGCRP 2023). Since the 1950s, the frequency and intensity of heavy precipitation events have increased across much of the US, particularly in the east (USGCRP 2023). Even where rainfall may be increasing, higher temperatures lead to more evaporation and increased water stress on plants, which could be particularly pronounced during the growing season (USGCRP 2023, USDA 2023, Novick et al 2024). Chronic climate-related factors (e.g., temperature increase, decreased water availability) affect tree regeneration, physiology, and growth at longer time scales, ultimately affecting their distribution and abundance across large landscapes (USDA AND USDI 2024: Appendix 11). Many of these observed trends are expected to continue as global temperatures increase. Average temperatures in the United States are projected to increase at a greater rate than average global temperatures, with the highest increases expected in the northern and western parts of the country (USGCRP 2023). Annual average precipitation is expected to increase in the northern and eastern regions of the continental United States and in Alaska, decrease in the Southwest and Texas, and decrease in the Caribbean. Decreases in summer precipitation are also expected in the northwestern United States (USGCRP 2023).

7.6.2 Climate interactions with disturbances and stressors

Climate change acts as both a driver and stressor and interacts with many of the disturbances and stressors described in this section, including wildfire, insect and disease outbreaks, and extreme weather events, with implications for old-growth forests. Temperature change has driven increases in the frequency and severity of some extreme events (e.g. heatwaves, coldwaves, heavy rainfall, periods of drought and flooding, and severe storms), and the role that climate change plays in extreme events can increasingly be quantified (Herring et al. 2022, USGCRP 2023). There is strong evidence that over the past several decades drought risk has been increasing, especially in the Southwest, rainfall has become more extreme, especially east of the Rockies, and wildfires have become more frequent and larger, especially in the West (USGCRP 2023). There is moderate evidence that since the 1980s heatwaves have become more common and severe in the West, and hurricanes have been intensifying more rapidly and causing heavier rainfall and higher storm surges (USGCRP 2023). The occurrence of extreme events is unprecedented in the observed record and increases in multiple types of disturbances and stressors are expected under future climates as are multiple disturbances occurring simultaneously or in close succession (USGCRP 2023, IPCC 2023). Disturbances can cause tree injury and mortality, and following the disturbance, set the stage for a competition among trees that will determine which species will persist in a warmer climate with more frequent disturbances (USDA AND USDI 2024: Appendix 11).

Drought

Of all these patterns in extreme events, increasing drought risk may be most relevant to mature and old-growth forests. Increased drought severity has emerged even in places where there are not precipitation deficits because of increased atmospheric evaporative demand and the imbalance between what the atmosphere demands and the existing water availability (Vicente-Serrano et al. 2022, IPCC 2023). Warming temperatures bring an exponential rise in the atmospheric vapor pressure deficit (VPD) – one way to measure evaporative demand – which is among the most consequential impacts of climate change to forested ecosystems. Rising VPD has negative and cascading effects on nearly every aspect of plant function, from photosynthesis to growth and survival (Yuan et al. 2019, Novick et al. 2024). As a result, mass tree mortality events have increased globally, and they have been attributed to hotter droughts (Hammond et al 2022). For example, nearly half a billion trees died from hotter-drought events in Texas and California alone since 2010 (Moore et al. 2016, Fettig et al. 2019, Hammond et al. 2022). VPD can preferentially kill plants with certain traits, such as taller species (Stovall et al. 2019) or those with greater vulnerability to hydraulic failure (Quetin et al. 2023). Large old trees can be especially susceptible to mortality with hotter droughts (Bennett et al. 2015, Lindenmayer et al. 2017, Hammond et al 2022). Drought can ultimately trigger persistent changes in forest community composition when mortality of pre-existing species is followed by recruitment of different species (Martínez-Vilalta et al. 2016, Batllori et al. 2020). Long term observational studies in intact forests have indeed observed transitions to species more tolerant of dry conditions (Esquivel-Muelbert et al. 2020).

Wildfire

The United States is already experiencing more intense and frequent wildfires associated with warming and drought and aggravated by past management practices, including the suppression of Indigenous land-use and fire stewardship practices (USGCRP 2023, USDA 2023, Eisenburg et al. 2024). Rising VPD is again a culprit, as it accelerates the drying of fuels, promotes wildifre spread, and increases the occurrence, size, severity, and burned area (Higuera and Abatzoglou 2020, Parks and Abatzaglou 2020). Climate change will continue to affect the likelihood and scale of wildfires in forests of the United States (USGCRP 2023, Turco et al. 2023). In addition, climate projections show an increase in VPD in the night, lessening the night-time ability to slow or extinguish fire (Balch et al. 2022) and impacting fire suppression efforts. Changes in days with wildfire potential are projected to rise by almost 200 additional days in the western United States by the end-of-century (Gannon and Steinberg, 2021). Though wildfire threats are currently mostly in the western US, an eastward expansion is predicted to occur by the end of century as VPD continues to rise with global warming. Exposure of inventoried old-growth forests on both Forest Service and Bureau of Land Management (BLM) lands to moderate to high-severity fire is predicted to be between 95 – 100 percent for old-growth by the end of the century, depending on the scenarios used (USDA AND USDI 2024).

Insects and disease

Forest disturbances from native and non-native insect species are influenced by climate change in several ways. Warmer temperatures can directly increase insect survival and reproductive rates and allow them to expand their ranges into higher elevations and more northern latitudes (Lesk et al. 2017, Pureswaran et al. 2018). In addition, warm temperatures and drought can reduce the defenses of host trees to both native and non-native insects (Pureswaran et al. 2018, Robbins et al. 2023). Both of these factors have been evident in increasing tree mortality from bark beetles in the western United States in the late 20th and early 21st centuries (USGCRP 2023, Robbins et al. 2023). These dynamics are expected to continue with increasing temperatures and drought, and modeling future insect outbreaks continues to be an active area of research (Robbins et al. 2023). Insect-caused tree mortality can also interact with other climate-amplified disturbances; for example, drought combined with bark beetle outbreaks can result in an accumulation of heavy and dry fuel loads that in turn can result in more extreme fire behavior or more severe fire effects (Reed et al. 2023). The effects of climate change on forest diseases are more mixed; for example, warmer and wetter conditions could lead to an increase in some fungal diseases, while warmer and drier conditions may decrease the prevalence of these diseases (USGCRP 2023).

Millions of acres of old-growth forests are exposed to climate-related disturbances and stressors, and the proportion exposed is expected to grow over time across a range of modeled climate futures (USDA Forest Service 2023, USDA and USDI 2024). The Mature and Old-Growth Threat Analysis specifically discusses current and future mature and old-growth forest exposure to high temperatures (days >90°F) and reduced water availability (climatic water deficit). Mature and old-growth forest exposure to both of these stressors is expected to increase under a variety of climate futures (USDA and USDI 2024). For example, the amount of old-growth forest inventoried on Forest Service and BLM lands that is exposed to climatic water deficit could increase by a factor of 14.1 by the end of the century under some future scenarios (USDA and USDI 2024).

Overall, the amount of forest land and rangeland in the United States experiencing drought is projected to increase in the future and, as noted earlier in this in this section, drought exposure will vary regionally (USDA and USDI 2024). Climate projections show that on average, exposure to drought more than tripled between the recent and mid-century periods (Costanza et al. 2023). Forest types including pinyon/juniper and ponderosa pine were projected to be exposed to drought more than 50 percent of the time on average across all RPA scenarios by mid-century, compared to no forest type being exposed to drought more than 25 percent of the time historically. Projections agreed less for the eastern United States, except for oak/hickory forests, where projections agree on increased drought exposure (Costanza et al. 2023).

As demonstrated above, there are also clear relationships between climate change and other disturbances including wildfire, insects and disease, and a variety of severe weather events which have already affected old-growth forests. Current mature and old-growth exposure to these disturbances and stressors is widespread and increased exposure is expected under future climates (USDA and USDI 2024).

7.6.3 Forest type vulnerability to climate change

Forest vulnerabilities to climate change vary widely across the US, and a forest's response will depend on its level of exposure to a climatic change, stressor or disturbance, the forest's sensitivity to these changes, and its adaptive capacity. For example, increasing exposure to heat and drought will not affect all forests in the same way, but may favor those forest types that are more heat and drought tolerant. Past management can have a large influence on adaptive capacity; for example, a closed-canopy forest that has replaced a forest ecosystem previously maintained by regular fire may be maladapted to climate change and less able to cope with drought, severe wildfires, forest insects, and pathogens (Eisenberg at al. 2024). In response to climate pressures, tree species may experience more stress, reductions in productivity, difficulty regenerating, reduced seedling establishment, or mortality (Brandt 2020, Hartmann et al. 2022). Suitable habitat ranges for some tree species may shift northward or upslope to higher elevations to align with cooler temperatures or may shift to track changes in moisture (Brandt 2020). Regional vulnerability assessments can offer insight into how climate change is expected to affect forested ecosystems and their associated resources and ecosystem services in different parts of the United States (USDA 2024 – CCVA dashboard). Understanding forest vulnerability to climate change can help us prioritize areas for proactive stewardship and design adaptation actions to help maintain the values associated with old-growth forests in light of increasing climate pressures (Eisenburg et al. 2024, USGCRP 2023).

Vulnerabilities for several forest types are summarized below, grouped broadly by forest types outlined in Eisenburg et al. 2024 and in USDA and USDI 2024: Appendix 11.

Boreal and hemiboreal forests

Rapidly changing fire regimes pose the primary broad-scale threat to mature and old-growth (MOG) forests in boreal and hemiboreal ecosystems (Eisenburg et al. 2024). Increasing fire frequency and severity is contributing to a shift in species distribution toward broadleaved and fast-growing conifer species, and away from late-successional conifer species (Eisenburg et al. 2024). Increasing temperatures will also likely lead to more extensive, severe, and longer lasting insect outbreaks and increasing drought stress directly affecting forest productivity and integrity (Eisenburg et al. 2024). Drought has caused extensive areas of aspen dieback and also causes declines in biomass and growth in both uplands and wetlands, as well as contributing to poor post-fire seedling establishment and regeneration (Eisenburg et al. 2024).

Eastern temperate forests

Southeastern Forests. Southeastern forests are expected to face a variety of climate-induced stressors, including an increase in drought, native and invasive pests and pathogens, risk of wildfire, extreme weather events, and sea level rise. Pine-dominant ecosystems are highly vulnerable to southern pine beetles and engraver beetles, which can lead to large scale mortality events especially under conditions of drought stress (McNulty et al. 2015). Longer and more intense periods of drought, increases in lightning, and increases in high and mean temperatures may lead to an increase in wildfire in the region (McNulty et al. 2015). Pine-Oak and Longleaf pine ecosystems that depend on frequent, low-intensity fires may be negatively affected by reduced opportunities for safely conducting prescribed burning on the landscape (Eisenburg et al 2024). Coastal Wet Forests are threatened by sea level rise, which can affect forests up to 3 miles from the coastline and can cause a conversion of forest to marshlands with increasing soil and water salinity (McNulty et al. 2015). High wind events can cause mortality of canopy tree species in a variety of forest types and can cause a buildup of fuels for wildfires (Eisenburg et al 2024).

Central Hardwoods and Appalachian Mountains. The legacy of past management combined with increased risk of drought, wildfire, and pests and pathogens, are expected to influence climate vulnerability in these forests. As drought increases, there could be up to a 5-fold increase in the incidence of wildfires in the Southern Appalachians (Robbins et al. 2024). Past fire suppression tactics and the removal of Indigenous peoples from the landscape have allowed the spread of more closed canopy, mesic forests at the expense of open Oak Woodland (Eisenburg et al. 2024), resulting in forests with higher susceptibility to drought and severe wildfire. Hemlock and northern hardwood forests, and mesic ecosystem-dependent species like beech and maple may be particularly susceptible to wildfire (Butler et al. 2015). Beech, pines, hemlocks, oaks and other species are vulnerable to increases in pests and pathogens (Butler et al. 2015). For example, the fungal disease Sudden Oak Death is expected to increase with wetter springs. Some specific ecosystems will face unique challenges. Dry calcareous forests depend on unique soil types, and thus shifting climate envelopes will be hard for them to adapt to by migrating (Butler et al. 2015). Floodplain forests may struggle with increased periods of inundation (Butler et al. 2015). High elevation forests such as red spruce and fir forests are often at the limit of their climate tolerances and may be among the region’s most vulnerable forested ecosystems (Butler et al. 2015).

Great Lakes and New England. Forests in this region will be coping with hydrologic changes, increases in insect pests and pathogens, and increased wildfire risk, among other climate changes. Beech bark disease, hemlock wooly adelgid, emerald ash borer and spongy moth already affect these forests and their ranges may increase with climate change. For example, species like hemlock wooly adelgid are limited by low minimum temperatures, which are increasing (Dukes et al. 2009). Wet-mesic forests and peatland forests that depend on specific hydrologic conditions will likely struggle with changing precipitation timing. For example, black ash dominant systems may not consistently receive the saturated spring and dry summer conditions they need to survive (Handler et al. 2014). Increased severe storms, winds and heavy precipitation events can tear down trees across multiple forest ecosystem types (Eisenburg et al 2024). In this region, boreal species that are at the southern limit of their range could struggle, like paper birch, black spruce and firs in the Midwest, and red and black spruce in New England (Janowiak et al. 2018). Forests that represent species on the northern edge of their climate tolerances are expected to do well, including Central hardwood-Pine forests in New England (Janowiak et al. 2018).

Western temperate forests

Pinyon-Juniper Forests. Pinyon-juniper forests are extensive at lower elevations in the Southwest and are found at lower elevations in southern and western Colorado. Drought can reduce the vigor of pinyon pine, increasing their susceptibility to bark beetle outbreaks that can cause extensive tree mortality. Juniper species are typically more drought tolerant than pinyon pine but can also be stressed by long droughts. Both species are especially susceptible to drought-induced mortality on the hottest and driest landscape positions. Pinyon pine and juniper species are fire intolerant. Therefore, an increase in the frequency and extent of wildfire will be a major stressor in the future, although the fire effects will vary depending on stand structure and fuel loading. Forests with high stem densities and high fuel loadings are conducive to crown fires and mortality of most of the MOG trees, whereas forests with low stem densities and low fuels may not generate flames high enough to propagate crown fires, allowing some MOG trees to survive (USDA AND USDI 2024: Appendix 11).

Wet Coastal Forest. This forest type occurs in wet coastal areas along the Pacific Coast, although mature and old-growth (MOG) forests are relatively rare except for in protected areas. The distribution of this zone is mostly limited to the coast and closely related to the occurrence of summer fog, extending deeper inland along river valleys. More fog-free days during the summer could have negative effects on growth by increasing vapor pressure deficits. The effects of increasing summer moisture deficits may be greatest on western redcedar and western hemlock that occur in the southern part of their range. Warmer, drier conditions in the summer will also contribute to drier fuel conditions that could facilitate high-severity fires. These fires would potentially cause high mortality in all conifer species in MOG forests, although redwood can sprout vigorously (USDA AND USDI 2024: Appendix 11).

Ponderosa pine forest. Mature and old-growth ponderosa pine woodlands and forests are comprised mostly of ponderosa pine and multiple species of shrubs and perennial grasses. Fire exclusion, grazing, and high-grade logging of the largest trees have altered the structure of these forests which currently have an increased density of small trees and a reduced large-tree component. MOG ponderosa pine forests are currently vulnerable to high-severity fire and outbreaks of insects including mountain pine beetle and pine butterfly. Increased density also makes ponderosa pine forests susceptible to drought-related mortality. Ponderosa pine has a deep taproot, which allows it to tolerate drought. However, several consecutive years of drought can weaken trees enough to make them susceptible to lethal bark beetle outbreaks. If droughts occur more frequently, early effects on ponderosa pine can be expected in the driest landscape positions (e.g., south aspects, steep slopes). Historically, ponderosa pine forest had a high-frequency/low-intensity fire regime; however, increased wildfire may be a stressor in areas where high fuel loadings can propagate crown fires. Invasions of nonnative annual grasses may increase fire frequency and affect native plant communities in ponderosa pine forests and woodlands (USDA AND USDI 2024: Appendix 11).

Mixed conifer forest. Increased frequency and extent of droughts will potentially affect all species, making them more susceptible to secondary factors such as insects. Mortality may be prominent in MOG forests with high stem densities; spruces and firs may be especially susceptible. Drought-tolerant species such as ponderosa pine and Douglas-fir may be “winners” in the long term, comprising a greater proportion of future MOG forests. Mortality and altered species distribution and abundance will be greater where lower soil moisture is more likely—south and west aspects, steep slopes, and lower elevations. Increased frequency and extent of wildfire will also favor fire-tolerant ponderosa pine and Douglas-fir (USDA AND USDI 2024: Appendix 11).

Lodgepole pine forest. Lodgepole pine tolerates a wide variety of climatic and soil conditions, achieving its best growth on gentle slopes and in basins with well-drained soils. Because lodgepole pine often germinates prolifically following wildfire, stands tend to be of uniform age and can achieve MOG conditions over time in the absence of insects and fire. Old, low-vigor, high-density lodgepole pine stands are susceptible to mountain pine beetles. Beetle populations are stimulated by higher temperatures, spreading from stressed trees to adjacent healthy trees in large outbreaks, and will be a major stressor in a warmer climate. Lodgepole pines have serotinous cones that disperse seeds quickly after a wildfire passes. Therefore, it is expected that this species will persist in a warmer climate, but more frequent wildfire combined with increased beetle outbreaks will make it difficult to achieve MOG conditions (USDA AND USDI 2024: Appendix 11).

Subalpine forest. Subalpine forests occupy the highest elevations where tree species exist in mountainous environments. MOG stands that have not been subject to logging are relatively common, especially in wilderness areas. Wildfires have already affected large extents of MOG subalpine forests. In addition to fire, subalpine MOG forests are especially vulnerable to increased frequency of low-snow years. Warmer temperatures and more frequent drought could increase susceptibility to mortality from insects and pathogens, as well as reduced growth. Where adequate soil moisture is available, higher temperature and a longer growing season may increase (or at least maintain) growth and productivity for these species, especially at the highest elevations. However, at lower elevations within the subalpine zone and other locations where snowpack decreases significantly, low soil moisture may decrease growth and subject MOG trees to stress during the growing season. None of the common species in subalpine forests are fire tolerant. As fire frequency and extent increase, it is likely that wildfire will increasingly spread from mixed conifer and ponderosa pine forests into subalpine forests, killing large areas of MOG subalpine forest. The potential for post-fire regeneration will be variable, and lower-elevation tree species may displace subalpine species over time (USDA AND USDI 2024: Appendix 11).

Vulnerability to ecological transition

Intensifying climate change and associated droughts, wildfires, and insect outbreaks, are already causing noticeable changes to some ecosystems through persistent changes in species composition, structure, function, and diversity (e.g., ecological integrity) (Steffen et al. 2018, NAS 2019, Coop et al. 2020, Williams et al. 2020, Guiterman et al. 2022). Climate change is altering the distribution and abundance of species and changing species composition in a given place (Parmesan and Yohe 2003, Foden et al. 2008, Chen et al. 2011, Staudinger et al. 2013, Pecl et al. 2017, Bonebrake et al. 2018, Stanke et al. 2021). Examples of ecosystems transitioning are increasing in the West. In the Southwest, there are many examples of semi-arid coniferous forests converting to non-forested ecosystems, the vast majority of which were triggered by high-severity wildfire (Guiterman et al. 2022). Between 2011 and 2020, half of the mature forest habitat in the southern Sierra Nevada declined by transitioning to lower density forest or converting to non-forest vegetation (Steel et al. 2022). Dense mature forest showed particularly pronounced change with an 85 percent decline. As climate change continues, resource managers may be faced with increased mass mortality events, extirpation of existing species, and colonization of new species, resulting in ecological transformation (Allen et al. 2015, Nolan et al. 2019) and altered ecological function and provision of services like carbon storage (Kodero et al. 2024). Many mature and old-growth forests in the United States remain vulnerable to severe disturbance and chronic climate trends without active management for beneficial disturbance dynamics (Steel et al. 2022). For example, in the warmer and drier pinyon-juniper (PJ) communities of the Southwest, population declines are projected to lead to loss of PJ in 40–80 percent of sites, depending on future climate scenarios, but reducing stem density could retain PJ woodland in ~20 percent of them (Noel et al. 2023).

8. Current management direction

Current management of old-growth is determined by plan components in land management plans (referred to as an LMP or plan), as amended, as well as other factors that can drive management, discussed at the end of this section.

An LMP provides guidance for project- and activity-level decision-making on a national forest or grassland. Plan components guide future projects and activities and the plan monitoring program. For this analysis, LMPs were reviewed in terms of whether the following types of plan components were included for old-growth: desired conditions, standards, and guidelines, defined as follows:

- A desired condition is a description of specific social, economic, and/or ecological characteristics of the plan area, or a portion of the plan area, towards which management of the land and resources should be directed. Desired conditions must be described in terms that are specific enough to allow progress towards their achievement to be determined but must not include completion dates (36 CFR § 219.7(e)(1)(i)).
- A standard is a mandatory constraint on project and activity decision-making that is established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements (36 CFR § 219.7(e)(1)(iii)). Standards can be developed for forest-wide application or be specific to a management area or geographic area.
- A guideline is a constraint on project and activity decision-making that allows for departure from its terms so long as the purpose of the guideline is met. Guidelines are established to help achieve or maintain a desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements (36 CFR § 219.7(e)(1)(iv)). A guideline can be forest-wide or specific to a management area or geographic area.

Plan direction can apply forest-wide or be restricted to a specific area of the unit that contains special, exceptional, or unique values that provide important ecosystem services. Such areas are identified as designated areas, management areas, or geographic areas:

- Management area and geographic area allocations are specific to areas or features across the unit with similar management needs and desired conditions to maintain a unique character, purpose, or management emphasis.
- A designated area is defined as an area or feature congressionally or administratively identified and managed to maintain its unique special character or purpose.[4] Congressionally designated areas are discussed in a separate section below.

Old-growth plan direction is applicable to unit areas as defined in the LMP. Old-growth definitions are found in either a plan component, the plan's glossary, or in the LMP FEIS. Old-growth definitions can be a qualitative definition that describes common old-growth features, a definition with some criteria for stand age or diameter of a trunk or bole of a standing tree at breast height (DBH), or a complete set of criteria that allows for reliable identification of old-growth on the landscape. There are also plans with old-growth plan components that do not have a definition or criteria for old-growth in the text of the LMP. Some plans do not refer to old-growth, but instead refer to old forest or late successional stage, concepts that intersect, or overlap with, old-growth, but that are not always interchangeable.

As shown in Table 10, a total of 123 national forest or national forest/national grassland LMPs, collectively referred to as national forest LMPs, were reviewed to determine the character of current old-

[4] Examples of congressionally designated areas include but are not limited to designated wilderness areas, wild and scenic rivers, and national scenic trails. Examples of administratively designated areas include but are not limited to research natural areas, scenic byways, and special areas with unique values.

growth management direction and the areas within each unit where this direction applies. National grasslands with their own LMPs are discussed in a separate section (8.3 National grasslands).

Table 10. The number of land management plans by region (includes plans for national forests or administrative units with both national forests and national grasslands)

Region	R1	R2	R3	R4	R5	R6	R8	R9	R10	TOTAL
Number of LMPss	10	12	11	16	19	19	19	15	2	123

The LMPs were reviewed to determine whether forest-wide or specific to management or geographic area within a unit), whether the plan has a definition and/or criteria for old-growth, if the definition/criteria aligns with the region, and if the criteria are sufficient for identifying old-growth on the landscape. In addition, six national grasslands have stand-alone national grassland LMPs, which are discussed in the following section. Although the majority of national forest LMPs include plan components for management of old-growth, with roughly half of the plans without forest-wide standards (see Table 11).

Table 11. Overview of old-growth management direction in national forest LMPs

Old-growth management direction	LMPs with (percent)	LMPs without (percent)
Does the LMP include any old-growth plan direction?	114 (93%)	9 (7%)
Of the LMPs with old-growth direction, are there any desired conditions?	92 (81%)	22 (19%)
Of the LMPs with desired conditions for old-growth, does the direction apply forest-wide?	51 (55%)	41 (45%)
Of the LMPs with old-growth direction, are there any standards for old-growth?	74 (65%)	40 (35%)
Of the LMPs with standards, do they apply forest-wide?	50 (68%)	24 (32%)

8.1 Programmatic amendments covering multiple forests

Broad-scale amendments that apply to multiple unit LMPs, referred to as programmatic amendments, incorporate management direction into the LMPs, either directly when a plan is revised, or the amendment direction can be incorporated as an appendix to an existing plan. There are a number of wildlife and vegetation management programmatic amendments with implications for old-growth management. The programmatic amendments that intersect with old-growth management are discussed below. Excerpts of old-growth related direction from these amendments are included as examples but these examples are not meant to be inclusive of all relevant direction.

8.1.1 Programmatic amendments for Regions 1 through 4

Wildlife-related programmatic amendments may be intended to streamline and standardize consultation for the Endangered Species Act or may be intended to prevent a given species from being federally listed by the USFWS or may be useful for the management of species that require attention across relatively large areas. Some of these, such as the two Canada lynx amendments, reinforce protection of older forests with mature trees but didn't necessarily mention "old-growth."

Northern Rockies Lynx Management Direction (2007) and Southern Rockies Lynx Management Direction (2008)

Background: The Northern Rockies Lynx Management Direction (NRLMD) and the Southern Rockies Lynx Management Direction (SRLMD) established management direction to conserve and promote the recovery of the Canada lynx by reducing or eliminating adverse effects from land management activities on national forest system lands while preserving the overall multiple-use direction in existing plans (NRLMD FEIS 2007 and SRLMD ROD 2008). The NRLMD implements the planning aspect of the Conservation Agreements for 18 national forests in Regions 1, 2, and 4, and four BLM units in the states of Idaho and Utah.[5] The SRLMD amended forest plans through most of Colorado and the Medicine Bow in Wyoming.[6] Two of those forests have since revised their LMPs and have incorporated the SRLMD (with some revision) into those plans.

How old-growth is addressed: Both lynx amendments focus on horizontal cover and coarse woody debris rather than age or diameter class. Focus on conserving the most important components of lynx habitat: a mosaic of young and mature multistory forests with horizontal cover and coarse woody debris and the importance of multi-story mature or late successional forests. Overall, both lynx amendments do not have the expressed goal of preserving mature and old-growth forests but have components that guide vegetation in mapped lynx habitat units. An excerpt of old-growth related plan content from both lynx amendments are included in Table 12 and Table 13.

Table 12. Specific old-growth-related plan components from the NRLMD

Type of Plan Component	Plan Component Text
Objective VEG O2	Provide a mosaic of habitat conditions through time that support dense horizontal cover, and high densities of snowshoe hare. Provide winter snowshoe hare habitat in both the stand initiation structural stage and in mature, multi-story conifer vegetation.
Standard VEG S6	Vegetation management projects that reduce winter snowshoe hare habitat in multi-story mature or late successional conifer forests may occur only: 1. Within 200 feet of administrative sites, dwellings, outbuildings, recreation sites, and special use permit improvements, including infrastructure within permitted ski area boundaries; or 2. For research studies or genetic tree tests evaluating genetically improved reforestation stock; or 3. For incidental removal during salvage harvest (e.g., removal due to location of skid trails). Project design must be consistent with VEG O1, O2 and O4, except where impacts to areas of dense horizontal cover are incidental to activities under this exception (e.g., construction of skid trails).
Exceptions	Exception 2 and 3 shall only be utilized in LAUs where standard VEG S1 is met. (NOTE: Timber harvest is allowed in areas that have potential to improve winter snowshoe hare habitat but presently have poorly developed understories that lack dense horizontal cover [e.g. uneven age management systems could be used to create openings where there is little understory so that new forage can grow]).

[5] Forests amended: Idaho Panhandle, Clearwater, Nez Perce, Kootenai, Flathead, Lolo, Lewis and Clark, Helena, Bitterroot, Beaverhead-Deerlodge, Gallatin, Custer, Bighorn, Shoshone, Salmon-Challis, Targhee, Ashley, and Bridger-Teton NFs

[6] Forests amended: Arapahoe-Roosevelt, Grand Mesa-Uncompahgre-Gunnison (Incorporated into LMP revision), Medicine Bow-Routte, Pike-San Isabel, Rio Grande (Revised components incorporated into LMP Revision), San Juan, White River

Table 13. Specific old-growth-related plan components from SRLMD

Type of Plan Component	Plan Component Text
Objective VEG O2	Provide a mosaic of habitat conditions through time that support dense horizontal cover, and high densities of snowshoe hare. Provide winter snowshoe hare habitat in both the stand initiation structural stage and in mature, multi-story conifer vegetation.
Standard VEG S6	Vegetation management projects that reduce winter snowshoe hare habitat in multi-story mature or late successional conifer forests may occur only: 1. Within 200 feet of administrative sites, dwellings, outbuildings, recreation sites, and special use permit improvements, including infrastructure within permitted ski area boundaries; or 2. For research studies or genetic tree tests evaluating genetically improved reforestation stock; or 3. For incidental removal during salvage harvest (e.g., removal due to location of skid trails); or 4. Where uneven-aged management (single tree and small group selection) practices are employed to maintain and encourage multi-story attributes as part of gap dynamics. Project design must be consistent with VEG O1, O2 and O4, except where impacts to areas of dense horizontal cover are incidental to activities under this exception (e.g., construction of skid trails).

Utah Northern Goshawk Amendment (2000)

Background: The Utah Northern Goshawk Amendment amended six national forests in terms of management direction for northern goshawk and its habitat. The affected lands are located primarily in Utah, with small portions in Wyoming and Colorado.[7] Of the original six forests, the amendment now only affects the Dixie, Fishlake, Manti-LaSal because other forests have since completed plan revision.

How old-growth is addressed: Components prioritize active treatment to achieve resilient forested ecosystems, maintaining and improving habitat for the northern goshawk and its prey by providing plan components for both vegetative and non-vegetative management activities. The goshawk amendment is focused on maintaining and promoting structural diversity of vegetation in forested ecosystems, including strong representation of early seral species. Guideline f, shown below in Table 14, uses a percentage-based threshold for structural stages and provides sideboards on vegetation treatments occurring in landscapes that are below the desired threshold for mature/old-growth. It does not establish sideboards where that threshold is being exceeded.

[7] Forests amended: Ashley (incorporated into revised LMP), Dixie, Fishlake, Manti-LaSal, Uinta (incorporated into revised LMP), Wasatch-Cache (incorporated into revised LMP)

Table 14. Utah Northern Goshawk plan component

Type of Plan Component	Plan Component Text
Guideline f	Planned vegetative management treatments (excluding unplanned and unwanted wildland fire) in the mature and/or old structural groups in a landscape that is at or below the desired percentage of land area in mature and old structural stages (40% conifer, 30% aspen), should be designed to maintain or enhance the characteristics of these structural stages. Within these landscapes the percentage of land area in mature and old structural stages treated should not move out of the mature and old structural stages. Planned treatments may vary from this guideline if the action was assessed through the biological evaluation (BE) process, and the BE concluded that the action is consistent with the intent of the Conservation Strategy and Agreement for Management of the Northern Goshawk in Utah.

Greater Sage Grouse Amendment

Background: In 2015, the Greater Sage Grouse Amendment for Idaho and southwestern Montana, Nevada and Utah amended 16 national forest land management plans. These amendments are limited to providing land use planning direction specific to conserving Greater Sage Grouse and its habitat. The amendment now only affects 15 units because the Ashley National Forest has since completed plan revision.[8]

How old-growth is addressed: Guideline GRSG-GRSGH-GL-028 addresses avoidance of old-growth when mitigating conifer encroachment into sagebrush habitat.

Table 15. Greater Sage Grouse Amendment guideline

Type of Plan Component	Plan Component Text
GRSG-GRSGH-GL-028-Guideline	When removing conifers that are encroaching into greater sage-grouse habitat, avoid persistent woodlands (i.e., old-growth relative to the site or more than 100 years old).

8.1.2 Programmatic Amendments for Regions 5 and 6

Region 5: Sierra Nevada Forest Plan Amendment (SNFPA)

Background: The Sierra Nevada Forest Plan Amendment (SNFPA; 2004) intent was to improve protection of old forests, wildlife habitats, watersheds and communities in the Sierra Nevada mountains and Modoc Plateau.[9]

How old-growth is addressed: While old-growth and late successional old-growth are terms used in the SNFPA, the term most frequently used is old forest. These terms are considered equivalent for description in terms of structure and function of a stand. The SNFPA does not define old-growth specifically but does define old forest emphasis area and areas for wildlife species dependent on old forests (California spotted

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[8] Amended forests: Ashley (amendment no longer applies due to LMP Revision), Beaverhead-Deerlodge, Boise, Caribou, Challis, Dixie, Fishlake, Humboldt, Manti-La Sal, Salmon, Sawtooth, Targhee, Toiyabe, Uinta, Wasatch-Cache, Curlew (National Grassland)

[9] The SNFPA partially amended the Modoc and Lassen NF (outside of NWFP) and fully amended the Plumas, Tahoe, Eldorado, Stanislaus, Sierra, Sequoia, and Inyo National Forest LMPs; as well as the portion of the Humboldt Toiyabe National Forest (Region 4) that is in the Sierra Nevada, and the Lake Tahoe Basin Management Unit.

owl and northern goshawk) to limit amounts of mechanical treatments. SNFPA generally identified old forest in relation to wildlife habitat. Broad goals for old forest and associated species conservation strategy exists. Old forest ecosystem strategy has components that are generally related to species habitat and include a network of land allocations. Old forest emphasis areas are managed to maintain or develop old forest habitat and connectivity. Proactive approaches for improving overall forest integrity and restoration after large scale disturbance are also included. A general forest allocation is included and within these areas old forest may exist but is not the emphasis. No forest-wide old-growth plan components exist in the SNFPA. Management activities in protected activity centers are minimized, including some breeding areas that generally restrict all treatment activities. Forest-wide, all trees greater than or equal to 30” DBH are retained, changes to canopy cover are limited and basal area retention standards apply to all mechanical thinning.

Regions 5 and 6: Northwest Forest Plan Amendment

Background: The Northwest Forest Plan (NWFP; 1994) sets the overall management direction and guidance for 17 national forests across 24 million acres of federally managed lands in western Oregon and Washington and northwestern California.[10]

How old-growth is addressed: The NWFP intent is protection of threatened and endangered species that depend on old-growth forests while contributing to regional, social, and economic sustainability. A central component of the NWFP was the creation of a several new land use allocations including late successional reserves, riparian reserves, and adaptive management areas to provide standards and guidelines for management within those areas. The matrix are lands outside of reserved allocations where most timber harvest and silvicultural activities are expected to occur. Within the NWFP, the need to meet dual needs of forest habitat and forest products was recognized. Standards and guidelines exist that promote resilience/adaptability, abundance/distribution and/or ecological/ecosystem service contributions of old-growth, but generally speaking, these all exist within the context of desired conditions for associated species habitat. Activity restrictions and limits apply in most land use allocation areas. In some cases, what is considered needed for species may run counter to managing old-growth in a proactive manner. There are no forest-wide old-growth plan components applied through this amendment.

NWFP old-growth definitions are included directly and indirectly – old-growth singularly and as a component of late-successional forest (mature and old-growth seral stages) – in analysis documents, Forest Ecosystem Management Assessment Team (FEMAT) Report and in the plan itself. These distinctions between old-growth and late-successional forests relate to associated species habitat affinity distinctions. Old-growth is defined in the plan glossary in narrative description manner as is late successional forest. The FEMAT report contains a late successional forest definition which is a mix of narrative descriptions and measurable criteria. The definition for late successional forest includes both mature and old-growth: “late-successional forests were defined as stands dominated by conifers at least 21 inches in diameter (‘medium and “large” classes) including single and multistoried stands.” In addition to the glossary narrative definition of old-growth, the seral stages are defined but only in a narrative descriptive manner. While measurable repeatable criteria were used to identify forest at different seral

[10] The NWFP amendment applies to the individual land management plans of these national forests wholly: Gifford Pinchot, Klamath, Mendocino, and Six Rivers, Mount Baker-Snoqualmie, Mount Hood, Olympic, Rogue River-Siskiyou, Shasta-Trinity, Siuslaw, Umpqua, and Willamette National Forests and partially on the Deschutes, Lassen, Modoc, Okanogan/Wenatchee, and a portion of the Winema of the Fremont/Winema National Forests.

stages to inform land unit allocations, there criteria, these are not further incorporated in NWFP documents beyond reference.

No language identifies a repeatable, criteria-based definition for managers to identify old-growth stands for project level needs in NWFP documents. Although an old-growth structural index (OGSI) is used for effectiveness monitoring purposes, no direction to use this measurable, repeatable method as a working definition to identify old-growth stands for unit project needs exists.

Region 6: Eastside Screen Interim Direction (ESS) as amended in 1995[11]

Background: The Eastside Screen interim direction (ESS; 1995) amended LMPs on six national forests in eastern Oregon and Washington on just under eight million acres.[12] The primary purpose of the ES is to conserve those components of the landscape – old forest abundance, wildlife habitat in late and old structural stages – in relation to larger ecosystem management to protect habitat for certain species of wildlife and to promote the vigor and integrity of the forests.

How old-growth is addressed: Limits to harvest late and old structural stands of timber are included: "Harvest of late and old structural stands of timber will be deferred unless a comparison of existing stands of late and old structure stands, with the historic range of variability (HRV), shows that the amount of existing late and old structure is within or above the HRV; and that the proposed timber sale will not decrease existing levels of late and old structure stands below the HRV."

PACFISH/INFISH Amendment (1995)

Background: Two large-scale aquatic restoration strategies were amended into many land management plans: Interim Strategies for Managing Anadromous Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, and portions of California ("PACFISH") and the Inland Native Fish Strategy for

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[11] The original interim standards amended the plans in 1994. An effectiveness monitoring report was completed by a regional review team, based primarily on field trips to the National Forests starting in May 1994. This resulted in a 1995 Environmental Assessment and Decision Notice which continued the 1994 interim direction with revision to structural stages of the interim ecosystem standard and clarification on the wildlife standard. The Environmental Assessment completed for a portion of the 1995 ESS for six forests (WW, DES, UMA, MAL, OCH FRE-WIN), in 2021 is currently being appealed. If the Forest Service wins the appeal, a whole new subset of components relative to the 21" piece of Scenario A as well as the snag and green tree retention would "replace" those parts of the 1995 amendment.

[12] Eastside Screens amendment applies to the individual land management plans of these national forests wholly Colville, Deschutes, Malheur, Ochoco, Umatilla, and Wallowa-Whitman National Forests and partially, the Fremont and a portion of the Winema on the Fremont-Winema and the Okanogan portion of the Okanogan-Wenatchee National Forests.

Managing Fish-Producing Watersheds in eastern Oregon and Washington, Idaho, western Montana and Portions of Nevada ("INFISH").[13]

PACFISH amended 15 national forest land management plans to incorporate explicit goals and riparian objectives. The USFS, through the INFISH, amended LMPs where PACFISH was not already in place. INFISH amended 22 national forest land management plans in Regions 1, 4, and 6. PACFISH and INFISH share similar goals, objectives, standards, and guidelines, which are collectively considered the Aquatic Conservation Strategy.

Many forests have revised their aquatic conservation strategies, since PACFISH/INFISH were only intended to be interim for 18 months. Currently, ten forests remain under PACFISH, INFISH, or both.

How old-growth is addressed: Direction for riparian management does not expressly relate to old-growth. Some aspects of the standards for riparian vegetation address the benefits of fire in ecosystem function. Standard TM-1 prohibits commercial harvest in riparian habitat conservation areas (RHCAs), salvage and fuelwood cutting may only be used retroactively in response to a catastrophic event, and watershed analysis is required prior to salvage harvest in priority watersheds.

Table 16. PACFISH/INFISH plan components specific to treatments in riparian areas

Type of Plan Component	Plan Component Text
Standard FM-1	Design fuel treatment and fire suppression strategies, practices, and actions so as not to prevent attainment of Riparian Management Objectives, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuel management actions could perpetuate or be damaging to long-term ecosystem function, listed anadromous fish, or designated critical habitat.
Standard FM-4	Design prescribed burn projects and prescriptions to contribute to the attainment of the Riparian Management Objectives.
Standard RA-2	Trees may be felled in Riparian Habitat Conservation Areas when they pose a safety risk. Keep felled trees on site when needed to meet woody debris objectives.

[13]Amended Forests still under PACFISH or INFISH: Bitterroot , Challis, Humboldt, Lassen, Lolo, Malheur, Ochoco, Salmon, Umatilla, Wallowa-Whitman. Note that some national forest LMPs amended by PACFISH have since been revised: Boise, Clearwater, Lassen, Los Padres, Nez Perce, Okanogan, Payette, and Sawtooth National Forests as well as the Sawtooth National Recreation Area and the Columbia River Gorge National Scenic Area, and likewise some national forests whose LMPs were amended by INFISH forests have since been revised: Boise, Caribou, Clearwater, Colville, Deerlodge, Deschutes, Flathead, Fremont, Helena, Idaho Panhandle, Kootenai, Okanogan, Payette, Sawtooth, and Winema National Forests.

Type of Plan Component	Plan Component Text
Standard TM-1	Prohibit timber harvest, including fuelwood cutting, in Riparian Habitat Conservation Areas, except as described below. a) Where catastrophic events such as fire, flooding, volcanic, wind, or insect damage result in degraded riparian conditions, allow salvage and fuelwood cutting in Riparian Habitat Conservation Areas only where present and future woody debris needs are met, where cutting would not retard or prevent attainment of other Riparian Management Objectives, and where adverse effects can be avoided to inland native fish. For priority watersheds, complete watershed analysis prior to salvage cutting in RHCAs. b) Apply silvicultural practices for Riparian Habitat Conservation Areas to acquire desired vegetation characteristics where needed to attain Riparian Management Objectives. Apply silvicultural practices in a manner that does not retard attainment of Riparian Management Objectives and that avoids adverse effects on inland native fish.

8.2 Old-growth Management by Region

An overview of old-growth management in LMPs by region follows. The management direction and definitions for old-growth discussed below are from current LMPs used by units to guide management. Any plans that are being revised will be incorporating the old-growth amendment management direction as part of the revision process. For additional information on specific national forests and national grasslands, refer to Appendix C, Comparison of Current Management of Old-Growth to Amendment, for the Draft EIS.

8.2.1 Region 1: Northern Region

The Northern Region (Region 1) has seven land management plans (LMP) written or revised under the 1982 Planning Rule. Three LMPs are currently being revised (Lolo National Forest, Nez Perce National Forest and Clearwater National Forest, with the latter two being revised as a single plan). Three LMPs have been revised and one was recently amended under the 2012 Planning Rule. All plans have forest-wide or management area plan components related to old-growth. The Dakota Prairie National Grassland in this region is discussed with the other grassland units in Section 8.3.

Eight plans have guidelines, standards, or both related to old-growth (see Appendix C, Comparison of Current Management of Old-Growth to Amendment, for the Draft EIS). The current Lolo National Forest plan addresses old-growth through a specific old-growth management area. Only some plans clearly indicate that proactive stewardship of old-growth is the driver of management and activity limitations in old-growth areas. Almost all plans have language indicating that the persistence of old-growth on the landscape is desirable and two plans are structured for the recruitment of old-growth including through management activities.

Four units (Idaho Panhandle National Forests, Flathead National Forest, Beaverhead-Deerlodge National Forest, Kootenai National Forest, Helena-Lewis and Clark National Forest, Custer Gallatin National Forest) have standard(s) or guidelines(s) for management in old-growth areas stating that vegetation treatments, even those intended to increase the resilience of old-growth, must not alter the stand to the extent that it no longer meets the minimum old-growth criteria identified by the regional guidance, "Old-Growth Forest Types of the Northern Region” (Green et al., 1992, errata 2001). Harvests or prescribed fire that would cause an area to fall below the minimum regional criteria of number of trees meeting age, size, trees per acres, and basal area requirements identified for that existing (old-growth type) and potential vegetation grouping (habitat type group) by geographic zone are prohibited.

Two units have specific exceptions in old-growth standards or guidelines for lodgepole pine forests, the Custer Gallatin National Forest and the Helena-Lewis and Clark National Forest. The Nez Perce National Forest and Clearwater National Forest plans also do not include lodgepole pine in the list of old-growth cover types identified for proactive management activities in their management area guidelines.

Four forests have additional desired conditions, standards, or guidelines related to old-growth that apply only in certain management or geographic areas. The Nez Perce National Forest, Clearwater National Forest, and Idaho Panhandle National Forests have management area or geographic area desired conditions and standards and/or guidelines. The geographic area plan components in the Idaho Panhandle National Forests support recruitment and proactive stewardship, and the Clearwater National Forest has additional direction to support recruitment.

Current Northern Region plan approach groupings

Existing LMP forest-wide desired conditions, goals, standards and guidelines related to old-growth are summarized below. In addition, components in exiting LMPs' which addressed resiliency, pro-active stewardship and recruitment of old-growth are included in the following summary. Plans without standards or guidelines for recruiting future old-growth are grouped separately from plans that have a standard or guideline addressing old-growth recruitment.

Plans with forest-wide old-growth standards and/or guidelines:

- Plans with guidelines and large tree structure direction for future old-growth: Helena-Lewis and Clark National Forest, Custer Gallatin National Forest
- Plans with standards: Beaverhead-Deerlodge National Forest, Bitterroot National Forest, Kootenai National Forest, Idaho Panhandle National Forests
- Plans with standards and guidelines that support recruitment and proactive stewardship, large and very large live tree structure direction for future old-growth: Flathead NF

Plans with Management Area (MA) or Geographic Area (GA) old-growth standards and/or guidelines but no forest-wide standards and/or guidelines:

- Lolo NF

Old-growth criteria in Northern Region land management plans

In Region 1, old-growth criteria are based on existing and potential vegetation groupings differentiated by geographic zones. The guidance document is "Old-growth Forest Types of the Northern Region," (Green et al. 1992, errata 2011), which is the report of the 1989 Region 1 Old-Growth Committee and coordinated geographic area sub-committees, containing descriptions of old-growth forest types, documentation on how these descriptions were developed, and the ecological context to guide the proper use of these descriptions (Green et al. Notes 2005, errata 2011). This guidance document includes minimum criteria that characterize old-growth for three different geographic zones within Region 1 that differ in biophysical characteristics: northern Idaho, western Montana, and eastern Montana. The minimum criteria are number of trees per acre that meet minimum age and DBH thresholds and stand density (basal area) of trees greater than 5 inches DBH which are meant to be used as a screening device to identify stands that meet the definition of old-growth. Additional characteristics by old-growth forest type are intended to be used as a guideline to evaluate initially selected stands on the minimum criteria and can assist in old-growth identification.

Most units in Region 1 indicate that the regional criteria are used to identify old-growth on the landscape. Many units contain a trigger clause that if the region updates the criteria, the unit will follow the region.

Groupings based on text of land management plans:

- **Unit LMPs using regional criteria:** Beaverhead-Deerlodge National Forest; Bitterroot National Forest; Custer Gallatin National Forest; Flathead National Forest; Helena-Lewis and Clark NF; Idaho Panhandle National Forests; Kootenai National Forest
- **Unit LMPs with complete LMP criteria that differs from the regional criteria:** Nez Perce National Forest, Clearwater National Forest
- **Unit LMPs with no old-growth criteria:** Lolo National Forest

8.2.2 Region 2: Rocky Mountain Region

Characteristics and definitions of old-growth forests

The Rocky Mountain Region (Region 2) consists of 12 national forest land management plans (LMPs) and one national grassland LMP for the Thunder Basin National Grassland.[14] Two LMPs have been revised under the 2012 Planning Rule: Grand Mesa, Uncompahgre, and Gunnison (GMUG) National Forests LMP and the Rio Grande LMP. The remaining 10 were revised under the 1982 Planning Rule.

The regional definitions for old-growth are based on *Old-Growth Descriptions for the Major Forest Cover Types in the Rocky Mountain Region* by Mehl (1992) and require that stands have a certain number of trees per acre over an age and size threshold; a certain number of trees with broken or dead tops; and a certain number of dead trees that are greater than a certain diameter limit. Numbers for each criterion vary by the dominant forest cover type: spruce/fir, Douglas-fir, lodgepole pine, ponderosa pine (broken out by the Front Range, Black Hills, and the Southwest), aspen, and pinyon-juniper.

The Bighorn National Forest LMP (2005), White River National Forest LMP (2002) and Routt National Forest (1998) fully incorporated the regional definition and criteria for old-growth. The GMUG National Forest LMP (2024) and the Rio Grande National Forest LMP (2020) developed old-growth criteria unique of the regional definition. The GMUG and Rio Grande use the term “old forest” while referencing the regional definition source (Mehl 1992) as the basis for their LMP criteria, which is an abbreviated or modified version of Mehl (1992) that is more accurate for the area of both national forests.

The remaining seven LMPs provided either no definition for old-growth or the definition provided was considered incomplete regarding the criteria or included ecotypes. The Arapaho-Roosevelt National Forest (including the Pawnee National Grassland) LMP (1998) and the San Juan National Forest LMP (2021) did not provide any definition for old-growth even though the term was used in the documents.

The Medicine Bow National Forest LMP (2003) and Black Hills National Forest LMP (1997) both cite the source of the regional criteria but do not provide which of the criteria are used in the plans. The Medicine Bow LMP uses the term ‘old-growth’ and provides a qualitative description of old-growth forests being distinguished by old trees and related structural attributes or characteristics as described in Mehl (1992). The Black Hills LMP uses the term ‘late succession’ in exchange for ‘old-growth’ but is still

[14] The Thunder Basin National Grassland is discussed separately in the National Grasslands section of the Affected Environment.

defined as "ecosystems distinguished by very large old trees and related structural features." The LMP also uses the term 'structural stage 5 (late succession)', but this term's definition is framed around characteristics specific to ponderosa pine (*Pinus ponderosa*).

Lastly, the Nebraska National Forest LMP (2002) (including the Buffalo Gap and Oglala National Grasslands), Pike San-Isabel National Forest LMP (1984) (including the Cimarron-Comanche National Grassland), and the Shoshone National Forest LMP (2015) all contained a limited number of criteria for old-growth or did not provide criteria for each ecotype.

The Nebraska LMP uses the term 'structural stage 5,' like the Black Hills; however, the Nebraska LMP provides an even more limited definition and application of the term. The Nebraska LMP also utilizes the term 'late succession forests', which are defined as "ecosystems distinguished by old trees and related structural features," which is defined further for the two types of late succession ponderosa pine present in the Northern Great Plains: open-canopy and closed-canopy. There is no reference to Mehl (1992) for any of these definitions. The Pike San-Isabel LMP was amended in 2009 and updated the definition to qualitatively define old-growth forests in terms of a variety of tree sizes depending on the species, number and size or large snags and logs, and the development of an often-patchy understory. The regional definition was not referenced in this amended LMP definition. Table 3 (p. 32) of the Shoshone LMP provides desired age class diversity based on cover type and defines the 'older' age class as greater than 80 years old for aspen, greater than 150 years old for lodgepole pine, and greater than 200 years old for all other forest cover types. This was not deemed sufficient to qualify as a complete definition.

Existing Old-Growth Plan Components

There is a wide range of existing direction regarding existing and future old-growth across all 12 forest LMPs. Overall, all existing Region 2 LMPs include some level of plan components that address existing old-growth. Appendix C, Comparison of Current Management of Old-Growth to Amendment for the Draft EIS provides an overview of each existing LMP's range and level of consideration for current and future old-growth.

For the units that did not provide a definition for old-growth in the LMPs, the Arapaho-Roosevelt does not provide desired conditions for existing old-growth but does include standards or guidelines that address forest-wide management for future old-growth. In contrast, the San Juan LMP does provide desired conditions for existing old-growth that emphasize resilience/adaptability, abundance/distribution, and/or ecosystem service contributions. The San Juan LMP does not include standards for existing old-growth, but it does provide forest-wide standards or guidelines that address management for future old-growth.

One example of a guideline for managing for future old-growth comes from the San Juan LMP: "Prior to any proposed agency actions on forested lands or woodlands, the affected stands should be screened against the current SJNF old-growth database in order to determine their old-growth status. Within landscapes not meeting desired conditions for old-growth, ponderosa pine forest stands, and mixed conifer forest stands that currently are not in the old-growth development stage, but that contain significant old-growth attributes should be prioritized as old-growth recruitment areas, largely based on tree age and distribution across the SJNF and managed for their old-growth values."

For the units that provided old-growth definitions that aligned with the Region 2 definition, there was still variability in the types of plan components in each LMP. The Bighorn LMP includes desired conditions for old-growth that emphasize resilience/adaptability, abundance/distribution, and/or ecosystem service contributions as well as forest-wide standards or guidelines that address management for future old-growth. This is the same scenario as shown for the San Juan LMP. As an example of a desired condition that emphasizes abundance/distribution, the Bighorn LMP desired condition states, "A well-distributed system of forested stands designated for management as old-growth will be in place and will provide key habitat conditions needed for emphasis species. Biological diversity will continue to be maintained across the Forest for all species, with the largest concern being management of noxious weeds and other non-native species. ..."

Despite the Routt LMP fully incorporating the regional definition of old-growth, the term is largely absent in the plan components, and is instead replaced with the term 'late-successional';' however, the Routt LMP does provide desired conditions for old-growth, but they do not have the type of emphasis as those in the Bighorn or San Juan LMPs. The Routt LMP does not provide any other plan components for existing or future old-growth. The White River varies from the Bighorn and Routt by not providing desired conditions for old-growth but still including forest-wide standards for existing and future old-growth.

There were two units that referenced the regional definition as a source for their LMP definition for old-growth but did not describe which of the criteria was being used. The Black Hills LMP and Medicine Bow LMP are opposites of each other as shown in Appendix C, Comparison of Current Management of Old-Growth to Amendment, for the Draft EIS. The Black Hills provides desired conditions for existing old-growth that emphasize resilience/adaptability, abundance/distribution, and/or ecosystem service contributions whereas the Medicine Bow LMP does not. However, the Medicine Bow LMP does provide standards for existing old-growth as well as forest-wide standards or guidelines for future old-growth, whereas the Black Hills LMP does not.

This standard from the Medicine Bow LMP provides an example of one standard that addresses both existing and future old-growth: "Manage old forest to retain or achieve at least the minimum percentages of old-growth by cover type by mountain range shown in the following table. If stands meeting the old-growth definition do not exist at these percentages, manage additional stands that are closest to meeting old-growth criteria as recruitment old-growth to meet these desired percentages."

The GMUG LMP and Rio Grande LMP use a unique definition of old-growth that is the same between the two plans. Both LMPs include desired conditions for existing old-growth and that emphasize resilience/adaptability, abundance/distribution, and/or ecosystem service contributions. In contrast, neither LMP provide standards for existing old-growth, or any standards or guidelines for future old-growth.

The remaining LMPs are the Nebraska, Pike and San Isabel, and Shoshone that all provided incomplete definitions or descriptions of old-growth. The Nebraska and Shoshone LMPs both include desired conditions of existing old-growth, but only the Shoshone LMP emphasizes resilience/adaptability, abundance/distribution, and/or ecosystem service contributions. None of these three LMPs provide standards for existing old-growth, or any standards or guidelines for future old-growth.

8.2.3 Region 3: Southwestern Region

General information – definitions/ criteria

The Southwestern Region (Region 3) includes 11 national forest land management plans and one national grassland land management plan. The Cibola National Grassland is discussed in the 8.3 National grasslands section; this current section discusses the national *forests* only. In terms of Region 3 national forests, four land management plans were revised under the 2012 rule (Carson, Cibola, Santa Fe, and

Tonto) and six under the 1982 (Apache-Sitgreaves, Coconino, Coronado, Gila, Kaibab, Lincoln, and Prescott). Of the latter six, four were revised relatively recently (Apache-Sitgreaves, Coconino, Coronado, Prescott, and Kaibab). The Gila and Lincoln are currently under revision; however, their existing plans were used for this analysis.

The Region 3 2022 regional definition for old-growth is based on analysis conducted to support plan revision (USDA Forest Service 2019, Weisz and Vandendriesche 2013) and relies mainly on quantitative measures (stand density, percentage of large trees, or minimum quadratic mean diameter of large trees) for different vegetation classifications, which are termed ecological response units (ERUs). Specifically, for ERUs identified as ecological frequent fire types, FIA data are used to assign stands to an ERU and then identified as ***potential*** old-growth if large trees have a stand density index (SDI) (Zeide 1982) above a certain percentage (when compared to the maximum SDI). In the case of ERUs classified as ecological infrequent fire types, the stand minimum quadratic mean diameter (QMD) serves as a coarse filter screen to determine ***potential*** old-growth stands. Specifically, Region 3 direction classifies trees as old if they are a minimum of 150 years of age; stand density index and minimum diameter threshold therefore function as the first filter, which must then be further verified by age determination.

The 11 Region 3 LMP old-growth definitions do not directly reference the criteria developed in the 2022 definition, however, because these criteria were originally developed to facilitate analysis associated with state and transition modeling.

The Gila and Lincoln LMPs include both qualitative definitions and *quantitative* criteria for old-growth. The remaining nine Region 3 LMP definitions align with *and use language from* 2019 regional guidance for old-growth,[15] emphasizing 1) qualitative (not quantitative) old-growth characteristics, which differ by vegetation type and over time (i.e., may not all be present/ evident at any given moment) and include components such as old trees, dead trees (snags), downed wood (coarse woody debris), and structural diversity; 2) the temporally transitory nature of old-growth in the Southwest, where succession and disturbance (tree growth and mortality) means that old-growth moves across the landscape over time; and 3) the variable spatial scale of old-growth – ranging from contiguous, larger areas in infrequent-fire ERUs to small patches (e.g., a single tree or small clump of trees with old-growth characteristics in an otherwise young forest) in frequent-fire ERUs.

As noted, the 2019 guidance does not include quantitative criteria or a fixed list of minimum necessary elements defining old-growth. Pertinent Region 3 LMP direction focuses on managing old-growth characteristics or components – as well as addressing representation of all structural stages/ recruitment.

Existing Old-Growth Plan Components

Ten of 11 current Region 3 LMPs include some forest-wide plan components relating to old-growth. Nine Region 3 LMPs include some forestwide desired conditions and guidelines for old-growth: Apache-Sitgreaves, Carson, Cibola, Coconino, Coronado, Kaibab, Prescott, Santa Fe, and Tonto. The Lincoln is the only Region 3 LMP to include standards (N = 3) relating to old-growth. Some Region 3 LMPs also include old-growth-related optional plan content (e.g., select management approaches for the Carson, Kaibab, Gila, and Santa Fe LMPs); most do not. The Gila LMP includes only management approaches for

[15] Southwestern Region Old-growth: Old-Growth Description Excepts from Region 3 Regional Desired Conditions (updated 11/16/2019)

two types of old-growth (ponderosa pine and mixed conifer: Douglas and white fir); these appear in the glossary (p. 307) along with associated definitions and criteria for these two vegetation types.

The Region 3 LMPs vary in the nature and extent of old-growth direction. Some components discuss elements relating to old-growth explicitly, whereas others do so only indirectly – e.g., referencing structural diversity, snags, coarse woody debris, and old or large trees. Also, while all LMPs except the Gila have some plan components addressing old-growth in forested vegetation types, some LMP components reference only certain ERUs and/ or species and exclude others – usually woodlands and shrublands and/ or broadleaf deciduous species.[16]

Abundance/ distribution. With the exceptions of the Gila and Lincoln, all LMPs have desired conditions (DCs) describing old-growth spatial *and* temporal presence on the landscape as per the 2019 regional guidance; however, these DCs are not necessarily for all ERUs. Some LMPs address old-growth for all vegetation types and then *also* for individual ERUs (in the latter case, plan component text usually distinguishes the spatial-temporal nature of old-growth in frequent versus infrequent fire vegetation types) – e.g., Apache-Sitgreaves and Coconino. Some LMPs address only select vegetation types (e.g., forested, select forested, and/ or woodland) – excluding others (e.g., deciduous broadleaf types, shrublands, select forested types, and/ or woodlands: e.g., Carson, Cibola, Coronado,[17] Kaibab, Santa Fe, Tonto.[18] The Lincoln LMP includes a standard addressing the geographic distribution of old-growth, directing management to provide for a flow of functions and interactions at multiple scales on the landscape.

Some Region 3 LMPs include direction to protect certain deciduous broadleaf species that references old-growth *characteristics* (large trees, snags, etc.), but do not address old-growth directly or systematically for the corresponding ERU. For instance, the Carson, Cibola, Santa Fe, and Tonto LMPs have guidelines to protect large cottonwoods (and in the case of the Tonto, also large Arizona sycamores), but do not frame this direction in terms of old-growth (rather, e.g., benefits to wildlife/ at-risk species). As well, the Carson LMP has a desired conditions describing an appropriate diversity of age classes for aspen, cottonwood, and Gambel oak and the Tonto has a similar guideline for cottonwood, willow, sycamore, ash, alder – but old-growth is not referenced.

Ecological Services. Most Region 3 LMPs acknowledge the ecological services that old-growth provides to plant and animal species, but only the Apache-Sitgreaves, Carson, and Cibola have explicit, related plan components. Aside from the Gila, the other LMPs discuss this role in the glossary or another narrative (e.g., introductory) section. And in the case of the Gila LMP, wildlife plan components reference old-growth, but no rationale (e.g., regarding ecosystem services) is given.

Connectivity. Current Region 3 LMPs reference connectivity more broadly – e.g., with respect to ecosystems, wildlife habitat, etc., except for the Gila, which does not address this at all.

Recruitment/ Proactive stewardship. The Cibola, Kaibab, Prescott, Santa Fe, and Tonto LMPs include guidelines addressing old-growth recruitment for all ERUs. The Apache-Sitgreaves, Carson, Coconino, and Coronado include guidelines for old-growth recruitment for select ERUs, but exclude other Region 3

[16] Broadleaf deciduous species may appear in LMP sections such as woodlands, shrublands, riparian areas.
[17] E.g., Madrean encinal woodland; Madrean pine-oak woodland; Montane meadows, wetlands, and riparian areas are not addressed.
[18] E.g., the Carson and Santa Fe LMPs do not address the abundance/ distribution of the cottonwood group or montane-conifer willow group.

old-growth types.[19] For example, the Apache-Sitgreaves LMP has a guideline for all 'forest' vegetation types (one of five groupings) but excludes other groupings – e.g., Madrean pine-oak woodland and piñon-juniper savanna and persistent woodland, even though "old-growth-like characteristics" are discussed in reference to both, pp. 54–55). Similarly, the Carson has a guideline for the ponderosa pine ERU, but not for others (e.g., bristlecone pine, spruce-fir, mixed conifer with aspen). The Coconino LMP includes guidelines only for pinyon juniper with grass, pinyon juniper evergreen shrub, ponderosa pine, and all mixed conifer – excluding mixed conifer with aspen, among others. The Coronado LMP includes guidelines for ponderosa pine-evergreen shrub, dry mixed-conifer forest, wet mixed-conifer, and spruce-fir, but excludes Madrean encinal woodland, Madrean pine-oak woodland, or Montane meadows, wetlands, and riparian areas (i.e., cottonwood, willow), among others.

Resilience. Most Region 3 LMPs do not directly address the resilience of old-growth to factors such as climate change. Exceptions are the Coronado LMP, which includes DCs for forested ERUs and the Carson LMP, which includes an optional management approach for all vegetation types.

Old-growth in Region 3 Management Areas

Documented old-growth occurs within a few management areas in the Southwestern Region. The Apache-Sitgreaves LMP (p. 124) references the circa 580-acre recommended Lower Campbell Blue RNA, "a prime example of high-quality riparian vegetation and old-growth forests," noting that the "area may serve as a reference for studying grazing impacts in riparian areas and climate change." The Coconino LMP (p. 189) describes the "926-acre Rocky Gulch proposed RNA … [as] an example of old-growth ponderosa pine… [and] a control for research in the Beaver Creek watershed. The Santa Fe LMP (p. 203) notes that forest "adjoining" the Cañada Bonita Recommended Research Natural "includes remnant patches of old-growth mixed-conifer and spruce-fir forests, including some of the oldest aspen ever documented."

8.2.4 Region 4: Intermountain Region

Definitions and criteria for old-growth

The Intermountain Region (Region 4) includes 16 national forest land management plans and one national grassland land management plan.[20] Most plans in the region were revised under the 1982 Planning Rule. The exception is the Ashley National Forest, which signed its revised plan in 2024. Overall, the Intermountain Region is characterized by contrasting approaches to management direction for old-growth. There is wide variation across plans in the definition and criteria for old-growth—if it is defined at all—and the nature and extent of plan components for old-growth.

The Intermountain Region has established *Characteristics of Old-Growth Forests in the Intermountain Region* (Hamilton 1993) as its primary source for old-growth criteria metrics. Currently, only three forest plans in the region fully incorporate Hamilton (1993): the Caribou, Targhee, and Uinta National Forest Plans. Ten plans in the region were published prior to Hamilton (1993). As a result, older plans discuss

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[19] As defined in MOG Definition Identification Initial Inventory April 2023.pdf.

[20] The Curlew National Grassland is discussed separately in the National Grasslands section of the Affected Environment.

"old-growth" qualitatively with no reference to Hamilton (1993) or other quantitative criteria. Some forests revised after the development of Hamilton (1993) instead adopted distinct, subregional "old forest" definitions and criteria. The use of "old forest" in these plans rather than "old-growth" reflects place-based conditions and definitions within the region and is distinct from, but sometimes overlaps with, old-growth. The term "old-growth" can have a different context in the fire-adapted forests of the interior West compared to the Pacific Northwest and Alaska.

The Boise, Sawtooth, and Payette National Forests revised together in 2003 under the Southwest Idaho Ecogroup. These plans describe that "old forest" terminology was chosen over "old-growth" because of frequent disturbances in this subregion; dense stands and decadence typically associated with late successional old-growth characteristics rarely occurred because of frequent, low-intensity fire. These plans follow "old forest" structural stages and criteria described in Wisdom et al (2000) and Hann et al. (1997). Hann (1997) uses similar tree size criteria to Hamilton (1993) as a proxy for age. These plans delineate the differences between "old-growth" and "old forest" definitions while acknowledging the potential for areas within ecotypes to meet both definitions. The Payette National Forest plan presents analysis contrasting the plan area classified as old forest versus old-growth by ecotype. In general, old forest is a more common component of the forest, with historic presence of large tree size classes in potential vegetation groups ranging from 19-91 percent, while the estimated old-growth representation in the same potential vegetation groups ranges between 0-26 percent (Morgan and Parsons, 2001).

The Unita-Wasatch-Cache National Forest also revised its plans in 2003, with separate plans for the Uinta and the Wasatch-Cache. The Uinta's plan components are based on "old-growth," following the regional definition of Hamilton (1993). The Wasatch-Cache Plan cites Hamilton (1993) but does not explicitly reference this source when defining or classifying old-growth. Instead, most plan components in the Wasatch-Cache Plan are based on "old forest areas" or "old forest landscape structure." While these terms are undefined, the plan recognizes that old forests are "dynamic, changing location as disturbances occur."

The Ashley National Forest is the region's only completed plan under the 2012 Planning Rule and uses "old forest" as one of its vegetation structure stages in the plan. Classification into a vegetative structural stage uses tree size as a proxy for age, following Reynolds et al. (1992), with no other criteria. The plan does not define the old forest structural stage for all forest ecotypes on the unit, and most of the DBH sizes used as the minimum for old forest classification do not match the Hamilton (1993) criteria. However, deliberative materials from the forest plan revision indicate that the unit uses "old forest" as interchangeable with "old-growth."

A portion of the Toiyabe National Forest Plan provides management direction for "old forest" due to a plan amendment. The Toiyabe Plan was completed in 1986 before Hamilton (1993). The Sierra Nevada Forest Plan Amendment (2004) established "old forest emphasis areas" in the western portion of the Humboldt-Toiyabe National Forest in California. This small proportion of the Forest now falls under the scope of the old-growth criteria described in Franklin et al. (1996) across the Sierra Nevada ecoregion. This Amendment is described in more detail in the Programmatic Amendments for Regions 1-4 section of the Affected Environment. The remainder of the Toiyabe National Forest follows a qualitative definition of old-growth, for which no reference or criteria is provided in the Plan.

Some nuances also exist between what old-growth definitions and criteria exist within a land management plan and management of old-growth on the landscape. For example, the Salmon National Forest Plan pre-dates Hamilton (1993) and includes no definition or criteria for old-growth. A 2008 Settlement Agreement stipulates that the Salmon National Forest must inventory stands within a project area for old-growth characteristics using the Hamilton (1993) definition prior to commercial timber harvest. Therefore, the Salmon National Forest uses Hamilton (1993) even though it is not directed to do so by their land management plan. The Settlement Agreement is only applicable until the Salmon National Forest completes an amendment or revision of its Forest Plan.

A minority of plans in the region contain complete definitions and criteria for old-growth (Appendix C, Comparison of Current Management of Old-Growth to Amendment, for the Draft EIS). In 2007, the Intermountain Regional Forester issued a letter to Forest Supervisors providing guidance on the minimum criteria defining "old-growth" forests and reaffirming the classification approach described by Hamilton (1993). In the absence of criteria in their land management plans, some national forests in the Intermountain Region defer to this guidance and follow Hamilton (1993) to define and inventory old-growth.

Existing plan direction for old-growth

National Forest land management plans in the Intermountain Region vary considerably in the nature and extent of plan components for old-growth. All plans in the region, except the Payette National Forest Plan, contain at least one plan component for old-growth (Appendix C, Comparison of Current Management of Old-Growth to Amendment, for the Draft EIS). The Payette Plan identifies "old forest" as a component of the large tree size class and includes multiple plan components for "large tree size class."

Many plans in the region have plan components for old-growth-dependent wildlife species and habitat conditions. However, these types of plan components often focus on maintaining and improving habitat for certain species, such as boreal owl or lynx. These plan components can be spatially limited to those species' habitats or certain wildlife habitat management areas. Additional components recognizing other ecosystem services provided by old-growth, such as carbon storage, soil stabilization, and spiritual and heritage values are not included in plans within the Intermountain Region.

Across plans in the Region, there is a general lack of restrictions on management activities in old-growth. Some older plans include standards that prioritize harvest of old stands of specific species. For example, the Toiyabe National Forest Plan includes a management area-level standard that "High risk old-growth, not needed for wildlife habitat, and overstocked intermediate Jeffrey pine stands, are highest priority for harvest." The Dixie National Forest Plan has a management area-level standard that directs toward "conversion of old-growth to young, thrifty stands" for the spruce-fire forest type. The Salmon National Forest Plan has forest-wide standards that "The lodgepole type and mature lodgepole stands should be given a very high priority for logging" and "Where possible, logging priority should be given to overmature or decadent stands, especially those where Douglas-fir beetle is active." In these cases, vegetation management may not be for the sole purpose of proactive stewardship. The Humbolt National Forest Plan is unique in precluding some proactive stewardship activities for ancient bristlecone pine, except with written permission of the Forest Supervisor. A minority of plans in the region, including the Ashley, Caribou, Sawtooth, and Uinta explicitly promote proactive stewardship of old-growth. The Sawtooth Plan directs for this active restoration within different management areas as part of its Wildlife

Conservation Strategy Amendment (2012); the other National Forest Plans direct toward proactive stewardship at the forest-wide level.

Six plans in the region contain desired conditions for old-growth (Appendix C, Comparison of Current Management of Old-Growth to Amendment, for the Draft EIS). These desired conditions present quite different aspirations across National Forests. For example, the Humbolt National Forest has no forest-wide desired condition for old-growth but has a desired condition for the Ruby Mountains and Snake Management Areas to protect ancient bristlecone pine. The Salmon, Toyiabe, and Uinta National Forest Plans all have forest-wide desired conditions that emphasize the importance of old-growth for certain species of wildlife. The Caribou and Salmon National Forest Plans both have forest-wide desired conditions that establish a target percentage of the landscape to maintain as old-growth. The Ashley has desired conditions that more broadly emphasize the distribution, abundance, resilience, and ecosystem service contributions of old-growth across the landscape.

Eleven plans in the Intermountain Region have one or more forest-wide standards for old-growth (Appendix C, Comparison of Current Management of Old-Growth to Amendment, for the Draft EIS). The most common standard for old-growth in the region establishes a percentage of the forested lands to maintain in old-growth structural stage. These percentages range across plans from at least 5 percent to at least 20 percent, with 10 percent as the most common. In some cases, management activities are not restricted in old-growth so long as these minimum percentages are met. The Sawtooth and the Boise National Forest Plans represent exceptions to the percentage-style standards. Instead, these plans direct management to retain *all* forest stands that meet the definition of old forest habitat, permitting management actions in such stands only as long as they will continue to meet the definition of old forest habitat.

Eight plans in the region have both standards and guidelines for old-growth (Appendix C, Comparison of Current Management of Old-Growth to Amendment, for the Draft EIS). The Targhee, Bridger-Teton, and Wasatch-Cache Plans use guidelines to establish the target percentage for old-growth forested acreage rather than standards. The Dixie and Fishlake National Forests have a single guideline from the Utah Northern Goshawk Amendment (2000). The Boise and Sawtooth National Forests have a single guideline for old-growth from the Greater Sage-Grouse Amendment (2015). These Amendments are described in more detail under the section discussing programmatic amendments covering multiple forests for Regions 1-4.

8.2.5 Region 5: Pacific Southwest Region

The Pacific Southwest Region (Region 5) includes 17 national forests, one management unit, and six national monuments managed by the Forest Service (three of which are jointly managed with the Bureau of Land Management) on 20 million acres of National Forest System land in California. These forests occur in the North Coast, Cascade, and Sierra Nevada ranges and from Big Sur to the Mexican border in the South Coast range. Note that the only national monument with an LMP that will be amended is Giant Sequoia National Monument as the other national monuments have management direction included within other national forest LMPs.

Existing definitions for old-growth

As described at the beginning of Section 4, in 1989, the Chief of the Forest Service sent out a memo to regional foresters outlining the Forest Service's position on old-growth as well as a generic definition and description of old-growth forests (USDA FS 1989). This definition encompassed the later stages of forest stand development that are usually distinguished by the presence of larger, older trees and structural attributes such as multiple canopy layers, decadence in the form of standing dead trees (snags), and accumulations of fallen trees (logs). It also noted that these characteristics differed by forest types, such that one definition would not fit all. And finally, it made clear that old-growth forest was not necessarily "virgin" or "primeval" forest but could be developed through thoughtful forest management. This generic definition was to serve as the starting framework for the development or modification of more specific definitions that related to structural components that could be readily identified or measured.

In Region 5, Old-growth Descriptions/Definitions for Eleven Forest Cover Types were developed in the early 1990s in response to Chief Robertson's 1989 letter. The definitions used the best available data at the time, which included the FIA database and the data collected by forest ecologists during the ecological classification sampling.

Old-growth forests were further highlighted in 1994, when Congress requested a scientific review of the remaining old-growth in the national forests of the Sierra Nevada in California by the Sierra Nevada Ecosystem Project (SNEP). SNEP used ten principal forest types for late successional analysis in the Sierra Nevada. Of the 10 forest types, the assessment of late successional old-growth forests was directed principally toward conifer forest types growing at middle elevations, the commercially important west-side mixed conifer, white fir, red fir, east-side mixed conifer, and east-side pine forests (Erman et al., 1996).

Region 5 has three LMPs written under the 2012 Planning Rule, and 16 under the 1982 Planning Rule. There are also programmatic amendments covering multiple forests. The NWFP amended six units in Region 5 in full: the Klamath, Mendocino, Shasta-Trinity and Six Rivers NFs; and two additional units were partially amended, the Lassen and Modoc NFs. In 2004, the Sierra Nevada Forest Plan Amendment (SNFPA) amended the Land and Resource Management Plans for 11 National Forests in the Sierra Nevada range. Within Region 5, the Modoc, Lassen, Plumas, Tahoe, Eldorado and Stanislaus continue to follow the SNFPA direction.

LMPs developed under the 2012 Planning Rule

2023 – Sequoia and Sierra National Forests

Both Sequoia NF and Sierra NF plans were revised in 2023. These plans do not mention old-growth, but old forest is included and considered equivalent to old-growth in terms of stand condition and function. Some of the plan components are tiered to the Sierra Nevada Forest Plan Amendment (SNFPA). The Terrestrial Ecosystems section includes old forest direction for forest types in the montane and upper montane ecological zones, including, ponderosa pine/dry mixed conifer, moist mixed conifer, Jeffrey pine, red fir, and lodgepole pine within context of overall landscape scale desired conditions. Other forest types contain no plan components for old forest. Guidelines are designed to retain or promote desired conditions during mechanical thinning or fire management activities. The Animal and Plant Species section includes direction in the Sierra and Sequoia LMPs for old forest-related desired conditions, guidelines and/or standards for select species habitat needs. Similarly, the Wildlife Habitat Management Area section contains desired conditions for old forest habitat. Direction for management in some areas is specifically for function of ecosystem, habitat improvement and/or fire resiliency. Restrictions are in place for denning and nesting areas, but do not preclude proactive management activities wholly. Direction to improve species habitat does include some retention for large diameter trees and snags.

The plans include identical definitions of old forest in glossaries, as a mix of narrative descriptions, and measurable criteria. Plans do provide direction to use a specific, measurable, repeatable criteria-based definition to identify old-growth stands at finer spatial scales.

2018 – Inyo National Forest

The Inyo NF LMP was revised in 2019. No old-growth specific plan components exist by name, but old forest is likely equivalent to old-growth in terms of stand condition and function. Management direction for Terrestrial Ecosystems and Vegetation is categorized by zones. Sierra Nevada Montane Zone includes old forest as a "state" with desired conditions and guidelines for old forest habitats on a landscape and stand scale. Guidelines are designed to retain or promote desired conditions during mechanical thinning or fire management activities. Timber forest types within this zone are where most management activities occur. Beyond that, a guideline for managing wildfire in the Fire section is the only other plan component specific to old forests. The Ancient Bristlecone Pine Forest is designated as a National Protection Area. Activities such as utility rights of way, timber harvesting and ski areas were deemed unsuitable for this area. Some of the plan components are tiered back to the SNFPA. Direction for management in some areas is specifically for function of ecosystem, habitat improvement and/or fire resiliency. Restrictions are in place for some wildlife species, including restrictions and limits on mechanical treatments. A standard for retention of trees over 30" DBH exists, with exceptions for safety, cultural or tribal need, equipment operability in area and to meet restoration goals. A 24" DBH standard for overstory trees applies in protected activity centers for California spotted owls.

The Inyo NF LMP does not contain a glossary definition of old-growth or old forest (although a definition of old forest is found in the associated Inyo NF LMP FEIS). A mix of narrative descriptions and measurable criteria related to desired condition amount and distribution of old forest and specific seral stage is included.

1982 Planning Rule

2016 – Lake Taho Basin Management Unit (LTBMU)

The LTBMU was established in 1973 to facilitate consistent management of National Forest System lands within the Lake Tahoe Basin watershed. These lands were previously managed by three separate national forests: the Tahoe, the Eldorado, and the Toiyabe. LTBMU LMP was revised in 2016 under the 1982 planning rule. Old-growth is not mentioned in the LMP and old-growth specific plan components do not exist by name, but old and late seral stage are likely comparable to old-growth in terms of stand conditions and function. Many of the plan components tier to the Sierra Nevada Forest Plan Amendment (SNFPA). Timber "production" as primary or secondary objective or goal does not exist and restoration is emphasized. There are no lands deemed suitable for timber production. Desired conditions are set by seral stage for various forested types, including an old seral stage. Strategies, standards, guidelines and desired conditions for late seral stands and habitat are included, all within context of associated species. A standard for retention of trees over 30" DBH exists, with exceptions including the need to achieve a desired condition for the forest type. Mechanical treatments are restricted in some areas associated with den sites and protected activity centers. Standards for retention of late seral and linkage canopy cover may limit activities in in certain areas.

No unit-wide components that promote resilience/adaptability, abundance/distribution and/or ecological/ecosystem service contributions of old-growth exist. While plan components may not be wholly old-growth-centric, management throughout the unit promotes old-growth resilience/adaptability, abundance/ distribution and/or ecological/ecosystem service contributions on a landscape scale. Activity limits and standard may affect this at a site-specific scale.

The LMP includes no definitions for old-growth or equivalent and does not provide direction to use a specific, measurable, repeatable criteria-based definition for unit project needs.

2012 – Giant Sequoia National Monument (GSNM)

GSNM was established in 2000 and the most recent LMP was developed in 2012. Overall strategic guidance is for managing the unique and special features of GSNM—including the giant sequoia groves and the ecosystems that support them. It was recognized that these features merit careful management, protection, and preservation. GSNM contributes to social, economic, and ecological sustainability by guiding the restoration or maintenance of the land administered under the plan. Old-growth is not directly discussed except for a description of giant sequoia specimen trees. Timber production was removed by proclamation. Projects proposed that could impact giant sequoia must meet design criteria and are specific to the use of fire in restoration.

No unit- wide components that promote resilience/adaptability, abundance/ distribution and/or ecological/ecosystem service contributions of old-growth exist. While plan components may not be wholly old-growth centric, management throughout the unit promotes old-growth resilience/adaptability, abundance/ distribution and/or ecological/ecosystem service contributions on a landscape scale.

No old-growth definition in narrative descriptive or measurable criteria form is included. The plans include no definitions for old-growth or equivalent and do not provide direction to use a specific, measurable, repeatable criteria-based definition to identify old-growth stands for unit project needs. No regional working definition for old-growth Giant Sequoia type exists; however, Giant Sequoia groves are a special type of moist mixed conifer forest and there is much overlap in structural and functional conditions.

2005 – Angeles, Cleveland, Los Padres and San Bernadino National Forests

The Angeles, Cleveland, Los Padres and San Bernadino NFs concurrently revised plans in 2005 and each forest has an individual plan. Management direction for these forests is also included in the Southern California National Forest Vision (SCNFV), which is discussed below. Plan components for old-growth are limited or non-existent in these plans. Cleveland NF includes a Special Interest Area which includes an old-growth stand of Tecate cypress. It is currently a proposed Research Natural Area. Los Padres includes a “place” described as having old-growth with desired conditions. Program emphasis in this “place” includes old-growth being part of the environment. The San Bernadino does discuss old-growth forest and a Special Interest Area with old-growth Jeffery pine and sugar pine. No forest wide old-growth plan components exist in the plans. No forest-wide components promote resilience/adaptability, abundance/distribution and/or ecological/ecosystem service contributions of old-growth. Collectively, the forests are working towards resilience from natural and human disturbances and restoring fire regimes. While plan components in designated areas that are appropriate for resilience/adaptability, abundance/ distribution and/or ecological/ecosystem service contributions of old-growth exist, they are not forest-wide. It is recognized that these four forests do not contain significant amounts of old-growth and where it exists, management activities are limited.

The plans include no definitions for old-growth or equivalent and do not provide direction to use a specific, measurable, repeatable criteria-based definition to identify old-growth stands for unit project needs. In fact, the ROD states “This glossary replaces both the Glossary in the FEIS and the January 2001 SNFPA ROD in their entirety.”

2005 – Southern California National Forest Vision (SCNFV)

The SCNFV provides direction for Angeles, Cleveland, Los Padres and San Bernadino NFs in addition to individual plans developed. It was created with the intention of focusing “on the condition of the land after project completion rather than the products removed from the land.” It is recognized that these four forests do not contain significant amounts of old-growth and where it exists, management activities are limited. No old-growth or equivalent plan components are included in SCNFV that promote resilience/adaptability, abundance/ distribution and/or ecological/ecosystem service contributions of old-growth exist.

The SCNFV FEIS glossary defines old-growth in a narrative descriptive manner. No direction to use a specific, measurable, repeatable method as a working definition to identify old-growth stands for unit project needs is included in the plan.

1995 – Klamath, Mendocino, Shasta -Trinity and Six Rivers NFs

These forests completed LMP revisions in 1995, after the Northwest Forest Plan (NWFP) amendment was in place. Late successional is considered equivalent to old-growth. Plan components related to old-growth tier back to NWFP. All are species centric, with any desired conditions, standards and guidelines or prescriptions related to habitat. Generally speaking, no specific, forest-wide old-growth plan components exist beyond those found in the context of NWFP land allocations. The Mendocino estimates unmapped Late Successional Reserve within management areas that include Matrix allocations. Six Rivers includes an RNA to study old-growth Redwood. Plan components that restrict or limit activities are directly related to the NWFP amendment. No forest- wide components that promote resilience/adaptability, abundance/ distribution and/or ecological/ecosystem service contributions of old-growth exist.

In three of the plans, definitions are narrative and descriptive in nature for either old-growth or late successional forests. No language identifies a repeatable, criteria-based definition for managers to identify old-growth stands for project level needs in plans for these units.

The one outlier is the Six Rivers LMP. The LMP itself does not include either a narrative or criteria-based definition of old-growth. The FEIS glossary provides an old-growth definition that is narrative, listing averages of some measurable criteria which usually occur on Six Rivers. It is noted that no standard biological definition for old-growth exists; and the definition provided is referred to as a working definition, not intended to be either comprehensive or conclusive.

1990 – Tahoe National Forest

Tahoe LMP includes broad management goals and strategies for old forest and their associated species. Language for consideration of old-growth in planning exists, but only in the context of an old-growth management plan that was to be developed, but confirmation of completion of such a plan could not be made. No forest-wide components promote resilience/adaptability, abundance/distribution and/or ecological/ecosystem service contributions of old-growth.

No old-growth definition exists. No language identifies a repeatable, criteria-based definition for managers to identify old-growth stands for project level needs in plans for these units. Plan states

“Although a 'Generic Definition and Description of Old-Growth Forest' has been developed by the Washington Office, specific forest type old-growth definitions have not yet been developed for the Tahoe.”

1991 – Modoc National Forest and Stanislaus National Forests

Modoc NFs is only partially managed under the 1991 plan. Some areas fall only under management direction of the unit plan, some under the direction of NWFP 1994 and some under the direction of SNFPA 2004. The Modoc plan has old-growth components related to species habitat, including retention areas. Guidelines to promote additional old-growth exist but may not be applicable to each project. A standard exists to provide amounts of old-growth by forest type in relation to species habitat needs. Management Area prescriptions allocate old-growth area for species habitat needs. No forest-wide components promote resilience/adaptability, abundance/distribution and/or ecological/ecosystem service contributions of old-growth.

Stanislaus NF plan was amended wholly by SNFPA in 2004. The original plan includes broad management goals and strategies for old forest and their associated species. These are intended for specific, mapped wildlife and old forest emphasis areas. A strategy exists for fire and old forest ecosystem conservation and some guidelines address old forest during salvage activities more broadly. No forest-wide components promote resilience/adaptability, abundance/ distribution and/or ecological/ecosystem service contributions of old-growth.

No language identifies a repeatable, criteria-based definition for managers to identify old-growth stands for project level needs in these unit plans. The plan includes no definitions for old-growth or equivalent and do not provide direction to use a specific, measurable, repeatable criteria-based definition to identify old-growth stands for unit project needs.

1992 – Lassen National Forest

The Lassen plan contains old-growth retention areas designated for species needs with limited timber management appropriate when necessary to enhance old-growth characteristics. There is direction to replace any areas of old-growth retention lost to wildfire. Wildlife prescriptions also focus on old-growth management and a late successional prescription to maintain old-growth ecosystems. No forest-wide components that promote resilience/adaptability, abundance/distribution and/or ecological/ecosystem service contributions of old-growth.

The plan includes no definitions for old-growth or equivalent and do not provide direction to use a specific, measurable, repeatable criteria-based definition to identify old-growth stands for unit project needs.

1988 – Eldorado and Plumas National Forests

For the purpose of this section, late successional is interpreted as equivalent to old-growth in terms of structure and function. These forest plans are wholly amended by SNFPA. Original plan components – which are limited in number – are species-centric, with any desired conditions, standards and guidelines or prescriptions related to habitat. The Eldorado LMP only discusses old-growth in terms of habitat improvements; no standards, guidelines, or specific desired conditions exist beyond that. Management practices are to provide wildlife species with late-successional and old-growth forests in high quality condition and keep these at greater than 100 acres as possible. The Plumas LMP discusses old-growth in terms of habitat improvements or existence within a management area; no desired conditions, guidelines, or standards are specific to its management. One management area containing old-growth was classified as a botanical area. No forest-wide components promote resilience/adaptability, abundance/distribution and/or ecological/ecosystem service contributions of old-growth.

No language identifies a repeatable, criteria-based definition for managers to identify old-growth stands for project level needs in these unit plans. The plans include no definitions for old-growth or equivalent and do not provide direction to use a specific, measurable, repeatable criteria-based definition to identify old-growth stands for project needs.

8.2.6 Region 6: Pacific Northwest Region

The Pacific Northwest Region (Region 6) includes 13 national forests, a national scenic area,[21] and one national grassland[22] in Oregon and six national forests in Washington on 24.7 million acres of National Forest System lands. Discussion of a LMP for the national scenic area is not included as a designated area management plan in in place as well as direction in the LMPs for the units the area is within. Note that six of the national forests are in administrative units with another national forest but each national forest is managed under a separate land management plan.

Existing definitions for old-growth

In 1985, an interagency group composed of technical experts from the USFS (management and research station), BLM, and Oregon State University began developing interim definitions of old-growth for the Douglas-fir (*Pseudotsuga menziesii*) and mixed-conifer forests in the Pacific Northwest (USDA 1986). This task force concluded that old-growth was best perceived as, "a stage of forest development characterized by more diversity of structure and function than that found in younger successional stages" and it was recognized that old-growth characteristics differed by forest type, such that a single definition was not feasible (Thomas et al. 1988).

Shortly thereafter, the Chief of the Forest Service sent out a memo to regional foresters outlining the Forest Service's position on old-growth as well as a generic definition and description of old-growth forests (USDA FS 1989). This definition encompassed the later stages of forest stand development that are usually distinguished by the presence of larger, older trees and structural attributes such as multiple canopy layers, decadence in the form of standing dead trees (snags), and accumulations of fallen trees (logs). It also noted that these characteristics differed by forest types, such that one definition would not fit all. And finally, it made clear that old-growth forest was not necessarily "virgin" or "primeval" forest but could be developed through thoughtful forest management. This generic definition was to serve as the starting framework for the development or modification of more specific definitions that related to structural components that could be readily identified or measured.

In January 1990, the Regional Forester for Region 6 formed five teams to develop definitions for the major forest types in the region using existing ecological plot data. The teams concluded that the plot data

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[21] Columbia River Gorge National Scenic Area; Direction for management of NFS lands is provided in the scenic area management plan and in the Land and Resource Management Plan for Mt. Hood National Forest (1990) and Land and Resource Management Plan for Gifford Pinchot National Forest (1990), as amended by the Northwest Forest Plan. refer to https://www.gorgecommission.org/management-plan/plan/ for additional information.

[22] See the National Grasslands section for more information.

was insufficient to develop definitions for individual Forests, so the definitions became Regional in scope. This resulted in Region 6's Interim old-growth Definitions for Ten Forest Cover Types. These definitions were labeled "interim" due to recognition of limited data base. Individual attributes were expected to be changed as more data was accumulated and analyzed.

Ecologists from Region 1 and Region 6 agreed that conditions on the Colville National Forest more closely resembled those in Region 1, so the Colville National Forest used Region 1 (North Idaho Zone) definitions. Region 6 interim definitions provided discrete classifications based on minimum amounts of old-growth structure attributes (USDA FS 1993). In 1993, the area of old-growth forests in California, Oregon, and Washington was estimated using various old-growth definitions in use at that time (Bolsinger and Waddell 1993). Translating these definitions into one single definition was considered "impossible." Furthermore, definitions had not yet been developed for some types of forests.

For the area that occurs within the Northwest Forest Plan (NWFP) footprint, a federal interagency monitoring program uses an old-growth structure index (OGSI) to track changes in older forests (Davis et al. 2022).

LMPs developed under the 2012 Planning Rule

The Colville National Forest was amended under the 2012 planning rule. The plan does not mention old-growth but does describe forest structure classes which were developed for five plant associations across the forest. Late open and late closed classes are equivalent to old-growth in terms of stand condition and function. The intent of managing for these structure classes was to replace the Eastside Screens 21-inch diameter limit by structural stage, wildlife habitat direction and a guideline for large tree management. The forest issued an Errata (2024-01-12) that strikes FW-GDL-VEG-03 and requires projects to be consistent with the 1995 Eastside Screens. Other 2019 desired conditions, objectives, standards, or guidelines remain in effect and unchanged. Plan components are primarily associated with historic range of variability within the plant association structural classes as well as species habitat. Desired range of variability across the landscape is included in a desired condition, with ranges being specific to each forest type. Patch size and opening size are also variable by forest type. One objective is to initiate active management activities on 18,000 to 25,000 acres per year over the next 15 years to move structure toward desired conditions at landscape scales and move the Forest toward desired vegetative conditions. There is a guideline for a 100' buffer related to threatened and endangered species occupied habitat. Plan components are applied forest wide. They address resilience/adaptability, abundance/ distribution and/or ecological/ecosystem service contributions. Management emphasis is to restore ecological integrity and ecosystem function at the landscape scale, using both active management (mechanical treatment and prescribed fire) and passive management (natural processes including disturbances and succession) to restore management natural processes and improve resiliency, while emphasizing important fish and wildlife habitats.

The Colville LMP has no old-growth definition. Structural classes are defined as follows: Structural Stage – *Late Open* Trees 20 inches or greater DBH, canopy cover between ten and 40 percent, Structural Stage – *Late Closed* Trees 20 inches or greater DBH, canopy cover 40 percent or greater across all forest types. The plan does not include direction to use a specific, measurable, repeatable criteria-based definition to identify old-growth stands for unit project needs. As previously mentioned, in January 1990, ecologists from Region 1 and Region 6 agreed that conditions on the Colville National Forest more closely resembled those in Region 1.

9.9.3 LMPs developed under the 1982 Planning Rule

LMPs developed in 1990: Deschutes, Gifford-Pinchot, Malheur, Mt Baker-Snoqualmie, Mt Hood, Siuslaw and Oregon Dunes NRA, Umatilla, Umpqua, Wallowa-Whitman, Willamette NFs, Winema portion of Fremont-Winema, Rouge portion of Rouge-Siskiyou and Wenatchee portion of Okanogan-Wenatchee.

LMPs developed in 1989: Crooked River NG, Ochoco NF, Fremont portion of Fremont-Winema, Siskiyou portion of Rouge-Siskiyou and Okanogan portion of Okanogan-Wenatchee.

LMPs developed in 1994: Oregon Dunes NRA.

Collectively, these unit plans are very similar in content related to old-growth. Any differences are not significant to consider at this level of planning.

Broad forest management goals for old-growth do not clearly articulate conditions, old-growth characteristics or function specifically. Amount of old-growth across a unit is often included and primarily for species habitat. Plans contain species habitat desired conditions. Plans may contain areas/prescriptions for old-growth. These range from broad aspirational goals to specific standards. Some management areas not specific to old-growth include it as part of the landscape character in the area. Management areas for species habitat associated with old-growth provide plan components that are species centric. Managing old-growth for enhancement of vegetation diversity on a landscape scale is part of some plans. Many discuss old-growth as being in or out of areas suitable for timber harvest. The Oregon Dunes NRA does not include old-growth components, but refence is made to NWFP. None of the plans have components for old-growth that address resilience/adaptability, abundance/distribution and/or ecological/ecosystem service contributions directly and/or are forest-wide.

Plan definitions for old-growth are narrative and descriptive in nature. The plans do not provide direction to use a specific, measurable, repeatable criteria-based definition to identify old-growth stands for unit project needs.

The Umatilla plan includes management Areas C1- Dedicated Old-growth and C2 - Managed Old-growth. These provide plan components for many resources, including wildlife. The wildlife section provides quantitative metrics as standards that one could interpret as a definition, However, similar to Eastside Screens standards and guidelines, they are project specific goals for post project site conditions based on species habitat. However, this is not applied forest-wide and not identified as the specific, measurable, repeatable criteria-based definition to identify old-growth stands for forest-wide project needs.

8.2.7 Region 8: Southern Region

The Southern Region (Region 8) is a diverse collection of lands that encompasses 13 states and Puerto Rico. The Region includes 14 national forests and two special units administering approximately 13.4 million acres representing approximately seven percent of all National Forest System lands. This diverse region includes hardwood, pine, and mixed forests, including the only tropical national forest – the El Yunque National Forest in Puerto Rico.

In the 19^{th} and early 20^{th} centuries, much of the forests of the Southeast were cut and converted to farmland. In contrast to the National Forests of the West which were all established by 1915, most eastern National Forests were not created until the Weeks Act of 1911 authorized the Federal Government to purchase and maintain lands as National Forests. Federal acquisition of cutover forests and depleted farmland increased through the Great Depression but slowed by 1945 (MacCleery 1992). This establishment history resulted in eastern national forests being smaller and more fragmented than their western counterparts. Additionally, as a result of post-European settlement activities there is very little old-growth forest in these areas with many parts of the southeast converted to short-rotation pine plantations, usually loblolly or shortleaf pine (Pan et al. 2011).

In response to the 1989 old-growth forests national position statement (USDA FS 1989), the Forest Service Southern and Eastern Regions, Forest Service Research and Development, and The Nature Conservancy developed old-growth definitions by forest community type (USDA FS 1992). In December 1995, the regional forester chartered the Region 8 Old-Growth Team "to finalize the old-growth effort and make the [draft] definitions operational and useful." The report, *Guidance for Conserving and Restoring Old-Growth Forest Communities on National Forests in the Southern Region*, was completed in 1997 (Gaines et al. 1997).

Plans with old-growth definitions that align with regional guidance and existing plan direction

Nearly all forest plans in the Southern Region recognize old-growth forests as a valuable natural resource worthy of protection, restoration, and management and contain plan direction to conserve and recruit old-growth forests. The majority of forests in the Southern Region have a tiered definition of old-growth in their land management plans to the 1997 regional guidance: Chattahoochee-Oconee National Forests, Cherokee National Forest, Croatan National Forest,[23] Daniel Boone National Forest, Francis Marion National Forest,[24] George Washington National Forest, Jefferson National Forest, Kisatchie National Forest, Land Between the Lakes National Recreation Area, National Forests in Alabama, National Forests in Florida, National Forests in Mississippi, Ouachita National Forest, Ozark-St. Francis National Forest, and Sumter National Forest. The National Forests in Texas revised their land management plan prior to the regional guidance, but their plan definition does not differ significantly. Likewise, the Nantahala and Pisgah National Forests recently revised their plan in 2023, and included a definition that is consistent with the regional guidance.

As a result of the 1997 guidance, in addition to having forest wide direction in the form of desired conditions or goals, most forest plans have identified management areas or designated old-growth networks for the recruitment and management of future old-growth. Plan components for conserving existing old-growth range from forest-wide desired conditions[25] to standards promoting old-growth only for selected areas, e.g. Management Areas. The plan for Land Between the Lakes NRA is an exception, however. At the time the plan was written (2004), it was noted that mature forests generally ranged from 60 to 90 years old, which does not meet the age criteria for possible or existing old-growth as defined in the Region 8 Old-growth Guidelines. The plan included desired conditions and monitoring questions, and it called for core areas of the forest to be classified as future old-growth and developed for old-growth characteristics. But there are no old-growth standards or project design considerations listed in the plan. The following plans do not automatically require conservation of exiting old-growth where it is found across the forest, focusing instead on specific landscapes, management areas, quality levels, under-represented ecosystems, or other needs: Chattahoochee-Oconee National Forest, Kisatchie National Forest, Nantahala and Pisgah National Forests, Ozark-St-Francis National Forest, National Forests in

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[23] The Croatan National Forest, Nantahala National Forest, Pisgah National Forest, and Uwharrie National Forest comprise the National Forests in North Carolina but are discussed separately in this section.

[24] The Francis Marion National Forest and Sumter National Forest are managed together as a single unit but have different land management plans.

[25] Some plans do not have desired conditions but rather apply goals or priorities as analogous.

Texas. Appendix C, Comparison of Current Management of Old-Growth to Amendment, for the Draft EIS provides an overview of each plan's level of consideration for old-growth.

Plans with no old-growth definitions and existing plan direction

Two forests in the Southern Region do not contain any definitions for old-growth in their land management plans: El Yunque National Forest and Uwharrie National Forest. The tropical forest communities of El Yunque (formerly named the Caribbean National Forest) were not included in the 1997 regional guidance, and therefore no definitions or criteria exist in the recently revised 2019 land management plan. The terms "primary forest" and "mature forest" were applied interchangeably and are intended to describe the forests that escaped cutting and conversion following European settlement. These remnant forests, therefore, are presumed old-growth forests on the unit. The El Yunque National Forest is unique in that it is the only national forest that has dual designation as an experimental forest (i.e., Luquillo Experimental Forest). In addition to the dual designation, the forest has attributed over 68% of the land to designated areas (e.g., Wilderness, Research Natural Area, Scenic Byway). All of the primary forests are contained within these management areas. The plan components for these areas do not separate out the conservation of old-growth forests from the systems within which they exist but rather consider management of the systems holistically. Given these circumstances, the current land management plan contains no plan components explicitly targeting nor preventing the conservation of old-growth forests within the inherent capability of the land.

The Uwharrie National Forest land management plan also does not contain either a qualitative or quantitative definition of old-growth forests. The amount of existing old-growth within the plan area is very limited. The overarching focus for the forest is centered around the restoration of the longleaf pine and oak ecosystems from planted loblolly pine conditions. Restoration of type-converted systems requires a multi-decade effort to accomplish and has an initial focus on forest composition, early structure, and function. Given these circumstances, the current land management plan contains no plan components or management area designations targeting nor preventing the conservation of old-growth forests within the inherent capability of the land.

8.2.8 Region 9: Eastern Region

The Eastern Region (Region 9) encompasses 20 states and consists of 15 national forests and one national tallgrass prairie.[26] It is home to over 43 percent of the nation's population, making it the most urban region. National forest boundaries include 24 million acres of land, although only one of every two acres within these boundaries is National Forest System land. The 12 million acres of national forest system lands are rich in biological diversity, spanning boreal forests, tallgrass prairies, pine barrens, central hardwood forests, glades, bogs, shoreline along three Great Lakes, and montane spruce-fir forests.

Large areas of old-growth forest are uncommon in the Eastern Region due to past land management activities. With some exceptions in more remote and topographically inaccessible areas (particularly Designated Wilderness Areas), existing old-growth forests occur in small, scattered stands within a larger landscape of younger forests (Nowacki and Trianosky 1993). Since most existing old-growth stands in the Region are small, the overall intent to conserve these stands has been to increase overall forest diversity by increasing the size of old-growth communities. Small stands of old-growth serve as nuclei for

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[26] Refer to the 8.3 National grasslands section.

expansion as surrounding forests age and develop old-growth characteristics. Consequently, much of the old-growth management direction contained within Eastern Region land management plans represent aspirational goals. Additionally, because old-growth forest conservation was an important issue in the revision of Eastern Region Forest Plans in the early 2000s, the consideration of options for management direction for old-growth was informed by extensive public engagement and reflected comments and input from national, state-level, and local community stakeholders and partners.

In 1998, Tyrrell and others published results of a broad inventory of old-growth forests in the Eastern Region. The sparse occurrence of old-growth forests in the Eastern Region, combined with the pronounced sub-regional differences in ecosystems and forest types, led the Region to refrain from creating a specific definition for old-growth forest. A region-wide strategy for the management of old-growth resources on National Forest System land was never developed and individual forests defined old-growth as informed by Tyrrell et al. (1998) employing the general criteria to inform management. With few exceptions, forest-specific land management plan definitions lack quantitative criteria.

Plans with old-growth definitions and associated criteria and existing plan direction

The Ottawa National Forest land management plan contains both a qualitative and quantitative definition of old-growth, and thus provides a transparent, repeatable methodology that can be applied for field applications. Plan components for old-growth management consist of a select set of forest-wide guidelines that target identification and representation across all forest types as well as limit timber harvest with few exceptions (e.g., threat to old-growth resources, human life, or adjacent lands; area no longer retains characteristics). A single forest-wide objective describes the ecological and ecosystem services associated with old-growth in general. There are no forest-wide desired conditions or goals that speak explicitly to old-growth, and there are no forest-wide standards for current or existing old-growth.

Plans with only old-growth definitions and existing plan direction

The majority of land management plans in the Eastern Region contain only a qualitative definition for old-growth: Allegheny National Forest, Chequamegon-Nicolet National Forest, Chippewa National Forest, Finger Lakes National Forest, Green Mountain National Forest, Hiawatha National Forest, Hoosier National Forest, Huron-Manistee National Forest, Monongahela National Forest, Shawnee National Forest, Superior National Forest, and White Mountain National Forest. A handful of plans have definitions that include limited quantitative criteria (e.g., minimum stand age), but this information lacks a transparent, repeatable methodology for field application.

The Superior National Forest land management plan has one forest-wide desired condition specifically targeting the restoration of old forest and old-growth forest age classes and vegetative growth stages. Two forest-wide objectives and one forest-wide standard provide general language for managing for an increasing amount of old-growth forest. Forest-wide standard, while not specifically calling out “future old-growth” has language inclusive of the intent as it points to maintaining or contributing toward the restoration of old-growth. Plan direction does not preclude proactive stewardship activities using standards or guidelines.

There is a wide range of existing plan direction regarding existing and future old-growth across the other eleven forests. Plan components range from forest-wide desired conditions to standards promoting future old-growth only for selected areas, e.g. Management Areas. Overall, most units include some level of plan components that address old-growth, and most do not outright preclude proactive stewardship activities using standards or guidelines. Appendix C, Comparison of Current Management of Old-Growth to

Amendment, for the Draft EIS provides an overview of each plan's range and level of consideration for current and future old-growth.

Plans without old-growth definitions

Two units in the Eastern Region have land management plans with no quantitative or qualitative definitions for old-growth: Midewin National Tallgrass Prairie and Wayne National Forest. The Midewin National Tallgrass Prairie is discussed in Section 8.3, along with national grasslands with a stand-alone land management plan.

The Wayne National Forest land management plan contains no definition for old-growth.[27] The land that encompasses the forest was significantly impacted by industry and agriculture over the past 200 years. Virtually all the forests that covered Ohio were cut for timber and firewood to make way for European settlements and farms. Mining for iron ore, limestone, coal, and clay altered the landscape and polluted streams. As factories closed and farms failed in the 1930s, the Forest Service began to acquire and restore the former oak-dominated systems. This remains an important focus in the current plan as restoration is a multi-decade effort and the time needed for old-growth characteristics to develop has not been reached. Plan components for old-growth consist of a single forest-wide guideline to apply prescribed fire treatments for the maintenance or contribution to the restoration of old-growth characteristics. There are no forest-wide desired conditions, goals, or objectives specifically addressing old-growth. "Future Old Forest" is identified as a desired condition for some management areas, but the intent is to apply a preservation-style of management (i.e., no proactive stewardship) and allow ecosystems to convert to uncharacteristic conditions.

8.2.9 Region 10: Alaska

The Alaska Region (Region 10) includes the two largest National Forests in the National Forest System encompassing over 22 million acres from the Chugach National Forest on the Kenai Peninsula to the southern reaches of the Alexander Archipelago on the Tongass National Forest. Forests across the region range from boreal forests to mixed hardwood conifer forests, to muskeg bogs to towering spruce-hemlock temperate rainforests. Forests occur on a range of geological settings with complex drainage patterns, respond to a spectrum of climatic conditions, and are still responding to post-glacial emergence and isostatic rebound. Forest conditions on the Chugach and the Tongass range from first generation forests on recent deglaciation, to young-growth forests beginning a new rotation in stand initiation, to complex old-growth. Disturbances such as fire, insects, disease, wind, landslides, human interactions, and climate change shape forest development resulting in complex, dynamic landscapes.

Alaska native people managed forests in the Alaska Region for centuries using construction materials for villages, fuelwood, boat making, cultural uses, and food gathering. In the later part of the 19th century and early 20th century Russian and American explorers, mining prospectors, and others moved into Alaska adding new and additional demand for forest resources. These influences were localized and modest in scale until the beginning of the pulp mill era (ca. 1954) on the Tongass National Forest. From 1954-1990, broader scale logging began harvesting old-growth temperate rainforests throughout the Alexander Archipelago. Roughly 440,000 acres of old-growth have been harvested on the Tongass since

[27] The FEIS contains a qualitative definition for old-growth that includes limited quantitative criteria, but this information lacks a transparent, repeatable methodology for field application.

1954. Forest harvest on the Chugach National Forest occurs in limited areas and typically for fuelwood or in response to bark beetle outbreaks and fire salvage.

In response to Forest Service Chief Dale Robertson's 1989 statement on, and narrative definition for, old-growth forests (USDA FS 1989), Region 10 convened an interdisciplinary team of scientists and professionals from federal, state, tribal, and private industry to develop an ecological definition of old-growth in the Alaska Region (USDA FS 1992).

Chugach National Forest

The Chugach LMP was revised under the 2012 planning rule. The Tongass LMP was developed under the 1982 planning rule, but subsequently amended under the 2012 planning rule. The LMP does not mention old-growth but includes a desired condition for late successional vegetation in the Municipal Watershed Management Area. Late successional is equivalent to old-growth in terms of stand condition and function. Beyond that no plan components for old-growth or equivalents exist. Forest-wide, FW-GL3-EPC-DC2 applies, and the desired condition is natural ecological patterns and processes dominating the landscape of the plan area. This includes a relative proportion of seral stages and key habitat components reflecting spatial and temporal patterns expected in a landscape predominantly shaped by natural disturbance processes. No lands are determined suitable for timber production, but this does not preclude integrated forest management on lands within and outside the roaded area.

The current LMP old-growth forest definition is narrative and descriptive in nature. The LMP does not provide direction to use a specific, measurable, repeatable criteria-based definition to identify old-growth stands for unit project needs. The 1992 old-growth definitions for southcentral Alaska were never integrated into either the 2002 or 2020 Chugach Forest Plan.

Tongass National Forest

In 1997, the revised Land and Resources Management Plan for the Tongass National Forest included a comprehensive strategy intended to provide for long-term viability of old-growth associated wildlife, well-distributed across Southeast Alaska. This strategy, referred to as the Tongass Old-Growth Conservation Strategy, was retained with minor modifications through 2008 and 2016 amendments of the Forest Plan. The Strategy includes a network of habitat reserves linked by corridors of old-growth forest and a collection of Standards and Guidelines that provide additional protection for vulnerable wildlife species. Elements of the Strategy are dispersed throughout the Forest Plan.

The reserve system is included among objectives listed in the 2016 Forest Plan to accomplish Forest-wide goals for biodiversity (2016 Tongass LMP page 2-3). The reserve system incorporates many different non-development land use designations (LUDs)[28] to provide adequate habitat for old-growth-associated wildlife across the forest and which cover approximately 12 million acres (2016 Tongass LMP page 3-2). In addition, there is a 1.2 million acre Old-Growth Habitat LUD that is used to identify and define management of old-growth reserves established within the matrix of development lands. In this LUD, components to attain old-growth forest characteristics, a diversity of old-growth habitat types and associated species and subspecies and allow ecological processes exist. Connecting corridors that

[28] These include Wilderness, National Monument, Legislated LUD II, Wild River, Remote and Semi-Remote Recreation, Research Natural Area, Municipal Watershed, and all other LUDs that essentially maintain the integrity of the old-growth ecosystem (USFS 2008 FEIS App. D, p. D-2).

conserve old-growth characteristics within beach and estuary fringe and riparian corridors are also a part of the Tongass Old-Growth Conservation Strategy. Lastly, the Strategy includes species-specific and habitat-feature Standards and Guidelines that call for additional retention of old-growth forest characteristics.

In 2016, an amendment to the Tongass Plan directed the transition from primarily old-growth to primarily young-growth timber harvest on suitable timber lands on the Tongass. At the end of the 15-year transition in 2031, the Tongass is projected to average 5 MMBF of old-growth timber harvest per year.

In 2021, the USDA announced the South Alaska Sustainability Strategy (SASS). While the Tongass National Forest has been implementing this strategy, it is not plan direction and does not represent law, regulation, directive, or a final agency action representing long-term management decisions on the forest. SASS includes 4 major components including ending large-scale, old-growth timber harvest and focusing resources to support forest restoration, recreation, climate resilience, and sustainable young-growth management. The SASS Forest Management strategy describes an integrated approach to shift from a singular objective of timber management to integrated management actions that include terrestrial and aquatic restoration, young-growth timber management, and small and micro old-growth timber sales. This implies that some areas of the Tongass may still be managed for commodity purposes, albeit likely a fraction of area compared to historic management activity.

In areas where the goal is to maintain old-growth forests and their associated natural ecological processes to provide habitat for old-growth associated resources, a definition is provided. In the context where this direction applies, there is direction to use Ecological Definitions for Old-growth Forest Types in Southeast Alaska (R10-TP-28). However, this is not applied forest-wide and not identified as the specific, measurable, repeatable criteria-based definition to identify old-growth stands for forest-wide project needs outside areas with the goal as described above.

8.3 National grasslands

Like national forests, national grasslands are managed through direction in an LMP. Some national grasslands are part of a larger administrative unit with multiple NFs and NGs and are managed under one LMP, other national grasslands are managed under a stand-alone national grassland LMP (see Table 17). This section will only address national grasslands managed under a stand-alone grassland LMP. For those national grasslands that form part of an administrative unit managed under one LMP (for example, the majority of grasslands in Region 2), refer to the section for the corresponding region.

Table 17. National grasslands by region and administrative unit

Region	National Grasslands	Admin Unit	LMP
1	Little Missouri, Sheyenne, Grand River, Cedar River	Dakota Prairie NG	NG LMP
2	Buffalo Gap and Oglala	Nebraska NFs and NGs	NF/NG combined LMP*
2	Cimarron and Commanche	Pike-San Isabel NFs and Cimarron and Commanche NGs	NF/NG combined LMP*
2	Pawnee	Arapaho-Roosevelt NFs and Pawnee NG	NF/NG combined LMP*
2	Thunder Basin	Medicine Bow-Routt NFs and Thunder Basin NG	NG LMP
3	Kiowa, Rita Blanca, McClellan Creek, and Black Kettle	Cibola NF and NG	NG LMP

Region	National Grasslands	Admin Unit	LMP
4	Curlew	Caribou-Targhee NF and Curlew NG	NG LMP
6	Crooked River NG	Ochoco NF and Crooked River NG	NG LMP
8	Caddo and Lyndon B. Johnson	Texas NFs and NGs	NF/NG combined LMP
9	Midewin National Tallgrass Prairie	Midewin National Tallgrass Prairie	NG LMP

*See Region 2 for discussion of the LMPs for these administrative units.

National grasslands include varying amounts of forested vegetation. An overview of the extent of forested vegetation by grassland and level of management for forested vegetation in the grassland LMP is provided in Table 18.

Table 18. Extent of forest and vegetation management approaches on national grasslands managed by a grassland LMP

Region	Grassland	Extent of forest (acres)	Vegetation types and management
1	Dakota Prairie[1]	Grand River/Cedar River NG: 500 forested acres (161,530 total NG acres) Little Missouri NG: 117,810 forested acres, 940 acres are tentatively suitable forest land and 49,500 acres are considered “not capable of producing crops of industrial wood” (1,027,520 total NG acres) Sheyenne NG: 5,110 acres of tentatively suitable forest land (70,260 total NG acres).	The Sheyenne National Grassland has several oak savanna stands and river broadleaf forests and woodlands. The Little Missouri National Grassland contains stands of ponderosa pine, cottonwood, bur oak, green ash, aspen, Rocky Mountain juniper, and one stand of limber pine. For the most part, grassland-wide direction does not directly address tree species or their management. There is geographic area direction, including DCs and objectives focused on vegetative composition and structure, as well as guidelines in the Badlands GA related to ponderosa pine to improve the integrity and vigor of the stands.
2	Thunder Basin[1]	Approximately 30,900 acres of forested land (out of 552,490 total NG acres)	None of the forest land is considered “suitable” for timber management. Foothill and lower-elevation mountain species, occur, such as ponderosa pine, Rocky Mountain juniper, Oregon grape and boxelder There are management area plan components that address forest cover target percentages for structural stages 4 and 5 (mature and late successional).
3	Cibola[2]	Kiowa and Rita Blanca NG: 9,069 acres of forested land tentatively suitable for timber production (out of 230,526 total acres). Black Kettle and McClellan Creek NGs 851 forested acres (32,735 total acres not capable of producing crops of commercial wood	The Kiowa and Rita Blanca Management Area include old-growth stands in the Pinyon-Juniper Vegetation Type and Juniper Grasslands Inclusion and the Cottonwood and Willow Riparian Veg Type. The Black Kettle and McClennan Creek NGs include shelterbelt and riparian woodland The plan provides direction on the management of firewood and firewood harvesting and gathering on the grasslands. There are DCs for Special Forest Products.
4	Curlew[3]	Sagebrush is the dominant vegetation cover type occupying 95 percent of the grassland. Utah juniper comprises less than 90 acres (out of 47,600 total acres)	Utah juniper is considered within historical patterns of size, shape and corridors. The distribution of structural age classes is skewed toward mid and older ages. There are isolated acres of quaking aspen. The LMP includes vegetation management DCs to maintain the

Region	Grassland	Extent of forest (acres)	Vegetation types and management
			diversity of the mosaic of shrub steppe plant communities and for fire/fuels management.
6	Crooked River	Of 111,379 total acres, approximately 2,000 acres are riparian, and 740 acres are forested.	Old-growth is in the juniper shrub type.
9	Midewin National Tallgrass Prairie	Predominately unforested (less than 4% of the unit is classified as forest/woodland)	Some areas of forest/woodland, limited management occurs in areas that are forested

1. From the Northern Great Plains Management Plans FEIS access at: https://www.fs.usda.gov/main/dpg/landmanagement/planning
2. From the LMP for the Kiowa, Rita Blanca, Black Kettle and McClennan Creek National Grasslands
3. Curlew National Grasslands LMP

For those national grasslands with a grassland LMP, generally the old-growth-related plan direction is for specific management areas, geographic areas, or for specific purposes, like maintenance of wildlife habitat. Although most of the grassland LMPs include a definition for old-growth, the definitions are not aligned with regional definitions.

The Curlew NG LMP does not include any old-growth-related direction. The other three NG LMPs include MA and/or GA old-growth-related direction.

The Thunder Basin NG LMP has both MA and GA direction for late successional forest. The Thunder Basin LMP does not use old-growth terminology and instead uses Structural Stage 5. The definition for Structural Stage 5 in the LMP glossary includes both late successional and old-growth interchangeably without distinction. There are no forestwide plan components for structural stage but there is geographic area direction.

On the Dakota Prairie NG, old-growth is defined in the LMP as structural stage 5 which is characterized by trees 160 years of age and older. Grassland-wide direction does not directly address tree species or their management, except the maintenance of standing-dead trees for wildlife purposes. Protected special interest areas (SIAs) and research natural areas (RNAs) includes several existing and proposed SIAs, including one for black cottonwood, one for aspen, and another for juniper. Direction includes two standards and a guideline call for the maintenance and enhancement (Standard 1), restoration (Guideline 3), and reclamation (Standard 4) of the characteristics for which the SIA was designated. Two vegetation guidelines for the Badlands Geographic Area (on the Little Missouri National Grassland) relate to ponderosa pine. Guideline 2 allows management that would improve the “health and vigor” of these communities; however, Guideline 3 allows cutting ponderosa under several circumstances, including to “improve aesthetics.” Guideline 3 for the Sheyenne Geographic Area (on the Sheyenne National Grassland) is not as restrictive or specific to old-growth as the proposed old-growth amendment components: “Use management practices in the oak savannas that maintain or create a mosaic of stand conditions that comprise a woody overstory and herbaceous understory” (p. 2-30). Other geographic area guidelines call for management for wildlife species, rather than for maintenance of or management toward mature/ old-growth (e.g., Management Indicator Species Guideline 4 for the Grand/Cedar Geographic Area in the Grand River and Cedar River National Grasslands).

On the Cibola National Grasslands, the Kiowa and Rita Blanca Management Area include old-growth stands in the Pinyon-Juniper Vegetation Type and Juniper Grasslands Inclusion and the Cottonwood and

Willow Riparian Veg Type. There are DCs for Special Forest Products. There is also an objective to restore riparian areas (which is one of the veg types that includes old-growth).

The Midewin National Tallgrass Prairie is a grassland unit that is predominately unforested (less than 4 percent of the unit is classified as forest/woodland). The primary focus in this land management plan is on the restoration of upland prairie, although it is acknowledged that complete return to pre-European settlement conditions is not within the inherent capability of the unit and therefore some areas of forest/woodland will remain. Limited management occurs in areas that are forested.

8.4 Other Factors driving old-growth management (national scale)

8.4.1 Existing riparian management direction

As described in the Water Resources section of the Affected Environment, riparian areas are interfaces between the terrestrial and aquatic environments that have distinctive characteristics, functions, and values (Gregory 1997, FSM 2526.05). These ecotones are easily disturbed and present unique considerations for forest management (Gregory 1997, Naiman et al. 2000). Riparian areas are managed under a multitude of state and federal legislations that establish appropriate management practices (Gregory 1997, Megahan and Hornbeck 2000, USDA Forest Service 2012). Forest Service policy directs that managers should "give preferential consideration to riparian-dependent resources when conflicts among land management activities occur" (FSM 2526.03). Within LMPs, riparian areas are managed differently from the surrounding landscape (FSM 2526.04b). LMPs can regulate two major features of riparian areas: 1) their width; and 2) the kind and amount of activity that can take place within or influence them (Spence et al. 1996, Quigley and Arbelbide 1997). More recent riparian management principles emphasize promoting ecological function and natural riparian forest pattern (Naiman et al. 2000). Older LMPs may lack explicit reference conditions that represent the goals of future riparian management (Gregory 1997).

The 2012 Planning Rule established distinct definitions for "riparian areas" and "riparian management zones" (RMZs) (USDA 2012). Riparian areas are ecologically defined areas of transition between terrestrial and aquatic systems (36 CFR 219.19). RMZs are portions of watersheds areas where riparian-dependent resources receive primary emphasis (36 CFR 219.19). Plans revised under the 2012 Planning Rule must establish widths for RMZs, but the Rule does not require a single national width because riparian resources across National Forest System lands are very diverse. Plans revised under the 1982 Rule (USDA 1982) use more varied terminology for riparian management areas, such as Riparian Habitat Conservation Areas (RHCAs), Riparian Conservation Areas (RCAs), Water Influence Zones (WIZs), Riparian Corridors, and Riparian Reserves. The 2012 Planning Rule retained the 1982 Rule requirements to "give special attention to land and vegetation within approximately 100 feet of all perennial streams and lakes" and to prevent management practices that have serious or adverse impacts to these areas (36 CFR § 219.8). The 2012 Planning Rule further increased riparian protections by requiring plan components for maintenance and restoration of the ecological integrity of riparian areas (36 CFR § 219.8).

Most LMPs contain more restrictive management direction for riparian areas that apply comprehensively to trees of all successional stages. For example, the PACFISH and INFISH amendments prohibit commercial timber harvest in RHCAs, and salvage and fuelwood cutting may only be used retroactively in response to a catastrophic event (USDA/USDI 1995; USDA 1995). The Northwest Forest Plan includes standards and guidelines for Riparian Reserves, which direct that prescriptions such as burning and silvicultural treatments should contribute toward attainment of Aquatic Conservation Strategy objectives. Some plans also require contextual, watershed-scale or site-specific analysis prior to resource management occurring in riparian areas. More protective management direction may also apply within select watersheds (USDA Forest Service 2018).

Restrictions or constraints on activities within riparian areas affect management of old-growth where it overlaps with those areas. Additionally, some more recent LMPs have a dynamic interaction between tree size and riparian zone management. For example, the Northwest Forest Plan matches riparian zone widths to the nature of the riparian forest condition. Boundaries for RMZs can be based on "site-potential tree heights"—the average height of trees that have attained the maximum height possible given the site conditions (Gregory 1997). Depending on the LMP, riparian forest conditions can influence the zone widths on which riparian management is based, or riparian management direction within fixed zone widths can influence riparian forest conditions.

8.4.2 Designated Areas

Certain specific areas of National Forest System lands contain outstanding examples of plant and animal communities, geological features, scenic grandeur, cultural, or other special attributes. Some of these areas are designated by law or may be designated administratively by executive order or through Agency planning efforts. Such "designated areas," are managed to emphasize the specific values (e.g., recreation, geology, history, etc.) identified in the law, order, or plan that designated each area. Activities are permitted in designated areas to the extent that the activities are in harmony with the values for which each area was designated.

The following types of designated areas were considered in relation to old-growth:

- Wilderness Areas
- National Wild and Scenic Rivers
- National Monuments
- National Recreation Areas
- National Scenic Areas
- Inventoried Roadless Areas, including Colorado Roadless Areas and Idaho Roadless Areas

There are other types of designated areas that were not considered, including, but not limited to Wilderness Study Areas, Research Natural Areas, and Special Interest Areas, because at the scale of the National Forest System, they comprise a negligible proportion of the land area.

The Forest Service manages each designated area as an integral part of National Forest System lands with an emphasis on the primary values identified in the law, order, or plan that designated each area. Secondly, the Forest Service manages values and resources not specifically identified or prohibited by law in a manner that complements or enhances the primary values of the designated area and are compatible with overall national forest management objectives. Lastly, designated areas are managed as showcases to demonstrate national forest management standards for programs, service, and facilities.

Management direction for designated areas may be met through the land management plan unless the authorities for the designation require a separate plan. Specific plans for designated areas must be consistent with the plan components (36 CFR 219.15(e)). There are several different ways that designated areas are included and addressed in LMPs primarily falling into three categories: some LMPs include brief references to monuments, some include full special area sections with a suite of plan components, and others describe overarching plan components but defer to separate designated area-specific plans.

For purposes of the FIA inventory data, the term "reserved lands," is defined to include the following types of designated areas: Wilderness, National Wild and Scenic Rivers, National Monuments, National Recreation Areas, and National Scenic Areas and the term "Inventoried Roadless Areas" is defined to include areas identified in state-specific roadless rules or the 2001 Roadless Rule, which limits timber harvest and road construction on these lands. Estimates of acres of old-growth in designated areas are based on Forest Inventory and Analysis (FIA) plots that are within reserved lands or within Inventoried Roadless Area that do not overlap with reserved lands.

As indicated in Table 19, which displays the inventoried old-growth area acreage by type of designated area, there are approximately 13.8 million acres of old-growth (56 percent of all old-growth) in the designated areas described above (reserved lands and inventoried roadless areas). Of this, approximately 4.2 million acres (17 percent of all old-growth) are within Wilderness, National Wild and Scenic Rivers, National Monuments, National Recreation Areas, and/or National Scenic Areas and 9.6 million acres (39 percent of all old-growth) are within Inventoried Roadless Areas that do not overlap with reserved lands.

Table 19. Old-growth in reserved lands and Inventoried Roadless Areas by region. Area and 90% confidence intervals (CI) are in thousands of acres; percents are the proportion of total old-growth for each type of designated area in each region.

USFS region	Total acres of old-growth (± CI)	Acres of old-growth in reserved lands (± CI)	Percent of old-growth within reserved lands	Acres of old-growth in Inventoried Roadless Areas that do not overlap with reserved lands (± CI)	Percent of old-growth within Inventoried Roadless Areas that do not overlap with reserved lands
Northern Region	2,496 (±188)	560 (±27)	22%	1,012 (±125)	41%
Rocky Mountain Region	2,497 (±185)	540 (±27)	22%	908 (±120)	36%
Southwestern Region	2,108 (±176)	207 (±19)	10%	326 (±74)	15%
Intermountain Region	2,659 (±198)	387 (±18)	15%	1,433 (±148)	54%
Pacific Southwest Region	1,701 (±154)	616 (±53)	36%	221 (±59)	13%
Pacific Northwest Region	6,037 (±179)	1,671 (±83)	28%	960 (±67)	16%
Southern Region	1,167 (±96)	100 (±10)	9%	167 (±40)	14%
Eastern Region	301 (±43)	50 (±9)	17%	22 (±12)	7%
Alaska Region	5,769 (±158)	39 (±0)	1%	4,561 (±173)	79%
Total	24,735 (±1,377)	4,171 (±245)	17%	9,609 (±815)	39%

What sets designated areas (DAs) apart from general forest areas is the special values, attributes, or unique features for which they were designated. The relationship between management of old-growth and management of DAs will vary depending upon the management emphasis for each area. For example, some DAs, such as Wilderness, restrict management activities, with natural processes such as fire and insect and disease infestations occurring without human intervention.

8.4.3 Climate Adaptation Plan

The USDA Forest Service Climate Adaptation Plan outlines key climate risks to the agency's operations and critical adaptation actions to reduce these risks. The plan notes the important ecological and cultural role that old-growth and mature forests play, and the risks to these forests posed by climate-amplified disturbances including drought, wildfires, and insect and disease outbreaks. The adaptation actions and supporting activities outlined in the Climate Adaptation Plan can help to inform the development of adaptation strategies such as those directed under the old-growth amendment to help maintain valued characteristics of mature and old-growth forests on Federal lands and reduce risk.

8.4.4 Fire policy

The Forest Service's Wildfire Crisis Strategy has been prompted by the increasing severity and frequency of wildfires in western U.S. forests, leading to a sense of crisis that has driven legislative and administrative actions. Recent large and destructive wildfires drawn significant public attention and catalyzed responses to address the escalating crisis. The severity of recent wildfire seasons has compelled state and federal governments to allocate budgets and prioritize policies to combat the worsening wildfire situation.

The Forest Service plays a crucial role in managing wildfires, being the largest bearer of federal costs for both pre-suppression and suppression efforts. However, the Forest Service faces challenges in balancing the immediate need for wildfire suppression with the long-term goal of ecosystem resilience (Evers et al., 2019). In response, the Forest Service's approach to wildfire prevention and management involves a combination of strategies, including fuel management activities guided by decision support systems (Ager et al. 2012).

The National Wildfire Cohesive Strategy underscores that extreme wildfire fire behavior poses a threat to more houses in the Willand Urban Interface (WUI), leading to a greater emphasis on suppression and proactive vegetation management to mitigate this threat. Nationally, based on FIA data, approximately 25 percent of current old-growth occurs in WUI (Figure 15). While fuel reduction treatments are implemented in the WUI with the primary purpose of aiding fire suppression, they often have secondary purposes of conserving wildlife habitat and restoring historical fire regimes. There may be instances, however, where fuels reduction efforts in the WUI do not necessarily align with maintaining ecological integrity (Stevens et al. 2016).

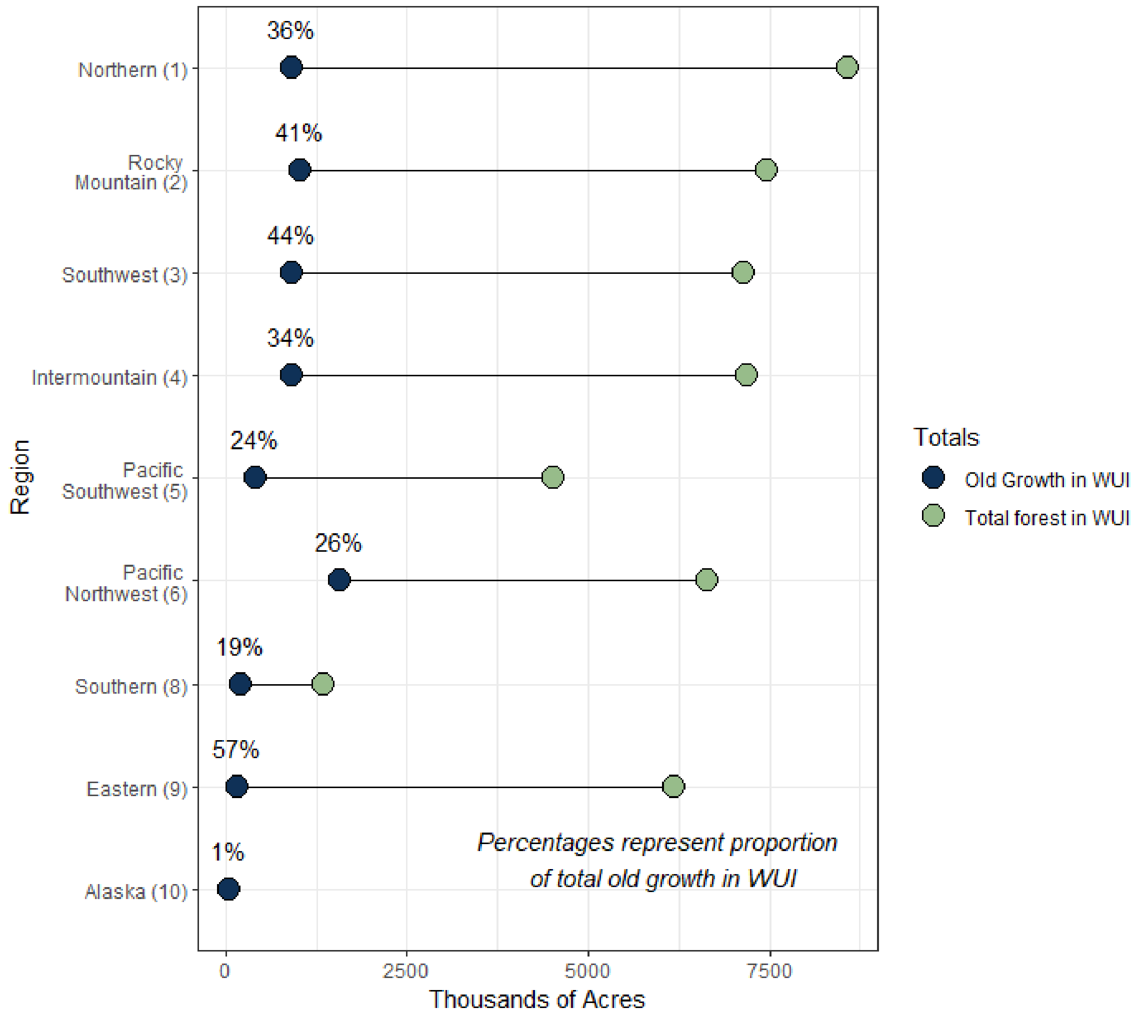

Figure 15. Percent of old-growth in WUI by Forest Service region

9. Ecosystem Effects Analysis

Refer to Chapter 2 of the Draft EIS for a description of the proposed action and alternatives. The following discussion addresses potential indirect potential indirect effects of the amendment on ecological conditions, with the emphasis being on old-growth forests. An integrated discussion of programmatic cumulative effects can be found in the Draft EIS, Chapter 3.

9.1 Ecological consequences common to all alternatives

Common vegetation management objectives and practices will continue under all alternatives, both within and outside of old-growth, as governed by the relevant land management plan. Consistent with the Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528–531) (MUSYA), the Forest Service manages the National Forest System (NFS) to sustain the multiple use of its renewable resources in perpetuity while maintaining the long-term health and productivity of the land. In addition, NFS planning focuses on ecological and social sustainability integrating forest restoration, ecological integrity, climate resilience, watershed protection, wildlife conservation, public engagement, and opportunities to contribute to vibrant local economies into an effective planning process that supports sustainable forests over time. Vegetation management activities that occur on the NFS, including in old-growth forest, are designed to foster ecosystems that are sustainable while also providing for multiple uses. These activities increasingly incorporate climate considerations to help foster climate resilience and promote adaptation. This can reduce negative effects of ecosystem stressors and buffer the impacts of climate change across all alternatives.

Vegetation management can have short-term adverse effects but local projects are designed to minimize or mitigate these impacts to ensure that long-term positive outcomes outweigh short-term negatives, ultimately resulting in net conservation benefits and fostering ecological integrity.

Modifying fire behavior will remain a priority in the Wildland-Urban Interface (WUI), which is typically, but not always, compatible with stewardship of old-growth ecosystems. Nationally, based on FIA data, approximately 25 percent of old-growth is in WUI. Areas with more frequent fire histories are in greater need of restoration and would benefit more from management actions that reduce vulnerability of old-growth while retaining old-growth forest and concurrently reducing the fire risk in WUI. These frequent-fire ecosystems make up the majority of the WUI. The Forest Service management objectives are to both conserve forest resources, including old-growth forests, and manage the NFS to reduce wildfire risk to natural resources, critical infrastructure and communities. Vegetation management is oftentimes necessary and effective to achieve these objectives (Davis et al. 2024, USDA and USDI 2024). To that end, by providing direction for the promotion of ecological integrity, the proposed amendment is complementary and consistent with the Wildfire Crisis Strategy and the Forest Service will continue to implement the Wildfire Crisis Strategy and related hazardous fuels reduction activities under all alternatives.

Existing plan components may or may not address old-growth forests specifically, but plan components often address related topics such as late successional forest, wildlife habitat, riparian areas, scenic integrity, and other facets of ecosystem integrity that will benefit old-growth. Therefore, all alternatives can benefit old-growth forest to some extent, though the degrees of protection and emphasis on proactive stewardship may differ.

Under all alternatives, there is uncertainty regarding the future trajectory of old-growth forests. The extent and resilience of old-growth will vary by region and ecosystem type primarily due to differences in the history of land use, disturbance regimes, climate scenarios, but also as a function of management setting. For example, frequent fire forests experiencing degraded or impaired conditions are highly vulnerable to stressors, but they are also expected to benefit significantly from targeted vegetation management. However, opportunities to use proactive stewardship to benefit old-growth are uneven. For example, according to FIA data, approximately 56 percent of old growth is in designated areas (e.g. wilderness, inventoried roadless) where vegetation management activities are limited. This management context, which varies within and across NFS units, is not expected to change in any alternative.

Forest Service funding is ultimately determined by Congress, with land management plans (LMPs) under the National Forest Management Act (NFMA) and 2012 Planning Rule (36 CFR 219) serving as guiding (but not compelling) documents that provide a framework for future actions. (See earlier discussion in Chapter 1 about the nature of a LMP under NFMA). While this Environmental Impact Statement (EIS) assumes adequate funding for management actions related to old-growth, land management plans do not make budget decisions. Should Congress emphasize specific programs by appropriation, a redistribution of priorities and allocation of funds would follow, regardless of the alternative implemented.

9.2 Ecological consequences common to all action alternatives

All action alternatives are designed to maintain and restore ecological integrity, diversity, function, and resiliency while contributing to social and economic sustainability as required by the 2012 Planning Rule (planning rule). In doing so, all action alternatives will achieve a consistent framework across the NFS to manage for the long-term persistence, distribution, and recruitment of old-growth forests.

NOGA-FW-DC-01 guides management to provide for old-growth forests that are resilient and adaptable to stressors and future climate conditions. NOGA-FW-DC-01 uses terms "amount", "representativeness", "redundancy", and "connectivity" to guide measurable progress toward achievement of the desired condition in a manner that is consistent with planning rule requirements for ecological sustainability and ecosystem integrity. NOGA-FW-DC-03 underscores that managing for the ecological integrity of old-growth forests will in turn provide valuable ecosystem services, such as water provisioning and carbon uptake, storage, and stability. Notably, while the proposed amendment is focused on old-growth forests, it also acknowledges that old-growth is a part of larger forested ecosystems, and that stewardship of old-growth should ultimately contribute to the integrity of terrestrial and aquatic ecosystems (NOGA-FW-DC-04).

The intent of NOGA-FW-DC-01 is reinforced and clarified by a suite of plan components and other plan content. First, NOGA-FW-OBJ-01 leads units to develop an "Adaptive Strategy for Old-Growth Forest Conservation" that will further guide planning and decision-making for the conservation and recruitment of old-growth forests. NOGA-FW-MA-1a provides additional detail on how to implement this objective, including consideration of climate change, tribal priorities, and incorporation of local information and Indigenous Knowledge. In addition, units should initiate at least three proactive stewardship projects/activities in the planning area to contribute to the achievement of old-growth forest desired conditions (NOGA-FW-OBJ-02) and exhibit a measurable, increasing trend towards Desired Conditions (NOGA-FW-OBJ-03).

NOGA-FW-DC-02 emphasizes that areas with "inherent capability", as defined in 36 CFR 219.19, represent higher than average value for the long-term persistence of old-growth, and is designed to promote retention of old-growth in appropriate locations given the anticipated impacts of climate change. NOGA-FW-MA-1b clarifies that these are areas of likely climate or fire refugia. NOGA-FW-GDL-01 supports NOGA-FW-DC-02 by constraining vegetation management projects in areas identified as compatible with and prioritized for the development of future old-growth forest to actions that help to promote those desired conditions.

Another central feature of all action alternatives is the incorporation of Indigenous Knowledge, and the recognition and respect for tribal sovereignty and treaties. The action alternatives are intended to foster tribal inclusion in the stewardship of old-growth. For example, NOGA-FW-GOAL-01 strives to encourage recognition and respect for the ethic of reciprocity and responsibility to future generations into the implementation of proactive stewardship activities. NOGA-FW-OBJ-03 further guides the initiation of at least one co-stewardship project with interested Tribes for the purpose of proactive stewardship within two years. Goals are optional content to include in a land management plan; however, once included they are not optional to follow. Including this goal as part of the proposed amendment fosters tribal inclusion in the interpretation and implementation of all aspects of the old-growth amendment leading to better and more sustainable ecological outcomes.

Further, NOGA-FW-MA-01 and NOGA-FW-OBJ-01 guide units to identify tribal priorities in the development of the *Adaptive Strategy for Old-Growth Forest Conservation*. These plan components are expected to empower Tribes to interact with implementation of the old-growth amendment on their terms. Incorporating these perspectives locally and focusing on the human interaction with these forests is expected to lead to better ecological, social, and cultural outcomes. For example, this could include increased emphasis on understory and associated ecosystem services. This could also include attention to the retention of ancient trees that have survived centuries of disturbances. NOGA-GDL-03 addresses culturally significant trees both within and outside old-growth. Finally, there may be more attention to functioning ecological systems rather than individual old-growth stands, as the boundary between old-growth and other ecological elements may receive less emphasis.

NOGA-FW-STD-01 defines where old-growth specific plan components shall apply in all action alternatives. NOGA-FW-STD-01, which clarifies the approach to defining old-growth forest and setting criteria to identify these forests, will change the area managed for old-growth on some planning units. However, this analysis assumes that these changes will not be more or less than 10 percent of the old-growth area addressed in current plans. About 70 percent of planning units will apply all or part of current regional old-growth criteria, if available, in accordance with NOGA-FW-STD-01, while the other 30 percent will operate under their existing criteria. Of the 90 units that will apply new criteria, 59 may see changes in the amount of area classified as old-growth compared to the existing condition, particularly in forest types that lack quantitative criteria or defined qualities in the text of the LMP. The remaining 30 units do not have a definition or criteria in the land management plan. Most of the 89 units applying the new criteria already have plan components related to old-growth in their land management plans. For these units, NOGA-FW-STD-01 will most likely have the effect of increasing the area to which these existing old-growth plan components apply. This is expected to increase the protections and proactive stewardship options for old-growth forest on these units.

Region 9 and parts of Region 5 present unique circumstances relative to NOGA-FW-STD-01. Currently in Region 9 there are no regional old-growth narrative definitions or criteria for units to tier to for field applications, and most units have either a narrative definition without quantitative criteria or a narrative definition and an age threshold. While the region is currently working with the Northern Research Station to develop operational definitions, they are not expected to be available until completion of the *Adaptive Strategy for Old-Growth Forest Conservation* (NOGA-FW-OBJ-01). Therefore, most units in Region 9 will not have regional criteria by the time the proposed amendment is to go into effect. Region 9 LMPs acknowledge the importance of old-growth on ecological integrity by describing desired future conditions that strive for encompassing all ecosystem seral stages. Therefore, the desire to move in the direction of promoting representation of old-growth follows the intent of the old-growth amendment. In Region 5, the regional materials present ranges of values developed to aid in the identification of old-growth, but no minimum criteria. Units in Region 5 that are a part of the Northwest Forest Plan or Sierra Nevada Forest Plan may have minimum criteria for old-growth classification to refer to that were developed in the analysis phase of the amendments.

As climate continues to deviate from historical conditions, acute and chronic climate-amplified disturbances such as drought, wildfires, and insect and disease outbreaks are expected to continue as primary threats to old-growth stands on national forests (USDA Forest Service Climate Adaptation Plan 2022, USDA and USDI 2024). In response, NOGA-FW-MA-01a provides guidance to support achievement of desired conditions through engagement in climate adaptation using explicit resistance, resilience, or transition approaches to address climate risks and achieve desired conditions, or otherwise intentionally accept alternative climate-driven outcomes. Adaptation actions can then be selected that respond to vulnerabilities and risks while meeting goals for a specific area, and these actions will vary based on context (Swanston et al. 2016). In many situations, intentionally accepting alternative climate-driven outcomes without implementing proactive stewardship may slow the development of old-growth forests or result in a reduction of old trees and old-growth forests (Steel et al. 2022, Case, Ettinger & Pradhan 2023, Noel et al. 2023, USDA and USDI 2024).

NOGA-FW-GDL 2 reiterates that proposed old-growth amendment plan components do not supersede existing plan components that directly or indirectly address old-growth resources. In certain cases, the retained existing plan components, when more restrictive than the old-growth amendment, may limit the ability to use proactive stewardship to achieve desired conditions of the action alternatives for the old-growth amendment. For example, Eastside Screens (USDA Forest Service 1994a, USDA Forest Service 1995) require that proposed timber sales be evaluated using three screens: ecosystem, riparian and wildlife. Once evaluated, there is a potential that forest stewardship activities could be restricted, limited, or continue with adherence to specific design criteria. These limits on harvest could be considered more restrictive than plan components proposed for the old-growth amendment, limiting the potential to actively reduce the vulnerability of these forests to stressors. In the Northern Region, five units have a standard or guideline stating that old-growth forests must continue to meet the regional old-growth minimum criteria after vegetation management for proactive stewardship, and not only for other purposes as in NOGA-FW-STD-02b. Some units will also have more restrictive language for a particular old-growth forest type, such as ancient cedar or bristlecone pine, where activities require more permissions or have fewer exceptions than the old-growth amendment. Based on current LMP direction, there is a potential for managers to encounter limitations to management tools available to meet proactive stewardship objectives.

In addition to the plan components and management approaches described above, all action alternatives contain two monitoring requirements designed to track the areas identified and prioritized for the retention and promotion of old-growth forests (NOGA-FW-MON-01) and provide regular updates on measurable changes in unit-level old-growth forest, actions taken pursuant to this amendment, and potential unintended consequences (NOGA-FW-MON-02). These monitoring requirements will facilitate learning, enable swifter progress towards the desired conditions, and provide for continuous support of the *Adaptive Strategy for Old-Growth Forest Conservation*.

In summary, all action alternatives contain the same desired conditions, guidelines, objectives, management approaches and monitoring requirements. This suite of plan components and other plan content common to all action alternatives are designed to encourage management actions that maintain or restore the structure, function, and composition of old-growth forests, reduce vulnerability to disturbance, contribute to the promotion of ecological integrity, and increase climate resilience. This will enhance the resiliency and adaptability of old-growth and foster its occurrence, stability, and connectivity. As such, all action alternatives will support ecosystem integrity and ecosystem services associated with old-growth forests such as biodiversity, carbon storage and stability, and water quality.

The difference between action alternatives are the standards which essentially influence the rate and manner of obtaining the desired conditions. Regardless of the standards, desired conditions are binding on projects (see 36 CFR 219.15(d)(1)) and the shared desired conditions among the action alternatives mediates effects of differences between the standards in the alternatives. The primary ecological differences among action alternatives will be assessed based on their anticipated impact on the rate of achieving desired conditions.

9.3 Unique ecological consequences

Alternative 1

Alternative 1 (no action) represents continuation of current management. Not all NFS units with Land Management Plans developed or revised under the 1982 planning rule will have plan components specifically designed to maintain or restore old-growth or the ecological integrity of terrestrial and aquatic ecosystems and watersheds in the plan area. Sixteen out of 128 Land Management Plans have been revised under the 2012 Planning Rule, with additional plans currently in the revision process. These plans all contain plan components designed to maintain or restore ecological integrity of terrestrial ecosystems, including old growth. However, the manner in which these plans addressed old growth is not necessarily consistent with the action alternatives proposed as part of this old-growth amendment.

The current rate of restoration in old-growth forests will continue but there is no assurance that proactive stewardship of old-growth will be prioritized or carried out in a strategic fashion, which could lead to increased vulnerability in the future relative to the action alternatives.

Alternative 2

Alternative 2 is the proposed action. Alternative 2 contains NOGA-FW-STD-03 which prohibits proactive stewardship in old-growth forests for the purpose of timber production. Timber production is defined as the purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use (36 CFR 219.19). This standard, along with NOGA-FW-STD-02a, ensures that the sole purpose of proactive stewardship will be to promote the composition, structure, pattern, or ecological processes necessary for old-growth forests to be resilient and adaptable to stressors and likely future environments. The proposed action, within the scope and scale of the amendment, is intended to further land management plans toward ecological integrity for old-growth forests and is anticipated to have a net-positive effect on the extent of old-growth forests and upon associated species, habitats, and ecosystem services. Given the combination of NOGA-FW-STD-03 and the preservation of all tools that could help implement proactive stewardship activities, including commercial timber harvest, Alternative 2 is anticipated to lead to the achievement of desired conditions at the fastest rate.

Alternative 2 and 3

Alternatives 2 and 3 contain NOGA-FW-STD-2a, NOGA-FW-STD-2b, and NOGA-FW-STD-2c. NOGA-FW-STD-2a limits vegetation management in old-growth to actions that "proactively steward" stands toward ecological integrity. It describes 12 specific elements of old-growth and relevant projects will need to address one or more of these elements. NOGA-FW-STD-2a will limit vegetation management in old-growth to actions that promote the composition, structure, pattern, or ecological processes necessary for old-growth forests to be resilient and adaptable to stressors and likely future environments.

NOGA-FW-STD-02b allows for the cutting or removal of trees in old-growth forests for the purposes other than proactive stewardship when two qualifiers occur: 1) when said action is incidental to the implementation of a management activity not otherwise prohibited by the plan, as amended, and 2) the area – as defined at an ecologically appropriate scale – continues to meet the definition and associated criteria for old-growth forest after the incidental tree cutting or removal. Examples of such activities, consistent with the LMP as amended, could be the development of infrastructure or recreation opportunities on or through NFS lands such as pipelines, transmission lines, roads, or ski area runs in which incidental tree cutting or removing is determined to be necessary or appropriate. Additionally, it may be necessary to have incidental cutting or removal of trees in old-growth forests in addition to proactive stewardship activities that may already be occurring. For example, trail construction or maintenance – not associated with the proactive stewardship – may be occurring in the same area and require incidental tree cutting. Future activities may do so, so long as said incidental tree cutting or removal of trees in old-growth forests does not diminish the ability for said forest to continue to meet the definition and criteria of old-growth, on an ecologically appropriate scale.

It should be acknowledged that some of these infrastructure or multiple use activities may be large enough that they impact whether an area meets the definition and associated criteria of old-growth at the ecologically appropriate scale.

NOGA-FW-STD-2c describes six scenarios where deviations to NOGA-FW-STD-2a and NOGA-FW-STD-2b are permitted, including:

> i. *In cases where this standard would preclude achievement of wildfire risk management objectives within municipal watersheds or the wildland-urban interface (WUI) as defined in Section 101 of the Healthy Forest Restoration Act of 2003 (16 USC 6511) and its application by the local planning unit, or would prevent protection of critical infrastructure from wildfire –*
>
> Nationally, approximately 6.2 million acres of old-growth (25 percent of total old-growth) is estimated to be in WUI. In these areas, the density of stands may be reduced through thinning or prescribed fire. The primary objective of these treatments is most likely to be to reduce probability of extreme fire behavior. Depending on the site-specific conditions, vegetation management actions that optimize wildfire risk reduction may not be the same as an objective that was strictly proactive stewardship. In these cases, the exception to NOGA-FW-STD-2c may be invoked. However, the majority of WUI is in frequent-fire ecosystems. As such, it is expected that objectives of wildfire risk management and proactive stewardship will usually be mutually compatible.
>
> *ii. to protect public health and safety*
>
> This could include the removal of trees at risk of falling and causing injury to the public or damage to infrastructure such as buildings, roads, campgrounds, or powerlines.
>
> *iii. to comply with other statutes or regulations, valid existing rights for mineral and energy resources, or authorizations of occupancy and use made prior to the old-growth amendment decision*
>
> In some instances where existing or proposed mineral and energy projects are within or adjacent to an old-growth forest, the operations would be allowed to proceed in accordance with laws, regulations and applicable instruments. Therefore, trees could be removed to clear areas for mineral and energy activities, to mitigate hazard trees, to allow for reasonable access to mining operations, and/or for use in locatable operations as all claimants (pre- and post-1955 Surface Resource Act) have a right to use the surface for mining purposes in accordance with the U.S. mining laws.
>
> *iv. for culturally significant uses as informed by tribes or for de minimis use for local community purposes;*

The specifics will be determined locally, but may include removal of trees for specific types of wood products of cultural value such as bark and trunks of the Eastern White Pine in the East Region; canoe-size wiigwaas (paper birch) in the Great Lakes Region; edible fruits and nuts, bark, leaves, and roots of old-growth American Persimmon in the East and Midwest region; edible fruits and nuts, bark, and trunk of Black Walnut throughout the central region; edible berries, leaves for medicines, and wood for building material from old-growth juniper in the southwest; or totem pole use in Alaska. Local community purposes could include firewood gathering or other such de minimis uses. Personal and free use could also fall under this exception.

v. in areas designated for research purposes, such as experimental forests or research natural areas.

Experimental forest and research natural areas are usually recommended in a land management plan and established through separate regulatory authorities. The specific management of these designated areas is described in a specific plan for each area.

Research natural areas (RNAs) and experimental forests are permanently established for research purposes and to represent the range of vegetation types and areas of special ecological significance on national forest lands. These designations are made with the goals of research and of maintaining natural ecosystem components and processes. Theys are identified and administratively designated by the Regional Forester with concurrence of the research station director, and serve as areas for research, education, and the maintenance of biodiversity. In some cases, stewardship management or experimental manipulation is needed to achieve objectives, including actions such as invasive weed control or prescribed fire. These management activities are also coordinated between the national forests and the research station.

vi. in cases where it is determined – based on best available science, which includes Indigenous Knowledge – that the direction in this standard is not relevant or beneficial to a particular species or forest ecosystem type.

In the western United States, seral lodgepole pine (*Pinus contorta*) is one example of a forest type that may fall under this exception. Lodgepole is a shade-intolerant, fire-adapted pioneer species that usually regenerates in dense, structurally homogenous, even-aged stands (Lotan and Perry 1983). Most lodgepole-dominated forests occur as early-to mid-successional forests persisting for 50-200 years on warmer, lower elevation forests, and 150-400 years in subalpine forests. Because, (1) large, contiguous areas of pure lodgepole are highly vulnerable to mountain pine beetle outbreak (Williams et al. 2018), (2) in the coming decades, warmer climates are predicted to further increase bark beetle outbreak frequency, severity, and range (Kurz et al. 2008, Bentz et al. 2009, Six et al. 2014), and (3) silvicultural treatments in mature lodgepole pine are the most useful tool managers have to promote landscape heterogeneity and sustain lodgepole pine ecosystems (Whitehead et al. 2003, Coops et al. 2008, Hood et al. 2016), excluding lodgepole forests from NOGA-FW-STD-2a may detract from ecological integrity. However, this determination must be made on a case-by-case basis within a local context.

Similarly, in the northern and western Great Lakes region, the jack pine (*Pinus banksiana*) ecosystem is characterized by a savanna-like overstory with a low diversity, open prairie understory. Ecosystem structure and species assemblage are maintained by a frequent fire regime (every 10-50 years). Fire is required for successful regeneration of the relatively short-lived (60-

100 years) jack pine as the serotinous cones depend on the heat to release the seeds, and fire exposes bare mineral soil and releases nutrients necessary for germination. Thus, the combination of frequent disturbance and short life spans of characteristic species makes old-growth management contrary with this ecosystem.

Exception *vi* of NOGA-FW-STD-2c may also apply in systems that are already above the natural range of variation and are not contributing to ecological integrity as determined by a local analysis based on best available scientific information.

For species or ecosystems where proactive stewardship is beneficial, where vegetation management would occur under the NOGA-FW-STD-2a, and for areas outside of WUI, the NOGA-FW-STD-2c exceptions *ii* to *vi* listed above are likely to be minimal, and less than five percent of the total amount of old-growth across each forest. This estimate is based on the following factors:

- Desired Conditions will continue to govern all Forest Service projects, regardless of the purpose of the project. While exceptions are allowed, management actions must not preclude the eventual attainment of the desired conditions for old-growth for the forest as a whole.

While some activities like mining can have significant local effects, they usually have a small footprint when compared to an entire National Forest. (See the mining discussion in the SocioEcon and Cultural Impacts Analysis Report.)

- The public health and safety exception would typically be applied near roads or developments such as campgrounds or areas with concentrated use, which is only a small footprint of National Forests.
- Vegetation management and incidental tree cutting and/or removal can still occur for the reasons listed in the exceptions while still meeting old-growth objectives, meaning in these cases no exceptions would need to be invoked.

Specific to Region 10, in contrast to Alternatives 1 and 4, Alternatives 2 and 3 would effectively halt larger commercial old growth timber sales on the Tongass NF, leaving commercial harvesting to occur within young or secondary growth areas. The 2016 Tongass Forest Plan, as amended, and the 2021 Southeast Alaska Sustainability Strategy (SASS) already envision reduced commercial timber harvesting of old growth. Although the SASS looks toward an end to large-scale, old-growth timber harvest, it also envisions small and micro-old-growth timber sales, likely to average 5 MMBF (million board feet) per year for cultural purposes and to help the timber industry in Southeast Alaska transition from primarily milling old-growth to young growth timber. This has been expected to be a very small portion of the old-growth in the Tongass, and timber harvests were likely to be concentrated in areas with road access.

As a general strategy, the SASS is not a component of the Tongass NF Plan, although it will be considered in revision of the Plan – which is underway. It is assumed that the strategy is compatible with Alternatives 1 and 4; however, NOGA-FS-STD-03 in Alternatives 2 and 3 removes the option for most commercial timber harvest. It is therefore assumed that the small commercial sales would not occur under Alternatives 2 and 3, although there may be ecologically appropriate stewardship actions under NOGA-FS-STD 2a and non-commercial activities in accordance with the exceptions.

Alternative 3

Alternative 3 is considered the most restrictive alternative. In this alternative, NOGA-FW-STD-3 would prohibit commercial timber harvest in old-growth in accordance with NOGA-FW-STD-1 and NOGA-FW-STD-2. (See the Glossary in the Draft EIS for a definition of commercial timber harvest.)

Commercial timber harvest on NFS lands is governed by the land management plan, as authorized by NFMA and its implementing regulations. Timber harvest on NFS lands occurs for many different reasons, including ecological restoration, community protection in wildland-urban interfaces and high-risk firesheds, habitat restoration, protection of municipal water supplies, and to contribute to economic sustainability through the production of timber.

As further explained in the Timber section of the SocioEcon and Cultural Impacts Analysis Report, Alternative 3 prohibits commercial timber harvest in old-growth for proactive stewardship (NOGA-FW-STD-03 as described for this alternative). From an ecological perspective, the anticipated negative effects of reducing the rate of proactive stewardship by limiting vegetation management tools – and thereby accepting avoidable loss of old-growth – likely outweighs any potential benefits of ensuring that commercial timber harvest does not negatively influence old-growth management decisions. The alternative is likely to be less effective at achieving desired outcomes under the old-growth amendment because it would limit ecologically necessary proactive stewardship activities governed by NOGA-FW-STD-2a. Consequently, the rate of restoration of old-growth will be slowest under this alternative because the agency's ability to restore old-growth resiliency and achieve desired conditions would be more limited with the removal of commercial harvest as a management tool.

Notwithstanding the fact that timber harvest and production are primary aspects of the agency's mission, there is an interest in the role that economic incentives play in shaping agency decision making, particularly as it relates to achievement of ecological management objectives. However, NOGA-FW-STD-2 clearly stipulates that vegetation management in defined old-growth areas "may *only* be for the purpose of proactive stewardship" (emphasis added). This sole purpose of the standard limits the risk of commercial incentives influencing the decision-making process.

It is reasonable to foresee that some number of projects that would harvest trees in old-growth would be avoided under this alternative compared to the preferred alternative, and thus the consequences of removing old trees in those projects would be avoided. It is not feasible, however, to predict with any certainty the extent or magnitude of those avoided consequences. As noted above, the risk of those consequences is limited due to the "sole purpose" language within NOGA-FW-STD-2. It should be noted that the *Adaptive Strategies for Old-growth Conservation Forest Conservation* provide further opportunities to design and evaluate the effectiveness of proactive stewardship activities at the appropriate ecological scale within unique socio-ecological management settings.

In contrast to Alternatives 1 and 4, Alternatives 2 and 3 would effectively halt larger commercial old growth timber sales on the Tongass NF, leaving commercial harvesting to occur within young or secondary growth areas. The 2016 Tongass Forest Plan, as amended, and the 2021 Southeast Alaska Sustainability Strategy (SASS) already envision reduced commercial timber harvesting of old growth. Although the SASS looks toward an end to large-scale, old-growth timber harvest, it also envisions small and micro-old-growth timber sales, likely to average 5 MMBF (million board feet) per year for cultural purposes and to help the timber industry in Southeast Alaska transition from primarily milling old-growth to young growth timber. This has been expected to be a very small portion of the old-growth in the Tongass, and timber harvests were likely to be concentrated in areas with road access.

As a general strategy, the SASS is not a component of the Tongass NF Plan, although it will be considered in revision of the Plan – which is underway. It is assumed that the strategy is compatible with Alternatives 1 and 4; however, NOGA-FS-STD-03 in Alternatives 2 and 3 removes the option for most commercial timber harvest. It is therefore assumed that the small commercial sales would not occur under Alternatives

2 and 3, although there may be ecologically appropriate stewardship actions under NOGA-FS-STD 2a and non-commercial activities in accordance with the exceptions.

Overall for Alternative 3, from an ecological perspective, the anticipated negative effects of reducing the rate of proactive stewardship by limiting vegetation management tools – and thereby accepting avoidable loss of old-growth – likely outweighs any potential benefits of ensuring that commercial timber harvest does not negatively influence old-growth management decisions. The alternative is likely to be less effective at achieving desired outcomes under the old-growth amendment because it would limit ecologically necessary proactive stewardship activities governed by NOGA-FW-STD-2a. Consequently, the rate of restoration of old-growth will be slowest under this alternative because the agency's ability to restore old-growth resiliency and achieve desired conditions would be more limited with the removal of commercial harvest as a management tool.

Alternative 4

Alternative 4 is considered the least restrictive as the only standard it retains is NOGA-FW-STD-1. By omitting NOGA-FW-STD-2a, NOGA-FW-STD-2b, NOGA-FW-STD-2c and NOGA-FW-STD-3, vegetation management in old-growth may be for purposes other than proactive stewardship in Alternative 4. However, the plan components common to all action alternatives – including desired conditions, objectives, and guidelines in addition to required monitoring elements and management approaches – would still guide old-growth management towards greater ecological integrity. As such, the rate of progress towards desired conditions under this alternative would likely be second fastest only to the proposed action because all management tools are available but not all old-growth treatments are necessarily optimized for proactive stewardship purposes.

Appendix 1. Old-growth Vegetation Types

As shown in Table 1-1, the nine Forest Service regions have identified approximately 200 old-growth forest types. These 200 types were further classified into 80 groups with at least 10 records per group to allow for more robust estimates (USDA Forest Service 2023; Woodall et al. 2023).

Table 20-1. Classification of regional old-growth vegetation types in groups

Groups	Regional Old-growth Vegetation Types
Region 1 (R1) Douglas fir	R1 Douglas fir; R1 Douglas-fir group; R1 Douglas-Fir-High
R1 Fir/spruce/mountain hemlock group	R1 Engelmann Spruce-Subalpine Fir-Warm-ID; R1 Spruce/Fir (Fir/spruce/mountain hemlock group); R1 Fir/spruce/mountain hemlock group; R1 Western white pine group; R1 Grand Fir
R1 Hardwoods (FIA aspen/birch group)[a]	R1 Alder/maple group; R1 Elm/ash/cottonwood group; R1 Aspen; R1 Gambel Oak; R1 Aspen/birch group; R1 Oak/hickory group; R1 Cottonwood; R1 Woodland hardwoods group
R1 Hemlock/Sitka spruce group	R1 Hemlock/Sitka spruce group
R1 Lodgepole Pine	R1 Lodgepole Pine; R1 Lodgepole pine group
R1 Pinyon Juniper - Western Softwoods	R1 Other Western Softwoods; R1 Other western softwoods group; R1 Pinyon/juniper group; R1 Pinyon-Juniper
R1 Ponderosa Pine	R1 Ponderosa Pine; R1 Ponderosa pine group; R1 Ponderosa Pine-RM-Climax
R1 Western larch group	R1 Western larch group
Region 2 (R2) Aspen/ Cottonwood/ Oaks	R2 Aspen; R2 Cottonwood; R2 Oak/hickory group; R2 Other hardwoods group
R2 Douglas fir	R2 Douglas fir
R2 Gambel Oak	R2 Gambel Oak
R2 Lodgepole Pine	R2 Lodgepole Pine
R2 Other Western Softwoods	R2 Other Western Softwoods; R2 Other eastern softwoods group
R2 Pinyon-Juniper	R2 Pinyon-Juniper
R2 Ponderosa Pine (FIA Ponderosa Pine Group)[a]	R2 Ponderosa Pine
R2 Spruce/Fir	R2 Spruce/Fir (Fir/spruce/mountain hemlock group); R2 Spruce/Fir (Spruce/fir group)
Region 3 (R3) Hardwoods (FIA Woodland Hardwoods Group)[a]	R3 Arizona Walnut; R3 Rio Grande Cottonwood/Shrub; R3 Gambel Oak Shrubland; R3 Sycamore - Fremont Cottonwood; R3 Narrowleaf Cottonwood - Spruce, Narrowleaf Cottonwood/Shrub; R3 Upper Montane Conifer/Willow; R3 Woodland hardwoods group; R3 Other
R3 Juniper Grass	R3 Juniper Grass
R3 Madrean Encinal Woodland	R3 Madrean Encinal Woodland
R3 Madrean Pinyon-Oak	R3 Madrean Pinyon-Oak
R3 Mixed Conifer -- Frequent Fire	R3 Mixed Conifer -- Frequent Fire
R3 Mixed Conifer w/ Aspen	R3 Mixed Conifer w/ Aspen; R3 Bristlecone Pine

Groups	Regional Old-growth Vegetation Types
R3 PJ Grass - Sagebrush	R3 PJ Grass; R3 PJ Sagebrush; R3 Semi-Desert Grassland
R3 PJ Shrub - Woodland	R3 Pinyon/juniper group; R3 PJ Woodland (persistent); R3 PJ Deciduous Shrub; R3 PJ Evergreen Shrub
R3 Ponderosa Pine	R3 Ponderosa Pine Forest
R3 Ponderosa Pine - Mixed	R3 Ponderosa Pine -- Evergreen Oak; R3 Ponderosa Pine/Willow
R3 Spruce - Fir	R3 Douglas-fir group; R3 Spruce-Fir Forest
Region 4 (R4) Aspen-Dry	R4 Aspen-Dry
R4 Aspen-Mesic	R4 Aspen-Mesic
R4 Bristlecone/ Limber/ Whitebark Pines	R4 Bristlecone Pine; R4 Limber Pine-Lower; R4 Limber Pine-Montane; R4 Whitebark Pine
R4 Douglas fir	R4 Douglas-Fir-High; R4 Douglas-Fir-Low; R4 Fir/spruce/mountain hemlock group; R4 Grand Fir; R4 Western larch group; R4 Conifer Mixed Forests-Productive
R4 Elm/ ash/ cottonwood (FIA Elm/Ash/ Cottonwood Group)[a]	R4 Elm/ash/cottonwood group
R4 Engelmann spruce	R4 Engelmann Spruce-Subalpine Fir-Warm-ID; R4 Engelmann Spruce-Subalpine Fir-Warm-UT; R4 Engelmann Spruce-Subalpine Fir-Alpine; R4 Blue Spruce; R4 Engelmann Spruce-Subalpine Fir-Cold; R4 Conifer Mixed Forests-Low
R4 Lodgepole Pine	R4 Lodgepole Pine
R4 Pinyon Juniper NW - Others	R4 Pinyon-Juniper-NW-High; R4 Pinyon-Juniper-NW-Low; R4 Woodland hardwoods group; R4 Other hardwoods group; R4 Other western softwoods group
R4 Pinyon-Juniper-SE-High	R4 Pinyon-Juniper-SE-High
R4 Pinyon-Juniper-SE-Low	R4 Pinyon-Juniper-SE-Low
R4 Ponderosa Pine	R4 Ponderosa Pine-N-Climax; R4 Ponderosa Pine-N-Seral; R4 Ponderosa Pine-RM-Climax; R4 Ponderosa Pine-RM-Seral
Region 5 (R5) Douglas-fir/ Tanoak/ Madrone	R5 Douglas-fir/Tanoak/Madrone
R5 Jeffrey Pine	R5 Jeffrey Pine
R5 Mixed Conifers	R5 Conifer Mixed Forests; R5 Interior Ponderosa Pine; R5 Lodgepole Pine; R5 Mixed Subalpine (Western White Pine Association), R5 Mixed Subalpine (Mountain Hemlock Association)
R5 Pacific Conifers	R5 Coast Redwood; R5 Pacific Douglas-fir; R5 Pacific Ponderosa Pine
R5 Region ed Fir	R5 Red Fir
R5 White Fir	R5 White Fir
R5 Region 6 Hardwoods (FIA Western Oak Group)[a]	R5 Alder/maple group; R5 Tanoak/laurel group; R5 Mixed Subalpine (Quaking Aspen Association); R5 Elm/ash/cottonwood group; R5 Western oak group; R5 Other hardwoods group; R5 Woodland hardwoods group; R6 Elm/ash/cottonwood group; R6 Aspen/birch group; R6 Hardwoods; R6 Western oak group; R6 Other hardwoods group
Region 6 (R6) Douglas-fir (eastside)	R6 Douglas-fir (eastside); R6 Douglas-fir (interior); R6 Douglas-fir group

Groups	Regional Old-growth Vegetation Types
R6 Douglas-Fir (NWFP)	R6 Douglas-Fir (NWFP)
R6 Mountain Hemlock	R6 Mountain Hemlock; R6 Fir/spruce/mountain hemlock group
R6 Ponderosa Pine - Lodgepole Pine	R6 Ponderosa Pine; R6 Jeffrey Pine; R6 Ponderosa pine group; R6 Lodgepole Pine
R6 Ponderosa pine (very late decadent)	R6 Ponderosa pine (very late decadent)
R6 Port Orford cedar - redwood	R6 Port Orford Cedar; R6 Redwood
R6 Silver Fir	R6 Pacific silver fir; R6 Silver Fir; R6 California Red Fir -Shasta Red Fir
R6 Sitka Spruce	R6 Sitka Spruce
R6 Subalpine fir	R6 Subalpine fir
R6 Subalpine Fir - Engelmann Spruce	R6 Subalpine Fir - Engelmann Spruce
R6 Tanoak	R6 Tanoak
R6 Western hemlock	R6 Western Hemlock
R6 White/Grand fir	R6 White Fir - Grand Fir; R6 White/Grand fir
Region 8 (R8) Conifer southern hardwood	R8 Eastern hemlock; R8 Shortleaf pine/oak; R8 Eastern redcedar; R8 Eastern redcedar/hardwood; R8 Slash pine/hardwood; R8 Eastern white pine/northern red oak/white ash; R8 Loblolly pine/hardwood; R8 Other pine/hardwood; R8 Virginia pine/southern red oak
R8 Longleaf pine	R8 Longleaf pine; R8 Longleaf pine/oak
R8 Oaks	R8 Chestnut oak; R8 Scarlet oak; R8 Chestnut oak/black oak/scarlet oak; R8 Southern scrub oak; R8 Northern red oak; R8 White oak; R8 White oak/red oak/hickory; R8 Post oak/blackjack oak
R8 Pines - Conifers	R8 Eastern white pine; R8 Eastern white pine/eastern hemlock; R8 Pond pine; R8 Slash pine; R8 Red spruce; R8 Table Mountain pine; R8 Loblolly pine; R8 Sand pine; R8 Virginia pine; R8 Pitch pine; R8 Shortleaf pine
R8 southern hardwoods	R8 Baldcypress/pondcypress; R8 Mixed upland hardwoods; R8 Sassafras/persimmon; R8 Cherry/white ash/yellow-poplar; R8 Red maple/lowland; R8 Sweetbay/swamp tupelo/red maple; R8 Baldcypress/water tupelo; R8 Other hardwoods; R8 Sugar maple/beech/yellow birch; R8 Cottonwood; R8 Red maple/oak; R8 Sweetgum/Nuttall oak/willow oak; R8 Yellow-poplar; R8 Black cherry; R8 Overcup oak/water hickory; R8 Sugarberry/hackberry/elm/green ash; R8 Elm/ash/black locust; R8 Red maple/upland; R8 Sweetgum/yellow-poplar; R8 Yellow-poplar/white oak/northern red oak; R8 Black walnut; R8 Pin cherry; R8 Swamp chestnut oak/cherrybark oak; R8 Willow; R8 Hard maple/basswood; R8 River birch/sycamore; R8 Sycamore/pecan/American elm
R8 Wet and rain forest[b]	R8 Lower montane wet and rain forest; R8 Palms; R8 Wet and rain forest
Region 9 (R9) Conifer northern hardwood	R9 Conifer northern hardwood; R9 Oak/pine group
R9 northern hardwood	R9 northern hardwood; R9 Aspen/birch group; R9 Beech maple basswood; R9 Oak/gum/cypress group; R9 Oak/hickory group; R9 Other hardwoods group; R9 wetland hardwood
R9 Northern pine	R9 Northern pine; R9 Loblolly/shortleaf pine group; R9 Exotic softwoods group; R9 Other eastern softwoods group

Groups	Regional Old-growth Vegetation Types
R9 oak	R9 dry oak; R9 mesic northern oak
R9 Spruce/ fir group	R9 Spruce/fir group; R9 Montane spruce; R9 sub-boreal spruce/fir
Region 10 (R10) Black Spruce	R10 Black Spruce SAF 204
R10 Mixed conifer	R10 Mixed conifer; R10 Shore pine
R10 Mountain hemlock	R10 Mountain hemlock; R10 Mountain Hemlock -SAF 225 Hi-elev; R10 Mountain Hemlock -SAF 225 low elev
R10 Sitka Spruce - Alluvial	R10 Sitka Spruce - Alluvial; R10 Sitka Spruce - SAF 223 Alluvial; R10 Aspen - SAF 217
R10 Sitka Spruce - Other	R10 Sitka Spruce – Other; R10 Sitka Spruce - SAF 223 Other
R10 Western Hemlock - poorly drained	R10 Western Hemlock - poorly drained; R10 Western Hemlock - SAF 224 poorly drained
R10 Western Hemlock - well drained	R10 Western Hemlock - well drained; R10 Western Hemlock - SAF 224 well drained
R10 Western Hemlock/ Alaska yellow cedar	R10 Western Hemlock/Alaska yellow cedar
R10 Western Hemlock/ western red cedar	R10 Western Hemlock/western Redcedar - well drained; R10 Western Hemlock/western Redcedar - poorly drained
R10 White spruce	R10 White Spruce SAF 201

a All plots are cross walked to the FIA forest type group shown in parentheses due to less than 10 FIA old-growth plot records for the mature vegetation class

b No mature plots due to not enough plots in this FIA tropical hardwoods group on lands managed by the Forest Service and BLM

Appendix 2. Estimated Amount of Old-growth Forest on NFS Lands

Table 21-1 lists FIA-based estimates of amount of old-growth forest (in thousands of acres by unit) as well as percent of forested NFS lands estimated to be old-growth.

Table 21-1. Estimates of old-growth forest in thousands of acres and percent of forested NFS estimated to be old-growth, by region and unit

Region	NFS Unit	Old-growth Estimate (1,000 acres)	95% Confidence Interval (1,000 acres)	Percent of Forested NFS Lands as Old-growth
1	Beaverhead-Deerlodge	438	345 - 531	16%
1	Bitterroot	125	74 - 177	9%
1	Clearwater	157	97 - 217	9%
1	Custer Gallatin	496	403 - 590	21%
1	Flathead	198	131 - 264	9%
1	Helena Lewis and Clark	255	183 - 328	10%
1	Idaho Panhandle	289	211 - 368	12%
1	Kootenai	187	124 - 250	8%
1	Lolo	115	64 - 166	5%
1	Nez Perce	235	163 - 307	12%
2	Arapaho-Roosevelt	157	100 - 213	13%
2	Bighorn	143	87 - 199	18%
2	Black Hills	9	0 - 20	1%
2	Grand Mesa-Uncompahgre-Gunnison	702	590 - 813	31%
2	Medicine Bow-Routt	169	108 - 230	8%
2	Nebraska	-	-	0%
2	Pike and San Isabel	305	225 - 385	17%
2	Rio Grande	157	99 - 214	12%
2	San Juan	420	333 - 508	27%
2	Shoshone	117	66 - 168	8%
2	White River	318	238 - 397	20%
3	Apache-Sitgreaves	226	159 - 293	14%
3	Carson	43	11 - 74	3%
3	Cibola	183	117 - 249	15%
3	Coconino	230	160 - 301	16%
3	Coronado	176	113 - 238	16%
3	Gila	475	377 - 573	17%
3	Kaibab	220	151 - 289	17%
3	Lincoln	119	67 - 172	13%
3	Prescott	100	53 - 147	15%
3	Santa Fe	92	46 - 139	6%
3	Tonto	243	176 - 311	20%

Region	NFS Unit	Old-growth Estimate (1,000 acres)	95% Confidence Interval (1,000 acres)	Percent of Forested NFS Lands as Old-growth
4	Ashley	120	69 - 172	13%
4	Boise	135	80 - 190	7%
4	Bridger-Teton	144	85 - 203	6%
4	Caribou-Targhee	108	59 - 157	5%
4	Dixie	410	319 - 502	27%
4	Fishlake	217	153 - 281	20%
4	Humboldt-Toiyabe	598	488 - 707	17%
4	Manti-La Sal	303	222 - 384	28%
4	Payette	88	45 - 132	4%
4	Salmon-Challis	280	203 - 357	9%
4	Sawtooth	94	47 - 140	8%
4	Uinta	83	40 - 126	12%
4	Wasatch-Cache-Uinta	75	34 - 115	8%
5	Angeles	13	0 - 30	8%
5	Cleveland	-	-	0%
5	Eldorado	63	27 - 100	11%
5	Inyo	97	50 - 144	10%
5	Klamath	163	104 - 221	12%
5	Lake Tahoe Basin	37	11 - 63	24%
5	Lassen	104	57 - 152	10%
5	Los Padres	10	0 - 24	2%
5	Mendocino	60	23 - 96	8%
5	Modoc	56	20 - 92	5%
5	Plumas	169	113 - 224	15%
5	San Bernardino	27	3 - 52	9%
5	Sequoia	141	90 - 191	15%
5	Shasta-Trinity	230	160 - 301	11%
5	Sierra	215	150 - 279	19%
5	Six Rivers	122	74 - 170	11%
5	Stanislaus	135	83 - 187	17%
5	Tahoe	60	26 - 94	8%
6	Colville	170	135 - 205	16%
6	Crooked River NG	-	-	0%
6	Deschutes	194	151 - 237	13%
6	Fremont	190	152 - 228	18%
6	Gifford Pinchot	390	342 - 438	31%
6	Malheur	284	240 - 327	20%
6	Mt. Baker-Snoqualmie	689	615 - 764	47%
6	Mt. Hood	366	314 - 419	38%
6	Ochoco	157	125 - 189	25%

Region	NFS Unit	Old-growth Estimate (1,000 acres)	95% Confidence Interval (1,000 acres)	Percent of Forested NFS Lands as Old-growth
6	Okanogan	299	231 - 366	19%
6	Olympic	199	161 - 236	34%
6	Rogue River	255	206 - 304	41%
6	Siskiyou	269	221 - 317	26%
6	Siuslaw	205	171 - 239	35%
6	Umatilla	285	228 - 341	24%
6	Umpqua	381	338 - 424	40%
6	Wallowa-Whitman	465	406 - 523	27%
6	Wenatchee	449	369 - 528	23%
6	Wilamette	605	542 - 668	38%
6	Winema	172	133 - 212	17%
8	Chattahoochee-Oconee	111	84 - 137	13%
8	Cherokee	66	46 - 86	10%
8	Daniel Boone	22	0 - 44	3%
8	El Yunque	6	0 - 17	50%
8	Francis Marion-Sumter	4	0 - 8	1%
8	George Washington	507	440 - 574	28%
8	Kisatchie	15	0 - 31	3%
8	Land Between the Lakes	6	0 - 19	4%
8	NFs in Alabama	66	33 - 99	10%
8	NFs in Florida	87	58 - 116	7%
8	NFs in Mississippi	33	18 - 48	3%
8	NFs in North Carolina	219	159 - 280	18%
8	NFs in Texas	-	-	0%
8	Ouachita	13	0 - 31	1%
8	Ozark and St. Francis	12	0 - 29	1%
9	Allegheny	10	2 - 19	2%
9	Chequamegon-Nicolet	61	38 - 84	4%
9	Chippewa	22	8 - 37	4%
9	Green Mountain	2	0 - 5	0%
9	Hiawatha	16	5 - 27	2%
9	Hoosier	7	0 - 15	3%
9	Huron-Manistee	3	0 - 7	0%
9	Mark Twain	20	6 - 33	1%
9	Midewin Tallgrass Prairie	-	-	0%
9	Monongahela	40	23 - 56	4%
9	Ottawa	35	19 - 51	4%
9	Shawnee	5	0 - 10	2%
9	Superior	70	44 - 97	3%
9	Wayne	9	0 - 18	3%

Region	NFS Unit	Old-growth Estimate (1,000 acres)	95% Confidence Interval (1,000 acres)	Percent of Forested NFS Lands as Old-growth
9	White Mountain	2	0 - 6	0%
10	Chugach	547	474 - 621	83%
10	Tongass	5,222	5047 - 5396	76%

Appendix 3. Estimated Amount of Old-growth Forest by Vegetation Type

The FIA-based estimates of amount of old-growth forest in thousands of acres by old-growth vegetation type grouping as well as percent of forested NFS lands in that vegetation type estimated to be old-growth are listed in Table 22-1.

Table 22-1. Old-growth estimate by vegetation type in thousands of acres and percent NFS lands

Vegetation Type	Fire Regime	Old-growth Estimate (1,000 acres)	95% Confidence Interval (1,000 acres)	Total Vegetation Type Estimate (1,000 acres)	Percent of Vegetation Type as Old-growth
R1 Douglas fir	Frequent	405	310 - 500	5,963	7%
R1 Fir / spruce / mountain hemlock group	Infrequent	1,241	1076 - 1405	7,274	17%
R1 Hardwoods	Infrequent	-	-- -	296	-
R1 Hemlock / Sitka spruce group	Infrequent	150	92 - 208	660	23%
R1 Lodgepole Pine	Infrequent	394	302 - 485	3,971	10%
R1 Pinyon Juniper - Western Softwoods	Infrequent	146	88 - 204	887	16%
R1 Ponderosa Pine	Frequent	99	52 - 147	856	12%
R1 Western larch group	Infrequent	61	25 - 98	753	8%
R2 Aspen / Cottonwood / Oaks	Frequent	820	689 - 950	2,868	29%
R2 Douglas fir	Frequent	124	68 - 179	1,217	10%
R2 Gambel Oak	Frequent	208	140 - 275	634	33%
R2 Lodgepole Pine	Infrequent	328	242 - 415	1,983	17%
R2 Other Western Softwoods	Infrequent	143	86 - 200	439	33%
R2 Pinyon-Juniper	Infrequent	61	22 - 100	529	12%
R2 Ponderosa Pine	Frequent	-	-- -	1,579	-
R2 Spruce / Fir	Infrequent	794	662 - 926	5,182	15%
R3 Hardwoods	Infrequent	-	-- -	218	-
R3 Juniper Grass	Infrequent	92	46 - 139	444	21%
R3 Madrean Encinal Woodland	Frequent	167	106 - 229	873	19%
R3 Madrean Pinyon-Oak	Infrequent	232	160 - 305	939	25%
R3 Mixed Conifer -- Frequent Fire	Frequent	84	40 - 128	2,313	4%

Vegetation Type	Fire Regime	Old-growth Estimate (1,000 acres)	95% Confidence Interval (1,000 acres)	Total Vegetation Type Estimate (1,000 acres)	Percent of Vegetation Type as Old-growth
R3 Mixed Conifer w/ Aspen	Frequent	94	47 - 141	551	17%
R3 PJ Grass - Sagebrush	Frequent	780	647 - 912	3,108	25%
R3 PJ Shrub - Woodland	Infrequent	246	173 - 320	1,857	13%
R3 Ponderosa Pine	Frequent	189	126 - 252	3,430	6%
R3 Ponderosa Pine - Mixed	Frequent	160	100 - 220	728	22%
R3 Spruce - Fir	Infrequent	58	20 - 95	765	8%
R4 Aspen-Dry	Frequent	128	74 - 181	709	18%
R4 Aspen-Mesic	Frequent	295	214 - 376	1,333	22%
R4 Bristlecone / Limber / Whitebark Pines	Infrequent	60	24 - 97	560	11%
R4 Douglas fir	Frequent	335	251 - 420	4,084	8%
R4 Elm / ash / cottonwood	Infrequent	-	-- -	-	-
R4 Engelmann spruce	Infrequent	189	124 - 255	4,620	4%
R4 Lodgepole Pine	Infrequent	195	127 - 263	2,260	9%
R4 Pinyon Juniper NW - Others	Infrequent	508	406 - 610	3,964	13%
R4 Pinyon-Juniper-SE-High	Infrequent	-	-- -	267	0%
R4 Pinyon-Juniper-SE-Low	Infrequent	780	652 - 908	1,486	52%
R4 Ponderosa Pine	Frequent	137	82 - 192	954	14%
R5 Douglas-fir/Tanoak/Madrone	Frequent	66	28 - 105	352	19%
R5 Jeffrey Pine	Frequent	110	62 - 158	621	18%
R5 Mixed Conifer	Frequent	1,071	920 - 1223	6,575	16%
R5 Pacific Conifers	Frequent	59	24 - 94	721	8%
R5 Red Fir	Frequent	173	109 - 236	508	34%
R5 White Fir	Frequent	130	74 - 186	908	14%
R5 R6 Hardwoods	Frequent	-	-- -	3,012	-
R5 R6 Pinyon Juniper - Western Softwoods	Infrequent	82	38 - 126	1,551	5%
R6 Douglas-fir (eastside)	Frequent	306	258 - 355	1,454	21%
R6 Douglas-Fir (NWFP)	Frequent	165	125 - 206	1,024	16%
R6 Mountain Hemlock	Infrequent	952	827 - 1077	2,345	41%
R6 Ponderosa Pine - Lodgepole Pine	Infrequent	18	7 - 29	313	6%
R6 Ponderosa pine (very late decadent)	Frequent	181	148 - 215	2,357	8%
R6 Port Orford cedar - redwood	Frequent	26	10 - 41	84	30%
R6 Silver Fir	Infrequent	1,107	996 - 1218	2,668	41%
R6 Sitka Spruce	Infrequent	52	32 - 72	269	19%

Vegetation Type	Fire Regime	Old-growth Estimate (1,000 acres)	95% Confidence Interval (1,000 acres)	Total Vegetation Type Estimate (1,000 acres)	Percent of Vegetation Type as Old-growth
R6 Subalpine fir	Infrequent	436	363 - 509	1,334	33%
R6 Subalpine Fir - Engelmann Spruce	Infrequent	179	122 - 236	921	19%
R6 Tanoak	Frequent	115	81 - 149	454	25%
R6 Western hemlock	Infrequent	1,065	974 - 1156	3,571	30%
R6 White / Grand fir	Frequent	1,430	1317 - 1544	5,405	26%
R8 Conifer southern hardwood	Frequent	72	43 - 101	1,436	5%
R8 Longleaf pine	Frequent	145	103 - 187	716	20%
R8 Oaks	Frequent	822	726 - 917	4,925	17%
R8 Pines - Conifers	Frequent	37	13 - 61	4,006	1%
R8 southern hardwoods	Frequent	86	50 - 121	2,015	4%
R8 Wet and rain forest	Frequent	-	-- -	-	-
R9 Conifer northern hardwood	Frequent	23	9 - 36	395	6%
R9 northern hardwood	Infrequent	54	33 - 76	5,786	1%
R9 Northern pine	Frequent	56	34 - 79	1,188	5%
R9 oak	Frequent	73	49 - 97	2,747	3%
R9 Spruce / fir group	Infrequent	95	65 - 125	1,672	6%
R10 Black Spruce	Infrequent	-	-- -	-	-
R10 Mixed conifer	Infrequent	1,233	1088 - 1379	1,397	88%
R10 Mountain hemlock	Infrequent	1,695	1529 - 1861	2,118	80%
R10 Sitka Spruce - Alluvial	Infrequent	160	104 - 216	285	56%
R10 Sitka Spruce - Other	Infrequent	1,467	1316 - 1619	2,036	72%
R10 Western Hemlock - poorly drained	Infrequent	95	51 - 139	226	42%
R10 Western Hemlock - well drained	Infrequent	399	312 - 487	535	75%
R10 Western Hemlock / Alaska yellow cedar	Infrequent	262	189 - 335	323	81%
R10 Western Hemlock / western red cedar	Infrequent	391	305 - 476	555	70%
R10 White spruce	Infrequent	62	28 - 96	71	87%

Appendix 4. Maps

Two maps were developed for each region based on FIA plot data as outlined in the *Mature and Old-Growth Forests: Definition, Identification, and Initial Inventory on Lands Managed by the Forest Service and Bureau of Land Management* technical report (USDA and USDI 2023): (1) percent old-growth of total forested NFS land within a fireshed and (2) extent (acres) of old-growth within a fireshed. These maps do not include standard errors associated with the FIA estimates and any subsequent use of these products should refer to the tabular estimates included in the inventory report itself (USDA and USDI 2023: Appendix 3), as the application of FIA estimates for small areas (with few sample plots) can result in substantial uncertainty as indicated by large sampling error.

List of Maps

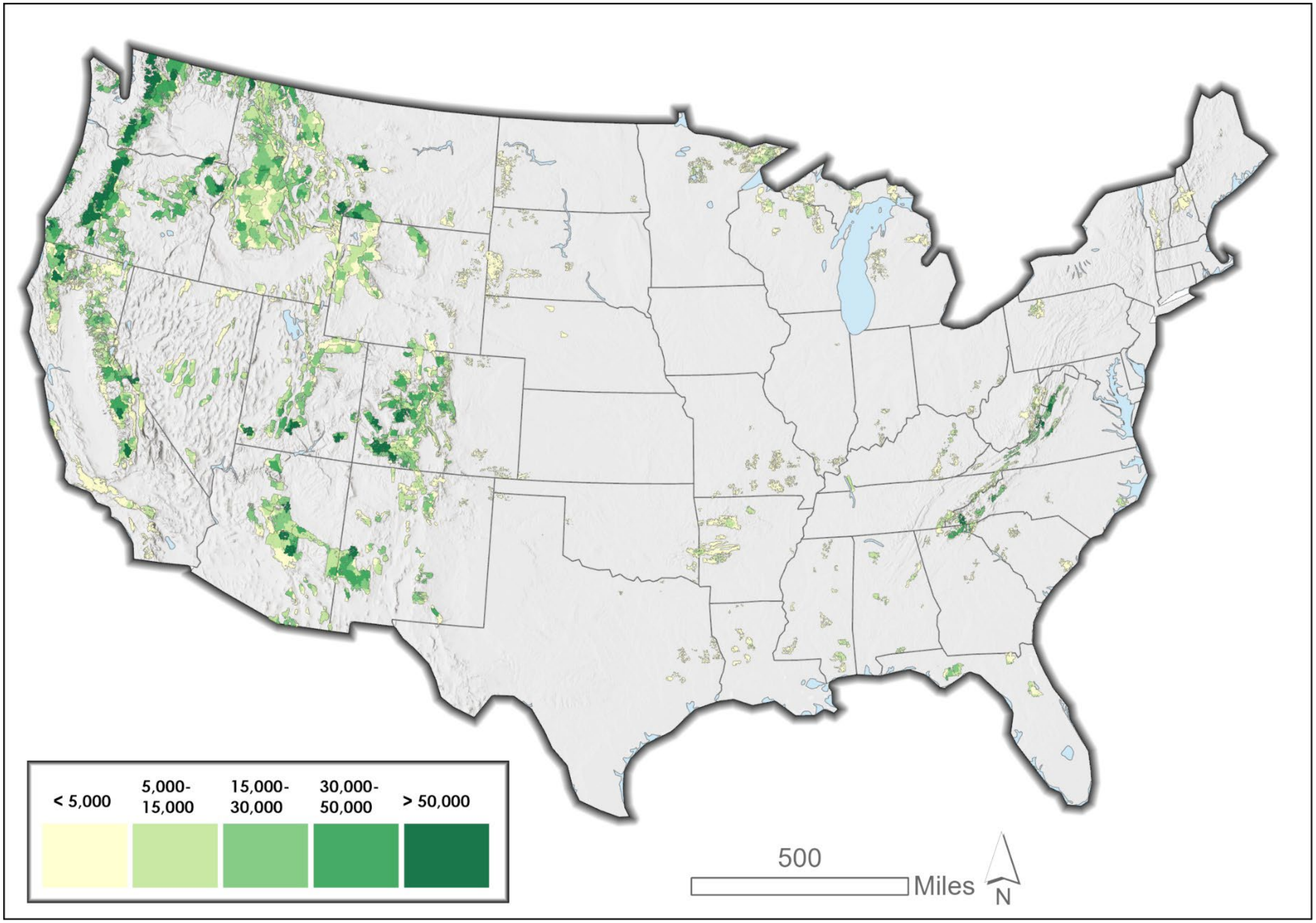

Figure 4-1. Area (acres) of old-growth in contiguous United States

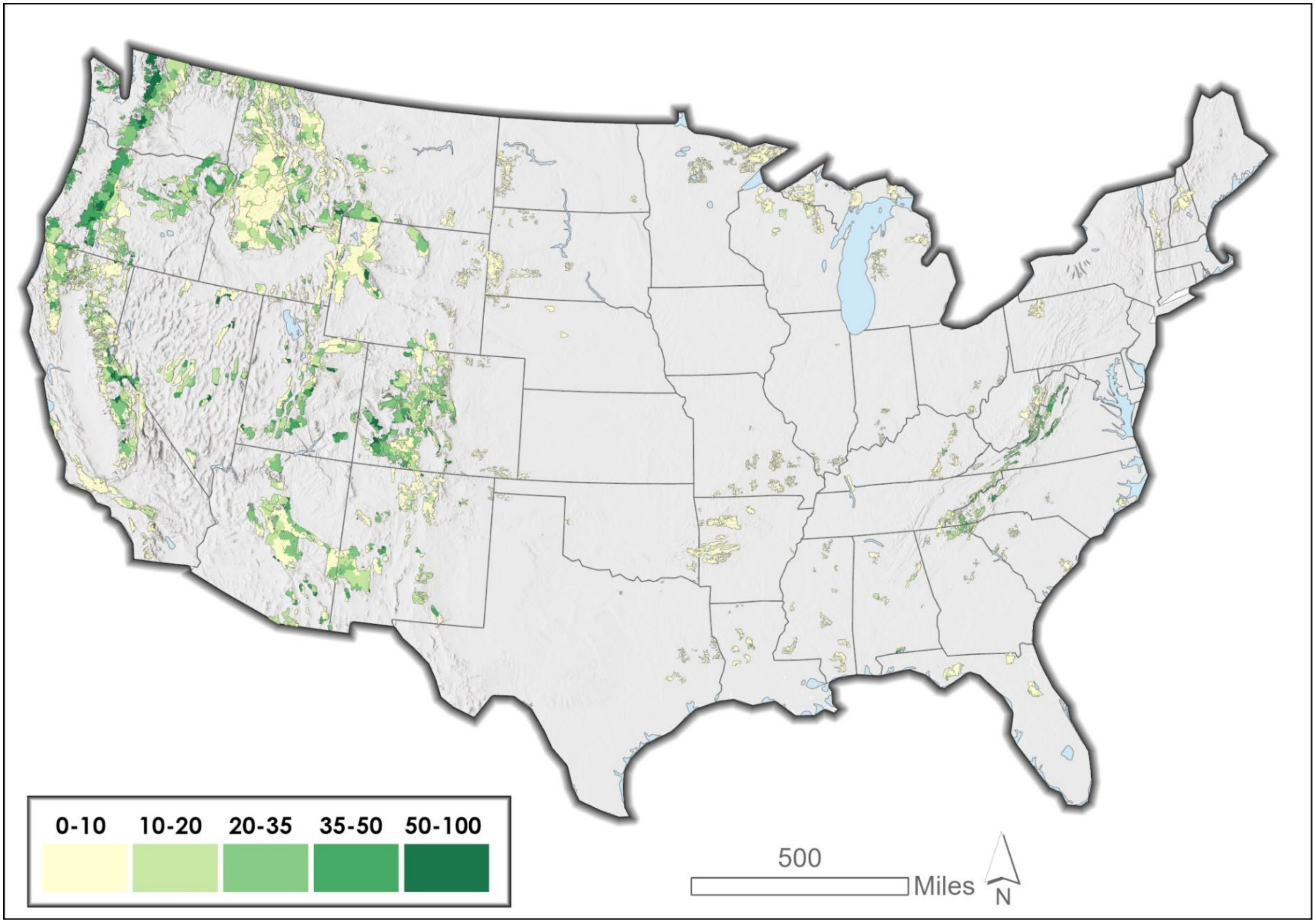

Figure 4-2. Percent of old-growth in contiguous United States

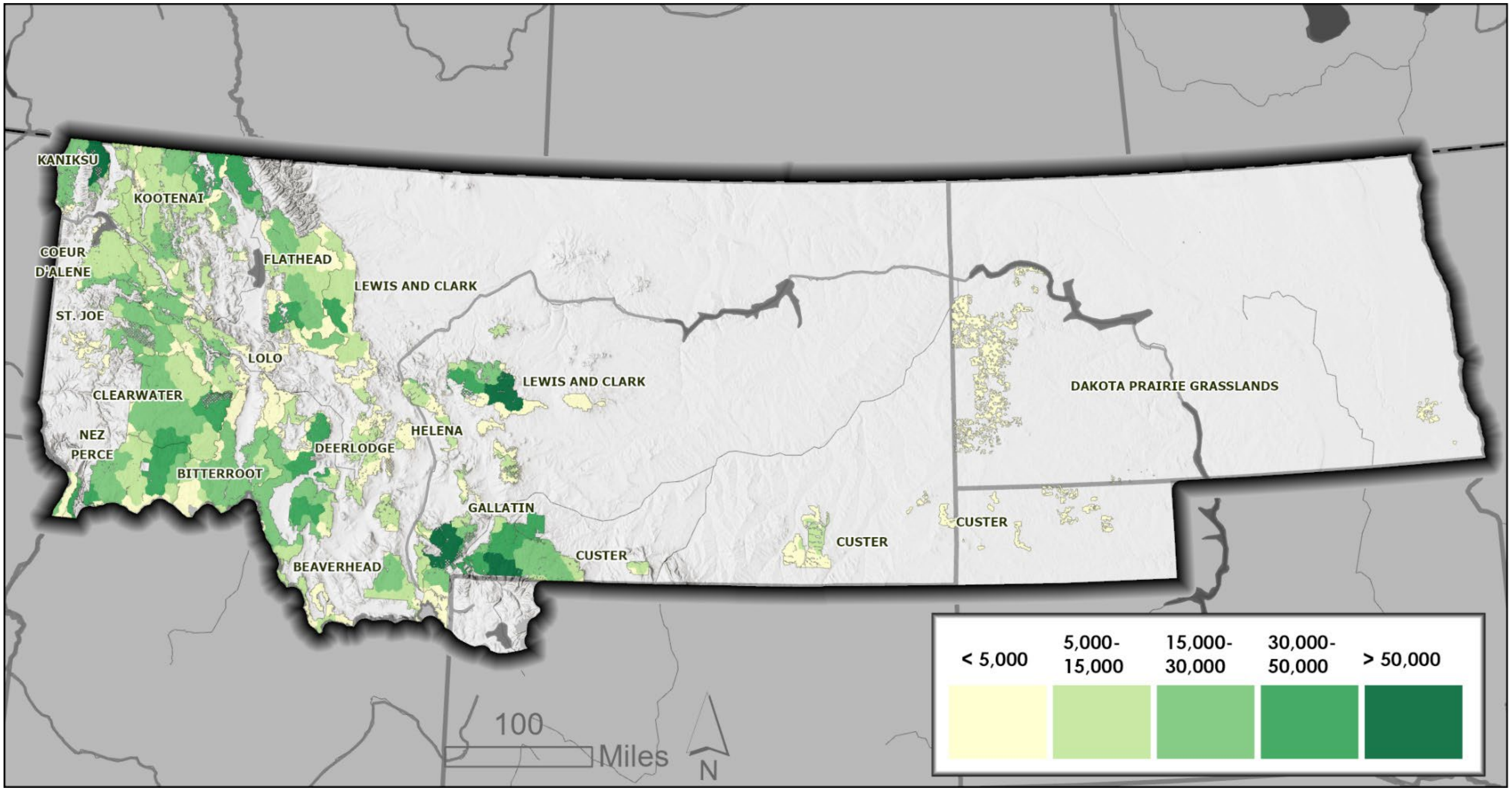

Figure 4-3. Area (acres) of old-growth in the Northern Region

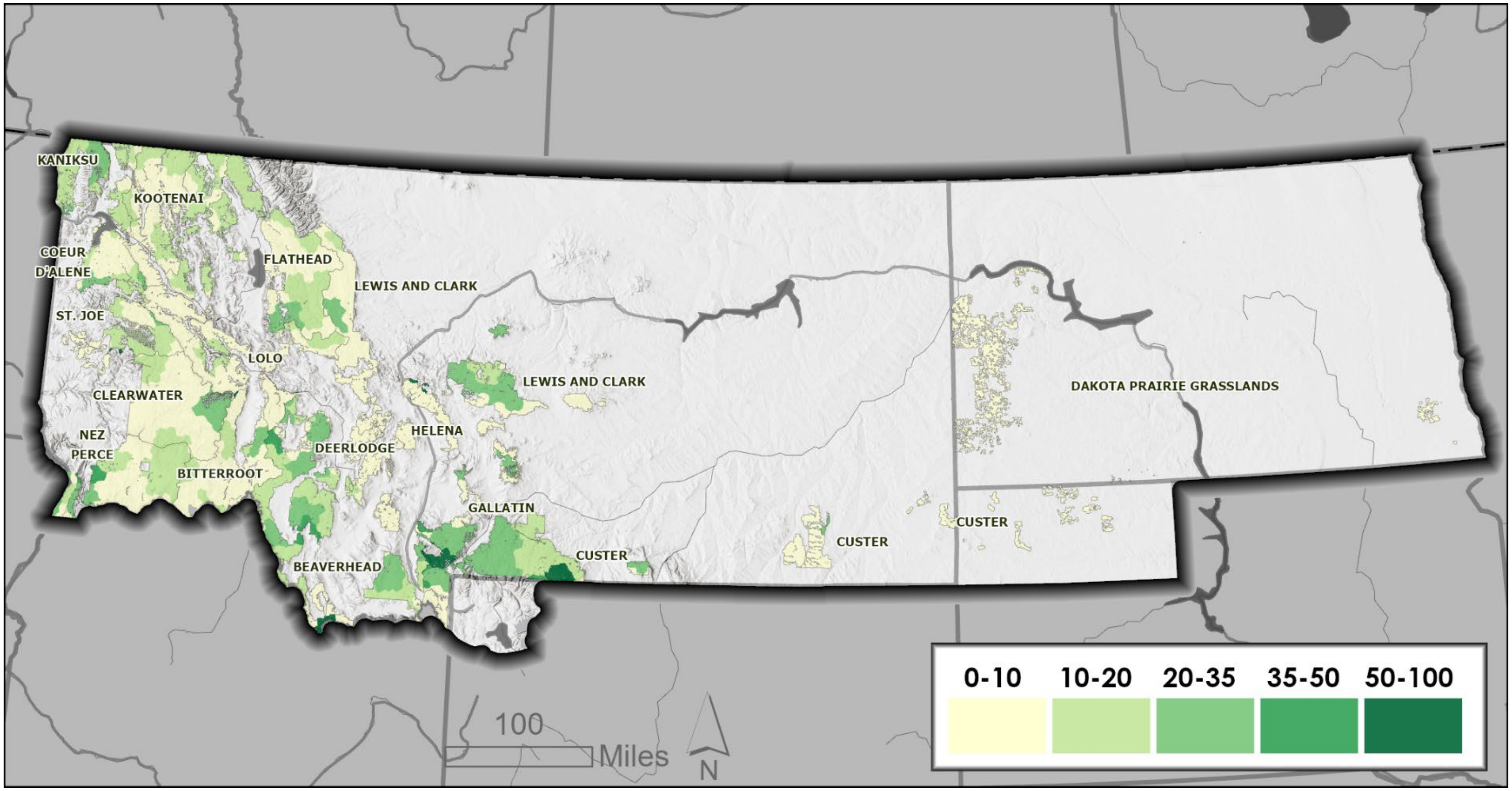

Figure 4-4. Percent of old-growth in the Northern Region

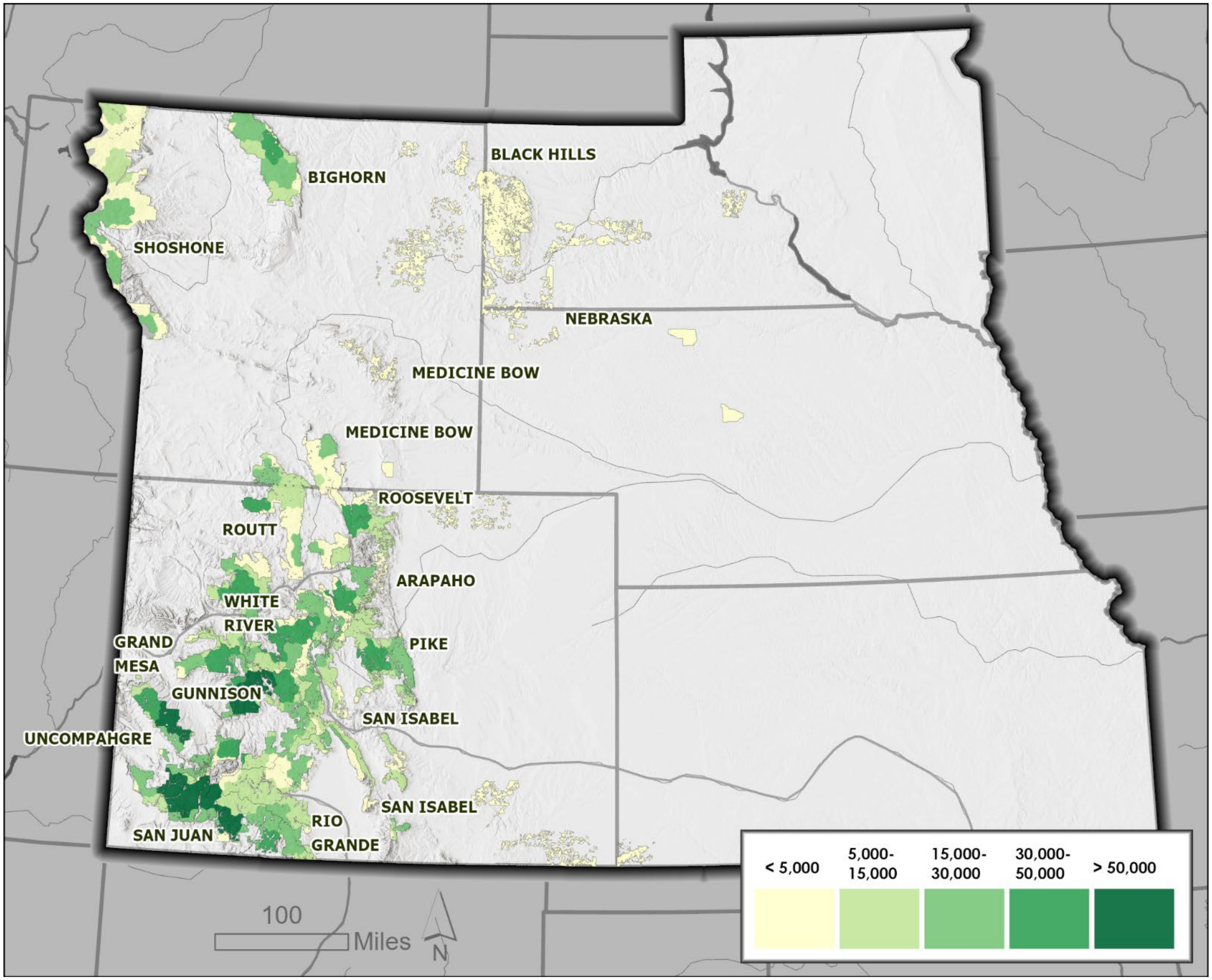

Figure 4-5. Area (acres) of old-growth in the Rocky Mountain Region

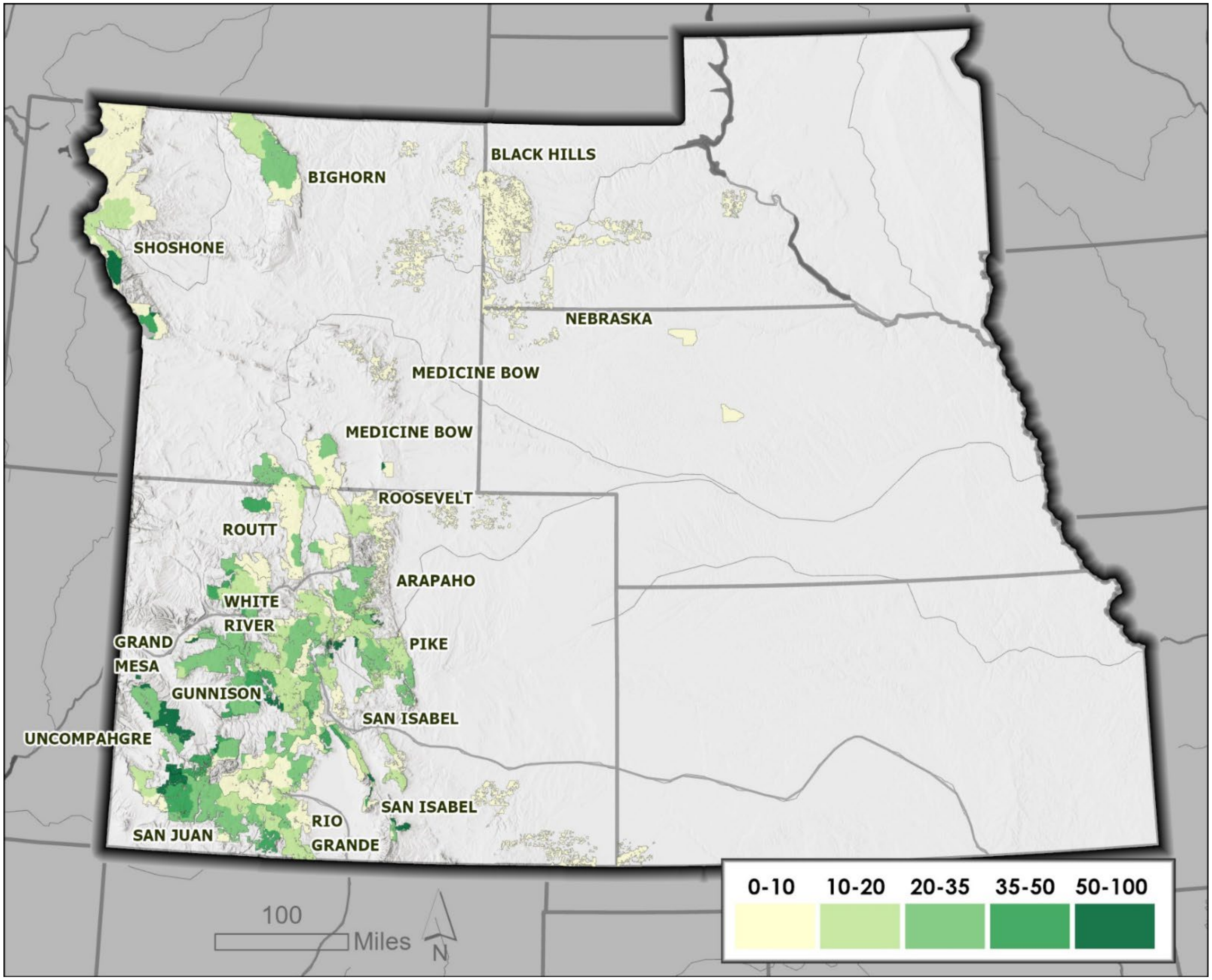

Figure 4-6. Percent of old-growth in the Rocky Mountain Region

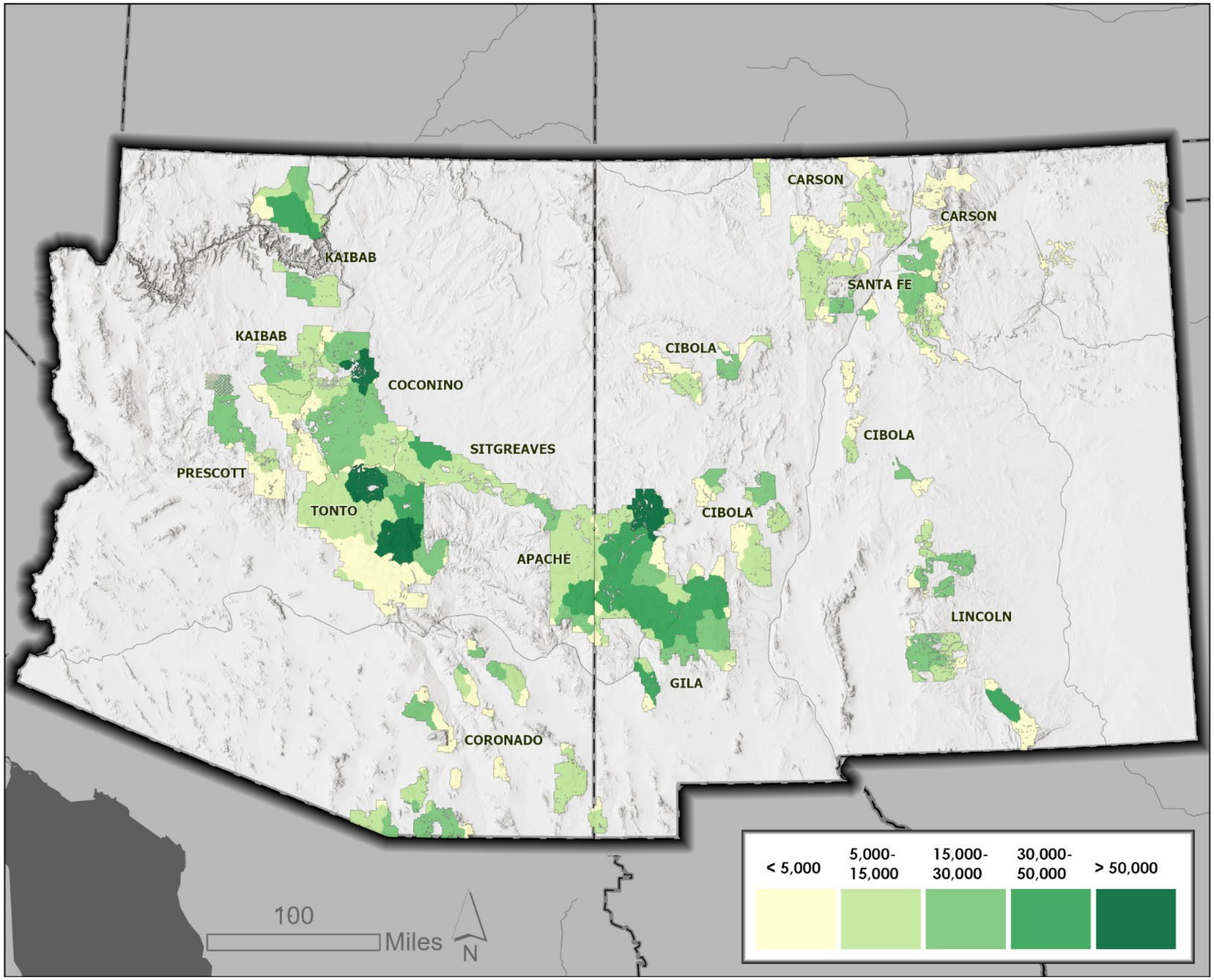

Figure 4-7. Area (acres) of old-growth in the Southwestern Region

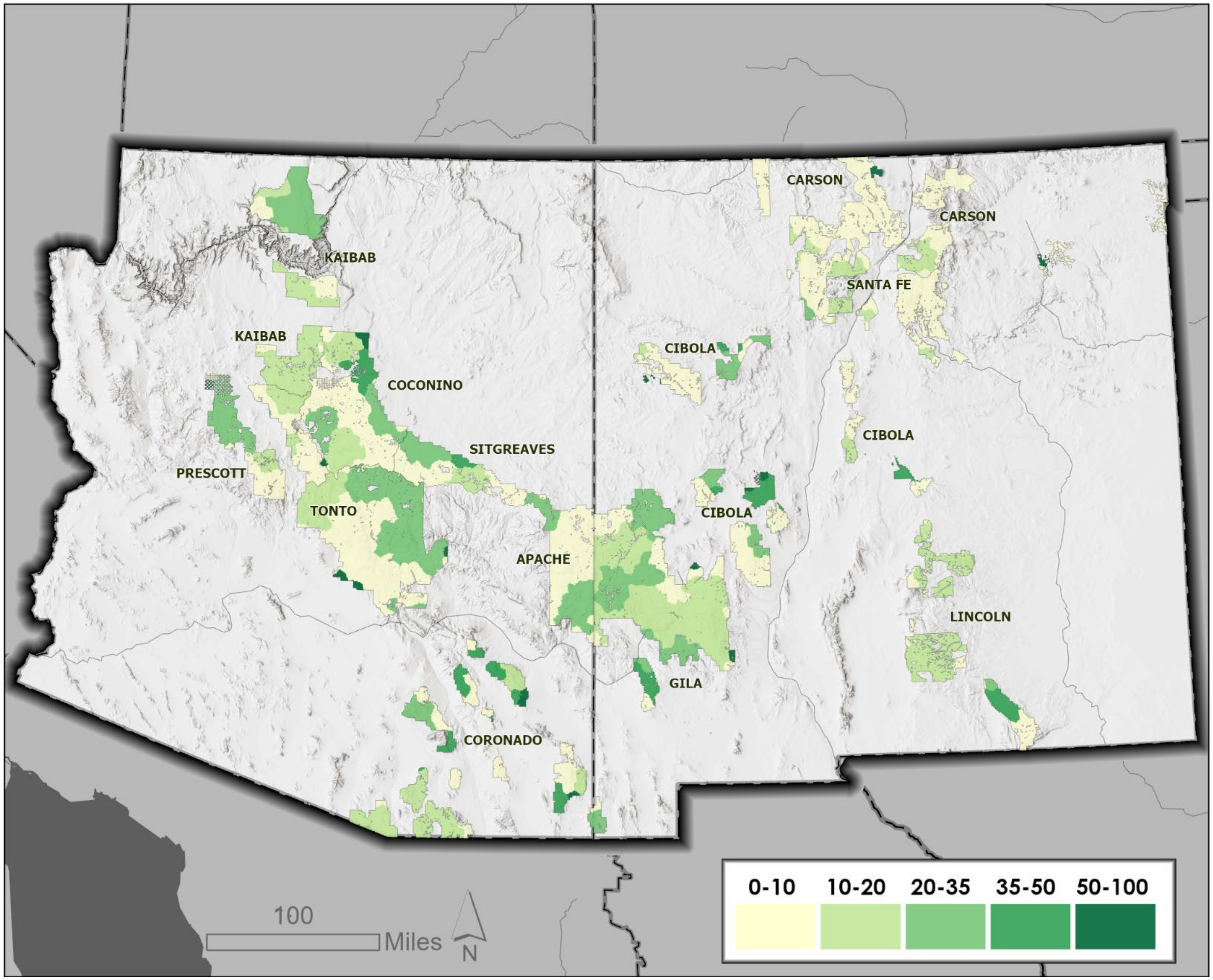

Figure 4-8. Percent of old-growth in the Southwestern Region

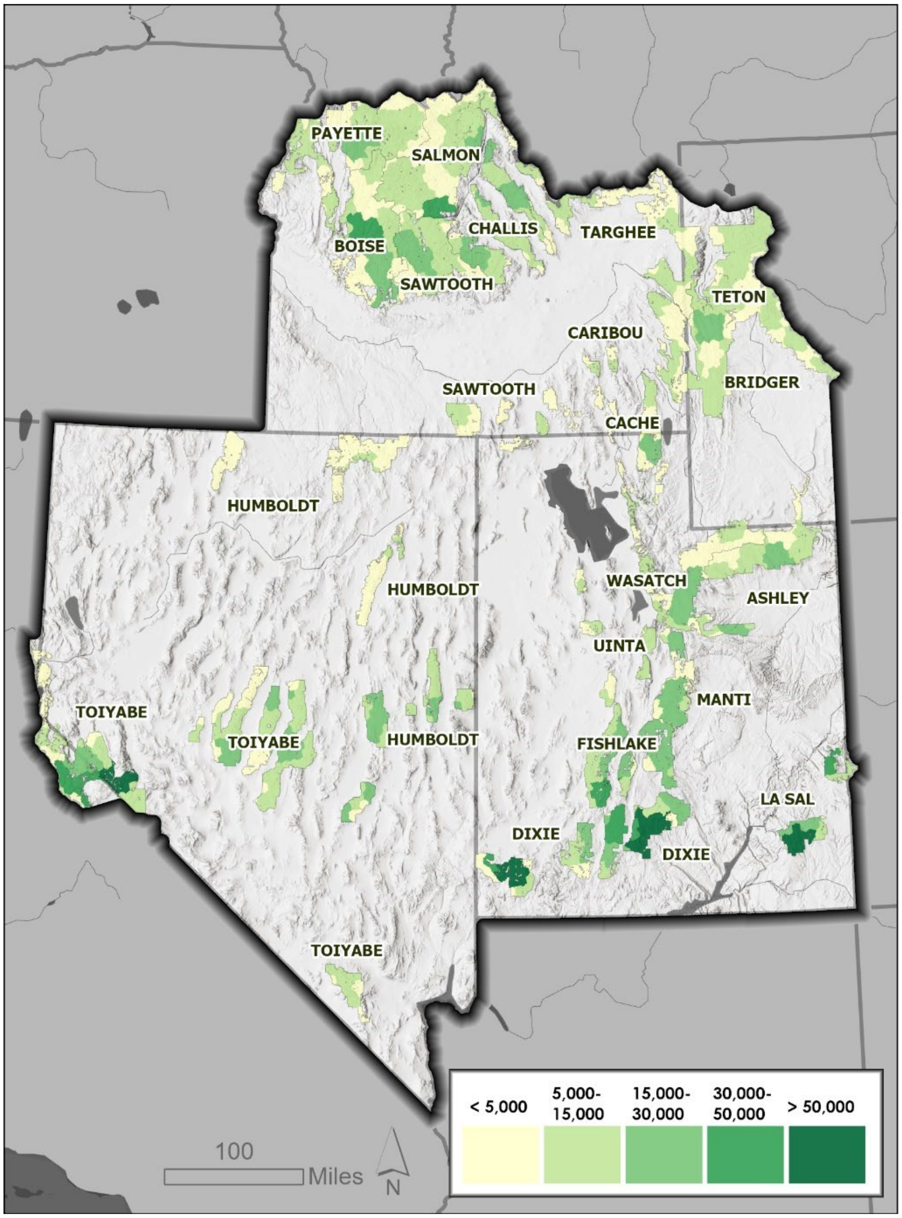

Figure 4-9. Area (acres) of old-growth in the Intermountain Region

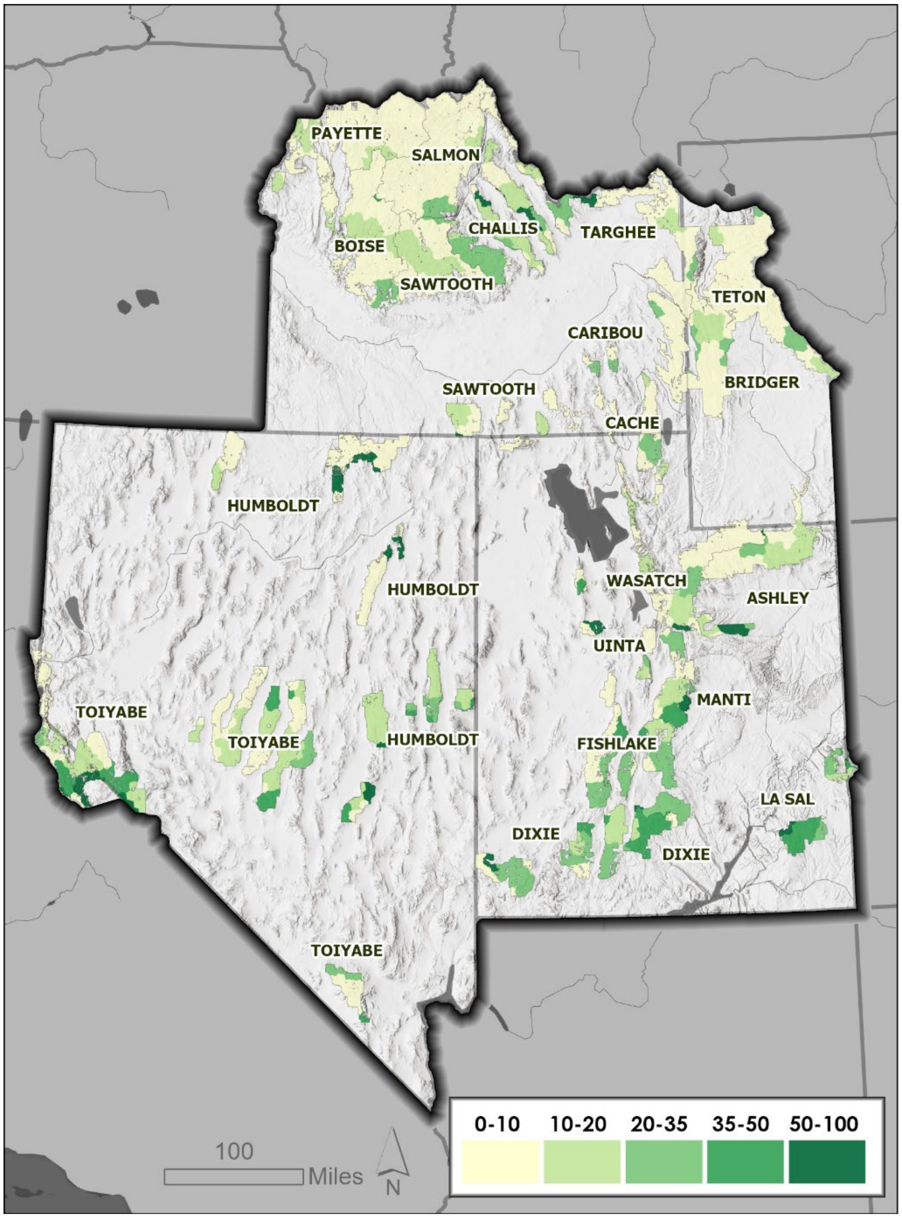

Figure 4-10. Percent of old-growth in the Intermountain Region

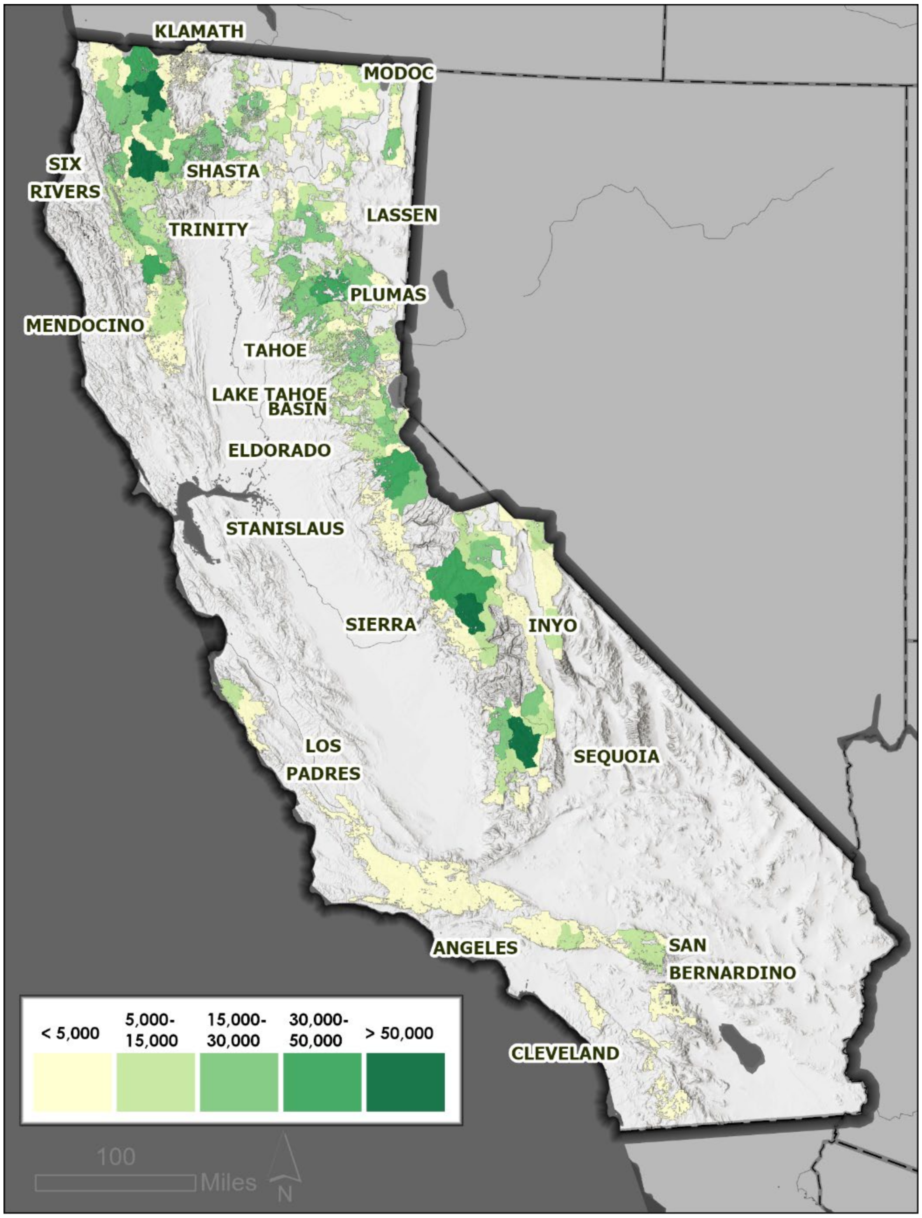

Figure 4-11. Area (acres) of old-growth in the Pacific Southwest Region

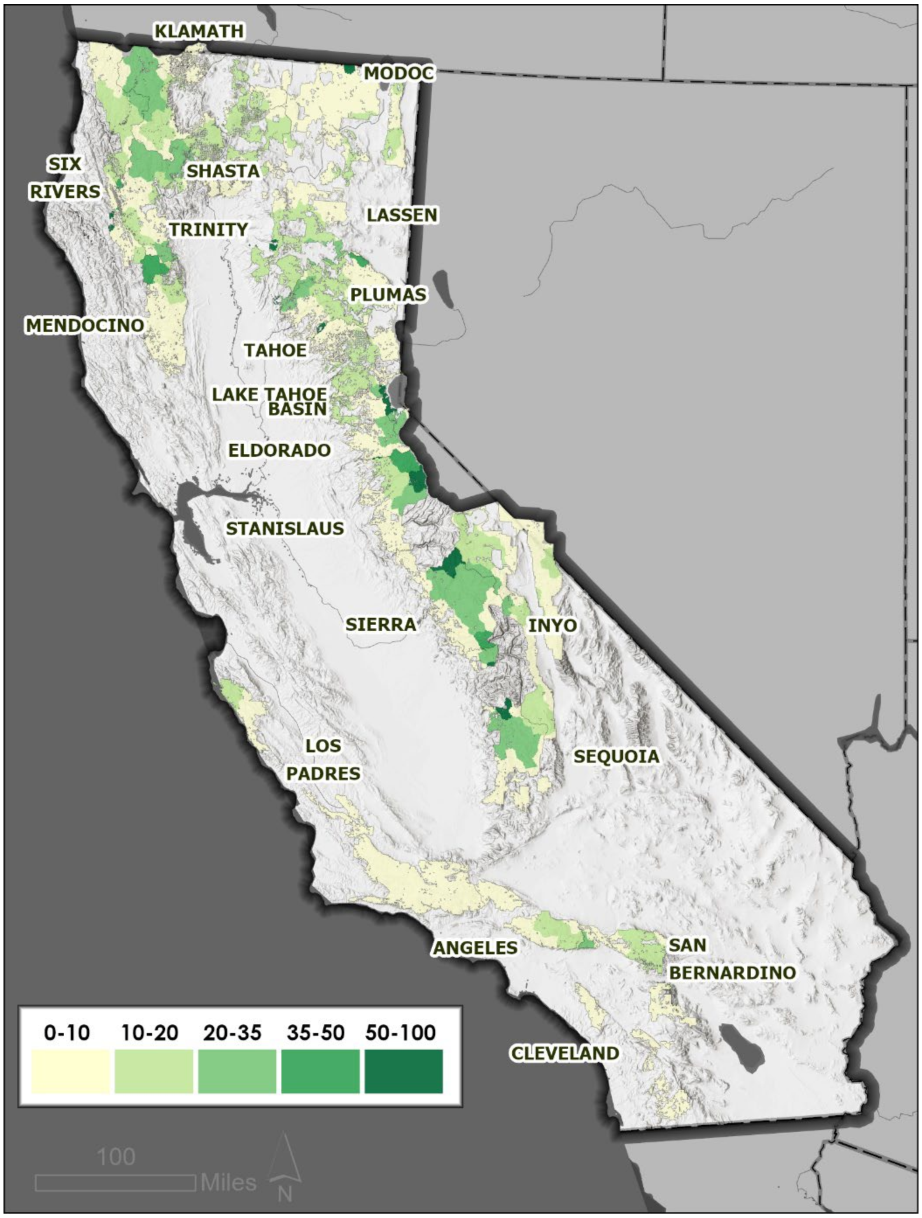

Figure 4-12. Percent of old-growth in the Pacific Southwest Region

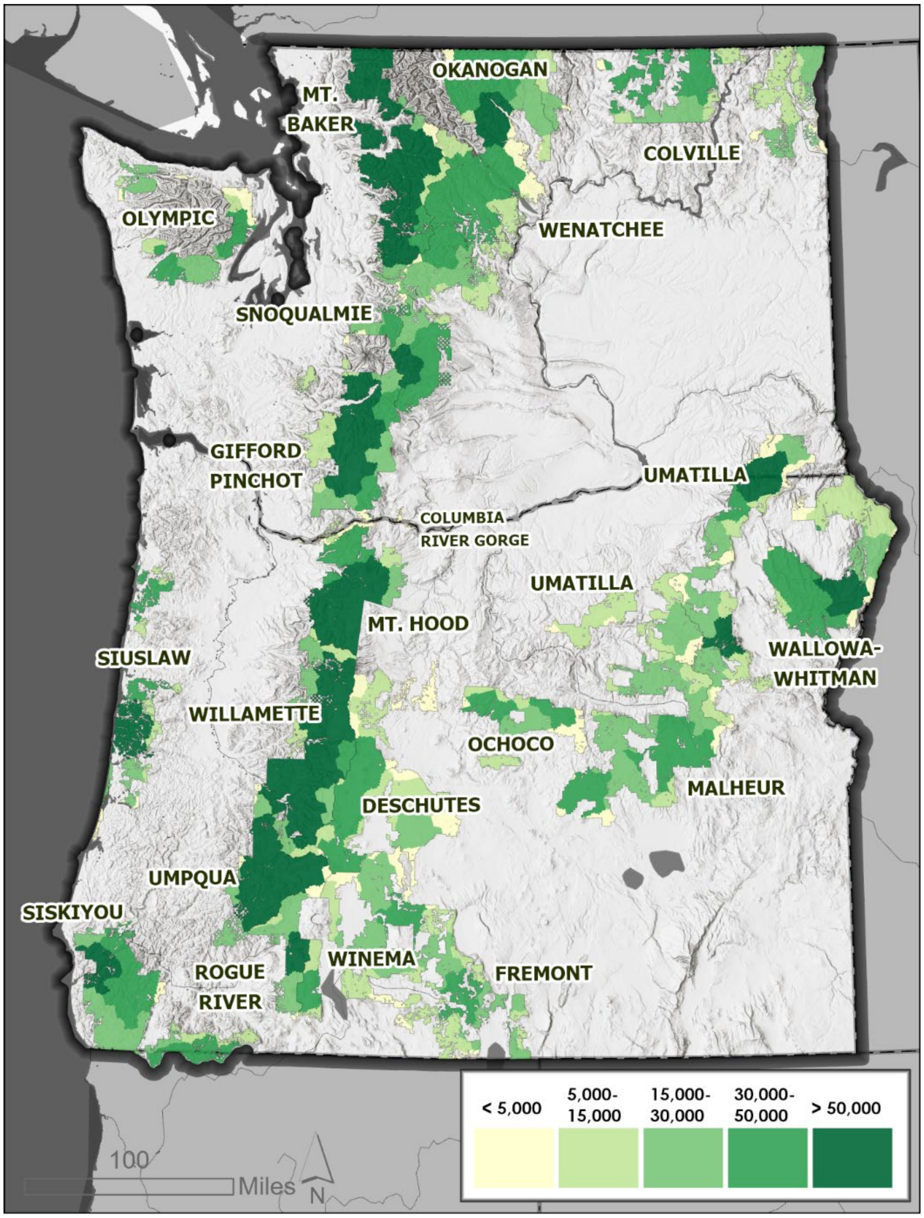

Figure 4-13. Area (acres) of old-growth in the Pacific Northwest Region

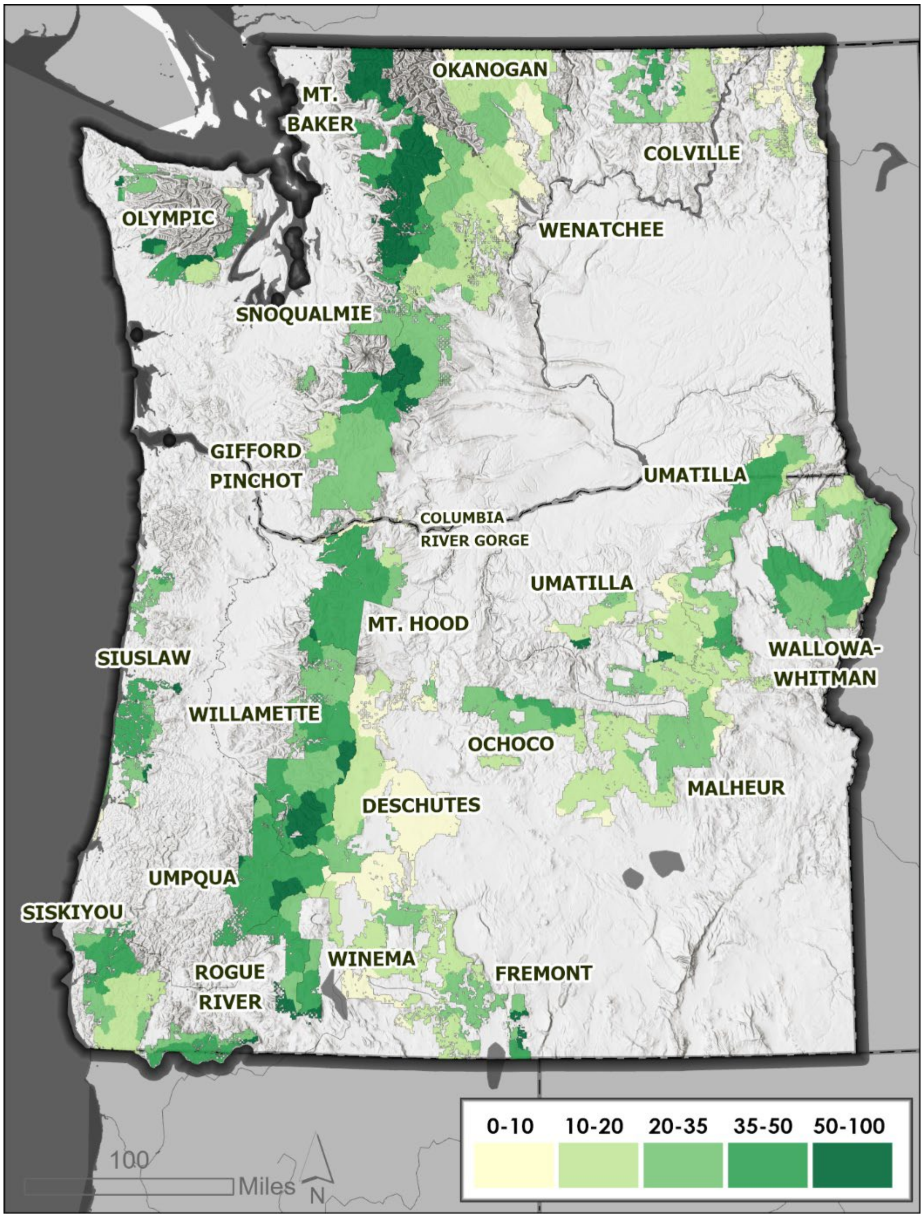

Figure 4-14. Percent of old-growth in the Pacific Northwest Region

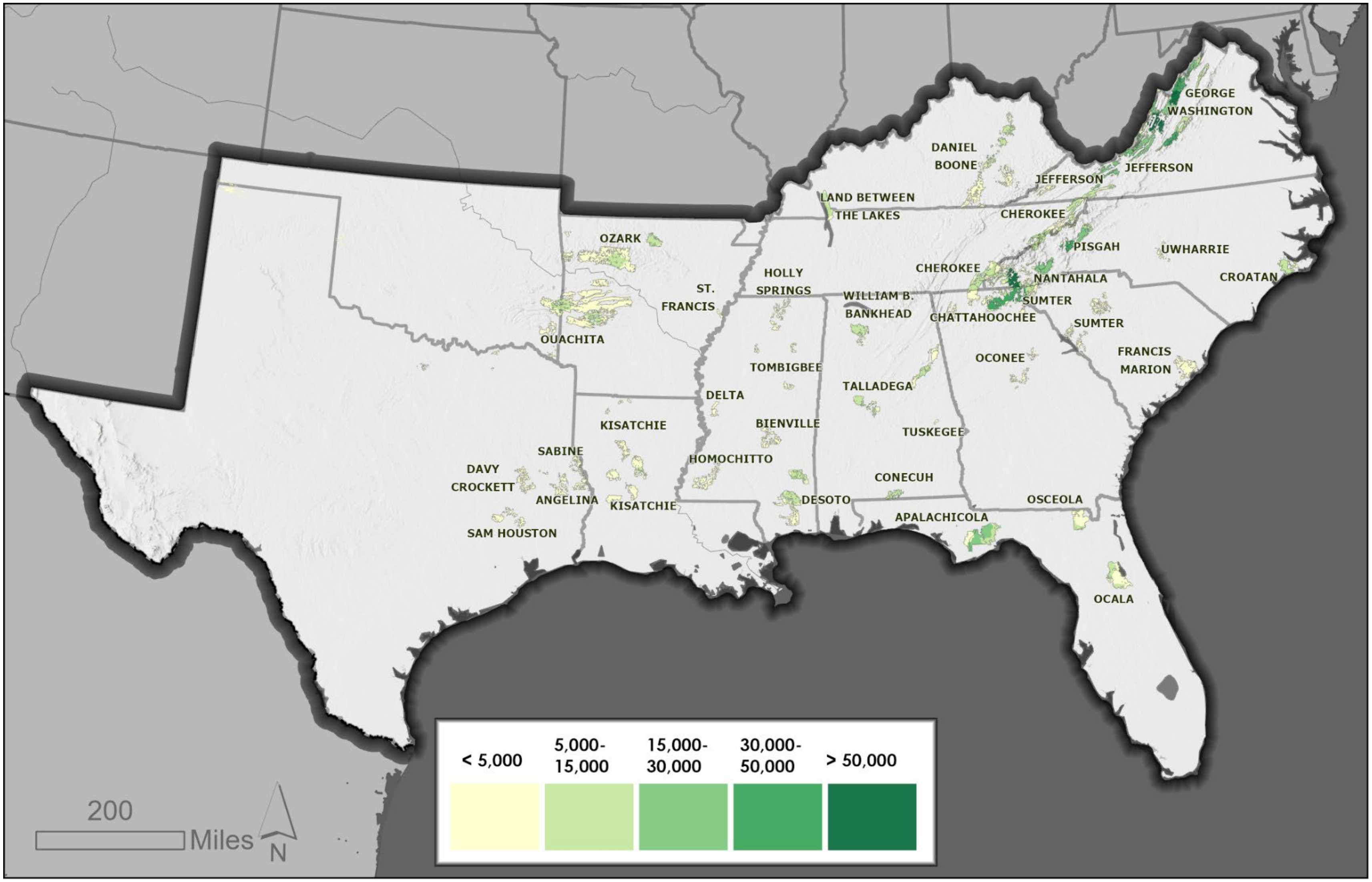

Figure 4-15. Area (acres) of old-growth in the Southern Region

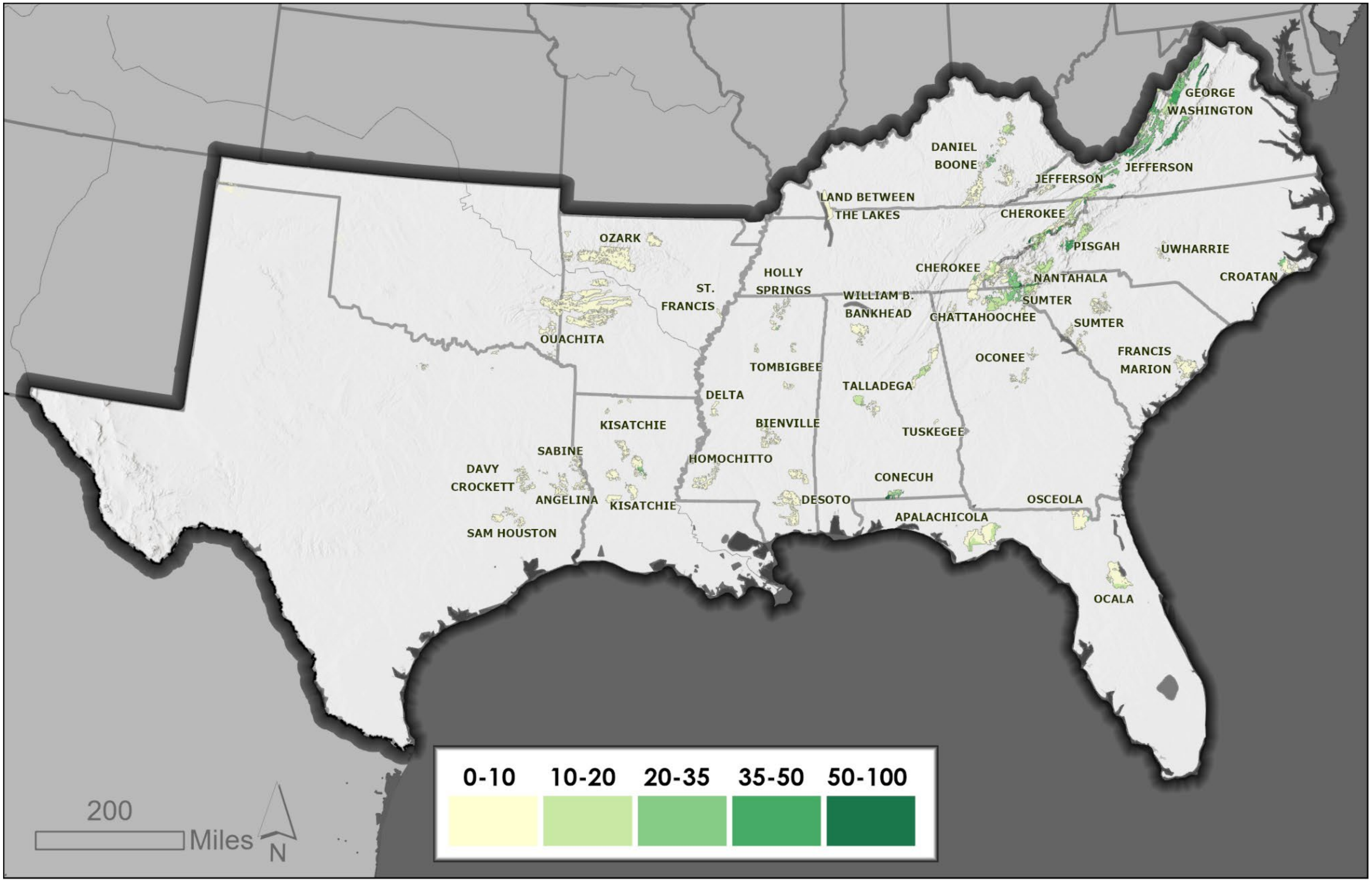

Figure 4-16. Percent of old-growth in the Southern Region

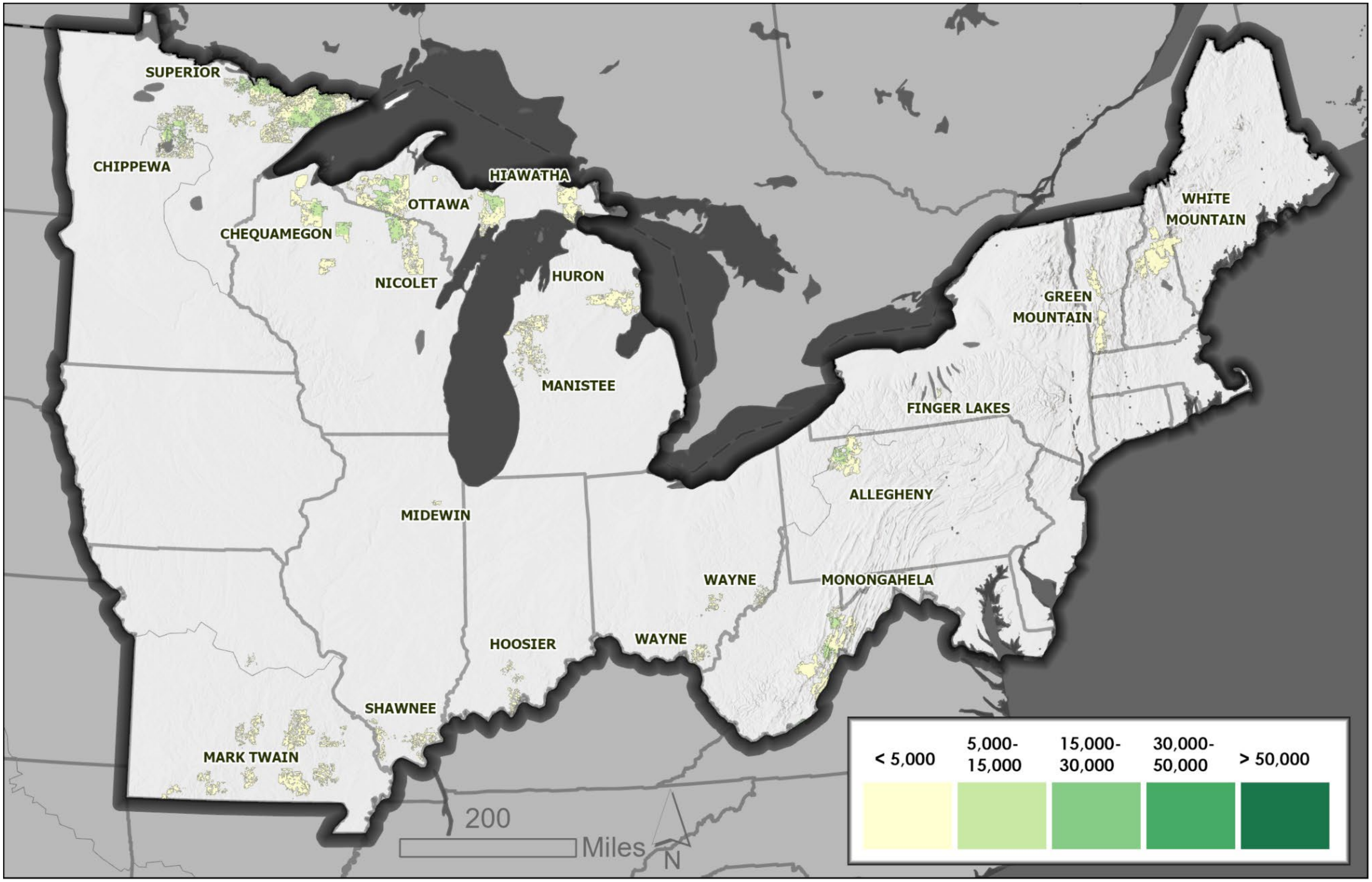

Figure 4-17. Area (acres) of old-growth in the Eastern Region

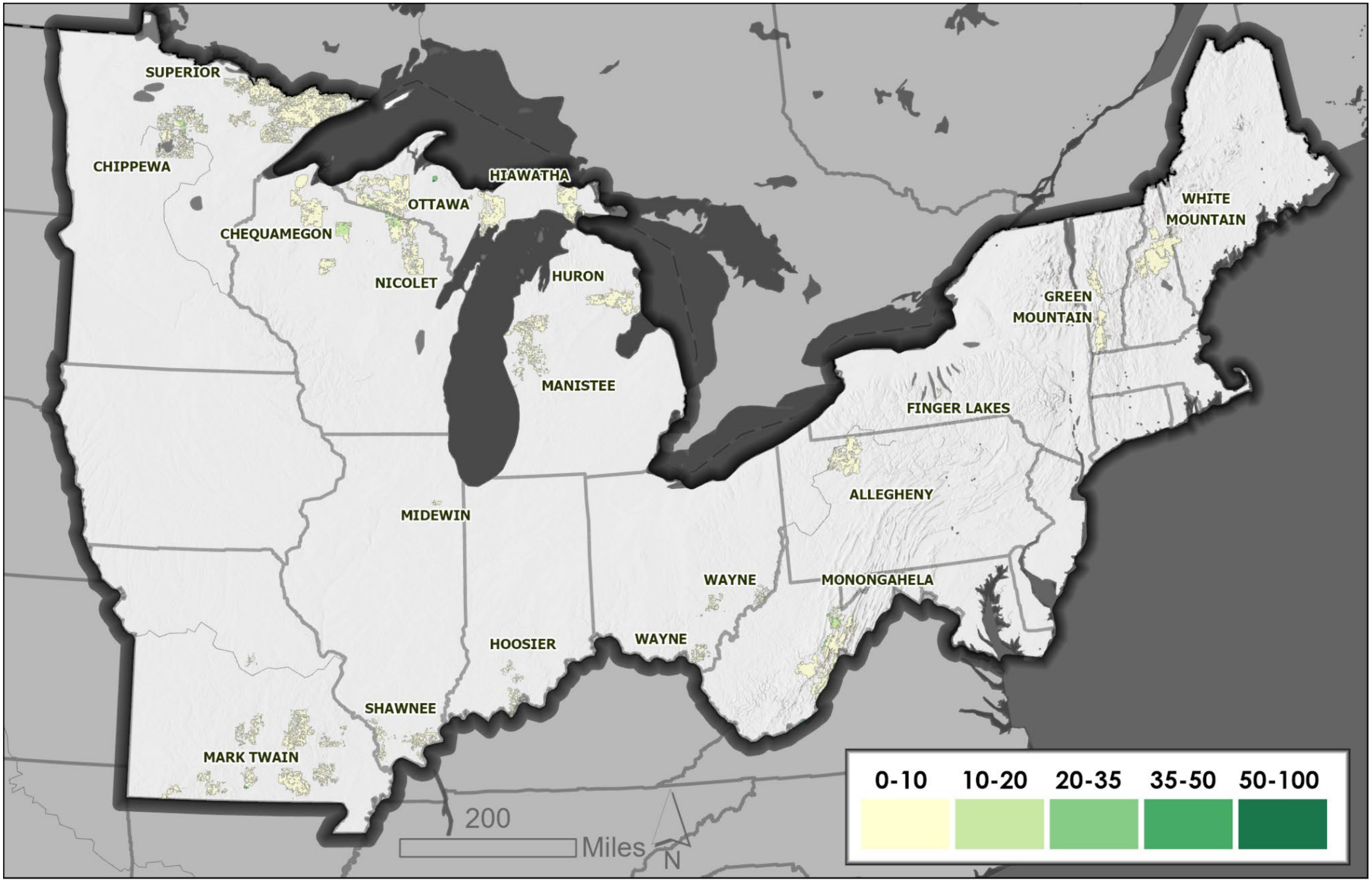

Figure 4-18. Percent of old-growth in the Eastern Region

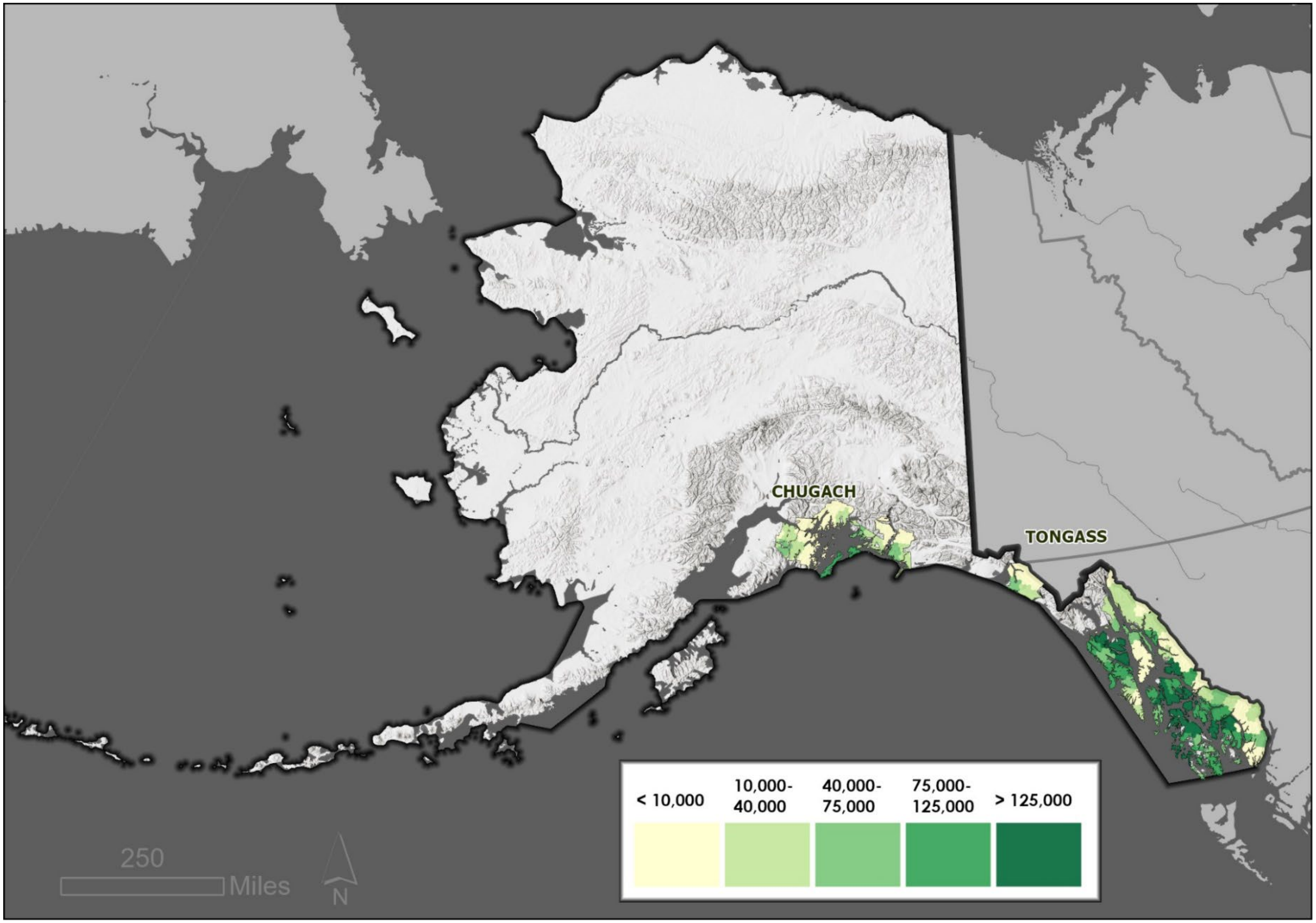

Figure 4-19. Area (acres) of old-growth in the Alaska Region

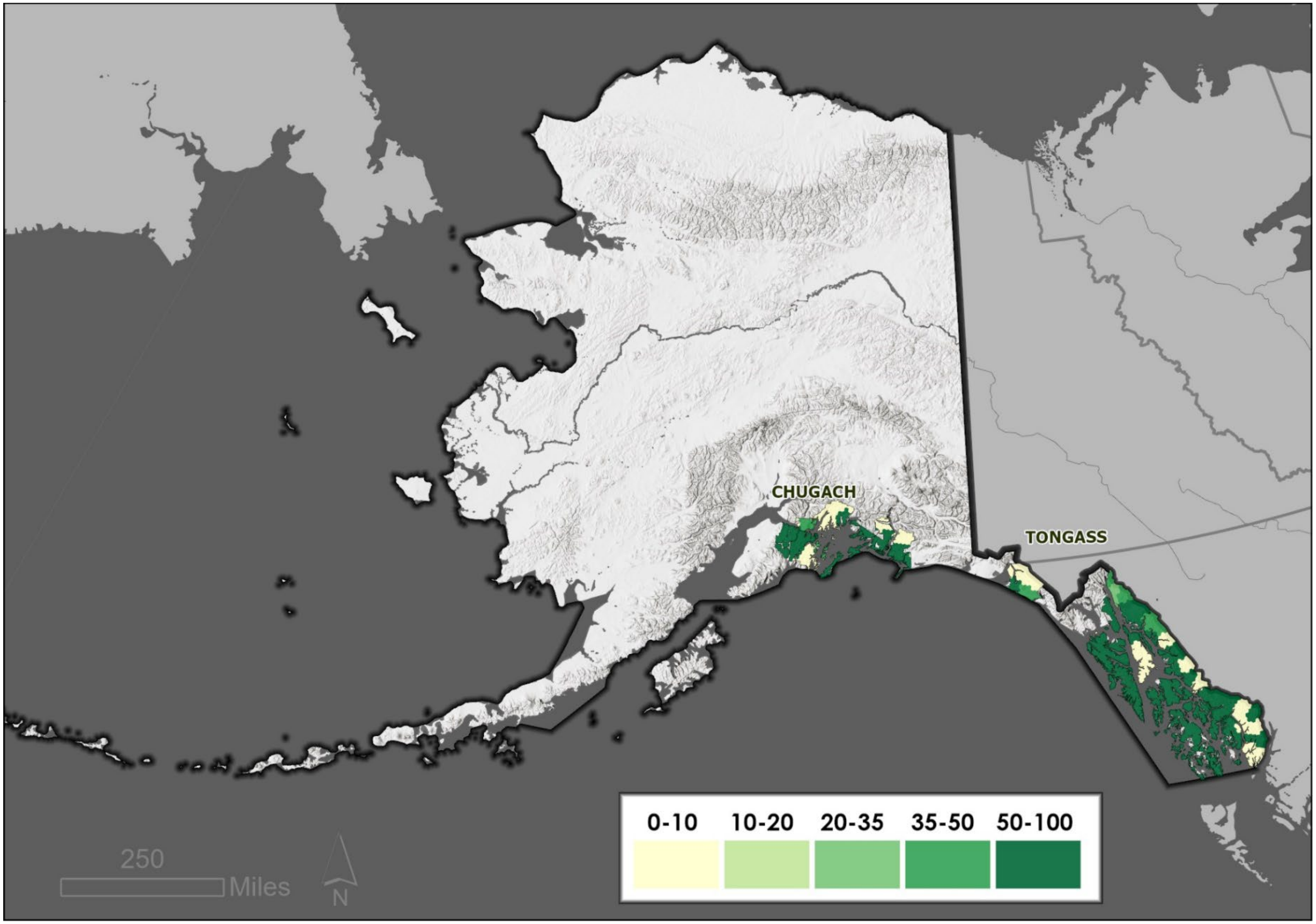

Figure 4-20. Percent of old-growth in the Alaska Region