Four Forest Restoration Initiative, Rim Country EIS

Silviculture Report

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for:

4FRI Rim Country EIS

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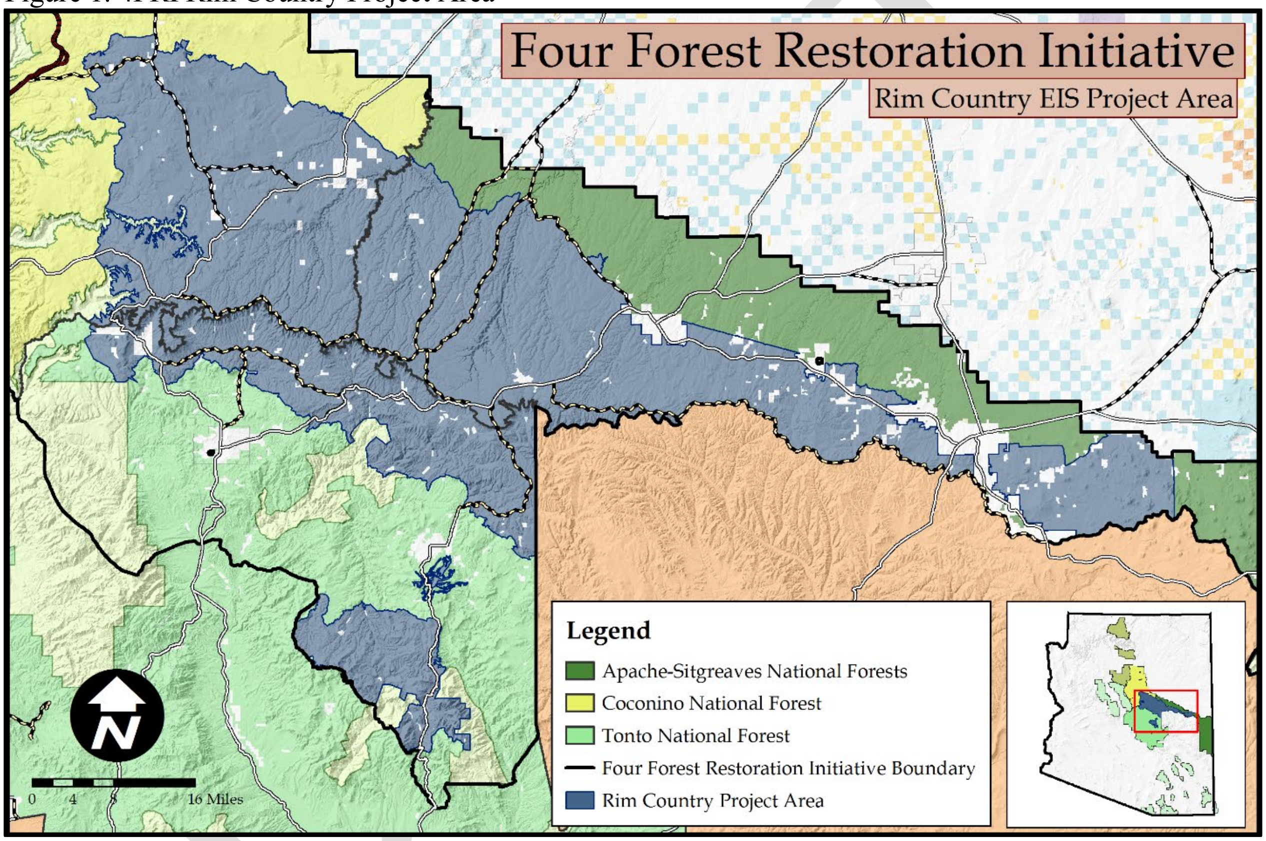
Introduction/Project Information

The Four Forest Restoration Initiative (4FRI) is a planning effort designed to restore forest resiliency and ecosystem function in ponderosa pine forests across four national forests in Arizona including the Coconino, Apache-Sitgreaves, and Tonto National Forests (Figure 1) and includes portions of Coconino, Yavapai, Gila, and Navajo Counties. The Rim Country Project EIS is an ecosystem restoration effort on about 1,238,658 acres on the Mogollon Rim and Red Rock Ranger Districts of the Coconino NF, the Black Mesa and Lakeside Districts of the Apache-Sitgreaves NF, and the Payson and Pleasant Valley Districts of the Tonto NF.

Figure 1. 4FRI Rim Country Project Area

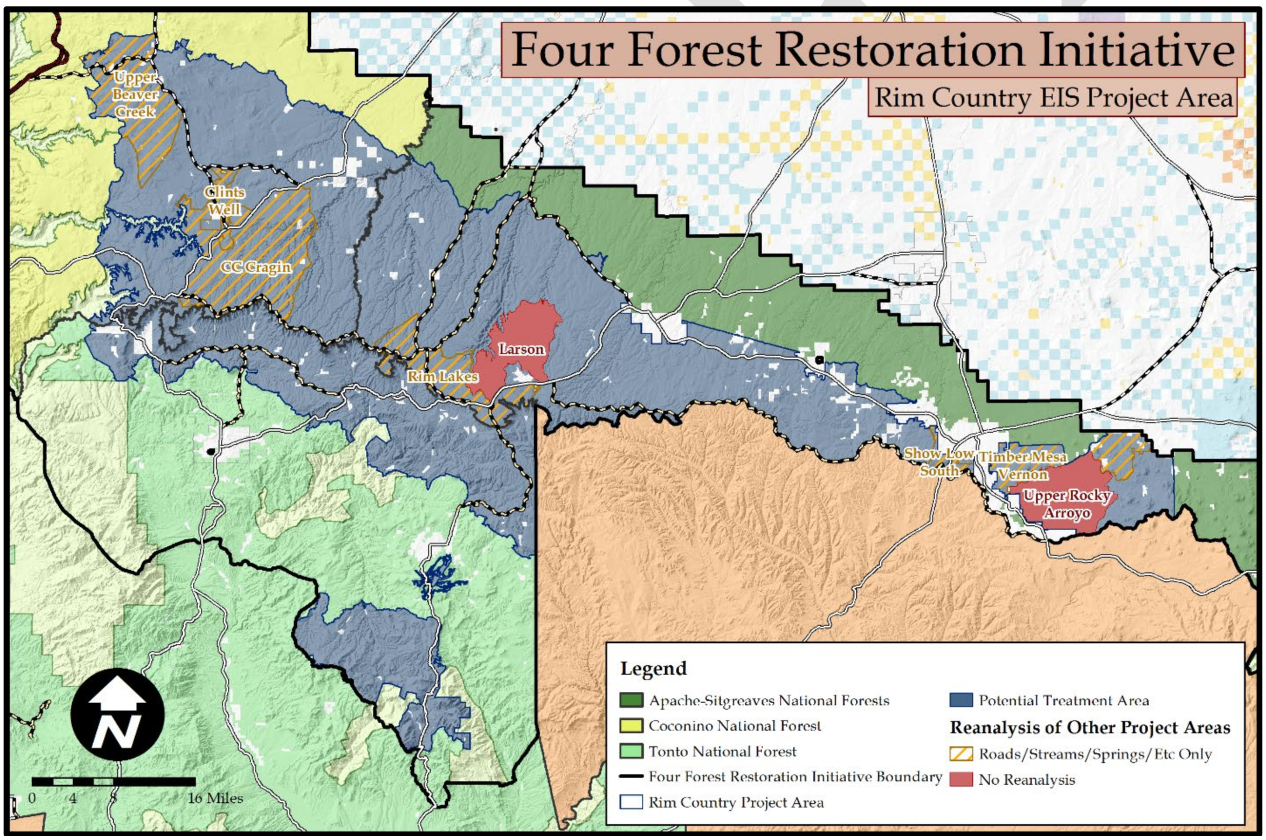


The cover types analyzed are limited to Aspen, Grassland/Meadow, Madrean Encinal Woodland, Madrean Pinyon-Oak, Mixed Conifer with Aspen, Mixed Conifer/ Frequent Fire, Pinyon-Juniper Woodland, Ponderosa Pine, and Ponderosa Pine/ Evergreen Oak and riparian for a total of 951,691 acres. For analysis purposes, the Madrean Encinal Woodland and Madrean Pinyon-Oak cover types will be combined into one category called Madrean Woodland due to limited acreage, data availability and similarity.

Of the 1,238,658 acres within the project area:

- Approximately 255,249 acres have been removed from this silvicultural analysis because they are part of an ongoing project or are being analyzed in a separate analysis (Figure 2). Silvicultural treatments and their effects within these areas will not be analyzed in this report.
- Approximately 30,263 acres are either non National Forest System lands, or are non-forested. The remaining 953,131 acres are identified by cover type and Forest in Table 7.
- An additional 1,141 of these acres identified as "Other" in Table 7 were determined to be either surface water, mineral pits, dams or road surface and will not be given a detailed description in this silvicultural analysis.
- The remaining 951,691 acres, considered the analysis area, will be analyzed in this report and are identified by forest in Table 3-1.

Figure 2. Other projects within the 4FRI Rim Country Project Area



The objective of the project is to restore forest structure, pattern, composition, diversity and landscape heterogeneity, within the Ponderosa Pine and Dry Mixed Conifer ecosystems that would lead to increased forest resiliency and function. The intent of the 4FRI project is to obtain a high level of vegetative responses that would increase ecosystem diversity by increasing horizontal and vertical heterogeneity. Restoration initiates or accelerates ecosystem recovery with respect to ecological health, integrity, and sustainability (R. T. Reynolds, Sanchez Meador, and others 2013). Resiliency increases the ability of the ponderosa pine and mixed conifer forests to survive natural disturbances such as insects, diseases, fire, and climate change (FSM 2020) without changing its inherent function (Society for Ecological Restoration International 2004). Restoration activities proposed with this project are expected to establish the project area on a trajectory towards comprehensive, landscape-scale restoration, with benefits that include improved vegetation horizontal and vertical biodiversity, wildlife habitat, soil productivity, and watershed function, as well as increased forest structure heterogeneity.

Silviculture is defined as the art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet diverse needs and values of landowners and society on a sustainable basis (Society of American Foresters 1998). Forest vegetation composition (tree, grass, herb, and shrub), density, structure, insects and diseases, such as bark beetles and dwarf mistletoes, are the primary forest conditions that can be affected by silvicultural systems. Stand composition can be altered with silvicultural treatments by manipulating a stand to create or enhance various stage conditions, including early seral.

The project was developed in consideration of the best available science. The best available science is a composite of the following key elements:

- On-site data through the Common Stand Exam collected data and history
- Scientific literature
- Professional knowledge, judgment and experience. The primary specialist who conducted the vegetation management analysis was Patrick T. Moore. The analysis has been reviewed by resource peers. The collective professional knowledge of the project area, judgment of how to integrate science with local conditions, and the experience gained from implementation of other projects have been incorporated into the analysis
- Modeling using currently acceptable analysis statistical techniques and software. The vegetation management was analyzed using the most current versions of software developed by the Forest Service Natural Resource Manager (http://www.fs.fed.us/nrm/index.shtml):

    a. FSVeg – Field Sampled Vegetation - stores data about trees, fuels, down woody material, surface cover, and understory vegetation. FSVeg supports the business of common stand exam, fuels data collection, permanent grid inventories, and other vegetation inventory collection processes.

    b. FSVeg Spatial – stores the vegetation polygons and Common Stand Exam plot locations for a forest. Summary vegetation attributes describing the stands are stored in associated attribute tables. Linkage to exams in FSVeg are maintained so as to support GIS based vegetation analysis.

    c. FSVeg Data Analyzer – designed to assist with landscape and NEPA analysis for a project area of any size. Users create alternatives and compare them through built in visualizer tools. Users assign FVS and FACTS activities via GIS to features within the project area to define alternative scenarios. For stands that have stand exams, the FVS growth simulator is used to model changes over time. Nearest Neighbor imputation can be used to fill in data gaps within the stand exam dataset. This set of tools is paired with FSVeg Spatial to allow the display of FVS data in a spatial format.

    d. Inventory and Mapping – maps Terrestrial Ecological Units, non-NASIS Soils and Potential Natural Vegetation (PNVT), mapping, characterization, interpretation, and classification of terrestrial natural resources. Specifically supporting Terrestrial Ecological Unit Inventory (TEUI) project work, and inventories for Geology, Soils, and Potential Natural Vegetation.

e. Forest Vegetation Simulator - (FVS) - a family of forest growth simulation models. It is a system of highly integrated analytical tools that is based upon a body of scientific knowledge developed from decades of natural resources research and experience.

Purpose and Need for Action

The purpose and need for the Rim Country Project EIS was determined by comparing the existing conditions in the project area to the desired conditions in the land and resource management plans (forest plans) related to forest and ecosystem function and resiliency. In addition, relevant research, the best available science and information, and the landscape restoration criteria found in the Omnibus Public Land Management Act of 2009 (P.L. 111-11, Title IV Forest Landscape Restoration) were used to develop the purpose and need. These criteria for landscape-scale restoration address community, wildlife habitat, and forest protection while retaining as many large trees as possible.

The purpose of the Rim Country Project is to reestablish and restore forest structure and pattern, forest health, and vegetation composition and diversity in ponderosa pine ecosystems to conditions within the natural range of variation, thus moving the project area toward the desired conditions. The outcome of improving structure and function is increased ecosystem resiliency. Resiliency increases the ability of an ecosystem to survive natural disturbances such as fire, insects and disease, and climate change (FSM 2020) without changing its inherent function (Society for Ecological Restoration International 2004). This project is needed to:

- Increase forest resiliency and sustainability
- Reduce risk of undesirable fire effects
- Improve terrestrial and aquatic species habitat
- Improve the condition and function of streams and springs
- Restore woody riparian vegetation
- Preserve cultural resources
- Support sustainable forest products industries.

The need for proposing this action was determined by comparing the Desired Conditions from the Apache-Sitgreaves NF Land Management Plan (USDA 2015), the Coconino NF Land and Resource Management Plan (Agriculture 2018), and the Tonto NF Plan (USDA 1985 (2011)), hereafter referred to as the Forest Plans, to the existing conditions and illustrating the need for change.

Relevant Law, Regulation, and Policy

The principal statutes governing the management and restoration of National Forest System lands include, but are not limited to, the following statutes. Except where specifically stated, these statutes apply to all National Forest System lands and resources.

1. Organic Administration Act of 1897 (at 16 U.S.C. 475, 551). States the purpose of the national forests, and directs their control and administration to be in accord with such purpose, that is, "[n]o national forest shall be established, except to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States." Authorizes the Secretary of Agriculture to "make such rules and regulations . . . to preserve the forests [of such reservations] from destruction."

2. Weeks Law of 1911, as amended (at 16 U.S.C. 515, 552). Authorizes the Secretary of Agriculture to enter into agreements with States for the purpose of conserving forests and water supply, and, to acquire forested, cutover, or denuded lands within the watersheds of navigable streams to protect the flow of these streams or for the production of timber, with the consent of the State in which the land lies.

3. Knutson-Vandenberg Act of 1930 (16 U.S.C. at 576b). Specifies that the Secretary may require any purchaser of national forest timber to make deposits of money in addition to the payments for the timber, to cover the cost to the United States of planting, sowing with tree seeds, and cutting, destroying or otherwise removing undesirable trees or other growth, on the national forest land cut over by the purchaser, in order to improve the future stand of timber, or protecting and improving the future productivity of the renewable resources of the forest land on such sale area.

4. Anderson-Mansfield Reforestation and Revegetation Joint Resolution Act of 1949 (at 16 U.S.C. 581j and 581 j(note)). States the policy of the Congress to accelerate and provide a continuing basis for the needed reforestation and revegetation of national forest lands and other lands under Forest Service administration or control, for the purpose of obtaining stated benefits (timber, forage, watershed protection, and benefits to local communities) from the national forests.

5. Granger-Thye Act of 1950 (16 U.S.C. at 580g-h). Authorizes the Secretary to use a portion of grazing fees for range improvement projects on NFS lands. Specific types of projects mentioned are artificial revegetation, including the collection or purchase of necessary seed and eradication of poisonous plants and noxious weeds, in order to protect or improve the future productivity of the range. Section 11 of the act authorizes the use of funds for rangeland improvement projects outside of NFS lands under certain circumstances.

6. Surface Resources Act of 1955 (30 U.S.C. 611-614). Authorizes the Secretary of Agriculture to manage the surface resources of unpatented mining claims located under the authority of the 1872 Mining Law as amended, including, but not limited to, reclamation of disturbance caused by locatable mineral activities.

7. Sikes Act (Fish and Wildlife Conservation) of September 15, 1960 (16 U.S.C. at 670g). Section 201 directs the Secretary of Agriculture, in cooperation with State agencies, to plan, develop, maintain, coordinate, and implement programs for the conservation and rehabilitation of wildlife, fish and game species, including specific habitat improvement projects, and shall implement such projects on public land under their jurisdiction.

8. Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528-531). States that the National Forests are to be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes, and that establishment and maintenance of wilderness areas are consistent with this Act. This Act directs the Secretary to manage these resources in the combination that would best meet the needs of the American people; providing for periodic adjustments in use to conform to changing needs and conditions; and harmonious and coordinated management of the resources without impairment of the productivity of the land. Sustained yield means achieving and maintaining in perpetuity a high-level annual

or regular periodic output of renewable resources without impairment of the productivity of the land.

9. Wild and Scenic Rivers Act (82 Stat. 906, as amended; 16 U.S.C. 1271 (note), 1271-1287). Establishes the National Wild and Scenic Rivers System, and policy for managing designated rivers and designating additions to the system. The Act prescribes for designated rivers and their immediate environments the protection and enhancement of their free-flowing character, water quality, and outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. Examples of management actions may include moving toward a desired range of structural vegetative conditions, increasing the amount of large in-stream wood, and improving water quality. Streams eligible for inclusion in the system must be in free-flowing condition or have been restored to this condition.

10. National Environmental Policy Act (NEPA) of 1969 (16 U.S.C. 4321 et seq.). Declares it is the policy of the Federal Government to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans. The Act requires agencies proposing major federal actions significantly affecting the quality of the human environment, to prepare a detailed statement on the environmental impacts of the proposed action, unavoidable adverse environmental impacts, alternatives to the action proposed, the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources which would be involved if the proposed action is implemented. The Act also provides that for any proposal which involves unresolved conflicts concerning alternative uses of available resources, an agency must study, develop, and describe appropriate alternatives to recommended courses of action.

11. Endangered Species Act of 1973 (P.L. 93-205, 87 Stat. 884; 16 U.S.C. 1531-1544, as amended). States its purposes are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, and provide a program for the conservation of such endangered species and threatened species. Federal agencies are to formulate and implement programs and activities to conserve threatened and endangered species and the ecosystems upon which they depend. Under the Act, conserve means the use of methods and procedures necessary to bring any endangered or threatened species to the point at which the measures provided under the Endangered Species Act are no longer necessary.

12. Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974, as amended by National Forest Management Act (NFMA) of 1976 (16 U.S.C. 1600-1614, 472a). States that the development and administration of the renewable resources of the National Forest System are to be in full accord with the concepts for multiple use and sustained yield of products and services as set forth in the Multiple-Use Sustained-Yield Act of 1960. It sets forth the requirements for land and resource management plans for units of the National Forest System, including requiring guidelines to provide for the diversity of plant and animal communities based on the suitability and capability of the specific land area.

13. Clean Water Act of 1977 (33 U.S.C. 1251, 1254, 1323, 1324, 1329, 1342, 1344; 91 Stat. 1566). Amends the Federal Water Pollution Control Act of 1972. Section 313 emphasizes Federal agency compliance with Federal, State, and local substantive and procedural requirements related to the control and abatement of pollution to the same extent as required of nongovernmental entities. Section 303d requires watershed improvement of impaired streams.

14. Clean Air Act, as amended 1977 and 1990 (42 U.S.C. 7401, 7418, 7470. 7472, 7474, 7475, 7491, 7506, 7602). Establishes a national goal to prevent any future, and remedy existing, visibility impairment in certain wilderness areas the Forest Service manages. It also directs the Forest Service as a Federal land manager to protect air quality related values from man-made air pollution in these same areas. Lastly, it obligates the Forest Service to comply with the Act's many provisions regarding abatement of air pollution to the same extent as any private person.

15. North American Wetland Conservation Act of 1989 (16 U.S.C. 4401 (note), 4401-4413, 16 U.S.C. 669b (note)). Section 9 (U.S.C. 4408) directs Federal land managing agencies to cooperate with the Director of the U.S. Fish and Wildlife Service to restore, protect, and enhance the wetland ecosystems and other habitats for migratory birds, fish and wildlife within the lands and waters of each agency to the extent consistent with the mission of such agency and existing statutory authorities.

16. Healthy Forests Restoration Act (HFRA) of 2003 (16 U.S.C. at 1611-6591). Provides processes for developing and implementing hazardous fuel reduction projects on certain types of "at-risk" National Forest System and Bureau of Land Management (BLM) lands, and also provides other authorities and direction to help reduce hazardous fuel and restore healthy forest and rangeland conditions on lands of all ownerships.

17. Stewardship End Result Contracting Projects (16 U.S.C. 2104 (note)). Grants the Bureau of Land Management (BLM) and the Forest Service ten-year authority to enter into stewardship contracts or agreements to achieve agency land management objectives and meet community needs.

19. Tribal Forest Protection Act of 2004 (P.L. 108-278, 118 Stat. 868; 25 U.S.C. 3115a). Authorizes the Secretary of Agriculture and the Secretary of the Interior to enter into an agreement or contract with Indian tribes meeting certain criteria to carry out projects to protect Indian forest land or rangeland, including a project to restore Federal land that borders on or is adjacent to Indian forest land or rangeland.

20. Federal Land Assistance Management and Enhancement Act (FLAME) of 2009 (Title V of Division A of P.L. 111-88). This legislation established a separate account for funding for emergency wildfire suppression activities undertaken on Department of the Interior and National Forest System lands.

21.

Omnibus Public Land Management Act of 2009 (Title IV – Forest Landscape Restoration of PL 111-11). The purpose of this title is to encourage the collaborative, science-based ecosystem restoration of priority forest landscapes through a process that—

(1) encourages ecological, economic, and social sustainability;

(2) leverages local resources with national and private resources;

(3) facilitates the reduction of wildfire management costs, including through establishing natural fire regimes and reducing the risk of uncharacteristic wildfire; and

(4) demonstrates the degree to which—

(A) various ecological restoration techniques—

(i) achieve ecological and watershed health objectives; and

(ii) affect wildfire activity and management costs; and

(B) the use of forest restoration byproducts can offset

treatment costs while benefitting local rural economies and improving forest health.

22. Collaborative Forest Landscape Restoration Act (CFLRA). Established the CFLR Fund providing funding authority for requests by the Secretary of Agriculture of up to $40,000,000 annually for fiscal years 2009 through 2019.

23. Apache-Sitgreaves National Forest Land Management Plan (USDA 2015)

24. Coconino National Forest Land and Resource Management Plan (Agriculture 2018)

25. Tonto National Forest Plan (USDA 1985 (2011))

26. National Forest System Land Management Planning (36 CFR Part 219) (2012 Planning Rule). Sets out the planning requirements for developing, amending, and revising land management plans (also referred to as plans) for units of the National Forest System (NFS).

27. FSM 2020. Provides policy for reestablishing and retaining ecological resilience of National Forest System lands and resources to achieve sustainable multiple use management and provide a broad range of ecosystem services.

Executive Orders

Principal Executive orders relevant to ecological restoration are listed below.

1. Executive Order 11514 issued March 5, 1970, as amended by E.O. 11991 issued May 24, 1977. Protection and enhancement of environmental quality (35 FR 4247, March 7, 1970). This order states that the Federal Government shall provide leadership in protecting and enhancing the quality of the nation's environment to sustain and enrich human life. This order provides for monitoring, evaluation, and control on a continuing basis of the activities of each Federal agency so as to protect and enhance the quality of the environment.

2. Executive Order 11990 issued May 24, 1977. Protection of wetlands (42 FR 26961, May 25, 1977). This order requires each agency to take action to minimize destruction, loss, or

degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands.

3. Executive Order 13112 issued February 3, 1999. Invasive Species (64 FR 6183, February 8, 1999). This order requires Federal agencies whose actions may affect the status of invasive species to, among other things, respond to and control populations of invasive species and provide for restoration of native species and habitat conditions in ecosystems that have been invaded by non-native invasive species.

References to Statutes

1. Text of the Agricultural Act of 2014 (16 U2014-title16/pdf/USCODE-2014-title16-.S.C. 6591c and 16 U.S.C. 2113a) Title VIII, Sections 8205 & 8206 is available at: *http://www.gpo.gov/fdsys/pkg/USCODE-chap84-subchapVI-sec6591c.pdf*

   and

   http://www.gpo.gov/fdsys/pkg/USCODE-2014-itle16/pdf/USCODE-2014-title16-chap41-sec2113a.pdf.

2. Text of the Anderson-Mansfield Reforestation and Revegetation Joint and 581j (note)) is available at: http://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap3-subchapII-sec581j.pdf.

3. Text about visibility protection for Federal class I areas (43 U.S.C. 7491) and text about control of air pollution from Federal facilities under the Clean Air Act (42 U.S.C. 7401, 7418, 7470. 7472, 7474, 7475, 7491, 7506, 7602) is available at: http://www.gpo.gov/fdsys/pkg/USCODE-2014-title42/pdf/USCODE-2014-title42-chap85-subchapI-partC-subpartiisec7491.pdf.
   and
   http://www.gpo.gov/fdsys/pkg/USCODE-2014-title42/pdf/USCODE-2014-title42-chap85-subchapIpartA-sec7418.pdf.

4. Text about Federal facilities water pollution control responsibilities (33 U.S.C. 1323) under the Clean Water Act (33 U.S.C. 1251, 1254, 1323, 1324, 1329, 1342, 1344) is available at: http://www.gpo.gov/fdsys/pkg/USCODE-2014-title33/pdf/USCODE-2014-title33-chap26-subchapIII-sec1323.pdf.

5. Text of the Endangered Species Act of 1973 (16 U.S.C. 1531–1544, as amended) is available at: http://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap35.pdf.

6. Text of the Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974, as amended by National Forest Management Act (NFMA) of 1976(16 U.S.C. 1600–1614, 472a) is available at:

http://www.gpo.gov/fdsys/pkg/USCODE-2010-title16/html/USCODE-2010-title16-chap5C.html.

7. Text of the Granger-Thye Act (16 U.S.C. 580g–h) is available at:
http://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap3-subchapI-sec580g.pdf .
and
http://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap3-subchapI-sec580h.pdf.

8. Text of the Healthy Forests Restoration Act (HFRA) of 2003 (16 U.S.C. 6501–6591) is available at:
http://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap84.pdf.

9. Text of the Knutson-Vandenberg Act (16 U.S.C. at 576b) is available at:
http://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap3-subchapI-sec576b.pdf.

10. Text of the Magnuson-Stevens Fishery Conservation and Management Act of 2006 (16 U.S.C. 1855, as amended) is available at: http://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap38-subchapIVsec1855.pdf.

11. Text of the Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528–531) is available at:
http://www.fs.fed.us/emc/nfma/includes/musya60.pdf.

12. Text of the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C.4321 et seq.) is available at:
http://www.gpo.gov/fdsys/pkg/USCODE-2011-title42/pdf/USCODE-2011-title42-chap55.pdf.

13. Text of the North American Wetland Conservation Act (16 U.S.C. 4401 (note), 4401–4413, 16 U.S.C. 669b (note)). Section 9 (U.S.C. 4408) is available at:
http://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap64-sec4408.pdf.

14. Text of the Organic Administration Act (at 16 U.S.C. 475, 551) is available at:
http://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap2-subchapI-sec475.pdf
and
http://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap3-subchapI-sec551.pdf.

15. Text of the Sikes Act (16 U.S.C. at 670g) is available at:
http://www.gpo.gov/fdsys/pkg/USCODE-2010-title16/html/USCODE-2010-title16-chap5C.htm.

16. Text of the Tribal Forest Protection Act of 2004 (25 U.S.C. 3115a) is available at: http://www.fs.fed.us/restoration/documents/stewardship/tfpa/TribalForestProtectionAct2004.pdf.

17. Text of the Weeks Act, as amended (at 16 U.S.C. 515, 552) is available at: http://www.fs.fed.us/land/staff/Documents/Weeks%20Law.pdf.

18. Text of the Wilderness Act of September 3, 1964 (16 U.S.C. 1131–1136) is available at: http://www.gpo.gov/fdsys/pkg/USCODE-2012-title16/pdf/USCODE-2012-title16-chap23.pdf.

19. Selected text of the Wild and Scenic Rivers Act of October 2, 1968 (Public Law 90–572; 16 U.S.C. 1271–1287), as amended, is available at: http://www.rivers.gov/documents/wsr-act.pdf.

2020.62—References to Federal Regulations

Text of 36 CFR 219 governing land and resource management planning as amended through April 19, 2013 is available at:

http://www.gpo.gov/fdsys/pkg/CFR-2013-title36-vol2/pdf/CFR-2013-title36-vol2-part219.pdf.

2020.63—References to Executive Orders

1. Text of Executive Order 11514 issued March 5, 1970, as amended by E.O. 11991, issued May 24, 1977. Protection and enhancement of environmental quality (35 FR 4247, March 7, 1970; 42 FR 26967, May 25, 1977) is available at: *http://www.archives.gov/federal-register/codification/executive-order/11514.html*.

2. Text of the *Executive Order 11644* issued February 8, 1972. Use of off-road vehicles on the public lands. (37 FR 2877, February 9, 972). Amended by E.O. 11989 issued May 24, 1977 and E.O. 12608 issued September 9, 1987 is available at: *http://www.archives.gov/federal-register/codification/executiveorder/11644.html*.

3. Text of the *Executive Order 11988* issued May 24, 1977. Floodplain management (42 FR 26951 (May 25, 1977)) is available at: *http://www.archives.gov/federalregister/codification/executive-order/11988.html*.

4. Text of the Executive Order 11990 issued May 24, 1977. Protection of wetlands. (42 FR 26961, May 25, 1977) is available at: *http://www.archives.gov/federalregister/codification/executive-order/11990.html*.

5. Text of the *Executive Order 13112* issued February 3, 1999. Invasive Species. (64 FR 6183 (February 8, 1999)) is available at: *http://www.gpo.gov/fdsys/pkg/FR-1999-02-08/pdf/99-3184.pdf*.

6. Text of the *Executive Order 13653* issued November 1, 2013. Preparing the United States for the Impacts of Climate Change. (78 FR 66819 (November 6, 2013)) is available at: *http://www.gpo.gov/fdsys/pkg/FR-2013-11-06/pdf/2013-26785.pdf*.

Forest Plan Direction

Desired Conditions for Forests:

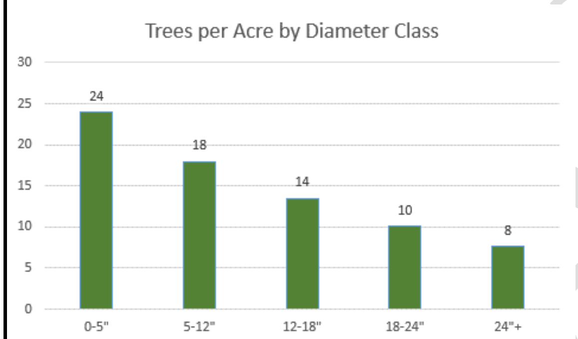
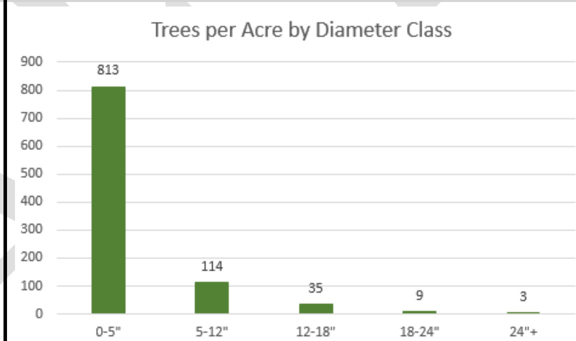
General

The project desired conditions have been developed based upon the project Purpose and Need and forest plan direction for forest vegetation management. Current best available science was used for analysis of conditions necessary to meet the project Purpose and Need. Science relative to historic reference conditions has informed this process. These desired conditions are consistent with the 4FRI project.

The Desired Conditions incorporated information on the ecology of the overstory and understory vegetation comprising the various types as well as information on their Natural Range of Variation in the composition, structure and pattern of vegetation.

Restoring southwestern ponderosa pine ecosystems revolves around restructuring of forest interspacing and tree groups and reintroducing a regime of frequent, low-severity fires like those that historically maintained forest structure and function (Friederici 2003; Leiberg and others 1904; R. T. Reynolds, Sanchez Meador, and others 2013). Restoration treatments that include prescribed burning, often preceded by thinning, have the potential to improve the ecological health of these forests (Erickson and Waring 2014); (Kerhoulas and others 2013)). In order to wisely set the goals that underlie these treatments, it is useful to know as much as possible about past forest conditions, especially the "reference conditions" that existed before forest structure and function were altered by Euro- American settlers. Such conditions were not unchanging, but they sustained themselves across what has been called a "Natural Range of Variation" (Friederici 2003). Forest Plan direction has been translated in to the desired conditions in table XXXX.

Table 1. Desired and existing conditions for the project area.

	Desired Condition	Existing Condition
Structure - Pattern	The majority of stands are in an open condition. Forest arrangement is in individual trees, small clumps, and groups of trees or randomly spaced trees interspersed within variably sized openings of grasses, forbs, and shrubs that are similar to historic patterns. Most forest stands in uneven-aged condition to meet forest resilience and sustainability goals while maintaining wildlife habitat. The majority of stands are in an open condition.	The majority of stands are in a closed condition and lacking groups and clumps of trees or randomly spaced trees. Grasses, forbs and shrubs are underrepresented compared to historic patterns. This is departed from historic conditions consisting of a matrix of groups, clumps and individual rendomly spaced trees with interspaces,
Structure - Trees per acre	Trees are distributed across size classes with total number of trees per acre between 10 and 250. Below is an idealized tree distribution across size classes totalling 73 trees per acre and carrying 90 ft^2 of basal area  	Total trees per acre is higher then the desired condition and are overrepresented in the smaller diameter classes and underrepresented in the larger classes 
Basal Area	Generally less than 90 square feet per acre to meet forest resilience goals. while maintaining wildlife habitat desired conditions. For MSO protected and nest/roost replacement habitat 110 to 120 square feet per acre is the minimum.	The current average basal area within the project area is 129 square feet per acre. High densities in terms of basal area make trees more susceptible to mortality from insects, disease, and competition and increase crown fire risk.
Stand Density Index	Maintain forest density between 25% and 45% of SDImax to maintain forest health and tree growth. For ponderosa pine this is between 112.5 and 202.5. For MSO protected and Nest/Roost replacement habitat, desired forest density is between 45% and 60% of SDImax or between 202.5 and 270.	Currently the average stand density index across the project area is 66% of MaxSDI. 21 percent of stands meet the desired condition for SDI. High densities in terms of stand density index make trees more susceptible to mortality from insects, disease, and competition and increase crown fire risk.
Forest Insects	Stands in the project area are in the Low or Moderate hazard for bark beetles	Currently 74% of acreage have a high bark beetle hazard rating. The remaining 26% of stands meet the desired condition for insect hazard.
Forest Disease	Stands in the project area have Low to Moderate dwarf mistletoe infection severity (Less than 20% of trees infected)	Currently 75% of acreage has a low dwarf mistletoe infection rating,. 22 percent of acres have a moderate rating and 4 percent have a severe infection rating. 5% of the project area meets the desired condition for mistletoe infection severity

Apache-Sitgreaves Forest Plan Direction

Ponderosa Pine

Landscape Scale Desired Conditions (10,000 acres or greater)

- The ponderosa pine forest is a mosaic of structural states ranging from young to old trees. Forest structure is variable but uneven-aged and open in appearance. Sporadic areas of even-aged structure may be present on 10 percent or less of the landscape to provide structural diversity.
- The forest arrangement consists of individual trees, small clumps, and groups of trees with variably-sized interspaces of grasses, forbs, and shrubs. Vegetation associations are similar to reference conditions. The size, shape, and number of trees per group and the number of groups per area vary across the landscape. Tree density may be greater in some locations, such as north-facing slopes and canyon bottoms.
- The ponderosa pine forest is composed predominantly of vigorous trees, but declining, top-killed, lightning-scarred, and fire-scarred trees provide snags and coarse woody debris. Snags and coarse woody debris are well distributed throughout the landscape. Ponderosa pine snags are typically 18 inches or greater in diameter and average 1 to 2 per acre.
- Coarse woody debris, including logs, ranges from 3 to 10 tons per acre. Logs average 3 per acre within the forested area of the landscape.
- Where it naturally occurs, Gambel oak is present with all age classes represented. It is reproducing to maintain or expand its presence on capable sites across the landscape. Large Gambel oak snags are typically 10 inches or larger in diameter and are well distributed.
- Grasses, forbs, shrubs, needles, leaves, and small trees support the natural fire regime. The larger proportion (60 percent or greater) of soil cover is composed of grasses and forbs as opposed to needles and leaves.
- Old growth occurs throughout the landscape, in small, discontinuous areas consisting of clumps of old trees, or occasionally individual old trees. Other old growth components are also present including dead trees (snags), downed wood (coarse woody debris), and/or structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).
- Frequent, low to mixed severity fires (fire regime I), occurring approximately every 2 to 17 years, are characteristic in this PNVT.

Mid-Scale Desired Conditions (100 to 1,000 acres)

- Ponderosa pine forest is characterized by variation in the size and number of tree groups depending on elevation, soil type, aspect, and site productivity. The more biologically productive sites contain more trees per group and more groups per area, resulting in less space between groups. Interspaces typically range from 10 percent in more biologically productive sites to 70 percent in the less productive sites. Tree density within forested areas ranges from 20 to 80 square feet basal area per acre.
- The tree group mosaic composes an uneven-aged forest with all age classes, size classes, and structural stages present. Occasionally, patches of even-aged forest structure are present (less than 50 acres). Disturbances sustain the overall age and structural distribution.
- Fires burn primarily on the forest floor and do not spread between tree groups as crown fire.
- Forest structure in the wildland-urban interface (WUI) may have smaller, more widely spaced groups of trees than in the non-WUI areas.
- Northern goshawk post-fledging family areas (PFAs) may contain 10 to 20 percent higher basal area in mid-aged to old tree groups than northern goshawk foraging areas and the surrounding

forest.

- Northern goshawk nest areas have forest conditions that are multi-aged and dominated by large trees with relatively denser canopies than the surrounding forest.

Fine Scale Desired Conditions (less than 10 acres)

- Trees typically occur in irregularly-shaped groups and are variably spaced with some tight clumps. Tree crowns in the mid- to old-aged groups are interlocking or nearly interlocking providing for species such as Abert's squirrel.
- Interspaces surrounding tree groups are variably shaped and composed of a grass, forb, and shrub mix. Some may contain individual trees or snags.
- Trees within groups are of similar or variable ages and may contain species other than ponderosa pine. Tree groups are typically less than 1 acre and average ½ acre. Mid- to old-aged tree groups consist of approximately 2 to 40 trees with interlocking canopies.
- Where Gambel oak occurs, the majority are single trunk trees over 8 inches in diameter with full crowns.

Guidelines for Forests: Ponderosa Pine

- Where Gambel oak or other native hardwood trees and shrubs are desirable to retain for diversity, treatments should improve vigor and growth of these species.
- Where consistent with project or activity objectives, canopy cover should be retained on the south and southwest sides of small, existing forest openings that are naturally cooler and moister. These small (generally one-tenth to one-quarter acre) shaded openings provide habitat conditions needed by small mammals, plants, and insects (e.g., Merriam's shrew, Mogollon clover, four-spotted skipperling butterfly). Where these openings naturally occur across a project area, these conditions should be maintained on an average of 2 or more such openings per 100 acres.

Dry Mixed Conifer

Landscape Scale Desired Conditions (10,000 acres or greater)

- The dry mixed conifer forest is a mosaic of conditions composed of structural states ranging from young to old trees. Forest structure and density are similar to ponderosa pine forest. Forest appearance is variable but uneven-aged and open. Sporadic areas of even-aged structure may be present on 10 percent or less of the landscape to provide structural diversity.
- The forest arrangement consists of small clumps and groups of trees with variably-sized interspaces of grass, forb, and shrub vegetation associations similar to reference conditions. Size, shape, number of trees per group, and number of groups per area are variable across the landscape. Where they naturally occur, groups of Gambel oak are healthy and maintained or increased. Tree density may be greater in some locations, such as north-facing slopes and canyon bottoms.
- The dry mixed conifer forest is composed predominantly of vigorous trees, but declining, top-killed, lightning-scarred, and fire-scarred trees provide snags and coarse woody debris. Snags and coarse woody debris are well distributed throughout the landscape. Snags are typically 18 inches in diameter or greater and average 3 per acre.
- Coarse woody debris, including logs, ranges from 5 to 15 tons per acre. Logs average 3 per acre within the forested area of the landscape.
- Southwestern white pine is present with the ability to reproduce on capable sites.

- Grasses, forbs, shrubs, needles, leaves, and small trees support the natural fire regime. The larger proportion (60 percent or greater) of soil cover is composed of grasses and forbs as opposed to needles and leaves.
- Old growth occurs throughout the landscape, in small, discontinuous areas consisting of clumps of old trees, or occasionally individual old trees. Other old growth components are also present including dead trees (snags), downed wood (coarse woody debris), and/or structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).
- Frequent, low to mixed severity fires (fire regime I) occurring every 10 to 22 years are characteristic.

Mid-Scale Desired Conditions (100 to 1,000 acres)

- The dry mixed conifer forest is characterized by a variety of size and number of tree groups depending on elevation, soil type, aspect, and site productivity. The more biologically productive sites contain more trees per group and more groups per area, resulting in less space between groups. Interspaces typically range from 10 percent in more biologically productive sites to 50 percent in less productive sites. Tree density within forested areas ranges from 30 to 100 square feet basal area per acre.
- The mosaic of tree groups is composed of uneven-aged forest. All age classes and structural stages are present. Occasionally, there are small patches (less than 50 acres) of even-aged forest present. Disturbances sustain the overall age and structural distribution.
- Fire burns primarily on the forest floor and does not spread between tree groups as crown fire.
- Forest structure in the wildland-urban interface (WUI) may have smaller, more widely spaced groups of trees than in the non-WUI areas.
- Northern goshawk post-fledging family areas (PFAs) may contain 10 to 20 percent higher basal area in mid-aged to old tree groups than northern goshawk foraging areas and the surrounding forest.
- Northern goshawk nest areas have forest conditions that are multi-aged but are dominated by large trees with relatively denser canopies than the surrounding forest.

Fine Scale Desired Conditions (less than 10 acres)

- Trees typically occur in irregularly-shaped groups and are variably spaced with some tight clumps. Tree crowns in the mid- to old-aged groups are interlocking or nearly interlocking providing for species such as red squirrel.
- Interspaces surrounding tree groups are composed of a grass, forb, and shrub mix. Some may contain individual trees or snags.
- Trees within groups are of similar or variable ages and one or more species. Tree group sizes typically are less than 5 acres, but often less than 1 acre, and at the mature and old stages consist of approximately 2 to 50 trees.
- Where Gambel oak occurs, the majority are single trunk trees over 8 inches in diameter with full crowns.

Guidelines for Forests: Dry Mixed Conifer

- Where Gambel oak or other native hardwood trees and shrubs are desirable to retain for diversity, treatments should improve vigor and growth of these species.

- Where consistent with project or activity objectives, canopy cover should be retained on the south and southwest sides of small, existing forest openings that are naturally cooler and moister. These small (generally one-tenth to one-quarter acre) shaded openings provide habitat conditions needed by small mammals, plants, and insects (e.g., Merriam's shrew, Mogollon clover, four-spotted skipperling butterfly). Where these openings naturally occur across a project area, these conditions should be maintained on an average of 2 or more such openings per 100 acres.

Mixed Conifer with Aspen (Wet Mixed Conifer)

Landscape Scale Desired Conditions (10,000 acres or greater)

- The wet mixed conifer forest is a mosaic of structural stages and seral states ranging from young to old trees. The landscape arrangement is an assemblage of variably-sized and aged groups and patches of trees and other vegetation associations similar to reference conditions.
- All seral states are present across the landscape, with each state characterized by distinct dominant species composition, biological and physical conditions, and enough of each state is present to develop into the next state progressively over time.
- Canopies are more closed than dry mixed conifer. An understory, consisting of native grass, forbs, and/or shrubs, is present.
- The wet mixed conifer forest is composed predominantly of vigorous trees, but declining, top-killed, lightning-scarred, and fire-scarred trees provide snags and coarse woody debris. Snags and coarse woody debris are well distributed throughout the landscape. The number of snags and logs and amount of coarse woody debris varies by seral state ranging from 8 to more than 16 tons per acre.
- Old growth occurs over large, continuous areas. Old growth components include old trees, dead trees (snags), downed wood (coarse woody debris), and/or structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).
- Mixed severity fire (fire regime III) is characteristic of this forest. High severity fires (fire regimes IV and V) rarely occur.

Mid-Scale Desired Conditions (100 to 1,000 acres)

- The size and number of groups and patches vary depending on disturbance, elevation, soil type, aspect, and site productivity. Patch sizes vary but are frequently hundreds of acres and rarely thousands of acres. Groups of tens of acres or less are relatively common. There is a mosaic of primarily even-aged groups and patches, which vary in size, species composition, and age. Grass, forb, and shrub openings created by disturbances may compose 10 to 100 percent of the area depending on the type of disturbance.
- Uneven-aged groups and patches, comprising about 20 percent of this PNVT, provide for species such as the black bear and red-faced warbler that need multistoried canopies with dense low- to mid-canopy layers.
- Tree density ranges from 30 to 180 square feet basal area per acre depending upon time since disturbance and seral states of groups and patches.
- There are 20 or more snags greater than 8 inches in diameter per acre and 1 to 5 of those snags are 18 inches or greater in diameter.
- Coarse woody debris, including logs, varies by seral state, ranging from 5 to 20 tons per acre for early-seral states; 20 to 40 tons per acre for mid-seral states; and may be as high as 35 tons per acre, or greater, for late-seral states. These conditions also provide an abundance of fungi

including mushrooms and truffles used by small mammals.

- Forested PNVTs in the wildland-urban interface (WUI) are dominated by early-seral, fire-adapted species growing in an overall more open condition than the surrounding forest. These conditions result in fires that burn primarily on the forest floor and rarely spread as crown fire.
- Mixed (fire regime III) and high (fire regime IV) severity fires in this PNVT, occurring every 22 to 150 years along with other disturbances, maintain desired overall tree density, structure, species composition, coarse woody debris, and nutrient cycling. High severity fires do not exceed patches of 1,000 acres of mortality. Other smaller disturbances occur more frequently.
- Northern goshawk post-fledging family areas (PFAs) may contain 10 to 20 percent higher basal area in mid-aged to old tree groups than northern goshawk foraging areas and the surrounding forest.
- Northern goshawk nest areas have forest conditions that are multi-aged but are dominated by large trees with relatively denser canopies than the surrounding forest.

Fine Scale Desired Conditions (less than 10 acres)

- In mid-aged and older forests, trees are typically variably spaced with crowns interlocking (grouped and clumped trees) or nearly interlocking providing for species such as red squirrel. Trees within groups can be of similar or variable species and ages.
- Small openings are present as a result of disturbances (e.g., wind, disease).

Aspen

Landscape Scale Desired Conditions (10,000 acres or greater)

- Areas of aspen occur and shift across the forested landscape. They are successfully regenerating and being recruited into older and larger size classes. Size classes have a natural distribution, with the greatest number of stems in the smaller size classes.

Mid-Scale Desired Conditions (100 to 1,000 acres)

- Aspen may compose 10 to 100 percent of the area depending on disturbance (e.g., fire, insects, silvicultural treatments) in multistoried patches.
- As an early seral species, aspen reproduction and recruitment benefit from low severity surface fires in association with ponderosa pine and dry mixed conifer forested PNVTs, and mixed-severity fires in association with wet mixed conifer and spruce-fir forested PNVTs.

Objectives for Forests: Aspen

- Aspen dominated and codominated acres within forested PNVTs, representing a range of age classes, are maintained on at least 50,000 acres during the planning period.

Guidelines for Forests: Aspen

- To preclude concentrated herbivore impacts, new surface water development should not be constructed within proximity to aspen stands (approximately a quarter of a mile).
- Restoration of aspen clones should occur where aspen is overmature or in decline to maintain a sustainable presence of this species at the landscape level.

- When managing for early seral states, competing conifers should be removed from aspen stands when needed to increase aspen longevity and increase diversity of aspen age classes.
- Aspen restoration and retention efforts should include measures to ensure viability of aspen on the landscape.

Woodlands: Madrean Pine-Oak

Landscape Scale Desired Conditions (10,000 acres or greater)

- A mix of desired species, ages, heights, and groupings of trees create a mosaic across the landscape.
- The majority of this woodland has an open canopy consisting of large trees and an herbaceous understory, with some groups of closed canopy. Overall, canopy cover is 10 to 50 percent.
- Snags, averaging 1 to 2 per acre, and older trees are scattered across the landscape. Coarse woody debris averages 1 to 5 tons per acre.
- Understory vegetation includes evergreen oaks, mountain mahogany, grasses, and forbs.
- Ground cover consists of perennial grasses and forbs that frequently carry fire through the landscape.
- Grasses, forbs, shrubs, needles, leaves, and small trees support the natural fire regime. The larger proportion (60 percent or greater) of soil cover is composed of grasses and forbs as opposed to needles and leaves.
- Fires are typically of low or occasionally moderate severity (fire regime I) and occur every 5 to 20 years.

Mid-Scale Desired Conditions (100 to 1,000 acres)

- Some large patches in the Madrean pine-oak woodland are closed canopy, have multiple age classes, large trees, and old growth-like characteristics (e.g., numerous snags, large coarse woody debris) in order to provide for wildlife such as Mexican spotted owl and black bear, that need denser habitat.
- The size and number of groups and patches vary depending on disturbance, elevation, soil type, aspect, and site productivity. Patch sizes vary but are mostly tens of acres, with rare disturbances of hundreds of acres. There may be frequent small disturbances resulting in groups and patches of tens of acres or less. A mosaic of groups and patches of trees, primarily even-aged, that are variable in size, species composition, and age, is present. Grass, forb, and shrub openings created by disturbance may compose 10 to 100 percent of the area depending on the disturbances.
- Woodland densities range from 15 to 50 square feet basal area per acre.

Fine Scale Desired Conditions (less than 10 acres)

- Single large trees or small groups are widely spaced between large expanses of herbaceous vegetation and shrubs.

Guidelines for Woodlands: Madrean Pine-Oak

- Where Mexican spotted owls are found nesting in canyons or on north slopes within the Madrean pine-oak woodland, adjacent treatments should be modified to meet the needs of foraging owls.

Piñon-Juniper – Savanna

Landscape Scale Desired Conditions (10,000 acres or greater)

- The piñon-juniper savanna is open in appearance with trees occurring as individuals or in small groups and ranging from young to old. Overall, tree canopy cover is 10 to 15 percent, but may range up to 30 percent.
- Scattered shrubs and a continuous herbaceous understory, including native grasses, forbs, and annuals, are present to support a natural fire regime.
- Grasses, forbs, shrubs, needles, leaves, and small trees support the natural fire regime. The larger proportion (60 percent or greater) of soil cover is composed of grasses and forbs as opposed to needles and leaves.
- Old growth occurs in isolated locations scattered throughout the landscape, as individual old trees or as clumps of old trees. Other old growth components may also be present including dead trees (snags), downed wood (coarse woody debris), and/or structural diversity.
- Fires are low to mixed severity (fire regime I), occurring every 1 to 35 years.

Grasslands

Landscape Scale Desired Conditions (10,000 acres or greater)

- Perennial herbaceous species dominate and include native grasses, grass-like plants (sedges and rushes), and forbs, and in some locations, a diversity of shrubs.
- Herbaceous vegetation and litter provide for and maintain the natural fire regime (fire regime I and II). In semi-desert grasslands, the natural fire return interval is approximately every 2 to 10 years. In Great Basin grasslands the natural fire return interval is approximately every 10 to 30 years. In montane/subalpine grasslands it ranges from approximately 2 to 400 years, depending on the adjacent forested PNVT.
- Landscapes associated with montane/subalpine grasslands vary from natural appearing where human activities do not stand out (high scenic integrity) to unaltered where only natural ecological changes occur (very high scenic integrity).

Mid-Scale Desired Conditions (100 to 1,000 acres)

- Woody (tree and shrub) canopy cover is less than 10 percent.
- Prairie dogs are present and support healthy grassland soil development and the diversity of associated species (e.g., western burrowing owl).

Fine Scale Desired Conditions (less than 10 acres)

- Average herbaceous vegetation heights range from 7 to 29 inches in Great Basin grasslands, 7 to 26 inches in montane/subalpine grasslands, and 10 to 32 inches in semi-desert grasslands.
- During the critical pronghorn antelope fawning period (May through June[22]), cool season grasses and forbs provide nutritional forage; while shrubs and standing grass growth from the previous year provide adequate hiding cover (10 to 18 inches) to protect fawns from predation.

Guidelines for Grasslands

- Restoration treatment of grasslands should result in a woody canopy cover of less than 10 percent; more than one treatment may be required.
- Mechanical restoration of grasslands should emphasize individual tree removal to limit soil disturbance.
- New fence construction or reconstruction where pronghorn antelope may be present should have a barbless bottom wire which is 18 inches from the ground to facilitate movement between pastures

and other fenced areas. Pole and other types of fences should also provide for pronghorn antelope passage where they are present.
- Pronghorn antelope fence and other crossings should be installed along known movement corridors to prevent habitat fragmentation.

Management Approaches for Grasslands

The management approach is to maintain and improve grasslands by eliminating competing conifers, leaving woody debris scattered across the ground, stabilizing gullies to restore water tables, and reseeding with native species. Treatments are located in restorable and treatable grasslands, primarily in the Great Basin and semi-desert grassland PNVTs. Obliteration and rehabilitation of unauthorized roads and trails may be needed. There is an emphasis to provide enough grass to reduce topsoil loss and allow fire to spread and resume its role in maintaining grasslands. Pronghorn antelope is a management indicator species (MIS) for grassland restoration. The treatment objective listed above would contribute to their viability.

Coconino National Forest Plan Direction

Desired Conditions for All Ecosystems

- Within their type and capability, ecosystems are functioning properly, provide habitat for native species, and are resilient to natural disturbances (e.g., flooding, fire, and periodic drought) and climate change. Ecosystem processes and contributions (e.g., nutrient cycling, water infiltration, and wildlife habitat) are sustained as vegetation on the forest adapts to a changing climate.
- The composition, structure, function, and mosaic of vegetation conditions reduce the threat of uncharacteristic disturbances.
- Native species dominate the landscape. Desirable non-native species and subspecies are present and in balance with properly functioning ecosystems. Ecosystem conditions promote endemic levels of invertebrates, including pollinators.
- Native insect populations and disease are generally within the natural range of variability with occasional outbreaks.
- Uncharacteristic fires are infrequent as is the associated flooding and sedimentation into downstream communities, perennial streams and their tributaries, headwaters, wildernesses, and other areas and resources.

Desired Conditions for All Terrestrial ERUs

- Each ERU contains a mosaic of vegetation conditions, densities, and structures. This mosaic occurs at a variety of scales across landscapes and watersheds and reflects the natural disturbance regimes affecting the area.
- Within their type and capability, terrestrial ERUs are functioning properly and are resilient to the frequency, extent, and severity of disturbances such as fire in fire-adapted systems, and adapt to climate variability. Natural and human disturbances provide desired overall plant density, species composition (i.e. mix of species), structure, coarse woody debris, and nutrient cycling. Desired disturbance regimes, including fire, are restored where practical.
- Vegetation and stream ecosystems are connected based on natural patterns that are consistent with landforms and topography and provide for upland and aquatic species movements and genetic exchange.

- Vegetation conditions allow for inclusions and variability with the landscape as well as for transition zones or ecotones between riparian areas, forests, woodlands, shrublands, and grasslands. Transition zones shift in time and space due to factors affecting site conditions (e.g. fire, climate). Stringers persist where they naturally occur. For example, pine stringers are noncontiguous narrow communities of pine (often large old trees) that extend into lower elevation vegetation.

- Vegetation provides ecologically sustainable amounts of products, such as wood fiber or forage.

Pinyon Juniper ERUs

General Description and Background

There are three pinyon juniper ERUs on Coconino NF. Pinyon and juniper ERUs are dominated by one or more species of pinyon pine and/or juniper and can occur with a grass and forb dominated understory (i.e., Pinyon Juniper with Grass ERU), a shrub dominated understory (i.e., Pinyon Juniper Evergreen Shrub ERU), or a sparse discontinuous understory of some grasses and/or shrubs (i.e., Pinyon Juniper Woodland ERU). Two-needle and single-leaf pinyon pine are common as well as one-seed, Utah, redberry, Rocky Mountain, and alligator juniper and a lesser abundance of oaks. Species composition and stand structure vary by location primarily due to precipitation, elevation, temperature, and soil type. In some locations, grassland soil types are interspersed with pinyon juniper soil types. Spreading, low intensity surface fires had a very limited role in molding stand structure and dynamics of many or most pinyon and juniper woodlands in the historical landscape. However, where tree density is sparse and grass cover is significant, the Pinyon Juniper with Grass ERU may be an exception.

Desired Conditions

- Pinyon Juniper with Grass is generally uneven-aged and open in appearance. Trees occur as individuals and small groups and range from young to old. Patch sizes of woodlands range from individual trees and clumps that are less than one-tenth acre, to tree groups of approximately an acre (Muldavin et al. 2003).

- In Pinyon Juniper with Grass, old growth structure occurs throughout the landscape, generally in small areas as individual old growth components, or as clumps of old growth. Old growth components include old trees, dead trees (snags), downed wood (coarse woody debris) and structural diversity. The location of old growth components shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).

- In Pinyon Juniper with Grass, snags and older trees with dead limbs are scattered across the landscape. At the landscape scale, snags 8 inches and above at DRC average 5 snags per acre, while snags 18 inches and above average 1 snag per acre (Weisz et al. 2011). Coarse woody debris increases with succession and averages 1-3 tons per acre.

- In Pinyon Juniper with Grass, fires typically occur every 1 to 35 years with low severity and patches of mixed severity (Fire Regime I) favoring regrowth and germination of native grasses and forbs.

- In Pinyon Juniper with Grass, scattered shrubs and a dense herbaceous understory including native grasses, forbs, and annuals, are present to support frequent surface fires. Shrubs average less than 30% canopy cover. Overall plant composition is similar to site potential (FSH 2090.11) but can vary considerably at the fine- and mid- scales owing to a diversity of seral conditions.

- In Pinyon Juniper Evergreen Shrub, a mix of trees and shrubs occurs as a series of vegetation states that move over time from herbaceous-dominated to shrub-dominated to tree-dominated. Trees occur as individuals or in smaller groups ranging from young to old. Pinyon trees are occasionally absent but one or more juniper species is always present. Arizona cypress and live oak are scattered across the landscape. Typically groups are even-aged in structure with all ages represented across the landscape for an overall uneven-aged grouped appearance. The patch size of woodlands ranges from 1 to 10s of acres.

- In Pinyon Juniper Evergreen Shrub, old growth structure occurs throughout the landscape, generally in small areas as individual old growth components or as clumps of old growth. Old growth components include old trees, dead trees (snags), downed wood (coarse woody debris), and structural diversity. The location of old growth components shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).

- In Pinyon Juniper Evergreen Shrub, snags and old trees with dead limbs/tops are scattered across the landscape. Large dead wood is present. Snags 8 inches and above at diameter at root collar (DRC) average 3 snags per acre, while snags 18 inches and above average 1 snag per acre (Weisz et al. 2011). Coarse woody debris averages 2-4 tons per acre.

- In Pinyon Juniper Evergreen Shrub, fires are typically mixed severity (25 to 75 percent mortality or top kill with a moderate frequency or Fire Regime III) although some areas exhibit occasional high severity fires (greater than75 percent mortality or Fire Regime IV).

- In Pinyon Juniper Evergreen Shrub, the understory is dominated by low to moderate density of shrubs, depending on successional stage. The shrub component consists of one or a mix of evergreen shrub, oak, manzanita, mountain mahogany, sumac, skunk bush, Fremont barberry, and other shrub species, which are well distributed. A variety of low to high growing native perennial and annual grasses and forbs are present in the interspaces. Shrubs average greater than 30% canopy cover. Overall plant composition is similar to site potential but can vary considerably at fine- and mid- scales owing to a diversity of seral conditions.

- At the landscape level in Pinyon Juniper Woodland, even-aged patches of pinyons and junipers form multi-aged woodlands. Very old trees (greater than 300 years old) are present. Tree density and canopy cover are high and where interlocking crowns shade the ground over extensive areas, shrubs are sparse to moderate and herbaceous cover is low and discontinuous. The patch size of woodlands ranges from 10s to 100s of acres (Muldavin et al. 2003).

- In Pinyon Juniper Woodland, old growth structure and components are often concentrated in mid- and fine-scale units as patches that range from less than 10 acres to 1,000 acres in size. Old growth components include old trees, dead trees (snags), downed wood (coarse woody debris), and structural diversity. The location of old growth components shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).

- In Pinyon Juniper Woodland, snags and older trees with dead limbs and/or tops are scattered across the landscape. Snags 8 inches and above at diameter at root collar (DRC) average 5 snags per acre, while snags 18 inches and above average 1 snag per acre (Weisz et al. 2011). Coarse woody debris increases with succession and averages 2-5 tons per acre.

- In Pinyon Juniper Woodland, fire as a disturbance is less frequent and variable due to differences in ground cover. The fires that do occur are mixed to high severity (Fire Regimes III, IV, and V).
- In Pinyon Juniper Woodland, ground cover consists of shrubs, perennial grasses, and forbs and some sites are capable of carrying surface fire. The amount of shrub cover depends on the TEUI unit and overall plant composition is similar to site potential and can vary considerably at fine- and mid-scales owing to a diversity of seral conditions.
- Plant litter (e.g., leaves, needles) and coarse woody debris create microclimate conditions necessary for pinyon seed germination. There are sufficient nurse trees to provide microclimate conditions in the understory. Nurse trees provide improved nutrient and soil properties, higher soil moisture, lower temperatures, and light levels which increases seedling survival under harsh conditions.
- A robust crop of pinyon nuts is regularly produced consistent with site potential.

Aspen and Maple

General Description and Background

Aspen is a shade intolerant species that occurs as groups or clones. Its distribution can vary in space and time and is influenced by soil type, soil moisture, low temperatures, and disturbances (primarily wildfires but occasionally flooding) that stimulate root sprouting and colonization. Aspen sites may or may not have a significant conifer component depending on successional status.

Species present in aspen groves include native plant species such as Colorado blue columbine and Rusby milkvetch, native animals such as woodpeckers, and a variety of fungi and microorganisms.

An accelerated aspen decline on the Coconino NF was documented between 2003 and 2007 due to a combination of a significant frost event, long term drought, and bouts of defoliation from western tent caterpillars (Fairweather and others 2008). This was more pronounced on low elevation dry sites than wetter high elevation sites. Widespread death of mature aspen trees, chronic browsing by ungulates (deer and elk in this study), and advanced conifer reproduction could result in further loss of this ecologically unique vegetation. Livestock can also graze on aspen.

Desired Conditions

- Where they naturally occur, all age classes of aspen and maple are present in groups or patches and are regenerating and vigorous, providing habitat for a variety of species. Natural and human disturbances are sufficient to maintain desired overall tree density, structure, species composition, coarse woody debris, and nutrient cycling. The size and number of patches depend on the scale and type of disturbance as well as microsite conditions such as elevation, soil type, aspect, and site productivity. A diverse understory consisting of native graminoids, forbs, and/or shrubs is present and has a variety of seral stages and age classes.
- The location of aspen shifts across the landscape as a result of succession and disturbance. Aspen may disappear from portions of the landscape due to succession however aspen patches result or

are maintained from natural levels of disturbances (e.g., insects, disease, wind, and fire) as well as mechanical treatments.

- Where early seral aspen is present, it is reproducing successfully and growing into older age classes. Older aspens generally occur within stands or patches where disturbance is less frequent. Characteristics of older aspen include old trees, dead trees (snags), coarse woody debris and logs. Amounts of these characteristics and tree density vary depending on microsite, time since disturbance, and whether it is a young or old aspen stand.

Ponderosa Pine

General Description and Background

Ponderosa Pine ERU covers approximately 797,171 acres within lands managed by the Coconino NF. About seven percent of the ponderosa pine within the forest boundary is at least partially in other ownership or managed by other agencies.

Besides ponderosa pine trees, other species commonly found in this ERU are oak, juniper, and pinyon pine. More infrequently species such as aspen, Douglas-fir, white fir, and blue spruce may be present in small groups or individual trees. There typically is an understory of grasses and forbs and sometimes shrubs.

Ponderosa Pine includes two subtypes: Ponderosa Pine Bunchgrass and Ponderosa Pine Gambel Oak. The Gambel oak subtype is particularly important to many wildlife species, including Mexican spotted owls. Higher species richness has been correlated with higher densities of Gambel oak. This subtype provides important nesting and foraging habitat for wildlife. The desired conditions below apply to both subtypes.

Ponderosa Pine ERU provides habitat for two management indicator species: the pygmy nuthatch (mature ponderosa pine and snags) and Mexican spotted owl (ponderosa pine-Gambel oak subtype). Recommendations regarding Mexican spotted owl (MSO) habitat are contained in the Recovery Plan for the Mexican Spotted Owl (USDI 2012)."

Ponderosa Pine also contains unique features such as ponderosa pine stringers—noncontiguous, narrow communities of predominantly ponderosa pine that extend below its normal elevation distribution into other ERUs. Ponderosa pine stringers provide connectivity between two vegetation communities as well as a unique microclimate in lower elevation environments.

Landscape Scale Desired Conditions (1,000-10,000+ acres)

- Ponderosa Pine has a mosaic of trees with varying age classes and understory vegetation which provide habitat for a variety of species, including Mexican spotted owls and northern goshawks, and ground fuels conducive to low-severity fires.

- The composition, structure, and function of vegetation conditions are resilient to the frequency, extent, and severity of disturbances and climate variability. The landscape is a functioning ecosystem that contains its components, processes, and conditions that result from natural levels of disturbances (e.g. insects, diseases, fire, and wind), including snags, downed logs, and old trees. Grasses, forbs, shrubs, and needle cast (e.g., fine fuels), and small trees maintain the natural fire regime. Vegetative ground cover provides protection from accelerated soil erosion, promotes water infiltration, and contributes to soil nutrient cycling, plant and animal diversity, and to ecosystem function.

- Frequent, low-severity fires (Fire Regime I) are characteristic in this ERU, including throughout northern goshawk home ranges. Spatial heterogeneity and discontinuous crowns (interspaces between groups and single trees) prevents fire spread. Natural and human disturbances are sufficient to maintain desired overall tree density, structure, species composition, coarse woody debris, and nutrient cycling.

- At the landscape scale, Ponderosa Pine is composed of trees in structural stages that range from young to old and are dominated by ponderosa pine trees. Forest appearance is variable but generally uneven-aged and open; occasional areas of even-aged structure are present. Forest arrangement is in individual trees, small clumps, and groups of trees interspersed within variably sized openings of grasses, forbs, and shrubs that are similar to historic patterns. Openings typically range from 10 percent in more productive sites to 70 percent in the less productive sites. The size and shape of trees, number of trees per group, and number of groups per area are variable across the landscape. Denser tree conditions exist in some locations such as north-facing slopes and canyon bottoms.

- The ponderosa pine forest vegetation community is composed predominantly of vigorous trees, but declining trees are a component and provide for snags, top-killed, lightning- and fire-scarred trees, and coarse woody debris (>3 inch diameter), all well-distributed throughout the landscape. Snags, down logs and coarse woody debris are representative of the species within the vegetation community. Ponderosa pine snags are typically 18 inches or greater at DBH and average 1 to 2 snags per acre. There are varying sizes of snags greater than 18 inches dbh. In the Gambel oak subtype, large oak snags (>10 inches) are a well-distributed component. Downed logs (>12 inch diameter at mid-point, >8 feet long) average 3 logs per acre within the forested area of the landscape. Coarse woody debris, including downed logs, ranges from 3 to 10 tons per acre is sufficient to maintain or improve long-term soil productivity and provide cover and food for a variety of species.

- Old growth structure occurs throughout the landscape, generally in small areas as individual old growth components, or as clumps of old growth. Consistent with vegetative characteristics of a frequent, low severity fire regime, old growth is a component of uneven-aged forests, generally comprised of groups of similarly aged trees and single trees interspersed with open grass–forb–shrub interspaces, but occasionally, it occurs in larger even-aged patches where local microsites facilitate less frequent fire regimes. Within group variability may be low but variation among groups is typically high and proportions of patches with different developmental stages may vary depending on site-specific conditions. Old growth components include old trees, dead trees (snags), and dead and downed wood (coarse woody debris including large size classes). Snags and large dead and downed fuels are irregularly distributed across the landscape and may not exist in some patches. The location of old growth components shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).

- In the Gambel oak subtype, all sizes, structures (i.e., the shrub or tree forms depending on the capability of the site), and ages of oak trees are present. The Gambel oak subtype is reproducing and maintaining its presence on suitable sites across the landscape. Large to moderate sized oak snags are scattered across the landscape, as are moderate to large live oak trees with dead limbs, hollow boles, and cavities. These provide shelter and nesting habitat for a variety of wildlife species, including owls and bats.

Mid-Scale Desired Conditions (10 to 999 acres)

- At the mid-scale, Ponderosa Pine is characterized by variation in the size and number of tree groups depending on elevation, soil type, aspect, and site productivity. The more biologically productive sites contain more trees per group and more groups per area, resulting in less space between groups. At the mid-scale, openings typically range from 30 percent in more productive sites to 60 percent in the less productive sites, but extreme outlying sites can range from 10 percent (i.e., high elevation, mesic sites) and may be as much as 90 percent in low elevation sites on south-facing slopes or where site specific information indicates the site was historically more open. Tree density within forested areas generally ranges from 22 to 89 square feet basal area per acre (R. T. Reynolds, Sanchez Meador, and others 2013) Ground cover consists primarily of perennial grasses and forbs capable of carrying surface fire, with basal vegetation values ranging between about 5 and 20% depending on the TEUI unit (Forest Service, 1986, 2006c).

- The mosaic of tree groups generally comprises an uneven-aged forest with all age classes present, including old growth. Groups of seedlings and saplings are maintained at sufficient levels to provide a reliable source of replacement as trees grow and progress into succeeding size and age classes. Infrequently patches of even-aged forest structure are present. Disturbances sustain the overall age and structural distribution.

- Diversity of understory species (e.g., grasses, forbs, and shrubs) is consistent with site potential and provides for infiltration of water and soil stability. The understory has a variety of heights of cool and warm season vegetation and produces seed heads and all age classes of vegetation food and cover for wildlife and forage for livestock. A mosaic of dense cover, high amounts of litter and bare ground provide habitat for a variety of species.

- Fires burn primarily on the forest floor and do not spread between tree groups as crown fire. Single tree torching and small group torching, however, are not uncommon, resulting in a mosaic across the landscape.

- Conditions in northern goshawk post-fledgling areas (PFAs) are similar to general forest conditions except these forests contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in northern goshawk foraging areas and the general forest. Northern goshawk nest areas have forest conditions that are multi-aged but are dominated by large trees with relatively denser canopies than other areas in Ponderosa Pine.

Fine Scale Desired Conditions (less than 10 acres)

- Trees typically occur in irregularly shaped groups and are variably spaced with some tight clumps. Crowns of trees within the mid-aged to old groups are interlocking or nearly interlocking. Interspaces surrounding tree groups are variably shaped and comprised of a grass/forb/shrub mix. Some natural openings contain individual and randomly distributed patches of trees and a diversity of grasses and forbs which provide habitat for species, including invertebrates, small mammals, migratory birds, and turkey. Trees within groups are of similar or variable ages and may contain species other than ponderosa pine. Size of tree groups typically is less than 1 acre, but they may range from a few to many trees in extent and be larger in areas managed for bald eagles and Mexican spotted owls. Old growth groups contain trees having similar age characteristics and conditions. Such groups may include fairly similar tree ages and sizes or combinations of ages and sizes, limited amounts of dead and downed material, and dead trees and spike tops (snags), but they are readily distinguished from adjacent groups having different characteristics. Groups at the mid-aged to old stages consist of 2 to approximately 40 trees per group.

- Dwarf mistletoe is an element of the forest landscape. There is a varied level of mistletoe across the landscape, comparable with historic conditions such that it does not impede achieving and sustaining uneven-aged forest structure. Witches brooms may form on infected trees, providing habitat for wildlife species.
- Large oak trees and pine-oak groups in the Ponderosa Pine Gambel Oak subtype provide cooler, moister microsites and higher overstory diversity than found in the Ponderosa Pine Bunchgrass subtype. Gambel oak acorns provide food for wildlife species.

Mixed Conifer ERUs

All Mixed Conifer ERUs

On the Coconino NF, there are two Mixed Conifer ERUs: Mixed Conifer with Frequent Fire and Mixed Conifer with Aspen. Mixed Conifer ERUs have higher biodiversity and different wildlife assemblages than Ponderosa Pine. They also provide habitat for the Mexican spotted owl (MSO), a threatened species and management indicator species. Recommendations regarding MSO habitat are contained in the Recovery Plan for the MSO (USDI 2012)."

These communities also contain unique features such as mixed conifer stringers—noncontiguous, narrow communities of predominantly Mixed Conifer that extend below their normal elevation distribution into other ERUS. Mixed conifer stringers provide connectivity between two vegetation communities as well as a unique microclimate in lower elevation environments.

Mixed Conifer with Frequent Fire ERU

Mixed Conifer with Frequent Fire is also known as Dry Mixed Conifer. It covers approximately 49,595 acres within lands managed by the Coconino NF and occurs in cooler, moister, and often higher sites than Ponderosa Pine. It primarily occurs on mountain slopes, canyons, and north-facing slopes. This ERU occupies the warmer and drier sites of the mixed conifer life zone and is characterized by a relatively open structure and a historic fire regime of frequent, low-severity fires and infrequent, mixed-severity fires. These conifer forests are dominated by mainly shade intolerant trees such as: ponderosa pine, southwestern white pine, limber pine, and Gambel oak, with a lesser presence of New Mexican locust and big toothed maple. Moderately shade tolerant species such as Douglas-fir and white fir tend to increase in older stages of succession. Aspen may occur as small groups in north-facing slopes, drainages, and other microsites where cooler, moister conditions prevail.

This ERU typically occurs with an understory of graminoids, forbs, and shrubs. The understory is similar to Ponderosa Pine, but it generally has more sedges, mosses, and liverworts. Big toothed maple primarily occurs in some drainages on the southern end of the forest.

Mixed Conifer with Aspen ERU

Mixed Conifer with Aspen is also known as Wet Mixed Conifer or Mixed Conifer with Infrequent Fire. It covers approximately 37,143 acres within lands managed by the Coconino NF and is generally on moister sites than Mixed Conifer with Frequent Fire such as higher elevations on the San Francisco Peaks or along the Mogollon Rim. It may also occur in canyons and north-facing slopes such as on Hutch Mountain and Mormon Mountain. Tree species composition varies depending on seral stage, elevation, and moisture availability. This ERU can be composed of dominant and codominant species such as: Douglas-fir, New Mexico locust, southwestern white pine and limber pine, and late seral species such as maple, white fir, and blue spruce. Ponderosa pine may be present in minor proportions. The absence of significant proportions of Engelmann spruce and/or corkbark fir distinguishes Mixed Conifer with Aspen from the Spruce-Fir ERU.

Disturbances typically occur at two temporal and spatial scales: large scale infrequent disturbances (mostly mixed severity fires at 35 to 200 year frequency or Fire Regime III) and small-scale, frequent disturbances (e.g., fire, insect, disease, wind).

Mixed Conifer with Aspen has an understory with a wide variety of shrubs, grasses, and forbs depending on soil type, aspect, elevation, disturbance, and other factors. In addition, it generally has more sedges, mosses, and liverworts than Mixed Conifer with Frequent Fire and more leaf litter because there are more deciduous species. Lichens may occur on the Douglas-fir trees. Understory vegetation tends to flower more in the spring and, compositionally, be more similar to vegetation in the adjoining Spruce-Fir ERU or in canyons.

Desired Conditions for all Mixed Conifer ERUs

- Mixed Conifer ERUs have a mosaic of trees with varying age classes and understory vegetation which provide habitat for wildlife species, including Mexican spotted owls and northern goshawks; ground cover for functional soil and watersheds; and fuel for fire to occur according to historic ranges of frequency and severity.

- Where they naturally occur, all age classes of maple are present in groups or patches and are regenerating and vigorous. A diverse understory comprised of native herbaceous and shrub species has a variety of seral and age classes and is vigorous and regenerating.

Desired Conditions for Mixed Conifer with Frequent Fire at Landscape Scale (1,000-10,000+ acres)

- At the landscape scale, Mixed Conifer with Frequent Fire is a mosaic of forest conditions composed of structural stages that range from young to old trees. Forest appearance is variable but generally uneven-aged and open; occasional patches of even-aged structure are present. Forest arrangement is in small clumps and groups of trees, interspersed within variably sized openings of graminoids, forbs, and shrubs similar to historic patterns. Openness typically ranges from 10 percent in more productive forested sites to 50 percent in the less productive sites. The size and shape of groups, number of trees per group, and number of groups per area are variable across the landscape. Where they naturally occur, groups of aspen and all structural stages of oak are present. Denser tree conditions exist in some locations such as north-facing slopes and canyon bottoms.

- Old growth structure occurs throughout the landscape, generally in small areas as individual old growth components or as clumps of old growth. Old growth components include old trees, dead trees (snags), downed wood (coarse woody debris). The location of old growth components shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).

Old growth exhibits age-class and structural diversity and is often mixed with groups of younger trees or as individual groups of mostly old trees.

- Mixed Conifer with Frequent Fire is composed predominantly of vigorous trees, but declining trees are a component and provide for snags; top-killed, lightning-scarred, and fire-scarred trees; and coarse woody debris (greater than 3-inch diameter), all well distributed throughout the landscape. Snags, down logs, and coarse woody debris are representative of the species in this vegetation community. Snags are typically 18 inches and above at d.b.h. and, average 3 snags per acre. Downed logs (greater than 12 in diameter at mid-point and greater than 8 feet long) average 3 per acre within forested areas. Coarse woody debris (greater than 3-inch diameter), including down logs, ranges from 5 to 15 tons per acres to maintain long-term soil productivity and provide wildlife habitat.

- The composition, structure, and function of vegetation conditions are resilient to the frequency, extent, and severity of disturbances and to climate variability. The landscape is a functioning ecosystem that contains all its components, processes, and conditions that result from natural levels of disturbances (e.g., insects, diseases, fire, and wind) including: snags, downed logs, and old trees. Graminoids, forbs, shrubs, needle cast (e.g., fine fuels), and small trees maintain the natural fire regime.

- Vegetative ground cover provides protection from accelerated soil erosion, promotes water infiltration, and contributes to soil nutrient cycling, plant and animal diversity, and to ecosystem function. Frequent, low-severity fires (Fire Regime I) are characteristic in this vegetation community, including throughout northern goshawk home ranges. Natural and human-caused disturbances are sufficient to maintain desired overall tree density, structure, species composition, coarse woody debris, and nutrient cycling.

Desired Conditions for Mixed Conifer with Frequent Fire at Mid-Scale (10 to 999 acres)

- At the mid-scale, Mixed Conifer with Frequent Fire is characterized by variation in the size and number of tree groups, depending on elevation, soil type, aspect, and site productivity. The more biologically productive forested sites contain more trees per group and more groups per area. Openings typically range from 10 percent in more productive sites to 50 percent in the less productive sites. Tree density within forested areas generally ranges from 30 to 100 square feet basal area per acre. Denser tree conditions exist in some locations such as north-facing slopes and canyon bottoms.

- The mosaic of tree groups generally comprises an uneven-aged forest with all age classes and structural stages, including old growth. Groups of seedlings and saplings are maintained at sufficient levels to provide a reliable source of replacement as trees grow and progress into succeeding size and age classes. Occasionally small patches (generally less than 50 acres) of even-aged forest structure are present. Disturbances sustain the overall age and structural distribution.

- The natural fire regime in Mixed Conifer with Frequent Fire is a combination of Fire Regimes I and III. Frequent, low severity fires (Fire Regime I) are predominant, including throughout northern goshawk home ranges however Fire Regime III occurs but is less frequent within this ERU. Generally, fires burn on the forest floor and may result in torching of single trees or tree groups. Grasses, forbs, shrubs, and needle cast (e.g., fine fuels) maintain the natural fire regime.

- Basal area per acre for mid-aged to old tree groups in northern goshawk PFAs is 10 to 20 percent higher than northern goshawk foraging areas and the general forest. Northern goshawk nest areas have forest conditions that are multi-aged but are dominated by large trees with relatively denser canopies than other areas in Mixed Conifer with Frequent Fire, consistent with current technical guides for northern goshawk in the southwestern U.S.

Desired Conditions for Mixed Conifer with Frequent Fire at Fine Scale (less than 10 acres)

- Trees typically occur in irregularly shaped groups and are variably spaced with some tight clumps. Crowns of trees within the mid-aged to old groups are interlocking or nearly interlocking. Old growth groups are trees having similar characteristics and conditions. Such groups may include fairly similar tree ages and sizes or combinations of ages and sizes, limited amounts of dead and downed material, and dead trees and spike tops, but they are readily distinguished from adjacent groups having different characteristics (Kaufmann et al., 2007). In local areas, trees are randomly distributed. Interspaces surrounding tree groups and patches are variably shaped and comprised of a mix of graminoids, forbs, and shrubs. Some natural openings contain individual trees or snags.

- Trees within groups are of similar or variable ages and one or more species. Size of tree groups typically is less than 1 acre. Groups at the mid-age to old stages consist of approximately 2 to 50 trees per group.

- Dwarf mistletoe is an element of the forest landscape. There is a varied level of mistletoe across the landscape, comparable with historic conditions such that it does not impede achieving and sustaining uneven-aged forest structure. Witches brooms may form on infected trees, providing habitat for wildlife species.

Desired Conditions for Mixed Conifer with Aspen at Landscape Scale (1,000-10,000+ acres)

- At the landscape scale, Mixed Conifer with Aspen is a mosaic of structural and seral stages ranging from young trees to old. The landscape arrangement is an assemblage of variably sized and aged groups of trees and other vegetation similar to historic patterns. Tree groups and patches are comprised of variable species composition depending on forest seral stages. Patch sizes vary but are frequently in the hundreds of acres, with rare disturbances in the thousands of acres. An approximate balance of seral stages is present across the landscape; each seral stage is generally characterized by distinct dominant species composition and biophysical conditions. Canopies are generally more closed than in Mixed Conifer with Frequent Fire. An understory consisting of native graminoids, forbs, and/or shrubs is present.

- Old growth structure generally occurs over large areas as stands or patches where old growth components are concentrated. Old growth components include old trees, dead trees (snags), downed wood (coarse woody debris), and structural diversity. The location of old growth components shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality).

- Mixed Conifer with Aspen is composed predominantly of vigorous trees, but older declining trees are a component and provide for snags, top-killed, lightning- and fire-scarred trees, and coarse woody debris, all well-distributed throughout the landscape. Number of snags and the amount of downed logs (>12 inch diameter at mid-point, >8 feet long) and coarse woody debris (>3 inch diameter) vary by seral stage.

- The composition, structure, and function of vegetation conditions are broadly resilient to the varying frequency, extent, and severity of disturbances and climate variability. The forest landscape is a functioning ecosystem that contains all its components, processes, and conditions that result from natural levels of disturbances (e.g., insects, diseases, wind, and fire), including: snags, downed logs, and old trees. Mixed severity fire (Fire Regime III) is characteristic, especially at lower elevations. High-severity fires (Fire Regimes IV and V) rarely occur and are typically at higher elevations. Natural and human disturbances are sufficient to maintain desired overall tree density, structure, species composition, coarse woody debris, and nutrient cycling. Vegetative ground cover provides protection from accelerated soil erosion, promotes water infiltration, and contributes to soil nutrient cyclying, plant and animal diversity, and to ecosystem function. Mosses and lichens are prevalent and function for recycling soil nutrients.

Desired Conditions for Mixed Conifer with Aspen at Mid-Scale (10 to 999 acres)

- At the mid-scale, the size and number of groups and patches vary depending on disturbance, elevation, soil type, aspect, and site productivity. Groups and patches of tens of acres or less are relatively common. A mosaic of groups and patches of trees, primarily even-aged, but variable in size, species composition, and age is present. Openness and prevalence of some species (e.g. aspen) is dependent on seral stages. Grass, forb, and shrub openings created by disturbance may comprise 10 to 100 percent of the mid-scale area, depending on the disturbances and on amount of time since disturbance. Aspen is occasionally present in large patches.

- Tree density ranges from 20 to 180 square feet basal area per acre depending upon age, site productivity, time since disturbance and seral stages of groups and patches. Snags 18 inches or greater at d.b.h. average from 1 to 5 snags per acre, with the lower range of snags of this size associated with early seral stages and the upper range associated with late seral stages. Snag density in general (greater than 8 inches d.b.h.) averages 20 per acre and provides wildlife habitat and future downed logs. Coarse woody debris, including downed logs, varies by seral stage, with averages ranging from 5 to 20 tons per acre for early seral stages; 20 to 40 tons per acre for mid-seral stages; and 35 tons per acre or greater for late-seral stages. Coarse woody debris and logs provide for long term soil productivity.

- Fire severity is mixed or high, with a fire return interval of 35 to 200 or more years (Fire Regimes III, IV, and V). Fire and other disturbances maintain desired overall tree density, structure, species composition, coarse woody debris, and nutrient cycling. During moister conditions, fires exhibit smoldering low-intensity surface behavior with single tree and isolated group torching. Under drier conditions, fires exhibit passive to active crown fire behavior with conifer tree mortality up to 100 percent across mid-scale patches. High-severity fires generally do not exceed 1,000-acre patches of mortality. Other smaller disturbances occur more frequently.

Forest conditions in northern goshawk post-fledgling family areas (PFAs) are similar to general forest conditions except PFAs typically contain 10 percent or greater tree density (basal area) than northern goshawk foraging areas and the general forest. Nest areas in Mixed Conifer with Aspen have forest conditions that are multi-aged but are dominated by large trees with relatively denser canopies than other areas.

Desired Conditions for Mixed Conifer with Aspen at Fine Scale (less than 10 acres)

- In mid-aged and older forests, trees are typically variably spaced with crowns interlocking (grouped and clumped trees) or nearly interlocking. Trees within groups can be of similar or variable species and ages. Locally, patches of random tree distribution are present.

- Small openings are present as a result of disturbances. Some openings may support grasses, forbs, and shrubs and provide habitat for species such as Colorado blue columbine, Rusby milkvetch, Oregon willow herb, and timberland blue-eye grass.

Grasslands

Terrestrial ERUs include forest, woodlands, shrublands, and grasslands. Riparian ERUs are described under Riparian Forests. One of the factors that distinguish grasslands from forest and woodland ERUs is canopy cover. In the plan, grasslands are those areas that have less than 10 percent canopy cover of overstory species and forest and woodland ERUs have 10 percent or greater canopy cover.

Table 6 provides the relative proportion of terrestrial ERUs on the Coconino NF. It also shows the percentage of plants known to be used by tribes that traditionally use the forest. For example, 57 percent of the plants known to be used by tribes occur within Desert Communities ERU. This is intended to show the relative importance of an ERU for culturally important plants. These percentages exceed 100 percent because some plant species are found in multiple ERUs.

General Description and Background for Grassland ERUs

The Coconino NF has three different grassland ERUs: Semi-desert Grassland, Great Basin Grassland, and Montane/Subalpine Grassland. One of the defining characteristics of grasslands is the amount of canopy cover, generally less than 10 percent. Many of these grasslands within the forest boundary are at least partially in private ownership. Semi-desert Grassland, Great Basin Grassland, and the montane portion of Montane-Subalpine Grassland ERUs provide habitat for pronghorn, a management indicator species.

Great Basin Grasslands

Great Basin Grassland ERU covers approximately 92,842 acres of the Coconino NF within lands managed by the Coconino NF. These grasslands are more arid than Montane/Subalpine Grassland ERU. Typical locations are Anderson Mesa and near Wupatki National Monument. They consist mostly of grasses with smaller amounts of forbs and shrubs. Trees can be present in trace amounts depending on the soil; however, tree canopy is increasing in some areas, especially in the northeast part of the forest around Wupatki National Monument. Species include, but are not limited to, western wheatgrass, black grama, blue grama, galleta grass, hairy grama, spike muhly, and needle and thread grass. Trees may include sparse one-seed juniper, alligator juniper, red berry juniper, Utah juniper, and Colorado pinyon pine. Natural disturbances are weather, low intensity fire (from adjacent ERUs), and natural soil movement (e.g., natural shrink–swell and seasonal surface cracking).

Montane/Subalpine Grasslands

The higher elevation Montane/Subalpine Grassland ERU covers approximately 23,656 acres within lands managed by the Coconino NF. Typical locations of the montane portion include Kendrick Park, Antelope Park, and Bargaman Park whereas the subalpine portion is located on the San Francisco Peaks, on deeper soils with warmer, drier aspects than adjacent mixed conifer or spruce-fir vegetation. This ERU is more productive than Great Basin, and Semi-desert Grassland ERUs.

In the Montane portion of this ERU, species include, but are not limited to muttongrass, mountain muhly, spike muhly, Arizona fescue, blue grama, red three-awn, squirreltail, yarrow, and pine dropseed. Non-native Kentucky bluegrass is present. Vegetation in some of the

Montane Grassland soil types is maintained by fire. Trees occur along the periphery of Montane Grasslands and tree canopy is increasing in some areas. These grasslands are susceptible to channel and gully erosion which can then result in lowering of the seasonal, perched water table. Natural disturbances are weather, low intensity fire (from adjacent ERUs), and natural soil movement (e.g., natural shrink–swell and seasonal surface cracking). Montane Grasslands were the focus of late 1800s and early 1900s homesteading activity within the ponderosa pine.

The Subalpine portion of this ERU covers approximately 2,462 acres within lands managed by the Coconino NF. It is more productive than the montane portion because annual precipitation is higher and there are higher amounts of soil organic matter. The subalpine portion may harbor several plant associations with varying dominant grasses and herbaceous species. Such dominant species may include: pine dropseed, nodding brome, various sedges, Arizona fescue, mountain junegrass, mountain muhly, muttongrass, and squirreltail. Trees may occur in trace amounts within these grasslands and along their periphery. Shrubs may also be present. Subalpine meadows are seasonally wet and closely tied to snowmelt. They are often maintained by fire from adjacent ERUs.

Desired Conditions for Grassland ERUs at the Landscape Scale (1,000-10,000+ acres)

- Grasslands are open areas with limited trees and shrubs on soils classified as Mollisol or those with relatively thick organic surfaces. Grasslands are dominated by native grasses, forbs and annuals that regenerate successfully in most years depending on seasonal climatic conditions. Succulents are present on more arid sites. Overall plant composition is similar to site potential and within the natural range of variability but can vary considerably at the fine- and mid-scales due to topography, soils, and smaller scale disturbances. Productivity and composition of understory vegetation varies. The composition and structure of vegetation shifts on the landscape over time as a result of succession and disturbance and reflects a mix of early, middle, and late seral stages. Early seral stages will typically contain more forbs, and as stages get older, they are dominated by more grasses and fewer forbs.

- Native understory vegetation is capable of supporting frequent surface fires (Fire Regime II). Invasive annuals do not alter the fire regime.

- Grasslands are connected based on the distribution of soils and are not fragmented.

- A mix of cool and warm season understory species, with a diverse structure, provide food and cover for invertebrates and wildlife, including pronghorn.

Desired Conditions for Grassland ERUs at the Mid-Scale (10 to 999 acres)

- Arroyos and gullies are stabilizing and recovering in Semi-desert Grasslands. Improved water infiltration reduces arroyos and gullies and prevents head cuts from forming in drainages.

- In Montane Grasslands, soil surface structure is granular or well aggregated to promote water infiltration and reduce runoff. Natural surface drainages and subsurface flow patterns maintain waterflow into connected waterbodies or streams.

Desired Conditions for Grassland ERUs at the Fine Scale (less than 10 acres)

- Trees occur as individuals but occasionally in smaller groups.
- Within site capability, a mosaic of vegetation patches are present. Vegetation density within these small patches ranges from densely vegetated areas that provide cover for ground-nesting birds and pronghorn fawns to bare areas that result from natural processes such as freeze–thaw action, erosion, drought, or prairie dog burrowing.
- Populations of big sacaton grass (Sporobolis wrightii) are reproducing sustainably and expanding on suitable habitat on the Red Rock Ranger District.

Tonto National Forest Plan Vegetation Direction

Forest-wide Direction

See 1996 plan amendment - regionally consistent direction for MSO habitat – ponderosa pine, mixed conifer, pine-oak

See 1996 plan amendment regionally consistent direction for ponderosa pine, mixed conifer and woodland in goshawk habitat – LOPFA and within PFA

Old Growth

Until the forest plan is revised, allocate no less than 20 percent of each forested ecosystem management area to old growth as depicted in the table in Appendix L, page 271.

In the long term, manage old growth in patterns that provide for a flow of functions and interactions at multiple scales across the landscape through time.

Allocations will consist of landscape percentages meeting old growth conditions and not specific acres.

All analyses should be at multiple scales - one scale above and one scale below the ecosystem management areas. The amount of old growth that can be provided and maintained will be evaluated at the ecosystem management area level and be based on forest type, site capability, and disturbance regimes.

Strive to create or sustain as much old growth compositional, structural, and functional flow as possible over time at multiple area scales.

Seek to develop or retain old growth function on at least 20 percent of the naturally forested area by forest type in any landscape.

Use information about pre-European settlement conditions at the appropriate scales when considering the importance of various factors.

Consider the effects of spatial arrangement on old growth function, from groups to landscapes, including de facto allocations to old growth such as goshawk nest sites, Mexican spotted owl protected activity centers, sites protected for species behavior associated with old growth, wilderness, research natural areas, and other forest structures managed for old growth function.

In allocating old growth and making decisions about old growth management, use appropriate information about the relative risks to sustaining old growth function at the appropriate scales, due to natural and human-caused events.

Use quantitative models at the appropriate scales when considering the importance of various factors. These models may include, but are not limited to: Forest Vegetation Simulator, BEHAVE, and FARSITE.

Forested sites should meet or exceed the structural attributes to be considered old growth in the five primary forest cover types in the southwest as depicted in the table in Appendix L, page 271.

Riparian

Coordinate with range to achieve utilization in the riparian areas that will not exceed 20% of the current annual growth by volume of woody species.

Coordinate with range to achieve at least 80% of the potential riparian overstory crown coverage.

Coordinate with range to achieve at least 50% of the cottonwood-willow and mixed broadleaf acres in structural Type 1 by 2030.

Rehabilitate at least 80% of the potential shrub cover in riparian areas through the use of appropriate grazing systems and methods.

Identify and delineate the home range of all bald eagle breeding areas.

Document and correct any resource conflicts and disturbances to bald eagles and their habitat. During portions of any year that a bald eagle's nest site is active, an appropriate area of land surrounding the nest will be closed to public entry if such closure is necessary.

Manage the warm water non-game type streams to support Gila sucker and longfin dace.

Any surface or vegetation disturbing projects in riparian areas will be coordinated and will specify protection or rehabilitation of riparian- dependent resources. For example, the required planting of large cottonwood poles in 7MileWash by Arizona Department of Transportation (ADOT).

Conduct surveys and write reports on allotments scheduled for re-analysis and possible stocking adjustments. Allow for forage to maximize Threatened and Endangered (T&E) species, management indicator species, and emphasis harvest species.

Rehabilitate and maintain, through improved management practices, mixed broadleaf riparian to achieve 80% of the potential overstory crown coverage. Natural regeneration is anticipated to achieve most of this goal. Artificial regeneration may be necessary in some areas.

Re-establish riparian vegetation in severely degraded but potentially productive riparian areas. Natural regeneration is anticipated to achieve this goal, but artificial regeneration may be necessary in some areas.

Rehabilitate cottonwood willow Type 11 to achieve conversion to Type 1 by the year 2030. Natural regeneration is anticipated to achieve most of this goal, but artificial regeneration may be necessary in some areas.

Provide wildlife access and escape ramps on all livestock and wildlife water developments.

Provide a minimum of four waters per section in small game and one water per section in big game key areas.

Maintain all habitat improvements to condition Level 2 on a five-year schedule.

Bat roosts and other sensitive biological resources within caves will be managed using all appropriate means identified in the Cave Implementation Plan.

Continue close coordination with State and other federal agencies for the benefit of plant and animal species.

Cooperate and consult with the Arizona Game and Fish Department, U.S. Fish andWildlife Service, State universities, professional societies, and various conservation organizations regarding proposals and programs concerned with management of wildlife habitat.

Maximize coordination with the U.S. Fish andWildlife Service regarding federal T&E plant and animal species and their habitats.

Maximize coordination with the Arizona Game and Fish Department regarding State listed species and their habitats.

Survey, study and assess the status of candidate species on a priority basis. Identify, document and correct any management conflicts to the species or their habitats.

Forest Plan Amendments

The Forest Plan for the Tonto National Forest was written in 1985 and was most recently amended in 2011. The Forest Plan revision process is underway but it is unlikely to be completed before the this analysis has been completed. Three non-significant Forest Plan Amendments would be required on the Tonto National Forest to implement the management actions that would meet the goals and objectives of the Rim Country Project. For this report, amendments 1 and 2 have relevance.

Tonto NF Plan Amendment (1): Mexican Spotted owl: The 1985 Tonto Forest Plan, as amended, includes direction from the former (1995) Mexican Spotted Owl Recovery Plan. There is a need for the Rim Country analysis to be in alignment with the management direction provided in the revised Recovery Plan and the other forest plans that are part of this landscape EIS. A project-specific plan amendment was written in order to bring the Tonto FP into alignment and is included in Appendix 1.

Tonto NF Plan Amendment (2): Ponderosa pine vegetation types: There is a need for the Rim Country analysis to be in alignment with the Apache-Sitgreaves and Coconino NF revised forest plan management direction. The revised forest plans reflect a change in conditions since the 1980s including acknowledgement that vegetation conditions (structure, composition, and function) are divergent from reference conditions and forest conditions indicate a substantial departure from the natural fire regime. The revised plans use the latest best available science and information. Because a final Tonto National Forest revised forest plan is not expected until 2019, an amendment is needed to:

- Replace forest plan standards and guidelines for ponderosa pine/bunchgrass, ponderosa pine/Gambel oak, ponderosa pine/evergreen oak, dry mixed conifer and old growth with desired conditions and guidelines

- Add a desired condition for the percentage of interspaces within uneven-aged stands to facilitate restoration.

- Add the desired interspaces distance between tree groups.
- Add a definition to the forest plan glossary for the terms interspaces and openings.

Mexican Spotted Owl Recovery Plan

This silviculture specialist report utilizes terminology consistent with the 2012 MSO Recovery Plan (USDI 2012). What follows is a general discussion of the relationship of this environmental analysis to(USDI 2012). For a more thorough discussion, consult the Wildlife Specialist Report in the project record.

Below are the levels of management are recommended in this Recovery Plan (FWS.2012):

1. **Protected Activity Centers (PACs).** PACs encompass a minimum of 600 acres surrounding known owl nest/roost sites. Management recommendations are most conservative within PACs, but by no means advocate a “hands-off” approach. The Recovery Team recognizes situations exist where management is needed to sustain or enhance desired conditions for the owl, including fire-risk reduction, as well as monitoring owl response. Mechanical treatments in some PACs may be needed to achieve these objectives; determining which PACs may benefit from mechanical treatments requires a landscape analysis to determine where the needs of fire risk reduction and habitat enhancement are greatest. PACs are the only form of protected habitat included in this revised Plan.

2. **Recovery habitat.** This habitat is primarily ponderosa pine-Gambel oak, mixed-conifer, and riparian forest that either currently is, or has the potential for becoming, nest/roost habitat or does or could provide foraging, dispersal, or wintering habitats.

3. **Recovery Nesting/roosting habitat**: This habitat typically occurs either in well-structured forests with high canopy cover, large trees, and other late seral characteristics, or in steep and narrow rocky canyons formed by parallel cliffs with numerous caves and/or ledges within specific geologic formations. Ten to 25 percent of forested recovery habitat should be managed as recovery nest/roost habitat varying by forest type and Ecological Management Unit (EMU). This habitat should be managed to replace nest/roost habitat lost due to disturbance (e.g., fire) or senescence and to provide additional nest/roost habitat to facilitate recovery of the owl. The remainder of forested recovery habitat should be managed for other needs (such as foraging, dispersing, or wintering) provided that key habitat elements are retained across the landscape.

4. **Other forest and woodland types**, such as ponderosa pine forest, spruce-fir forest, and pinyon-juniper woodland. No specific management is suggested for these habitat types, recognizing that current emphasis for sustainable and resilient forests should be compatible with needs of the owl.

Protected Activity Centers (PACs): ALLOWED ACTIVITIES

1) All activities within PACs should be coordinated with the appropriate FWS office.

2) No mechanical or prescribed fire treatments should occur within PACs during the breeding season unless non-breeding is inferred or confirmed that year per the accepted protocol.
3) Removal of hardwoods, downed woody debris, snags, and other key habitat variables should occur only when compatible with owl habitat management objectives as documented through reasoned analysis.
4) Road or trail maintenance, repair, and building in PACs should be undertaken during the non-breeding season (September 1 to February 28) to minimize disturbance to owls unless non-breeding is inferred or confirmed that year per the accepted survey protocol. It is recommended that no new roads or construction occur in PACs.
5) Within all PACs, light burning of surface and low-lying fuels may be allowed following careful review by biologists and fuel-management specialists. Generally, burns should be done during the non-breeding season (September 1 to February 28) unless non-breeding is inferred or confirmed that year per the accepted protocol.
6) In some situations prescribed fire alone may be insufficient to reduce fuels and protect PACs.

Mechanical treatments used singly or in combination with prescribe fire may be needed to reduce fire risk to owl nest/roost habitats and may enhance owl habitat. As a general guide, forest management programs in PACs should be structured as follows:

***Strategic Placement of Treatments*.** Conduct a landscape-level risk assessment to strategically locate and prioritize mechanical treatment units to mitigate the risk of large wildland fires while minimizing impact to PACs. Treatments should also strive to mimic natural mosaic patterns.
***Area Limitations*.** Mechanically treat as needed up to 20% of the non-core PAC area *within an EMU* identified through the landscape-level assessment. This landscape proportion may be allocated flexibly. That is, this does not mean that 20% of each PAC should be treated, or that only 20% of any PAC can be treated. Treatment placement and extent should be guided by fire modeling as discussed above.
Designate Nest/Roost Core. Within each PAC identified for treatment, designate a 40-ha (100-ac) nest/roost core area as described above.
Types of Treatments. Within the remaining PAC acreage (202+ ha [500+ ac]), combinations of mechanical and prescribed fire treatments may be used to reduce fire hazard while striving to maintain or improve habitat conditions for the owl and its prey (see desired conditions in Table C.2).
***Seasonal Restrictions*.** Treatments should occur during the non-breeding season (1 Sep - 28 Feb) to minimize disturbance to resident owls during the breeding season, unless nonbreeding is inferred or confirmed that year per the accepted survey protocol.

Recovery Habitat and Nest/Roost (Mixed conifer, pine-oak, and riparian forests):

Recovery Habitat

For planning purposes in Forested Recovery Habitat, there are two types of stands with respect to desired nest/roost conditions: those that meet or exceed the conditions and those that do not. The overriding goal is to manage a specified portion of the landscape (Figure 3) as recovery nest/roost habitat. Thus, managers should identify and protect stands that meet or exceed nest/roost conditions and then assess whether or not these stands satisfy the area requirements in Table C.3. If these stands are not sufficient to meet the area Requirements in Table C.3, managers should identify those stands in the planning area that come closest to meeting nest/roost conditions and manage those stands to develop nest/roost conditions as rapidly as reasonably possible to meet recommended percentages. Prescriptions may include thinning to promote growth of large trees. Stands that do not meet nest/roost conditions and are not designated for development of such can be managed to meet other resource objectives.

Forested stands meeting or exceeding owl nest/roost conditions:

- Manage for nest/roost replacement habitat.
- Do not treat stands in such a way as to lower stand conditions below thresholds in Table C.2
- Emphasize attainment of nest/roost conditions as quickly as reasonably possible.
- Retain large trees.
- Strive for spatial heterogeneity.
- Manage for species diversity.
- Retain key owl habitat elements (e.g., large trees, large snags, large logs, hardwoods, etc.).
- Emphasize large hardwoods, where appropriate

Forested stands managed to provide foraging, dispersal, wintering, or other habitat needs:

- Emphasize large hardwoods, where appropriate
- Retain key owl habitat elements (e.g., large trees, large snags, large logs, hardwoods, etc.).
- Minimize tree removal.

Riparian Recovery Habitat:

- Manage for proper functioning ecological conditions.
- Manage for species diversity.
- Manage grazing effects.
- Minimize construction activities.
- Maintain key habitat components (e.g., large trees, large snags, large logs, hardwoods, etc.).
- Minimize tree removal.

Riparian areas

Emphasize maintenance and restoration of healthy riparian ecosystems through conformance with LRMP's riparian Desired Conditions. Management strategies should move degraded riparian vegetation toward good condition as soon as possible. Damage to riparian vegetation, stream banks, and channels should be prevented.

Nesting and Roosting Threshold Conditions

Forested stands used by spotted owls have certain structural features in common. These conditions do not, or cannot, occur everywhere.

Criteria for Nest/Roost conditions uses tree basal area, large tree (>45.7 cm [18 inches] d.b.h.) density, and tree size-class distribution as the variables to define nest/roost conditions. These are summarized below in Table C.3.(USDI 2012).

Table C.3. Minimum desired conditions for mixed-conifer and pine-oak forest areas managed for Recovery nesting/roosting habitat. Forest types are defined in Appendix C, above. Parameter values are based on averages among plots sampled within forest stands. Numbers of stands included in analysis: 74 for Basin and Range-East (BRE), 27 for mixed-conifer forest in other EMUs, and 47 for pine-oak forest.

EMU(s) Forest Type	% of area[1]	% BA by size class		Minimum tree BA[2]	Minimum density of large trees[3]
		30-46 cm dbh (12-18 in)	>46 cm dbh (>18 in)		
BRE Mixed-conifer	20	>30	>30	33.3 (145)	37 (15)
CP, UGM, SRM, BRW Mixed-conifer	25	>30	>30	27.5 (120)	30 (12)
CP[4], UGM, BRW Pine-oak	10	>30	>30	25.3 (110)	30 (12)

[1] % of area pertains to the percent of the planning area, subregion, and/or region in the specified forest type that should be managed for threshold conditions.

[2] BAs in m^2/ha (ft^2/acre), and include all trees >1 inch dbh (i.e., any species). We emphasize that values shown are **minimums**, not targets.

[3] Trees > 46 cm (18 inches) dbh. Density is tree/ha (trees/acre). Again, values shown are minimums rather than targets. We encourage retention of large trees.

[4] Pine-oak forest type: ≥10% of the stand BA or 4.6 m^2/ha (20 ft^2/ac) of BA consist of Gambel oak ≥ 13 cm (5 in) drc.

[5] Pine-oak recommendations apply only to the Mount Taylor and/or Zuni Mountains regions within the CP EMU.

Figure 3. Desired Conditions for Mixed Conifer and Pine Oak Forests Managed for MSO Recovery Nesting/Roosting Habitat (Taken from USDI 2012).

Northern Goshawk Habitat

What follows is a general discussion of the relationship of this environmental analysis document to the three Forest Plans. For a more thorough discussion, consult the Wildlife Specialist Report.

The three LRMP's covering this analysis use GTR-217 (R. T. Reynolds and others 1992) to inform the Desired Conditions within the Ponderosa Pine and Dry Mixed Conifer forest types within Northern Goshawk (NOGO) habitat, but is not implicitly used to describe the management guidelines for the NOGO. Northern Goshawk Desired Conditions are described at the mid-scale (100-1,000 acres) in both the Ponderosa Pine and Mixed Conifer forest types in the following terms:

- Northern goshawk post-fledging family areas (PFAs) may contain 10 to 20 percent higher basal area in mid-aged to old tree groups than northern goshawk foraging areas and the surrounding forest.
- Northern goshawk nest areas have forest conditions that are multi-aged and dominated by large trees with relatively denser canopies than the surrounding forest.

Snags and Large Trees in MSO and NOGO Habitats

Large live trees and large snags (>18" dbh) play a significant role in habitat structure for many species, but are of particular interest within MSO and NOGO habitats.

Snag density calculations are based on Common Stand Exam that dates back to 1990 and newer. Snags, being dead trees and considered standing fuels are tracked within the Fire and Fuels Extension of FVS. Snag fall rates, in general, occur at about 3-5% per year within the first 10 years (Schmid et al. 1985(Passovoy and Fulé 2006)) The FVS tracks the initial inventory of snags from the CSE, the creation of snags as trees die, and the fall rate as snags decompose. As snags fall they move the biomass from standing dead (snag) and into down woody debris and they become a component of the surface fuels calculations. Accounting for snags at the fine- and mid-scale is a very dynamic exercise and all calculations should be considered approximations for any given time period based on climate, management, and fire histories.

Chambers and Mast (Carol L. Chambers and Mast 2005; C. L. Chambers and Mast 2014) found high occupancy of cavity nesting birds (81%) when the snag was larger than 40cm (15.7") and had a broken top, with increased longevity when killed by fire when compared to bark beetles. Ganey (Ganey 2015) in an extensive study of snag retention in northern Arizona, concluded that: "…many cavity snags were smaller in diameter or shorter than some of the recommended minimum size criteria. This suggests that it may be feasible to reduce these minimum size criteria while still providing nest substrates for cavity-nesting birds."

Required Monitoring

Areas proposed for harvest under selection cutting can be regenerated using standard reforestation techniques. The reforestation technique and range of desired stocking will be documented in a formal silvicultural prescription. These areas will be monitored by the implementation silviculturist to ensure the areas meet the prescribed post treatment stocking. If the areas do not meet desired stocking after 5 years, conditions that are inhibiting regeneration will be identified and remedial action may be prescribed to ensure regeneration.

Proposed mechanical treatments (thinning) are designed to establish interspace percentages of approximately 10%, 25%, 40%, and 55% to establish uneven-aged stand structure (UEA), to mitigate adverse dwarf mistletoe impacts (Intermediate thin –IT), or to improve stand structure and health in younger stands (Stand Improvement – SI) depending on stand existing conditions, site quality (site index, soils, aspect, elevation, etc.) and LRMP Desired Conditions.

The project area is extensive; therefore, the silviculture analysis is stratified by 5th Hydrologic Unit Code and all existing forest cover types (Table 7) (Figure XX).

A need for change (vegetation structure, pattern, spatial arrangement, potential for destructive fire behavior and effects) was identified for each targeted cover type.

Assumptions and Methodology

The basic unit for characterizing of vegetation conditions is the stand. All lands within the Apache-Sitgreaves, Coconino and Tonto National Forests are delineated into stands based on similar characteristics such as vegetation cover type, slope, aspect, species composition, aerial photo interpretation signatures, and management history. Stands vary in size depending upon their uniformity; within the Rim Country Project this is from less than one acre up to 1,324 acres. Spatial and general vegetation information about each stand is stored in the stand database for each forest within the Forest Service Field Sampled Vegetation (FSVeg) database.

The focus of the Rim Country Project is the restoration of resistance, resiliency, and ecological function within the frequent, low-severity fire ecosystems of the ponderosa pine, ponderosa pine-Gambel oak, ponderosa pine-evergreen oak, and dry mixed conifers forests that constitutes the project area.

This analysis of the Rim Country Project EIS emphasizes the Existing Conditions (EC) of the Ponderosa Pine Ecosystem forest cover types within the analysis area with detailed analysis within areas defined by a frequent-fire/low severity fire regime and their degree of departure from their Desired Conditions (DC) and Natural Range of Variation (NRV). The forest cover types of interest are Ponderosa Pine, Ponderosa Pine/Gambel Oak, Ponderosa Pine/Evergreen Oak, and Dry Mixed Conifer as defined in Forest Plans for the Apache-Sitgreaves NF (2015), Coconino NF (2018), and the Tonto NF (1987). Additional analysis will be conducted to determine the need for treatment in other cover types such as: Aspen, Riparian, Grassland/ Meadow, and Savanna. Ranges of values presented in Desired Conditions reflect varying multiple use needs and/or their natural variation in their vegetation composition and structure due to soils, elevation, and aspect. The desired conditions do not necessarily represent historical reference conditions, since it may not be possible, nor desirable, to return to that condition (Apache-Sitgreaves NF, 2015) and would be defined as Functional Restoration (FR) activities (FSM 2020).

The analysis of the forested landscapes within the Rim Country Project EIS takes several forms. The majority of the proposed treatment area represents forest types that are highly departed from their Desired Conditions because their existing condition represents extremely high densities in Basal Area (BA), Trees Per Acre (TPA), Stand Density Index (SDI), loss of understory diversity, and these areas are at high risk of major disturbances from uncharacteristic fire behavior, insects and disease, density-related mortality, and climate change. Some areas are highly departed from their desired conditions caused by disturbances from fire, insects and diseases, grazing, herbivory, and past management activities and stand densities are below their Desired Condition for stocking and represent a need to address reforestation. Some areas, because of past management activities are at, or near, their Desired Condition but still may indicate a need for treatment for their lack of desired forest structure in composition, spatial arrangement and group structure. The intent of the proposed treatments will bring these areas back to, or towards, their Desired Conditions and help to establish a sustainable, resistant, resilient, and functioning ecosystems.

Data Rounding

Data is typically reported to the nearest acre, mile, or percentage. Most values have been rounded from their actual decimal values. Totals were calculated before any values were rounded in order to give the most accurate sum. Any apparent inconsistency between the total values reported in a table and a sum resulting from adding up individual values in a table typically accounts for a discrepancy of about 1 percent in the case of rounding percentages or miles, and less than 2 acres in the case of acres.

In an attempt to avoid confusion over these kinds of inconsistencies, minor adjustments to the numbers in the EIS document were made to allow for numbers in tables to add up correctly as displayed. As a result, some numbers may not be exactly the same in the EIS document as compared to this report. The numbers in this report are the most accurate and any differences do not alter any determination of effects.

Stand Data and Modeling

Stand exam data is an average characterization of the area within the stand boundaries. It is limited by sampling intensity and the variability within the sampled area.

Comprehensive tree data has been collected on a subset of the stands within the project area over the last 25 years. Within each sampled stand, tree characteristics were measured at sample points, using both variable basal area factor plot and fixed plot designs. Specific tree data collected includes species, class, diameter, height, age, growth, damage and disease. Other data sometimes collected depending on design included surface fuels and understory plant species. This stand data is currently stored in the Field Sampled Vegetation (FSVeg) database which is a standard national (Forest Service wide) database used to store field sampled data in a common format. A thorough review of the stand data was done for the project area to ensure validity. Data that did not match on the ground conditions or minimum sampling intensity was culled. Approximately 34 percent of the ponderosa pine forest type within the analysis area has current stand exam data. The remaining area either had no data collected, or the data was no longer valid.

Tree data used in the vegetation analysis of the forest and woodland areas within the analysis area has come from stand exam data (discussed above) and several Nearest Neighbor Analysis computer program within the NRM FSVeg Spatial Data Analyzer. Tree data from the “Reference Stand” is then imputed to the “Child Stand”. The quality of MSN imputations is controlled by the extent to which the sample of reference observations covers the range of variation expected in the project observations. For this project area, the reference observations adequately cover the majority of forested conditions within the ponderosa pine and mixed conifer cover types. However, there are fewer reference observations for the other cover types therefore the imputations within these cover types may have reduced reliability. Approximately 27 percent of analysis acres have stand exam data and the Nearest Neighbor analysis was used to impute data for the remainder of the analysis acres. Of the acres imputed by the Nearest Neighbor methodology, 88 percent of acres meets the criteria for being a Reference Stand or having Above Threshold imputation quality. The remaining 12 percent was below the threshold. (Cite DA Documentation). Below Threshold imputation quality does not mean that the imputation was not used or that the imputation is not accurate, just that the model fit was less than our threshold value. Table 2 summarizes the category of the data for the forested areas within the analysis area.

Table 2. Imputation quality by vegetation cover type

Vegetation Cover Type	Above Threshold	Below Threshold	Reference	Grand Total
Aspen	1%	75%	25%	100%
Grassland/Meadow	0%	100%	0%	100%
Madrean Woodland	34%	57%	9%	100%
Mixed Conifer with Aspen	7%	53%	40%	100%
Mixed Conifer/Frequent Fire	23%	49%	28%	100%
Pinyon-Juniper Woodland	7%	73%	20%	100%
Ponderosa Pine	5%	64%	31%	100%
Ponderosa Pine/Evergreen Oak	15%	65%	20%	100%
Riparian	24%	57%	19%	100%
Grand Total	9%	64%	27%	100%

All of the stand data was then compiled within NRM FSVeg Data Analyzer and modeled in the Forest Vegetation Simulator (FVS). The FVS is a model used for predicting forest stand dynamics throughout the United States and is the standard model used by various government agencies including the USDA Forest Service, USDI Bureau of Land Management, and USDI Bureau of Indian Affairs (Dixon 2015). The FVS is an individual tree, distance independent growth and yield model with linkable modules called extensions, which simulate various insect and disease impacts, fire effects, fuel loading, snag dynamics, carbon pools (internal and external), climate effects, and development of understory tree vegetation. FVS can simulate a wide variety of forest types, stand structures, and pure or mixed species stands (Keyser and Dixon 2017). Forest managers have used FVS extensively to summarize current stand conditions, predict future stand conditions under various management alternatives, and update inventory statistics.

Geographic variants of FVS are developed for most of the forested lands in the United States. New "variants" of the FVS model are created by imbedding new tree growth, mortality, and volume equations for a particular geographic area into the FVS framework(Keyser and Dixon 2017). The Central Rockies (CR) variant covers all forested land in Forest Service Regions 2 and 3 and was used in the vegetation analysis for this project area. This variant was initially developed in 1990 and has been continually updated to correct known deficiencies and quirks, take advantage of advances in FVS technology, incorporate additional data into model relationships, and improve default values and surrogate species assignments (Keyser and Dixon 2017).

All data was updated to the base year 2019. This process allowed characterization of the current stand conditions and determination of the need for change and appropriate treatments based on the project purpose and need. A combination of field reconnaissance, GIS analysis and review of stand data is used to determine treatment needs, logging feasibility, and stand health (see the project record for more details on the development of the proposed action). The FVS was used to simulate cutting and prescribed burning treatments, growth and yields, carbon stocks, and climate change following treatment for each alternative up to the year 2049.

For simulation purposes, each data set was grouped by current forest type, site class, stand structure, and treatment type. Simulations were developed for each treatment based on LRMP Desired Conditions, relevant Recovery Plans, soils, TES, and other considerations concerning other resources. A multitude of vegetation and fuels attributes were computed for each growth cycle. Attributes include tree density (trees per acre, basal area and stand density index) by species or species groups and Diameter Size Class (old VSS), dwarf mistletoe infection, insect hazard, cubic feet of biomass removed, canopy base height and bulk density, live and dead surface fuel loading, live and dead standing wood, coarse woody debris, and snags. These attributes were then averaged for all the data sets represented in the simulation. All of these attributes were then compiled into an "effects" database and used to analyze and display the direct and indirect effects to the vegetation resource.

Modeling Assumptions

The following is a list of general modeling assumptions. Tables 2, 3, and 4 list modeling assumptions specific to each treatment type in the proposed action.

- All tree data was grown to the common year of 2019 and is considered to represent the existing condition.
- Beginning in the year 2019, using the Climate-FVS extension (N.L. Crookston 2014), the effects of climate change were incorporated in the data analysis using the Ensemble_rcp60 scenario
- All tree cutting and removal was modeled in the year 2019 as 2019 is the earliest anticipated first year of treatments

- Two prescribed burns were modeled, post-mechanical treatment in the year 2024, and then again in 2034 with the exception of the aspen treatment which modeled one prescribed burn in the year 2024, post-mechanical treatment.
- After treatment, the tree growth data was simulated to the common year of 2029 and 2039 and is considered to represent the post treatment condition.
- The tree data does not indicate tree age. Simulations initially use diameter as a surrogate for age based on the vegetative structural stage definitions. We acknowledge that there are trees on the landscape where age class overlaps size class. For example there may be: young trees that are larger than 11.9 inches; or mid-aged trees that are larger than 17.9 inches; or mature trees that are less than 18".
- Within this project area, the majority of trees that meet the old tree definition are greater than or equal to 18". On the ground cutting prescriptions will follow the Old Tree Implementation Plan (OTIP) and trees larger than 18" that do not meet the OTIP criteria may be cut during implementation.
- All cutting simulations assume 15 percent of the cut stems are left on site and 10 percent of the branchwood from the cut and removed stems are left on site. All other biomass resulting from the cutting is assumed to be removed.
- Snags and coarse wood amounts are based on the inventory or default parameters within the model if they were not inventoried. Snag fall rates and changes in surface fuels are based on default parameters.
- Stand exam data is an average characterization of the area within the stand boundaries. It is limited by sampling intensity and the variability within the sampled area.
- Default parameters within the model were used to predict tree growth, mortality, and dwarf mistletoe infection intensification.
- Dwarf mistletoe infections are nearly impossible to detect from remote imagery. Therefore, any nearest neighbor imputation process may impute stand data showing mistletoe infections to stands that are not infected and visa-versa.
- FVS is a distance-independent growth model. It is not spatially explicit and cannot model tree groups and interspaces together. The modeling results are an average approximation of the desired forested structure at the stand level and all results are interpreted as "attribute values" per acre. Output from the FVS model used in this analysis is a characterization of the existing condition and absolute conditions are neither intended nor implied.

Table 3. General treatment modeling assumptions used in the Forest Vegetation Simulator

Treatment Type	Interspace Created (%)	Thinning Cutting Control	Prescribed Burning Regime	Regeneration Regime
Aspen	N/A	Thin non-aspen 0-24" DBH to residual conifer canopy cover of 10%	Aspen	Aspen
Facilitative Operations	N/A	Thin trees 0-18" DBH from below to residual canopy cover of 30%	Standard	Light
Grassland/Meadow	N/A	Thin trees 0-24" DBH from below to residual canopy cover of 3%	Standard	Light
Intermediate Thin - IT10-25	10-25	Uneven-aged BDQ method where B=35 ft^2, D=0-18 and Q=1.1, retention of 30 legacy trees/acre	Standard	Light
Intermediate Thin - IT25-40	25-40	Uneven-aged BDQ method where B=30 ft^2, D=0-18 and Q=1.1, retention of 26 legacy trees/acre	Standard	Moderate
Intermediate Thin - IT40-55	40-55	Uneven-aged BDQ method where B=25 ft^2, D=0-18 and Q=1.1, retention of 23 legacy trees/acre	Standard	Moderate
Intermediate Thin - IT55-70	55-70	Uneven-aged BDQ method where B=20 ft^2, D=0-18 and Q=1.1, retention of 20 legacy trees/acre	Standard	Heavy
MSO Recovery - Future Nest/Roost	N/A	Uneven-aged BDQ method where B=55 ft^2, D=0-18 and Q=1.1, retention of 99 legacy trees/acre	Low	Light
PAC - Aspen	N/A	Thin non-aspen 0-18" DBH to residual conifer canopy cover of 10%	Aspen	Aspen
PAC - Facilitative Operations Mechanical	N/A	Uneven-aged BDQ method where B=55 ft^2, D=0-18 and Q=1.1, retention of 99 legacy trees/acre	Low	Light
PAC - Facilitative Operations / Rx only	N/A	.	Low	Light
PAC - Grassland/Meadow	N/A	Thin trees 0-18" DBH to residual canopy cover of 3%	Low	Light
PAC - Mechanical	N/A	Uneven-aged BDQ method where B=55 ft^2, D=0-18 and Q=1.1, retention of 99 legacy trees/acre	Low	Light
PAC - Prescribed Fire Only	N/A	.	Low	Light
PAC - Severe Disturbance Treatment Area	N/A	Masticate 90% non-pine (0-18" DBH), thin pine (0-18" DBH) from below to 150 trees/acre	Low	Light
Savanna	N/A	Thin trees 0-24" DBH from below to 10% canopy cover	Standard	Light
Severe Disturbance Treatment Area	N/A	Masticate 90% non-pine (0-18" DBH), thin pine (0-18" DBH) from below to 150 trees/acre	Standard	Light
Stand Improvement - SI10-25	10-25	Uneven-aged BDQ method where B=60 ft^2, D=0-18 and Q=1.1, retention of 15 legacy trees/acre	Standard	Light
Stand Improvement - SI25-40	25-40	Uneven-aged BDQ method where B=55 ft^2, D=0-18 and Q=1.1, retention of 15 legacy trees/acre	Standard	Moderate
Stand Improvement - SI40-55	40-55	Uneven-aged BDQ method where B=45 ft^2, D=0-18 and Q=1.1, retention of 15 legacy trees/acre	Standard	Moderate
Stand Improvement - SI55-70	55-70	Uneven-aged BDQ method where B=35 ft^2, D=0-18 and Q=1.1, retention of 15 legacy trees/acre	Standard	Heavy
Single Tree Selection - ST	N/A	Uneven-aged BDQ method where B=35 ft^2, D=0-18 and Q=1.1, retention of 30 legacy trees/acre	Standard	Moderate
Uneven-aged Selection - UEA10-25	10-25	Uneven-aged BDQ method where B=30 ft^2, D=0-18 and Q=1.1, retention of 30 legacy trees/acre	Standard	Moderate
Uneven-aged Selection - UEA25-40	25-40	Uneven-aged BDQ method where B=27 ft^2, D=0-18 and Q=1.1, retention of 27 legacy trees/acre	Standard	Heavy
Uneven-aged Selection - UEA40-55	40-55	Uneven-aged BDQ method where B=23 ft^2, D=0-18 and Q=1.1, retention of 23 legacy trees/acre	Standard	Heavy
Uneven-aged Selection - UEA55-70	55-70	Uneven-aged BDQ method where B=23 ft^2, D=0-18 and Q=1.1, retention of 20 legacy trees/acre	Standard	Heavy

Table 4. Prescribed fire assumptions for Forest Vegetation Simulator modeling

Regime	Years Burned	Wind Speed	Moisture	Temperature	Season	% Burned
Aspen	2024	5 MPH	Moist	70 F	Fall	70%
Standard	2024, 2034	5 MPH	Dry	70 F	Fall	90%, 50%
Low	2024, 2034	5 MPH	Moist	70 F	Fall	70%, 50%

Table 5. Regeneration assumptions for Forest Vegetation Simulator modeling

Regime	Automatic Establishment	2019	2029	2039	2049
Aspen	Yes	10	5	5	5
Light	Yes	20	5	5	5
Moderate	Yes	250	20	20	20
Heavy	Yes	500	30	30	30

Discussions on Stand Metrics

Measures of stand density used in this analysis are Basal Area (BA), Trees per Acre (TPA) and Stand Density Index (SDI). Basal area is the cross-sectional area of all trees, measured in square feet per acre measured at 4.5 feet above the ground. Trees per acre (TPA) is simply a count of the total number of trees on an acre. Stand Density Index is a measure of the relative stand density within forest stands.

Density

Stand density, a measure of the degree of crowding within stocked areas (SAF 1998), is the dominant factor affecting the health and vigor of conifer forests in the western United States (Foresters 2005) and high stand densities leads to reduced ecosystem resilience (Reynolds et al 2013. One of the major factors affecting forest structure and development, specifically the rate at which individual trees grow and advance through successional stages, is inter-tree competition. Competition refers to density-related scarcity of one or more environmental factors necessary for growth (e.g., moisture, nutrients, and sunlight). Early in stand development, and prior to competition between trees, individual trees are growing at their full potential. As stand development advances, relative densities increase as the size of individual trees increase and the competition begins to increase. Individual trees begin to experience some competitive interaction with other trees and self-pruning of lower branches begins. At this stage in stand development, individual trees begin to exhibit height growth differentiation due to genetics, microsite differences, and damage caused by biotic and abiotic factors. As stands continue to develop, competition between trees continues to increase as trees increase in size. Growth rates for individual trees decrease as competition increases. Eventually, stands near the point of full site occupancy and self-thinning occurs due to density-based competition mortality. At this stage of stand development, trees are growing at much less than full potential.

Trees per Acre

Trees per acre is simply a count of the number of stems per acre of an individual species or all species combined regardless of size. Trees per acre is much more informative when considered with an additional stand metric such as quadratic mean diameter or basal area. This additional information provides insight into the forest processes that may be occurring within a stand.

Basal Area

Basal area is the cross-sectional of all stems of a species or all stems in a stand measured at breast height (4.5 feet above the ground) and expressed as square feet per acre. This analysis uses basal area as a key measure of density. Higher basal areas can be indicators of increased competition, risk to insect outbreaks, and density-dependent mortality as well as closed canopy conditions.

Stand Density Index

Stand Density Index (SDI) is a measure of relative stand density based on the number of trees per acre and the mean diameter (Reineke 1933). Percent SDIMax expresses the actual density in a stand relative to a theoretical maximum density possible for trees of that diameter and species. SDI is a good indicator of how site resources are being used by taking both tree size (DBH) and numbers (TPA) into account.

Those who use SDI, or any index of stand density, as an estimate of growing stock, must assume that the index is proportional to site utilization (Long and Smith 1984). Since the contribution of individual stand components to both total SDI and total site utilization is additive, SDI can be used to assess control of growing stock in uneven-aged stands as well as even-aged stands (Long and Smith 1984). Although SDI and the maximum size-density relationship were originally described for pure, even-aged stands, Long and Daniel (1990) have proposed extension of its utility to uneven-aged and multi-aged situations.

Long (1985) divided SDI percentages into four zones which consider the percent of a stand occupied by trees. Based upon established forest density/vigor relationships, density-related mortality from competition begins to occur once the forest reaches 45-50 percent of maximum stand density (zone 3), and mortality is likely at density levels of 60 percent+ of maximum stand density (zone 4).

High forest densities result in increased inter-tree competition, decreased tree health, decreased growth and vigor, decreased regeneration of shade intolerant species, stagnation of structural stage progression, increased insect and disease-related mortality especially in older age classes, decreased horizontal and vertical heterogeneity, decreased understory productivity and diversity, and increased fire risks. Based on these forest density relationships, a variety of stand and tree characteristics will develop by varying the timing, scale, and intensity of density management.

Table 6. Stand density index and forest stand development characteristics

%Maximum SDI*	Zone	Forest Stand Development and Tree Characteristics
0-25% Low Density	1	• Less than full site occupancy, maximum understory forage production. • No competition between trees, little crown differentiation. • Maximum individual tree diameter and volume growth. • Minimum whole stand volume growth at upper range of zone.
25-35% Moderate Density	2	• Less than full site occupancy, intermediate forage production. • Onset of competition among trees, onset of crown differentiation. • Intermediate individual tree diameter and volume growth. • Intermediate whole stand volume growth.
35-55% High Density	3	• Full site occupancy, minimum forage production. • Active competition among trees, active crown differentiation. • Declining individual tree diameter and volume growth. • Maximum whole stand volume growth. • Upper range of zone marks the threshold for the onset of density-related mortality.
55+% Extremely High Density	4	• Full site occupancy, minimum forage production. • Severe competition among trees, active competition-induced mortality. • Minimum individual tree diameter and volume growth, stagnation. • Declining whole stand volume growth due to mortality

High forest densities result in increased inter-tree competition, decreased tree health, decreased growth and vigor, decreased regeneration of shade intolerant species, stagnation of structural stage progression, increased insect and disease-related mortality especially in older age classes, decreased horizontal and vertical heterogeneity, decreased understory productivity and diversity, and increased fire risks.

Based on these forest density relationships, a variety of stand and tree characteristics will develop by varying the timing, scale, and intensity of density management. A few examples follow:

Grassy stands of open canopy, large-diameter trees with long, heavy-limbed crowns will develop by maintaining densities in zones 1 and 2.

Stands of moderately dense canopy, intermediate-sized trees with thrifty, well-pruned crowns will develop by maintaining densities in the upper half of zone 2 and the lower half of zone 3.

Clumpy, irregular stands containing groups of varying ages will develop by periodically making openings (regeneration group openings) where growing space is made available for seedling establishment. Growing space areas would fall into zone 1.

Longevity of existing old-growth trees would be enhanced by thinning adjacent smaller trees to create zone 2 or 3 growing conditions.

Avoiding density-related mortality and maintaining forest vigor can be achieved by maintaining densities at or less than the lower half of zone 3.

Openness

A key characteristic of historical ponderosa pine and mixed conifer forests was the grass-forb-shrub interspersed among tree groups; defined as interspace. This interspace typically comprised a large portion of the landscape. The term openness as used in this analysis conveys the percentage of the forested area that is grass-forb-shrub interspace.

Determining openness is best accomplished thru aerial imagery analysis. At present, this sort of analysis is only available for a small portion of the project area. In the absence of a detailed aerial imagery analysis we determined that stand-level inventory data was appropriate to classify the canopy conditions that currently exist within the project area. See the implementation Plan (Appendix C) for guidance in meeting openness objectives.

Affected Environment

Silviculture Area of Analysis

The 1,238,643 acre EIS project area is located on the Black Mesa and Lakeside Ranger Districts of the Apache-Sitgreaves NF (ASNF), the Mogollon Rim and Red Rock Ranger Districts of the Coconino NF (CNF), and the Payson and Pleasant Valley Ranger Districts of the Tonto NF (TNF)

Of the 1,238,658 acres within the project area:

- Approximately 255,249 acres have been removed from this silvicultural analysis because they are part of an ongoing project or are being analyzed in a separate analysis (Figure 2). Silvicultural treatments and their effects within these areas will not be analyzed in this report.
- Approximately 30,263 acres are either non National Forest System lands, or are non-forested. The remaining 953,131 acres are identified by cover type and Forest in Table 7.
- An additional 1,141 of these acres identified as “Other” in Table 7 were determined to be either surface water, mineral pits, dams or road surface and will not be given a detailed description in this silvicultural analysis.
- The remaining 951,691 acres, considered the analysis area, will be analyzed in this report and are identified by forest in Table 3-1.

The cover types analyzed are limited to Aspen, Grassland/Meadow, Madrean Encinal Woodland, Madrean Pinyon-Oak, Mixed Conifer with Aspen, Mixed Conifer/ Frequent Fire, Pinyon-Juniper Woodland, Ponderosa Pine, and Ponderosa Pine/ Evergreen Oak and riparian for a total of 951,691 acres. For analysis purposes, the Madrean Encinal Woodland and Madrean Pinyon-Oak cover types will be combined into one category called Madrean Woodland due to limited acreage, data availability and similarity.

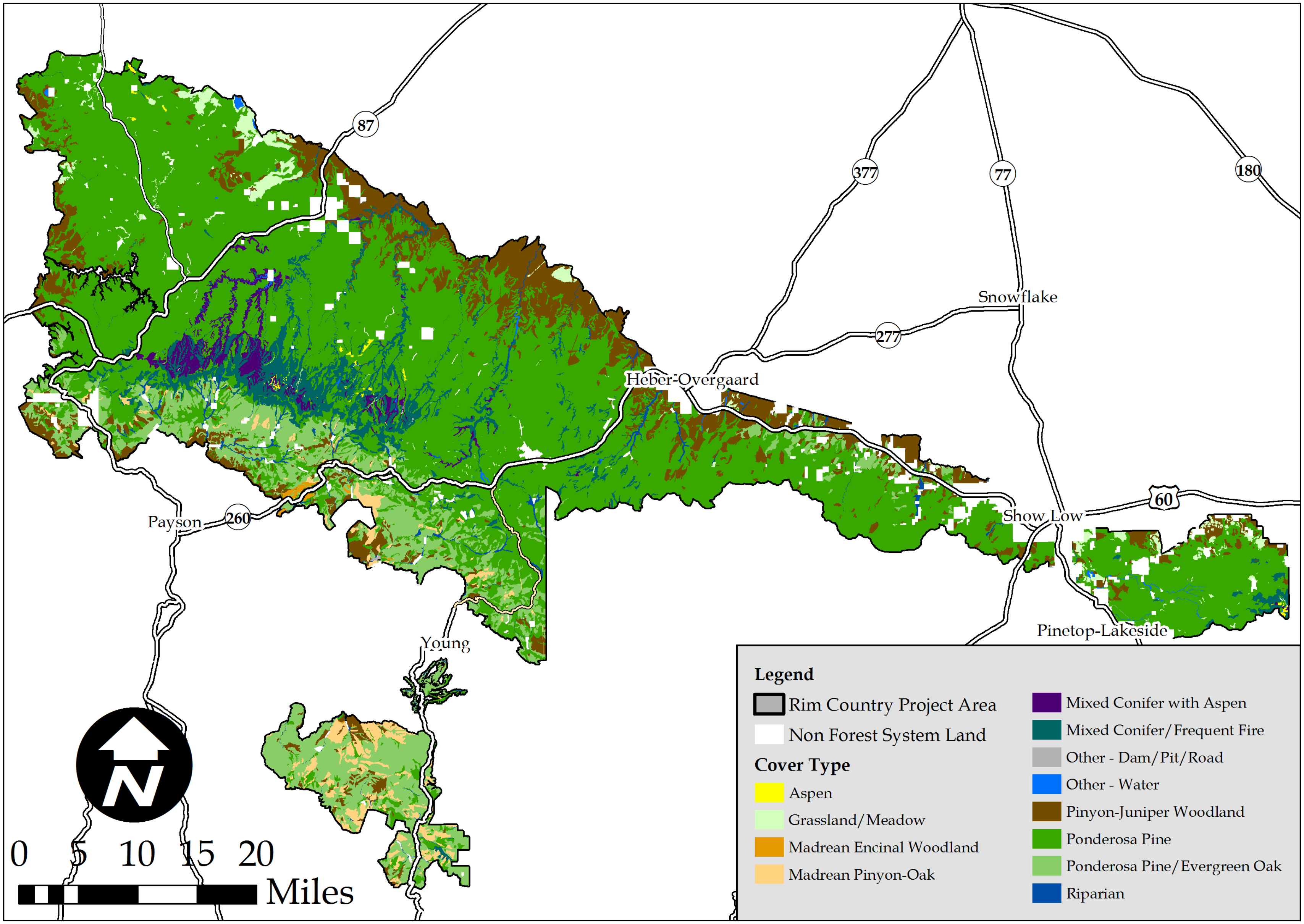


Figure 4 – Existing Condition – Cover Type

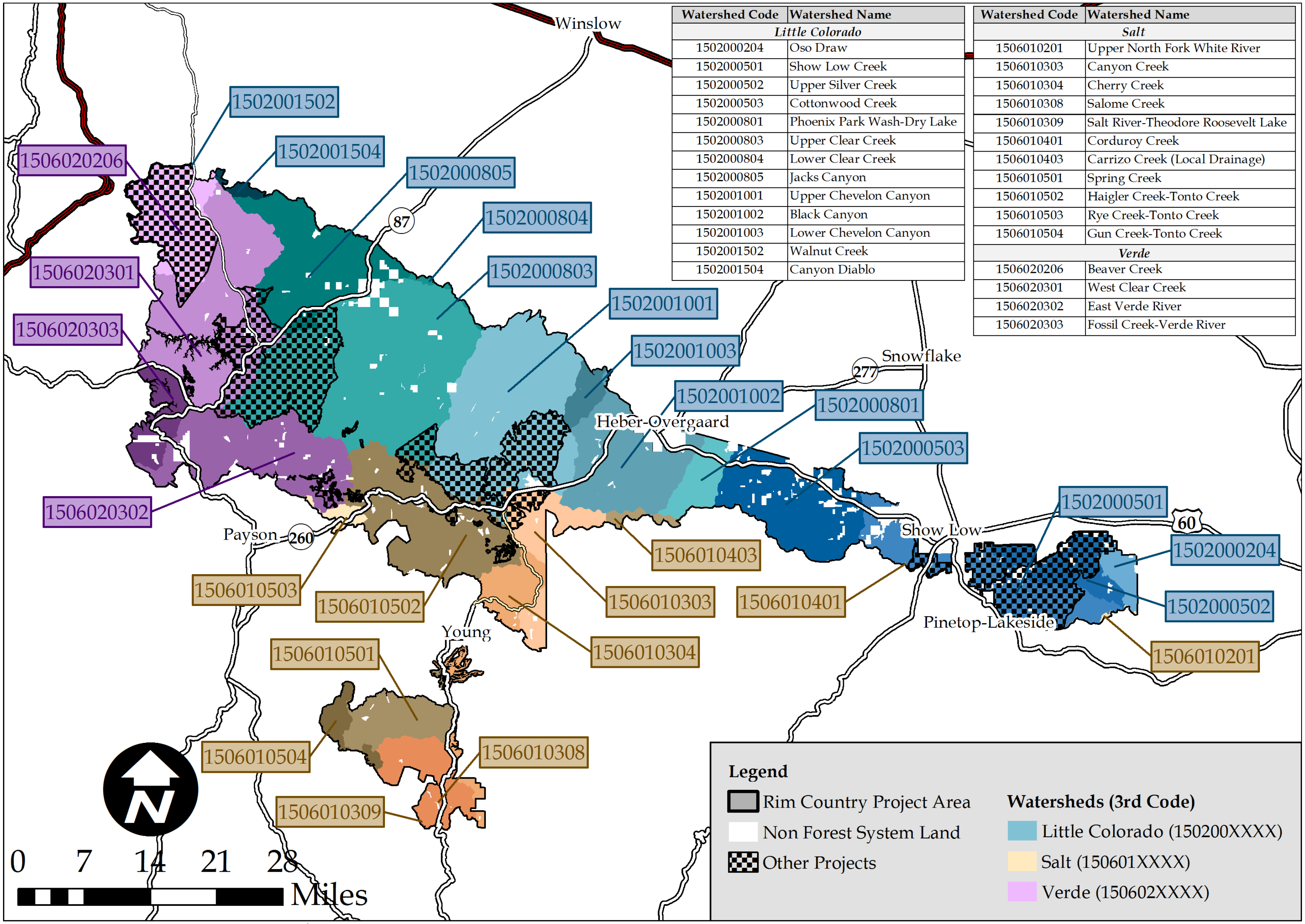


Figure 5 – Existing Condition – 5th HUC Watersheds

Table 7. Existing Condition - Cover type by Forest

Cover Type	Coconino	Sitgreaves	Tonto	Grand Total
Aspen	635	805		1,440
Grassland/Meadow	12,292	6,526	25	18,843
Madrean Woodland			24,996	24,996
Mixed Conifer with Aspen	1,809	1,311		3,120
Mixed Conifer/Frequent Fire	16,648	21,207	11,444	49,299
Pinyon-Juniper Woodland	29,074	80,027	25,961	135,062
Ponderosa Pine	196,976	281,548	77,779	556,304
Ponderosa Pine/Evergreen Oak	1,824	9,052	137,193	148,069
Riparian	2,716	5,402	6,440	14,558
Grand Total	261,974	405,878	283,839	951,691

Table 8 describes each 5th Code HUC by the amount of area within the analysis area. These 5th Code HUCs vary widely in size due to the fact that only small portions of some HUCs are in the project area (Figure 3-2). Due to their limited size, the data summarizing some of the smaller HUCs such as Corduroy Creek, Salt River-Theodore Roosevelt Lake, and Upper North Fork White River HUCs may not be considered as representative of the entire watershed during analysis.

Table 8. Existing Condition - 5th Code HUC watersheds in the project area

5th HUC Name	5th HUC Code	Acres
Beaver Creek	1506020206	9,986
Black Canyon	1502001002	69,584
Canyon Creek	1506010303	26,040
Canyon Diablo	1502001504	3,232
Carrizo Creek (Local Drainage)	1506010403	3,954
Cherry Creek	1506010304	28,923
Corduroy Creek	1506010401	59
Cottonwood Creek	1502000503	66,489
East Verde River	1506020302	76,611
Fossil Creek-Verde River	1506020303	21,767
Gun Creek-Tonto Creek	1506010504	10,059
Haigler Creek-Tonto Creek	1506010502	83,662
Jacks Canyon	1502000805	71,752
Lower Chevelon Canyon	1502001003	11,108
Lower Clear Creek	1502000804	1,477
Oso Draw	1502000204	9,656
Phoenix Park Wash-Dry Lake	1502000801	19,723
Rye Creek-Tonto Creek	1506010503	4,967
Salome Creek	1506010308	32,946
Salt River-Theodore Roosevelt Lake	1506010309	108
Show Low Creek	1502000501	23,394
Spring Creek	1506010501	31,446
Upper Chevelon Canyon	1502001001	102,820
Upper Clear Creek	1502000803	139,911
Upper North Fork White River	1506010201	327
Upper Silver Creek	1502000502	10,464
Walnut Creek	1502001502	75
West Clear Creek	1506020301	91,151
Grand Total		951,691

Summary of post-European Settlement Era Ecological Changes

Open, “frequent low-severity fire” forest structure has been altered by logging, grazing, and fire suppression and has led to overly dense forest structure and fire regimes highly departed from their desired conditions.

Large, old ponderosa pines and oaks have become underrepresented in many areas. The remaining large, old ponderosa pines are suffering increased mortality rates as a result of competition with small trees, insects and disease, and climate change.

Ponderosa pine forests have increased in density as abundant tree seedlings have regenerated in canopy openings and replaced open, multiple age class forest structure with a dense and predominately single age class structure. This resulted from logging practices, protection from fire, grazing, and a relatively wet climatic cycle during the early part of the 20th century (Schubert 1974).

Frequent low-severity fire regime forests have increased densities from shade tolerant and fire intolerant species. Dry mixed conifer forests are far denser and with a species composition that is not necessarily representative of their NRV.

Competition for moisture and nutrients is intense in currently dense stands, and results in stress that increases vulnerability to attack by insects such as pine bark beetles (*Dendroctonus* spp.) and *Ips* beetles (Kane and Kolb, 2014).

Though the extent of dwarf mistletoe infections have become more widespread with increased negative impacts in some areas due to closed forest conditions, lack of low severity fire, and lack of adequate mitigation management, thereby resulting in reduced forest health and growth, increased risks to insect attacks, accumulated ladder fuels, and negative effects from projected climate change.

Potential fire severity has changed from low-severity to mixed- and high-severity. The risk of stand replacing fires has increased.

High severity fires often result in ecosystem conversions, increased soil erosion, loss of hydrologic function, and invasion by nonnative species.

Stand-replacing wildfires within ponderosa pine ecosystems have resulted in conversion from forest to grass or persistent shrub for long periods or dense, even-aged structure. These areas will not again support old-growth forest structure for centuries.

Trees have significantly encroached into historical grasslands and meadows.

Historical Context of the Existing Condition

Current expression of the Existing Conditions are a culmination of the natural processes and past human activities. The following is a summary of activities and processes that occurred during the last century and a general discussion of how they influenced the existing forest structure, pattern, and composition within the project area. Additional narratives have been included where there are Desired Conditions for certain discussed conditions.

Natural Range of Variation

The Natural Range of Variation (NRV)(FSM 2020.5) across the Four Forest Restoration Initiative on the Apache-Sitgreaves, Coconino, and Tonto NF's project area comes from research and scientific literature, early written records, general land office surveys, Forest Service records, oral histories, and photographs as well as old forest remnants, physical remains of old trees, and dendrochronology. Cooper (1960) researched the cultural evidence to document the historic condition of southwestern pine forests. Many early travelers, surveyors and government officials left records of their impressions of pine forest country specific to the project area. The 19th century descriptions of ponderosa pine forest conditions by Lt. Edward Beale, Lt. Ives, C. Hart Merriam, J.B. Lieberg, S.J. Holsinger could be summarized as follows: "The forest was decidedly open and park-like; reproduction was not abundant, and in many areas was markedly deficient; grass was abundant but not universal" (Cooper, 1960). Leiberg (1904) noted that "The yellow-pine type of forest consists of open, continuous stands, here and there interrupted by tracts denuded of their forests through close logging." "Reproduction of the yellow pine is, generally, extremely deficient as regards seedling and young sapling growth, except in an area lying east of Stoneman Lake and· south of Mormon Lake." (Leiberg, 1904). Other documentation that has informed our current understanding of the NRV includes plot data by early scientists (Woolsey 1911, Pearson 1950), tree ring, dendrochronological, and restoration studies (Covington and Moore 1994, Swetnam and Baisan 1996, Covington et al. 1997), natural area and old growth studies (White 1985), and wildland fuel management strategies (e.g. Pearson 1950, and Fulé et al. 1997). The following is a NRV description based on these and many other references. Recently Reynolds et al (2013) more fully explores and explains the historical reference conditions and management implications. The Rim Country project relies heavily on this science.

All southwestern forests and woodlands are periodically affected by natural disturbances such as fire, insects, disease, wind, and herbivory (Mast et al. 1998 and 1999, Brown et al. 2001, Ehle and Baker 2003). These disturbances have variable effects on forest vegetation depending on the type, frequency, intensity, and spatial scale of disturbances. The type, frequency, and intensity of disturbances varied historically among forest and woodland types. A forest or woodland's characteristic composition, structure, and landscape pattern, the result of vegetation establishment, growth, and succession, combined with the periodic resetting of these by characteristic natural disturbances, constitutes a forest or woodland's Natural Range of Variation (FSH 2020, Reynolds et al 2013).

The temporal and spatial variation in vegetation establishment, growth, and mortality, and the consequences of natural disturbances in a forest or woodland define the Natural Range of Variation. Much of the range of variation derives from fine- to landscape-scale heterogeneity in aspect, slope, elevation, and soils that can lead to topographically different growing conditions and disturbance regimes (Fulé et al. 2003). The ability of a forest ecosystem to absorb (resistance) and recover (resilience) from disturbances without drastic alteration of its inherent function is central to the concept of Natural Range of Variation. In the southwestern United States, fire is a primary disturbance agent and fire regimes are central to understanding Natural Range of Variation as it relates to the composition, structure, and pattern in various forest types (Fulé et al. 2003). Lieberg in 1904 observed: "It is very evident that the yellow-pine stands, even where entirely untouched by the axe do not carry an average crop of more than 40 per cent of the timber they are capable of producing, and that the crop in the transition and lower subalpine belts do not exceed 8 per cent of the timber producing capacity of these areas. These conditions are chiefly attributable to the numerous fires which have swept over the region within the last two hundred years, carrying with them the inevitable consequences of suppression and destruction of seedling and sapling growth."

Table XX defines the ranges of reference conditions for ponderosa pine in the southwestern United States (Reynolds et al. 2013). The ranges serve to inform and compare the analysis with the Natural Range of Variation. These metrics are not project area desired conditions but remain supporting science defining restoration.

Table 9. Ranges of reference conditions for ponderosa pine and dry mixed conifer forests in the southwestern United States from studies detailed in RMRS-GTR-310

	Reference condition by forest type	
Forest attribute	Ponderosa pine	Dry mixed-conifer
Trees/acre	11.7-124	20.9-99.4
Basal area (ft2/acre)	22.1-89.3	39.6-124
Openness (%)[a]	52-90	78.5-87.1
Openness on sites with strong tree aggregation (%)[a]	70-90	79-87
Spatial Patterns	Grouped or random	Grouped or random
Number of trees/group	2-72	Insufficient data
Size of groups (acres)	0.003-0.72	Insufficient data
Number of groups / acre	6-7	Insufficient data
Snags / acre	1-10	≥ Ponderosa pine forests
Logs / acre	2-20	≥ Ponderosa pine forests

[a]Openness is the proportion of area not covered by tree crowns, estimated as the inverse of canopy cover. Openness data for dry mixed-conifer is limited; range of reference condition openness will likely change with additional studies

Tree Density and Distribution

Historical tree densities on reconstructed plots throughout the Southwest vary depending on factors such as elevation, aspect, slope, soils, moisture, and a site's unique history. An example of this was a reconstruction study involving 53 2.5-acre plots representing nine different ponderosa pine ecosystem types near Flagstaff, Arizona. Historical tree densities on these sites varied 19- fold, and averaged between 2-40 trees per acre (Abella and Denton 2009). Moore's et al. (2004) reconstruction study on their 15 2.5 acre Woolsey plots estimated a mean density of 40 trees per acre based on live tree and cut-stump basal area (Moore et al. 2004). On the same Woolsey plots, Sanchez-Meador et al. (2010) found that the number of tree groups ranged from 4-11 per acre and ranged in size from 0.004 ac to 0.06 acre. Other reports of historical tree densities include 22 trees per acre near Walnut Canyon (Menzel and Covington 1997), 23 trees per acre at Bar-M-Canyon (Covington and Moore 1994a), 24 trees per acre on the Gus Pearson Natural Area (GPNA) on the Fort Valley Experimental Forest (Mast et al. 1999), and 24 trees per acre at Camp Navajo (Fulé et al. 1997). A 1938 forest inventory on the long Valley Experimental Forest (central Arizona) showed that 75 trees per acre were present prior to the cessation of frequent fire (between 1880 and 1900). Woolsey (1911) reported an average of 18 trees per acre (> 4 inches DBH) in northern Arizona in the early 20th century.

Structural characteristics widely reported for historical Southwest ponderosa pine are relatively open forests with trees typically aggregated in small groups within a grass/forb/shrub matrix (Cooper 1960, White 1985, Pearson 1950, Covington et a1.1997, Abella and Denton 2009).

Recent work in northern Arizona has shown that tree densities across nine different ponderosa pine ecosystems depended largely on soil type and climatic variables such as minimum spring and fall temperatures, and May precipitation (Abella and Denton 2009). This work also showed that the degree to which trees were aggregated into groups was largely explained by ecosystem soil type. Twenty-eight to 74 percent of all trees were in groups; the remaining trees were scattered individuals (Abella and Denton 2009). These structural conditions were maintained by frequent low-intensity surface fires that more often killed small rather than large trees (Weaver 1951, Fiedler et al. 1996, Cooper 1960). Other small-scale disturbances such as insects, disease and others also shaped this characteristic forest structure. Low intensity fires occurred every 2 to 12 years and maintained an open canopy structure (Covington et al. 1997, Moir et al. 1997). Other work (Rodman et al. 2017) used classification and regression trees to show the importance of characteristics such as Terrestrial Ecosystem Units, parent material and site moisture condition to characterize the vegetation condition.

Typical historical tree groups ranged from 0.1 to 0.75 acres in size and comprised 2 to 72 trees per group (Reynolds et al, 2013, White 1985, Fulé et al. 2003, Covington et al. 1997). The grass/forb/shrub understory and fine fuels (needles, cones, limbs) from large trees fueled these frequent fires started by lightning and, to an uncertain extent by Native Americans (Kaye and Swetnam 1999, Allen et al. 2002). Regular fire thinned or eliminated thickets of small trees, resulting in open, park-like forests (Cooper 1960, Covington et al. 1997, Allen et al. 2002).

Restoration studies on the Fort Valley Experimental Forest near Flagstaff, Arizona, showed an average of 23 trees per acre that were grouped into distinct 0.05- to 0.7-acre groups consisting of 2-40 trees (Covington et al. 1997).

Forest Openings and the Grass/Forb/Shrub Vegetation Matrix

Woolsey (1911) described late 19th century southwestern ponderosa pine forests as follows: "The typical western yellow (ponderosa) pine forest of the Southwest is a pure park-like stand(s) made up of scattered groups of from 2 to 20 trees, usually connected by scattering individual. Openings are frequent and vary in size. Because of the open character of the stand and the fire-resisting bark, often 3 inches thick, the actual loss in yellow (ponderosa) pine by fire is less than with other, more gregarious species." Others also described historical ponderosa pine forests as having low tree density, open, savanna-like stands consisting of groups of pine trees interspersed with grassy or shrubby openings (White 1985, Leiberg 1904). The actual degree of "openness" has received little measurement; instead, most reconstruction/restoration studies focused on tree densities and tree aggregation. Although White (1985) did not define how close trees had to be to constitute a "group" (he used the absence of 1919 regeneration beneath large tree crowns to define groups), he reported 22 percent of his plots on the GPNA was under tree groups. Thus, 78 percent of the 18-acre area would likely have been open before the 1919 regeneration pulse (White 1985). White (1985) reported that 12 percent of the historical trees on his plot were not in groups of three trees; if he had included single trees and groups of 2 trees, the percent open would have been less than 78 percent. Covington et al. (1997), also working on the GPNA, reported that while canopy cover was high within groups of trees, only 19 percent of the surface area of their study plot was under pine canopy; the balance (81%) represented grassy openings (Covington et al. 1997). Where crown cover was not reported, Gill's et al. (2000) mean crown radius for mature ponderosa pine (19.7 feet) can be used to estimate area under crowns. Of the 53 study plots in Abella and Denton (2009), those with only two trees had less 2 percent under tree crown (98% open). At the opposite extreme, a plot with 40-trees had an estimated 28 percent under crowns (72% open). Using the same approach on the Long Valley Experiment Forest, for the 75 trees present before the cessation of fire (about 1900) resulted in about 52 percent of the per acre area under tree crowns (48% open). Reynolds et al. 2013 found a similar range between 10 and 30 percent on reconstructed Woolsey plots located throughout Arizona and New Mexico. Canopy cover determined from reconstruction sites ranged from 10% to 22% with a median of 16.7% (Huffman et al. 2012).

Sustainability and Resilience

Knowledge of the historical forest composition and structure on a site can provide estimates of forest composition, structure and pattern that was resilient to disturbance agents (i.e., insects and fire) and sustainable through at least several generations of trees (Allen et al. 2002, Abella et al. 2011, Reynolds et al 2013). It may not be necessary, or even desirable in some cases, to have desired conditions that are within the Natural Range of Variation at every site in southwestern forests and woodlands. However, historical conditions are more synchronous with the natural disturbance regime to which the forest and woodland ecosystems are adapted. Social, political and economic factors are much different today than a century ago and there are valid considerations for leaving areas of higher or lower tree-density or differing composition to meet resource management needs. But Functional Restoration (FSM 2020) on portions of the landscape to conditions reminiscent of pre-European settlement times will provide for greater biodiversity, and greater ecosystem productivity, stability, sustainability, and services.

Old Growth

In southwestern forested ecosystems, old growth is different than the traditional definition based on northwestern infrequent fire forests. Because of large differences among Southwest forested ERUs, cover types and natural disturbances, old growth forests vary extensively in tree size, age classes, presence, and abundance of structural elements, stability, and presence of understory (Helms, ed., 1998). Old growth refers to specific habitat components that occur in forests and woodlands—old trees, dead trees (snags), downed wood (coarse woody debris), and structure diversity (Franklin and Spies, 1991; Helms, ed., 1998; Kaufmann et al., 2007). These important habitat features may occur in small areas, with only a few components, or over larger areas as stands or forests where old growth is concentrated (Kaufmann et al., 2007). In the Southwest, old growth is considered “transitional” (Oliver and Larson, 1996), given that that the location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality). Some species, notably certain plants, require “old forest” communities that may or may not have old growth components but have escaped significant disturbance for lengths of time necessary to provide the suitable stability and environment.

Grazing

The arrival of railroads in the early 1880s caused livestock (cattle and sheep) numbers across most of Arizona to rapidly increase. By the end of the decade, many ranges were overstocked and by the time the first Forest Reserves were established in New Mexico and Arizona in the 1890s, most of the understory in accessible ponderosa pine forests had been intensively grazed (Scurlock and Finch 1997). Overgrazing was most severe in the 1880's and during the war years of 1916-18 primarily due to the demand for wool and beef during WW1 (Schubert 1974) and the impacts are still evident today (Allen et al. 2002). Early Forest Reserve management often exacerbated the problem by urging heavy grazing to eliminate the herbaceous fuels that allowed surface fires to sweep across the land (Drake 1910, Belsky and Blumenthal 1997). Forest Service regulation and the post-war agricultural depression from 1919 to 1921 resulted in dramatically reduced grazing numbers. This trend of reduced numbers grazed and permitted continued into the 1950s when numbers were stabilized reflecting modern range management techniques (Scurlock and Finch 1997). Heavy grazing resulted in trampling and browsing damage that lessened the understory vegetation and inhibited the spread of low-intensity fire, and created conditions prime for natural regeneration of ponderosa pine. Furthermore, , grazing increases the presence of exotic plant species (Bakker et al. 2010). Livestock also compact soils, decreasing the soils’ ability to absorb water and increasing erosion (Belsky and Blumenthal 1997).

Logging

Since the 1880s, lumbering has been a primary industry of the region that includes the Apache-Sitgreaves, Coconino and Tonto National Forests (USDA Forest Service 2006). The earliest logging efforts in the study area supplied local needs and were small in scale using the strategy of setting up small, portable sawmills adjacent to the timber (USDA Forest Service 2006). The development of the Atlantic and Pacific (A&P) Railroad revolutionized the lumber industry, pushing it to an intense new level of operation. Construction of the transcontinental carrier created a tremendous demand for ties as well as a means to export lumber to distant areas (USDA Forest Service 2006). The first large scale lumber mill in the area went into operation in Flagstaff in 1882 which coincided with arrival of the A&P Railroad. Wagons and carts hauling logs overland initially supplied this mill. By 1888, this system was improved thru development of logging railroads that provided logs to the mills. From the late 1880s to the 1940s, logging railroads supplied several lumber and timber companies operating in the Flagstaff and Williams area (USDA Forest Service 2006).

Tom Pollock, a Flagstaff, Arizona businessman, built the Apache Lumber Company on land surrounded by the Fort Apache Indian Reservation in northeast Arizona in 1916. Pollock named the site “Cooley,” after prominent Army scout and Arizona trailblazer, Corydon E. Cooley. Despite Pollock’s early success, his business floundered and decided to sell his mill. Just as Pollock needed a buyer, W.M. Cady and James G. McNary, co-owners of a McNary, Louisiana lumber mill, exhausted the timber in the forests surrounding their company. McNary and Cady purchased Pollock's company, and moved their mill westward to Cooley. Shortly after their move, Cooley was renamed McNary (Abraham et al 1990, Geta LeSeur 2000).

In the nineteenth century the lumber industry operated relatively free of government regulation and was able to clear the land on which they held timber rights purchased from the transcontinental railroads who owned the land. Cuts on these lands generally removed 70 to 80 percent of the merchantable volume. Some areas were laid waste, and huge amounts of slash accumulated which lead to some high severity fires (Schubert 1974). By 1910, after the establishment of the National Forests, the federal government became actively involved in the management of federal forests and the regulation of timber cutting on those lands. The concept of sustained yield was applied to the cutting contracts the logging companies had with the Forest Service in order to ensure the long-term sustainability of northern Arizona’s forests. Regulation included leaving mature trees to promote forest regeneration and leaving young trees to stock the harvested lands. The objective during this period was to select the old, decadent groups near areas with advance reproduction first. The companies were also required to clear logging slash after their operations in order to reduce the fire hazard (USDA Forest Service 2006).

By 1940, the railroads had removed all the profitable lumber they could access. The only logging railroad still in use after World War II was the line to Allan Lake which continued to operate in support of truck logging until 1966 (USDA 2006). Motorized trucking emerged as a technology more flexible for transporting timber from the woods. Logging trucks made their appearance in the project area in the 1920s and slowly gained in importance as railroads declined. Trucks became a more cost-effective transportation tool due to their less expensive roadbeds, lower initial expenses, ability to negotiate sharper curves and steeper grades, and capacity to access isolated units of timber.

Records of timber removal on public and private lands in Arizona indicate timber harvests increased steadily through most of the twentieth century depending on markets. This included a peak in 1929, a downturn during the depression years, leading to another peak just after WWII, a downturn during the 1950’s, a steady output during 1960’s and 1970’s with another peak in 1964, and a slight downturn during the early 1980’s. Harvests continued to rise until 1990, when a total of 433 million board feet were harvested within the region (Scurlock and Finch 1997). A high percentage of the timber removed was large diameter, mature ponderosa pine with the Coconino and Apache-Sitgreaves forests contributing a significant share to this total especially during the railroad logging era.

From the 1950s-1970s, management within the project area focused on sanitation/salvage of imminent tree mortality and diseased/damaged trees. Minimal forest density management occurred during this period. In the 1960s, the practice of cutting snags to mitigate fire risk also reduced the number of snags currently standing but may have increased the number of logs present in some areas.

Starting around 1980, management was focused on even-aged forest management (intermediate thinning and shelterwood silviculture system). Where mature trees dominated, regeneration treatments (shelterwood seed-cuts) focused on removal of most overstory trees and low-density retention of scattered seed trees. Where sapling or mid-aged trees dominated, treatments focused on thinning to manage stand density. Much of the thinning treatments yielded pulpwood products, and the removal and regeneration treatments yielded sawtimber. Treatments were conducted on selected stands and large blocks throughout the project area.

Timber sales within the project area implemented prior to the 1996 Forest Plan amendment targeted the harvest of medium and large diameter trees. This even-aged forest management focus continued until the mid-1990s, leaving the legacy of current forest conditions where much of the landscape is single or two-aged, with homogenous forest canopy structures and high density. The overall majority of the areas where regeneration treatments were conducted have adequately regenerated.

During the recent past (mid 1990s – mid 2000s), selected areas were thinned to mitigate fire risk adjacent to public areas such as residential areas and recreational sites. These thinning treatments focused on removal of the smallest trees, producing results similar to the mid-aged stand thinning treatments conducted during the 1980s period.

By 2005, management shifted towards forest health, diversity and restoration objectives with a continued attention toward reducing fire risk. Treatments concentrated on restoring grasslands, savannas and tree group/interspace forest structure with an emphasis on managing for old age trees and sustaining a mosaic of vegetation densities, age classes and species composition across the landscape.

Fires and Fire Suppression

Early Forest Reserve management plans often urged heavy grazing to eliminate the herbaceous fuels that allowed surface fires to sweep across the land (Drake 1910). Logging, fire exclusion, overgrazing and climate change has altered the trajectory of stand development, ecosystem function, and spatial pattern of ponderosa pine stands in northern Arizona (Moore et al. 2004, Pearson 1910, Arnold 1950, Cooper 1960, Stein 1988, Savage and Swetnam 1990, Savage 1991, Covington and Moore 1994, Swetnam and Baisan 1996, Heinlein 1996). Early foresters became convinced that any wildfires were detrimental to the forest (Pyne 1982). Organized fire suppression efforts by the Forest Service date back to the first decade of the twentieth century; largely in response to unacceptable fire effects due to heavy slash loads left by railroad logging; in 1935 the Forest Service further instituted a policy that all fires were to be extinguished by 10:00 of the day following their detection (Pyne 1982). Throughout most of the twentieth century, foresters continued to extinguish all fires regardless of ignition cause, intensity, or degree of danger to human safety or property. Widespread fire suppression efforts continue today, and a high percentage of federal resources are focused on suppression (Friederici 2003).

Fire exclusion has resulted in changing fuel loads and a shift from frequent, low intensity fires to infrequent mixed and high severity crown fires (Reynolds et al 2013, Covington and Moore 1994, Steele et al 1986, Westerling et al 2006). Several large-scale fires have occurred around and within the project area. Many of these areas experienced crown fire and large areas of stand mortality. Stand-replacing wildfires on ponderosa pine sites have resulted in site conversion from forest to grass or persistent shrub perpetuated for long periods or dense, even-age structure. This radical change in forest structure, pattern and composition will not again support old-growth pine trees for centuries (Friederici 2003). Logging, grazing, and fire suppression are the primary factors that, when combined, have allowed landscape patterns to become homogenized, shifting fire regimes across much of the project area from frequent, low-intensity/low severity surface fires to infrequent, high- intensity/high severity crown fires (Belsky and Blumenthal 1997). A more thorough discussion of fire history and frequency is included in the Fire Ecology Specialist Report.

Forest Health

Forest insects and diseases play a significant role in forest ecosystem dynamics as agents of change. Forest insect and disease-driven change alters forest ecological processes, forest structure and composition. The following is a summary of historic disturbance information of the major forest insects and diseases specific to the ponderosa pine, dry mixed conifer, and associated forest types (piñon- juniper and aspen) within the project area for approximately the last century (Lynch et al. 2008a and 2008b). Aside from dwarf mistletoe's, insect and disease activity across the current Rim Country Project landscape can best be characterized as endemic. See Appendix E: Forest Health Protection Report, 2015 for a more detailed analysis.

At various times, most of the vegetation types within the project area have incurred extensive damage by one or more disturbances. The transitory agents causing the most extensive and severe damage have been piñon Ips, (*Ips* spp.) bark beetles in ponderosa pine, and multiple biotic and abiotic agents in aspen. In recent years, the most extensive damage has been in the piñon-juniper. The most extensive and damaging persistent agent is southwestern dwarf mistletoe in ponderosa pine. Each of the vegetation types shows distinct periods of increased insect damage, one during the 1950s and another during recent droughts.

For the purposes of this analysis, forest health is defined by the vigor and condition of the forest stands, and the presence (or lack thereof) of insects and diseases that affect the sustainability of the forest. A working definition of a healthy forest is a forest where native insect and disease activity is within the historic range of variability, and non-native insects/diseases are absent or incidental. Stand densities are at levels that facilitate overall forest development, tree vigor, and resilience to characteristic disturbances. Forest structure represents all age classes necessary for a sustainable balance of regeneration, growth, mortality and decomposition. And overall these conditions are resilient to natural biotic and abiotic disturbances (e.g., insects, diseases, fire, and wind).

Aspen

An accelerated decline of aspen occurred across the project area following a frost event in June 1999, a long-term drought that included an extremely dry and warm period from 2001 through 2002, and defoliation events by the western tent caterpillar in 2004, 2005, and 2007. Surveys across the Coconino National Forest have shown aspen on low-elevation xeric sites (<7500 ft) sustained up to 95% mortality since 2000. Mid-elevation sites (7500–8500 ft) lost 61% of aspen stems during the same time period; mortality is expected to continue in these sites because some remaining trees have 70 to 90% crown dieback. Several insects and pathogens were associated with aspen mortality but appeared to be acting as secondary agents on stressed trees (Fairweather et. al. 2008). Aspen regeneration occurred to some degree on all the sites studied following the death of mature trees although aspen sprouts were nearly nonexistent by the summer of 2007. This loss of spouting was attributed to browsing by elk and deer as none of the sites studied were currently being grazed by domestic cattle. Widespread mortality of mature aspen trees, chronic browsing by ungulates, and continued conifer reproduction within aspen stands/clones are expected to result in rapid vegetation change of many ecologically unique and important sites (Fairweather et. al. 2008). More recently, oystershell scale has been considerably impacting aspen health within the project area (Grady 2017). Looking forward under a changing climate aspen can be expected to face survival challenges and reducing in occurrences across Rim Country Project.

Bark Beetles

Ponderosa pine is attacked and killed by several different bark beetles in the genera *Dendroctonus spp.* and *Ips spp*. Although *Dendroctonus* species are the most notorious tree killers in the western United States, *Ips* species play a very important role in southwestern pine forests.

At endemic levels most bark beetles are considered secondary mortality agents because they prefer weakened hosts; typically attacking scattered individual trees weakened by fire, lightning, disease, old age, and competition. Beetles, especially *Ips spp.* are attracted to fresh logs and slash created by logging, windthrow, or snow breakage.

When environmental factors and stand conditions favor beetle development, populations may exceed endemic levels rapidly and successfully attack healthy trees. During outbreaks, small groups of killed trees become larger and more numerous, eventually merge into large stands of dead trees. Bark beetle outbreaks are initiated and sustained through the supply of susceptible hosts, suitable stand conditions, favorable weather, and a relative scarcity of natural enemies (Fettig et al. 2007). Factors that lower tree resistance, such as poor site quality, overcrowding, prolonged drought, injury, and disease, favor outbreaks.

Early reports indicate that bark beetle activity in ponderosa pine was less frequent, less extensive, and less damaging in the Southwest than in other Western regions (Hopkins 1909, Woolsey 1911). There have been periodic reports of bark beetle activity within the project area. The Coconino N.F. experienced significant bark beetle outbreaks in the mid-1920s, late 1930s, mid-1960s, late 1970s through early 1980s, and late 1990s through the mid-2000s. The 1950s and 2000s outbreaks appear to be more extensive than other outbreaks, damaging at least 200,000 and 72,000 ac, respectively.

There seems to have been a shift in bark beetle activity over time, with pre-1950 outbreaks mostly being *Dendroctonus* species (western pine beetle, roundheaded pine beetle), while post-1950s and contemporary outbreaks were not only much larger but comprised mostly of *Ips* species (pine engraver beetle, Arizona fivespined ips) (Yasinski and Pierce 1958, USDA Forest Service 2004). This probably reflects the size and density of host trees available as ponderosa pine forests have transitioned from open stands with uneven diameter class distributions to denser stands dominated by much more even-aged pole-sized trees (Covington and Moore 1994b). *Dendroctonus* species, such as western pine beetle, commonly attack large-diameter ponderosa pine, while most *Ips* species focus their attacks on smaller diameter pine or, initially, the tops of large diameter trees (Furniss and Carolin 1977, Kolb et al. 2006).

An outbreak of bark beetles, starting in 2002 to 2003, resulted in widespread mortality across Arizona, including mortality in the project area. The outbreak was primarily the result of several native bark beetle species responding to the weakened condition of moisture-stressed, over- crowded forests. Trees on stress-prone sites were most affected. A decrease in affected acres began to occur in 2007 (USDA Forest Service 2008b). See Appendix E for contemporary insect and disease survey flights and outbreak distributions and implications.

When trees are growing at high densities, there is a greater amount of inter-tree competition for resources like light, water, and nutrients compared with trees growing at lower densities (Kolb et al. 1998). Research in the West clearly show that when trees are stressed from overstocking they are more susceptible to bark beetle attack (DeMars and Roettgering 1982, Schmid and Mata 1992, Schmid et al. 1994, Chojnacky et al. 2000, Negrón et al. 2000,). During the recent landscape-level bark beetle outbreak in Arizona, elevation and tree density were significant variables for estimating the probability of occurrence of mortality in ponderosa pine stands on several forests (Negrón et al. 2009). Dwarf mistletoe infection also appears to influence attack patterns of bark beetles on ponderosa pine during drought events (Kenaley et al. 2006, 2008).

Ponderosa Pine – Defoliators and other insects

Southwestern pine tip moth and western pine shoot borer are the most common and damaging tip moth in northern Arizona, but other species occur as well (Long and Wagner 1992). These insects feed on terminal shoots of young trees, impairing height and radial growth and altering tree form (Lessard and Jennings

1976; Long and Wagner 1992). Damage to the primary leader can also deform the main stem. Repeated attacks by tip moths and western pine shoot borer severely

deform host trees and retard height growth (Jennings and Stevens 1982). These insects are especially prevalent within areas of planted and naturally regenerated ponderosa pine that established after extensive timber harvesting and large fires, but they are not considered major pests.

Ponderosa pine needleminer defoliated over 9,000 ac of ponderosa pine on the Coconino N.F. in 1999, and approximately 48,000 ac on other National Forests in northern Arizona (USDA Forest Service 2000). Damage near Flagstaff by this insect was also noted in 1972 (Germain et al. 1973). This insect defoliates ponderosa pine by mining inside the needles. It and closely related species are capable of large outbreaks in extensive areas of host trees, and are capable of causing mortality (Furniss and Carolin 1977). (add TNF and ASNF)

Pathogens

Dwarf Mistletoe

Dwarf mistletoes are the most widespread and damaging forest pathogens (disease-causing organisms) in the Southwest (Hawksworth 1961, Hawksworth et al 1989, Hawksworth and Wiens 1996, Conklin and Fairweather 2010). Damage from dwarf mistletoes includes growth reduction, deformity, especially the characteristic witches' brooms, increased susceptibility to insect attacks, and decreased longevity. Infected areas often have much higher mortality rates than uninfected areas. Infection is often a major factor in mortality attributed to other damaging agents. For example, severely infected trees are often attacked by bark beetles (USDA Forest Service 2011).

Southwestern dwarf mistletoe (*Arceuthobium vaginatum ssp. Cryptopodum*) infection in ponderosa pine and Douglas-fir dwarf mistletoe (*Arceuthobium douglasii* Engelm.) are common throughout the analysis area. *A. douglasii,* the smallest species of dwarf mistletoe in the project area, induces some of the largest and most damaging witches' brooms with its systemic mode of infections (Conklin and Fairweather 2010). On both the stand and landscape level, the distribution of dwarf mistletoes are usually patchy, with more or less discrete infection centers surrounded by areas without the disease. Infection centers usually expand slowly, so overall incidence changes little from year to year (USDA Forest Service 2011).

Survival of host trees is influenced by the severity of dwarf mistletoe infection and site factors. Secondary bark beetles frequently attack heavily infected trees. During the bark beetle outbreak on the Coconino and Tonto National Forests in 2002-2003 the probability of ponderosa pine mortality within dwarf mistletoe infested stands was greater in severely infected trees (Kenaley et al. 2006).

Southwestern dwarf mistletoe incidence and infection severity have increased within the project area. For example, in the mid-1980s, Hessburg and Beatty (1985) estimated a 2 to 4% increase from a similar survey 30 years earlier (Andrew and Daniels 1960). Based on present understanding of mistletoe ecology (Parmeter 1978, Hawksworth and Weins 1996), increases in host abundance over the past 150 years, decreases in fire frequency, and evidence of previous forest conditions and fire regimes, it can be inferred that southwestern dwarf mistletoe abundance was likely lower in the historic period (Dahms and Geils 1997, Conklin and Fairweather 2010).

Spread and intensification of dwarf mistletoe within a stand is a function of stand density, age, and site index, and averages one or two feet a year laterally. Spread is most efficient and rapid from an infected overstory to an understory and slowest through a dense even-aged stand. Overall effects of long-term infection include increased stand openings (both more openings and increased size of existing openings), lower-hanging crown canopies, denser canopy due to witches' brooms, and fewer large-diameter trees (Lynch et al. 2008a and 2008b), and increased fire risk.

When dwarf mistletoe has been targeted during forest management, silviculture prescriptions have typically tried to reduce infection levels, rather than attempt to eliminate dwarf mistletoe from sites. Some large crown fires have reduced the size of the infected area by eliminating both the host and its dwarf mistletoe, however dwarf mistletoe continue to spread into uninfected areas within the project area.

Native forest insects and diseases are vital disturbance agents in forested ecosystems. These agents create snags and brooms for wildlife habitat, serve as a food source, aid with decomposition, and create heterogeneity across the landscape (Anhold et al, 2016). Southwestern dwarf mistletoe incidence is higher on the landscape than historical norms (Conklin and Fairweather 2010). High dwarf mistletoe ratings increase tree stress and the likelihood of Ips attacks during drought (Kenaley et al. 2006, 2008).

Root Disease

Root diseases are common in the forests of the Southwest, and are commonly associated with mortality attributed to bark beetles where they predispose trees to stress, reduced growth rates, decay, and windthrow. Root diseases are usually more common in mixed conifer and spruce-fir forests than in ponderosa pine forests. Like dwarf mistletoes, root diseases spread slowly, so overall incidence changes little from year to year. There are very few known root disease centers associated with ponderosa pine within the project area.

Piñon-Juniper Woodlands

Both localized and widespread mortality events have occurred over time in the piñon-juniper woodlands on the Apache-Sitgreaves, Coconino and Tonto National Forests. These events have typically been pinyon Ips outbreaks associated with periods of drought, such as occurred in the 1950s, the mid-1990s, and more recently in 2001-2003.

At least for the historic period, the size and severity of the recent drought and pinyon ips-related die-off is unprecedented for northern Arizona (Allen 2007; Mueller et al. 2005). The contemporary piñon die-off is 100 times as large (two orders of magnitude) as any previously recorded acreage for piñon ips for the Apache-Sitgreaves, Coconino, and Tonto NFs. Factors that may have contributed to the size of this outbreak include changes in woodland character over time, drought, and altered temperature regimes (especially drought combined with warmer temperatures) (Allen 2007).

Juniper species are more drought hardy than piñon, but juniper mortality from wood borers and *Phloeosinus* beetles has occurred in areas of poor site within the project area during the recent drought (Mueller et al. 2005; USDA Forest Service 2002, 2003). Juniper mortality averaged 3.3% within an 80 km radius of Flagstaff, with greater mortality on grassland vs. non-grassland sites (Gitlin et al. 2006).

Aspen Forest

Aspen communities throughout the Southwest have been declining for decades; a phenomenon thought to be the result of: 1) altered fire regimes since European settlement which promoted natural succession to conifer forests (USDA Forest Service 1994, Dahms and Geils 1997) and 2) heavy browsing by large ungulates which prevented successful regeneration of aspen in burned or harvested forests (Shepperd and Fairweather 1994, Rolf 2001). Recent increased mortality and decline, due to weather, defoliation, and fire events, coupled with the inability of aspen regeneration to survive browsing, are resulting in accelerated conversion of aspen forest to coniferous forest (Fairweather et al. 2006).

This decline has accelerated on the CNF and ASNF after a series of contemporary events resulting in cumulative effects of several abiotic and biotic agents: severity of the 1999 frost damage, severe drought conditions, and western tent caterpillar defoliation in 2004 and 2005. The defoliating insect and disease agents individually do not normally cause significant mortality. However, mortality has been extensive, especially in the low- and mid- elevation areas, continues to the present day, and accelerated considerably after the 1999 frost event. Although dying trees sprouted, survival has been very low due to ungulate browsing.

Aspen mortality has been greatest in the low-elevation range. During the past 5 years, more than 50% of surveyed aspen sites below 7,500 feet elevation experienced 97% mortality (Fairweather et al 2008).

Ungulate browsing has impacted aspen regeneration since the 1960s (Rolf 2001) on the Coconino and ASNF since the mid-1980's. For these reasons, permanent exclusion fences have proven to be a necessity to regenerate and maintain aspen throughout these forests. Recently, oystershell scale has been observed on the Coconino NF, though the longer-term implications of this are unknown (FHP 2014).

Salt Damage

De-icing salts continue to damage roadside trees (especially ponderosa pines) along many highways within the project area. Mortality from de-icing salt use has increased in northern Arizona and the Arizona department of transportation removes salt damaged trees annually. Additional damage from dust abatement salts have been observed in other areas and is probable wherever they are used.

Carbon Sequestration and Climate Change

Climate scientists agree that the earth is undergoing a warming trend, and that human- caused elevations in atmospheric concentrations of carbon dioxide and other greenhouse gases are among the causes of global temperature increases. Forests serve as carbon reservoirs; however, large-scale fire events can counter this benefit by releasing significant amounts of carbon into the atmosphere. Restoration treatments (e.g., thinning, prescribed fire) as identified in the proposed action, promote low-density stand structures, characterized by larger, fire-resistant trees. This strategy should afford for greater carbon storage in southwestern fire-adapted ecosystems over time (Hurteau and North 2009). Although fire-excluded forests contain higher carbon stocks, this benefit is outweighed in the long term by the loss that would be likely from uncharacteristic stand-replacing fires if left untreated (Hurteau et al. 2011). Research has also shown that the long- term gains acquired through prescribed fire and mechanical thinning outweighs short-term losses in sequestered carbon. In the long term (e.g., 100 years) thinning and burning would create more resilient forests, less prone to stand-replacing fire

Finkral and Evans (2008) examined the full effects on carbon of an actual restoration thinning treatment in a ponderosa pine forest. They found that while the treatment initially produced a 30- percent reduction in the carbon held in live trees, it significantly reduced the threat of an active crown fire, which they predicted would kill all the trees and release 3.7 tons of carbon per acre in any untreated areas. Such findings are especially important when one considers that climate change is expected to make the conditions for catastrophic fire and insect outbreaks even more prevalent in the western United States.

Climate Change and Insect Disturbance

Climate can have direct effects on insect metabolism and lifecycles and can indirectly affect "factors such as food quality and predation" (Bentz, Alston, & Evans, 2008). Although future climate change at the local level is uncertain, a shift towards a drier or seasonally drier condition could result in an increasing risk over time of large-scale insect attack in the absence of management action to control tree stocking levels. Increased tree densities result in increased inter-tree competition for limited water and nutrients. Increased moisture stress reduces the natural defenses of the tree to repel insect attack and makes the forest susceptible to large- scale loss during periods of extended drought.

Climate Change and Wildfire Severity

Climate warming associated with elevated greenhouse-gas concentrations may create an atmospheric and fuel environment that is more conducive to large severe fires. General circulation model studies suggest that fire occurrence or area burned could increase across North America under a doubled CO_2 environment because of increases in lightning activity, the frequency of surface pressure and associated circulation patterns conducive to surface drying, and fire-weather conditions in general that are conducive to larger and more severe wildfires (McKenzie, Heinsch, & Heilman, 2011) (Chambers, 2008, p. 30) (Ziska, Reeves III, & Blank, 2005).

Existing Condition

The descriptions of the existing condition are organized under the criteria determined to be part of a properly functioning ecosystem. An ecosystem that is properly functioning is thought to be resilient to perturbations in structure, composition, and biological or physical processes. Systems at risk are those that may be degraded beyond the range of resiliency and sustainability. The four ecosystem characteristics discussed below are cover type, composition, structure, pattern, and processes.

Cover Types - Ecological Response Units (ERU), Potential Natural Vegetation Types (PNVT), and Existing Vegetation Type (EVT)

Apache-Sitgreaves (2015) NF use of PNVT

Current forest planning efforts have their Desired Conditions derived from ecological classifications systems. The Apache-Sitgreaves used a classification system utilizing Potential Natural Vegetation Types (PNVT). PNVTs are coarse-scale groupings of ecosystem types that share similar geography, vegetation, and historic ecosystem disturbances such as fire, drought, and grazing by native species. PNVTs represent the vegetation type and characteristics that would occur when natural disturbance regimes and biological processes prevail. It is important not to confuse PNVTs (or ERUs used in this document) with existing vegetation types. The PNVT mapping (located in the Apache-Sitgreaves NFs' GIS database) was derived from the forests' terrestrial ecosystem survey mapping. This mapping is intended to be used for mid- and landscape-scale planning. It is important to validate the PNVTs at the project and activity level. Note that not all PNVTs nor PNVT acres are represented in the Rim Country Project EIS silviculture area of analysis.

Coconino NF (2018) use of Ecological Response Unit (ERU)

The Coconino NF Plan components for terrestrial ecosystems are grouped by ecological response units (ERUs). ERUs represent an ecosystem stratification based on vegetation characteristics that would occur when natural disturbance regimes and biological processes prevail (TNC 2006), and combine potential vegetation and historic fire regimes to form ecosystem classes useful for landscape assessment (USDA Forest Service 2014). ERU's are the next derivation based on the concepts developed for PNVT's. ERUs incorporate more information concerning fire and its role in the ecosystem. For the purposes of the Rim Country Project EIS analysis PNVTs and ERUs are considered equivalent and the term ERUs will be used throughout.

Tonto NF (1985) use of Cover Type (EVT)

The brief discussions of forest cover types as discussed in the Tonto NF Forest Plan are outlined in USDAFS (1983, 2015). For the purposes of the Rim Country Project EIS analysis ERUs will be used throughout.

Forest Cover Types Used in Silviculture Analysis

Because the current direction in the Forest Service Region 3 is to describe the forested areas in terms of their ERU and EVT types, this analysis will follow those nomenclatures and descriptions.

The ERU system (formerly "PNVT") is a stratification of units that are each similar in plant indicator species, succession patterns, and disturbance regimes that, in concept and resolution, are most useful to management (Wahlberg et al, 2014 DRAFT). ERUs represent an ecosystem stratification based on vegetation characteristics that would occur when natural disturbance regimes and biological processes prevail (TNC, 2006), and combine potential vegetation and historic fire regimes to form ecosystem classes useful for landscape assessment (Wahlberg et al, 2014 DRAFT).

In this analysis when referring to an ERU (i.e. Ponderosa Pine ERU) it will be clearly labelled as an ERU. This will usually be done when describing an ecosystem at the landscape level and not a forested habitat or a forested cover type (mid- or fine-scale). When referring to a forested cover type, or EVT (or Existing Condition, EC), it will be clearly labelled as a Cover Type (i.e. ponderosa pine/Gambel cover type (CT)), and will usually be done when describing vegetation at the fine- to mid-scale.

The EVT is the culmination of all activities, climate, and disturbance forces that have preceded up to this point and the ERU is an expression of what the various ecosystems might look like into the future with only historical disturbances. Because the new forest plans describe the Desired Conditions in terms of the ERU it is logical to discuss the existing conditions in similar terms, thereby tying this analysis to the forest planning efforts. For a more thorough discussion on the vulnerability of these ERUs to a changing climate consult USDA (2017).

Forest ERU and EVT Descriptions

There are three broad categories that describe a vegetative state: 1) barren (non-vegetated), 2) non-forest, and 3) forest. The following is a description of the cover types that occur within the analysis area. Table 1 lists the acres within the analysis area by cover type.

Barren (non-vegetated)

These areas include mines, quarries, gravel pits and rock, talus or scree, and some rights of way. There are 3,220 non-vegetated acres within the silviculture analysis area.

Non-Forest

Grasslands: Colorado Plateau/Great Basin Grassland

The Colorado Plateau Great Basin Grassland Ecological Response Units (ERU) is typically found along elevational and temperature gradients above Semi-Desert Grasslands and below Montane-Subalpine Grasslands. It occupies cooler and wetter sites than Semi-Desert Grasslands and is common above the Mogollon Rim. This ERU is typically associated with Pinyon-Juniper Grass along the grassland-woodland ecotone in cool climates. Vegetation coverage consists of mostly grasses and interspersed shrubs. Grass species may include but are not limited to: Indian ricegrass (*Achnatherum hymenoides*), threeawn spp. (*Aristida* spp.), blue grama (*Bouteloua gracilis*), fescue spp. (*Festuca* spp.), needle and thread grass (*Hesperostipa comata*), spike fescue (*Leucopoa kingii*), *Muhlenbergia spp*., James' galleta

(*Pleuraphis jamesii*), and Sandberg bluegrass (*Poa secunda*). Shrub species may include but are not limited to: sagebrush (*Artemesia tridentate*), saltbush (*Atriplex* spp.), Ephedra, snakeweed (*Gutierrezia* spp.), winterfat (*Krascheninnikovia lanata*), one-seeded juniper (*Juniperus monosperma*), Utah juniper (*Juniperus osteosperma*) and wax currant (*Ribes cereum*). As described, this ERU may have had over 10% shrub cover historically, but had less than 10% tree cover.

Other works (e.g., Robbie 2004) have treated the Colorado Plateau Grasslands separately from Great Basin Grasslands. While the floristic distinction between these two is recognized here, the coarse ecosystem dynamics driving the two systems are similar, and therefore they are considered to be a common ERU in this guide. As the understanding of ecosystem processes evolves for these systems, and as state and transition models are developed, subclasses may be developed in the future. The reader is referred to Robbie (2004) for a description of the differences between the two grassland types.

Laying in a patchwork across the Colorado Plateau, grasslands vary in size from just a few acres to well over 1,000 acres. Grasslands within the project area typically occur between 6,300 and 9,000 feet in elevation and are categorized as the productive Montane/Subalpine and the more arid Colorado Plateau/Great Basin. A wide variety of species of grasses, forbs, shrubs and/or trees characterize their vegetation which varies according to soil type, soil moisture, and temperature.

Historically, these grasslands had less than 10 percent tree cover. Impacts from grazing, logging, and fire suppression practices that started in the late1800s are still discernible on the landscape today. These practices reduced or eliminated the vegetation necessary to carry low-intensity surface fires across the landscape, thereby altering the natural fire regimes and allowing uncharacteristic forest succession to take place. The grassland cover type has experienced some degree of conifer (pinyon, juniper, and ponderosa pine) encroachment over the last 100 years as a result of fire exclusion, grazing, and agricultural use. These conditions have been further exacerbated by soil erosion and increases in invasive, nonnative plants, low-density rural home development, and grazing (Belsky and Blumenthal 1997). Other changes include shifts to more frequent occurrences of fire intolerant species, increases in litter (Abella et al. 2007), changes in species composition and functional groups including shifts toward more shade tolerant understory species under denser tree canopies (Laughlin et al. 2011).

Approximately 28,580 acres within the analysis area are classified as grassland cover type (Table 4). Much of the grassland cover type has experienced some degree of tree encroachment (pinyon, juniper, and ponderosa pine) over the last 100 years as a result of fire exclusion, grazing, and agricultural use. Many of the pre-settlement trees that grew along the edges of these grasslands were removed. The edges as well as much of the interior of the grasslands have become stocked by sapling and young to mid-aged trees. These trees are growing rapidly due to the open growing conditions and a lack of competition.

Forest

Forest cover types (Table 1) are named for the tree species that are presently dominant, using relative density and cover as the measure of dominance. Cover type is based on the species type which has the majority of dominance in the upper most layer of the site (dominant and co-dominant trees). In the case of pinyon-juniper, several species have been lumped together into a single cover type grouping and codominance is not necessarily implied. The forest cover types have been grouped into communities. The woodland community is dominated by woodland tree species and the forest community is dominated by forest tree species.

Woodland Vegetation Community

Pinyon-Juniper (PJ) –

The pinyon-juniper ERU is collectively composed of the pinyon-juniper grassland, pinyon-juniper evergreen shrub and pinyon-juniper persistent woodland cover types. Within the project area, pinyon-juniper communities generally occur at elevations between 6,100 and 8,000 feet.

Under their natural disturbance regime, these plant communities are dominated by one or more species of pinyon pine and/or juniper with at least 10 percent tree canopy. They can occur with a grass/forb-dominated understory (pinyon-juniper grasslands), a shrub-dominated understory (pinyon-juniper evergreen shrub), or a sparse discontinuous understory of some grasses and/or shrubs (pinyon-juniper persistent woodland forest community). Two- needle pinyon pine (*Pinus edulis Engelm.*) is common; as well as one-seed (*Juniperus monosperma (Engelm.) Sarg.*), Utah (*Juniperus osteosperma (Torr.) Little*), Rocky Mountain juniper (*Juniperus scopulorum Sarg.*), and alligator juniper (*Juniperus deppeana Steud.*) with occasional common juniper (*Juniperus communis var. depressa L*) . Species composition and stand structure vary by location primarily due to precipitation, elevation, temperature, and soil type.

Most of the pinyon-juniper vegetation communities are currently younger and denser than they were historically, because of changes in wildfire occurrence. Greater tree density has increased competition for water and nutrients. This, in turn, has caused a reduction in understory plant cover and diversity, a loss of ground cover, and subsequent increases in soil erosion.

Juniper Grassland

The Juniper Grassland is typically found on warmer and drier settings beyond the environmental limits pinyon, and just below and often intergrading with the pinyon-juniper zone. The Juniper Grass ecosystem is generally Uneven-aged and very open in appearance, primarily on mollisol soils. Trees occur as individuals or in smaller groups and range from young to old. A dense herbaceous matrix of native grasses and forbs characterize this type. Typical disturbances (fire, insects, and disease) are low severity and high frequency. These disturbance patterns create and maintain the uneven-aged, open-canopy nature of this type. The tree and grass species composition varies throughout the Region, consisting of a mix of one or more juniper species. Typically, native understory grasses are perennial species, while forbs consist of both annuals and perennials. Shrubs are characteristically absent or scattered. This type is typically found on sites with well-developed, loamy soil characteristics, generally at the drier edge of the woodland climatic zone. Generally these types are most extensive in geographic areas dominated by warm (summer) season or bi-modal precipitation regimes. Overall these sites are less productive for tree growth than the Pinyon-Juniper Woodland Type.

Oak Woodlands

This community consists of Gambel oak (*Quercus gambelii* Nutt.) thickets containing various diameter stems, and low-growing, shrubby oak. Some areas contain oak trees with relatively large hollow boles or limbs. When present, coniferous trees are widely scattered and are frequently mature or old. Within the project area, oak woodlands generally occur at elevations between 6,000 and 8,500 feet.

Forest Vegetation Community

Ponderosa Pine

The ponderosa pine forest vegetation community is the most extensive represented cover type generally occurring at elevations ranging from 5,800 to 9,200 feet and, is dominated by ponderosa pine (*Pinus ponderosa* Lawson & C. Lawson var. *scopulorum* Engelm.), and commonly includes other species such as oak, juniper, and pinyon. Species such as quaking aspen (*Populus tremuloides* Michx.), Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco var. *glauca* (Beissn.) Franco), white fir (*Abies concolor* (Bord. & Glend.) Lindl. Ex Hildebr.) , and blue spruce (*Picea pungens* Engelm.) may also be present, but occur infrequently as small groups or individual trees. This forest vegetation community typically occurs with an understory of grasses and forbs although it sometimes includes shrubs.

The majority of the project area is the ponderosa pine plant association. Associations are named for the most shade tolerant tree species successfully regenerating, and for an understory species (shrub or herb) which is most diagnostic of the site. The ponderosa pine associations within the project area include three major sub-types: Ponderosa pine-bunchgrass, Ponderosa pine-Gambel oak, and Ponderosa pine-evergreen oak.

Ponderosa pine commonly grows in pure stands and currently is found in even-aged and uneven-aged structural conditions across the area. The open park-like stands characteristic of the reference conditions for ponderosa pine forests promoted greater diversity and fire resilience than the dense stands of today. Ponderosa pine forests within the project are generally denser and more continuous than in reference conditions and accumulations of forest litter and woody debris are much higher than would have occurred under the historic disturbance regime (Brown et al, 2003). Lack of fire disturbance has led to increased tree density and fuel loads that increase the risk of uncharacteristically intense wildfire and drought-related mortality. When fires occur under current conditions, they tend to kill a lot of trees, including the large and old trees. These trees take longer to replace, moving the forest further from desired conditions, and increasing the time it would take to return to desired conditions. There is a high risk of insect and/or disease outbreak, which is also a function of increased tree density (see Forest Health Section).

Ponderosa Pine / Bunchgrass Subclass

This subclass is characterized by open stands supporting an understory of primarily herbaceous species, and is commonly found above the Mogollon Rim on mollisol soils. A grassy understory, and ample needle cast / duff are the primary carriers of fire, and support frequent, non-lethal fires. The role of fire in this subclass is essential to maintain canopy openings and prevent excess stocking. Common grass species include blue grama (*Bouteloua gracilis*), Arizona fescue (*Festuca arizonica*), and mountain muhley (*Muhlenbergia montanum*).

Ponderosa Pine / Gambel Oak Subclass

While structurally similar to its counterpart subclass, the Ponderosa Pine / Gambel Oak subclass is typically found on alfisols or inceptisol soils and is primarily distinguished by the presence of the deciduous Gambel oak in the sub-canopy. Other common species include alligator juniper, twoneedle pinyon, and New Mexico locust (*Robinia neomexicana* A. Gray var. *neomexicana*)).

Gambel oak is frequently the only deciduous tree in otherwise pure ponderosa pine forests, adding diversity to these forests. A portion of the stands have a large enough component of Gambel oak to be considered pine-oak habitat for MSO (as described in the 2012 MSO Recovery Plan). Similar to pure ponderosa pine forests, pine- Gambel oak forests have become altered since Euro-American settlement in the late 1800s resulting in an overall increase in small- and medium sized Gambel oak stems and a more simplified forest structure (Abella 2008a). Oak management strategies within this project includes conservation of all existing large, old oaks, maintaining a variety of growth forms and managing for densities similar to the range of variability of oak's evolutionary environment.

Understory Vegetation Within Ponderosa Pine Forest

Herbaceous vegetation (grass, forbs, and shrubs) are a major understory associate within the ponderosa pine plant associations throughout the analysis area. Research at the Fort Valley Experimental Forest has shown that substantial declines in herbaceous vegetation diversity and growth have occurred over the past century due to increased tree density, increased canopy covers, and increased forest floor depth (Covington et al 1997). This trend indicates a shift away from a more diverse balance across a broad variety of understory plants to productivity dominated by pine trees. High stand densities dominate the ponderosa pine analysis area and closed tree canopies.

Ponderosa Pine with Evergreen Oak

The Ponderosa Pine-Evergreen Oak ERU occurs in the mild climate gradients of central and southern Arizona, particularly below the Mogollon Rim, where warm summer seasons and bi-modal (winter-summer) precipitation regimes are characteristic. Within the silviculture analysis area this type occurs primarily on the Tonto NF with small occurrences on the CNF and the ASNF. This type occurs at elevations ranging from 5,500-7,200 ft, on sites slightly cooler-moister than the Madrean Pinyon-Oak ERU, and with a much greater plurality of ponderosa pine. This system is dominated by ponderosa pine and can be distinguished from the Ponderosa Pine Forest ERU by well-represented evergreen oaks (e.g., Emory oak (*Quercus emoryi*), Arizona white oak (*Quercus arizonica*), silverleaf oak (*Quercus hypoleucoides*), grey oak (*Quercus grisea*)), alligator juniper, and pinyon pine. In terms of disturbance, the Ponderosa Pine-Evergreen Oak averaged greater fire severity than the ponderosa pine forests above the Mogollon Rim, and greater patchiness with less horizontal uniformity and more even-aged conditions. Site potential, fire history, and the importance of perennial grasses versus shrubs in the understory vary on a gradient between two provisional subclasses (described below). Understory shrubs include manzanita (*Arctostaphylos sp*.), turbinella oak (*Quercus turbinella*), skunkbush sumac (*Rhus trilobata*), and mountain mahogany (*Cercocarpus montanus*). Historically this ERU had over 10% tree canopy cover, with the exception of early, post-fire plant communities.

Ponderosa Pine – Evergreen Oak (Perennial Grass Subclass)

This subclass is distinguished from the Ponderosa Pine–Evergreen Shrub subclass by a more continuous layer of perennial grasses in the understory and a relatively minor shrub component. These circumstances may be less evident in the current condition depending on the degree of shrub encroachment. Trees occur as individuals or in smaller groups and range from young to old, but were historically more uneven-aged in structure. The understory is dominated by low to moderate density shrubs, with herbaceous plants in the interspaces. Common grass species include Arizona fescue (*Festuca arizonica*), a variety of muhleys (e.g. *Muhlenbergia longiligula*, *M. dubia*, *M. straminea*, and *M. montanum*). Fire frequency varied, but averaged higher with less severity. These disturbance patterns create and maintain the uneven-aged (grouped) low to moderately-closed canopy nature of this type. Site potential and disturbance history also maintained oak, juniper, and pinyon as subdominant tree components, with herbaceous plants in the interspaces.

Due to the effects of long-term fire suppression in this type, in many locations the current condition is severely departed from historic conditions. Typically these changes include in-filling of the canopy gaps, increased density of tree groups, higher fire severity, and reduced composition, density and vigor of the herbaceous understory plants. Currently many of these sites are closed-canopied forests, capable of supporting crown fires.

Ponderosa Pine – Evergreen Oak (Evergreen Shrub Subclass)

Ponderosa Pine–Evergreen Shrub forests differ from the former subclass by site potential, typically favoring high shrub cover, higher fire severity, and more even-aged conditions characteristic of mixed-severity fire regimes. This type is found on well-drained soils, frequently with coarse-textured or gravelly (stony) soil characteristics, that favor shrub layer development (particularly oaks). Trees occur as individuals or in small groups and patches and range from young to old, but typically groups or patches are even-aged in structure. The understory is dominated by moderate to high density shrubs, with limited grass cover. Typical disturbances (fire, insects, disease) worked collectively to favor mixed severity conditions (fire regime III), where sufficient tree canopy provides needle-cast to facilitate fire spread). Some high-density evergreen shrub patches exhibit infrequent, high severity fire (fire regime IV; stand replacement at 35-200 years). Areas where this pattern was persistent are likely to be mapped as Interior Chaparral ERU. More typical disturbance patterns created and maintained the even-aged tree groups, with a moderate to moderately-closed canopy.

Due to the effects of long-term fire suppression in this type, in many locations the current condition is departed from historic conditions. Typically these changes include in-filling of the canopy gaps, increased density of tree groups; and reduced composition, density and vigor of the herbaceous understory plants. Other significant changes resultant from fire exclusion are increased homogeneity of the shrub structural stages on the landscape, facilitating larger patch sizes of high-severity fire effects. Currently, many of these sites are closed-canopy forests, capable of supporting crown fires.

Mixed Conifer – Frequent Fire (Dry Mixed Conifer)

The Mixed Conifer-Frequent Fire ERU, sometime referred to as "Dry Mixed Conifer", spans a variety of semi-mesic environments in silviculture analysis area. In the southwestern US, mixed conifer forests may be found at elevations between 6,000 and 10,000 ft., situated between ponderosa pine, pine-oak, or pinyon-juniper woodlands below and spruce-fir forests above. For the most part, the frequent fire type occupies warmer and drier sites of the mixed conifer life zone, and are characterized by an historic fire regime of frequent (9-22 years; Baisan and Swetnam 1990; Grissino- Mayer et al. 1995; Heinlein et al. 2005) low severity surface fires, and infrequent mixed severity fires.

Typically this type was dominated by ponderosa pine in an open forest structure (<30% tree cover), with minor occurrence of aspen, Douglas-fir, white fir, and Southwestern white pine. Unlike the Mixed Conifer with Aspen ERU (discussed below), aspen occurs within dissimilar inclusions and not as a seral stage in the Mixed Conifer-

Frequent Fire ERU. On contemporary landscapes, more shade tolerant conifers, such as Douglas-fir, white fir, and blue spruce, tend to increase in cover in late succession, contrary to conditions under the characteristic fire regime. However, historically, these species could have achieved dominance in localized settings where aspect, soils, and other factors limited the spread of surface fire. Currently, much of this type is dominated by closed structure (>30% tree cover) and climax species as a result of fire suppression.

Mixed Conifer with Aspen (Wet Mixed Conifer) (MCW)

The Mixed Conifer with Aspen ERU hosts a variety of dominant and co-dominant species spanning mesic environments. This ERU is found at elevations between 7,000 and 10,000 ft., situated between ponderosa pine and dry mixed conifer forests below and Spruce- Fir Forest ERU above. Dominant and co-dominant vegetation varies in elevation and moisture availability. Ponderosa pine occurs incidentally or is absent, while Douglas-fir, Southwestern white pine, white fir, and Colorado blue spruce occur as dominant and or codominant conifer species. Understory vegetation is comprised of a wide variety of shrubs, graminoids, and forbs depending on soil type, aspect, elevation, disturbance history, and other factors.

This type may be dominated by quaking aspen and may or may not have a significant conifer component, depending upon successional status. The understory structure may have shrubs and an herbaceous layer, or just an herbaceous layer. Common shrubs include oceanspray (*Holodiscus dumosus*), thimbleberry (*Rubus parviflorus*), fivepetal cliffbush (*Jamesia americana*), and mountain ninebark (*Physocarpus monogynus*). The herbaceous layer may be dense or sparse, dominated by graminoids or forbs. Some of the species typically found associated with aspen include Arizona peavine (*Lathyrus arizonica*), meadow rue (*Thalictrum fendleri*), deer's ears (*Frasera speciosa*), yarrow (*Achillea millefoliuma*), violet (*Viola canadensis*), paintbrush (*Castilleja* spp.), and several grasses and sedges (*Poa spp.* and *Carex* spp.). Distribution of aspen within this ERU is limited by several factors including adequate soil moisture required to meet its high evapotranspiration demand, the length of the growing season or low temperatures, and major disturbances that clear areas of vegetation and stimulate root sprouting and colonization.

Quaking Aspen (QA)

Aspen (quaking aspen) occurs as small inclusions within a variety of ERUs, however most prominently occurs as a component of the Mixed Conifer with Aspen ERU. As a species, aspen is adapted to a much broader range of environmental conditions than most plant species associated with it. This highly variable ecological community can comprise mostly aspen or aspen codominating with few to several conifer species. Aspen occurs across the forested landscape as a shifting mosaic over space and time. At lower elevations, conifers include ponderosa pine, Rocky Mountain Douglas-fir, and white fir. At middle elevations, conifers include Rocky Mountain Douglas-fir, white fir, blue spruce, southwestern white pine, and ponderosa pine. Rocky Mountain juniper can also be present. At higher elevations, conifers include Rocky Mountain Douglas-fir, southwestern white pine, subalpine fir, corkbark fir, and Engelmann spruce.

Relatively pure aspen stands may function as natural firebreaks across the landscape, support watershed stability, and contribute to scenic landscapes. Aspen is a disturbance dependent species requiring fire, windthrow, or cutting to regenerate an overmature stand into a young stand.

Without periodic fire or with high levels of herbivory, conifers will replace aspen. As a result, this type is considerably altered today and may be difficult to identify because of conifer succession. The presence of even a single aspen tree in a conifer stand provides strong evidence that the area historically supported a seral component of aspen.

Aspen exist as single storied or, more commonly, multistoried depending on disturbance history and local stand dynamics. Historically, aspen suckers (root sprouts) were common. Aspen stands are usually closed canopied (>30%). The understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse, dominated by grasses and grass-like plants or forbs. Some of the species typically found associated with aspen include bracken fern, Arizona peavine, meadow rue, deer's ears, yarrow, violet, paintbrush, arnica, and several grasses and sedges. Decaying coarse woody debris is common.

Aspen stands are typically moister and cooler, supporting a greater abundance of plants, fungi, invertebrates, mammals, and cavity-nesting bird species than the surrounding forest. Even small aspen groups provide this unique habitat. Aspen is second only to riparian ecosystems in biological diversity and supports more bird species than other forested areas in the Southwest. For these reasons, aspen is designated as an "ecological indicator" or EI. EIs are selected and monitored as a means to assess management effects to biological diversity; in this case, the diversity of habitats that aspen provides and the associated species.

Fire regimes for aspen are determined by the adjacent forested ERUs, with fire return intervals ranging from 2 to 20 years at low elevations in ponderosa pine, to 10 to 30 years for mixed conifer at middle elevations, and up to 30 to 400 years for spruce-fir. Both spruce-fir and mixed conifer forested ERUs have mixed severity fire regimes, experiencing frequent, low severity surface fires, as well as infrequent, stand replacing crown fires. Aspen is primarily affected by fire, wind, insects, disease, pathogens, herbivores, and climate interactions.

The decline in aspen throughout its western range is of ecological concern. This declining trend has been noted for the past 50 years, but aspen mortality has become more pronounced since about 2002. Not only are trees dying, but their clonal root systems are also dying. Several factors have been hypothesized as causal agents in the decline of aspen: fire suppression, conifer competition, ungulate browsing, drought, insects, pathogens, and climate change.

Riparian Communities

Riparian systems provide critical ecosystem services nationwide, and in the arid southwest, their importance is further amplified. Serving as an essential link between upland and aquatic systems, riparian areas provide critical watershed functions through processing, transport, and storage of sediment and water, as well as providing important habitat to terrestrial and aquatic wildlife. The Southwestern Region has adapted the following definition for riparian areas for the purposes of ecosystem mapping (Triepke et. al. 2013)

The southwestern US contains 21 riparian Ecological Response Units with widely varying distribution. While the primary ERU concept applies equally to riparian units, these systems are more strictly bounded by landform than their upland counterparts due to their reliance on available soil moisture. As a result, riparian ERU's are typically found in valley bottoms, floodplains, and depressional areas, and tend to occur in smaller, more linear configurations distributed within upland ERUs. The primary delineation of riparian ERUs in the southwest is provided by the Regional Riparian Mapping Project (RMAP). The reader is referred to the RMAP project report (Triepke et. al. 2013) for a full description of the riparian mapping effort as well as riparian ERU descriptions.

Tables 10 and 11 describe the distribution of cover types by 5th HUC watersheds and by Forest. The cover types are well distributed across the landscape. The ponderosa pine, ponderosa pine/evergreen oak and mixed conifer frequent fire combine for a total of 737,496 acres of the total 939,924 acres.

Vegetation Composition

Vegetative composition refers to the vegetation cover types, species present and their relative abundance. A thorough description of the vegetation cover types as they relate to ERUs is described above. It includes information on species diversity and the balance of early seral and late seral species. .

Table 10. Existing Condition - Distribution of Ecological Restoration Unit (ERU) cover types across 5th HUC watershed

5th HUC Watershed	Aspen	Grassland/ Meadow	Madrean Woodland	Mixed Conifer with Aspen	Mixed Conifer/ Frequent Fire	Pinyon-Juniper Woodland	Ponderosa Pine	Ponderosa Pine/ Evergreen Oak	Riparian	Grand Total
Beaver Creek	40	1,624		0		2,498	5,729	0	95	9,986
Black Canyon		495		59	2,323	16,577	48,492	42	1,595	69,584
Canyon Creek		8	114	25	624	1,247	19,072	4,410	540	26,040
Canyon Diablo	104	418		15	91	137	2,466			3,232
Carrizo Creek (Local Drainage)					106	1	3,846			3,954
Cherry Creek			1,599			887	14,003	11,895	538	28,923
Corduroy Creek						11	49			59
Cottonwood Creek		481				11,464	46,536	7,192	816	66,489
East Verde River		25	2,110		7,772	8,042	21,938	33,919	2,804	76,611
Fossil Creek-Verde River			326		24	3,252	13,319	4,845		21,767
Gun Creek-Tonto Creek			504			611	511	8,372	61	10,059
Haigler Creek-Tonto Creek			4,441	0	5,100	7,165	28,728	36,397	1,831	83,662
Jacks Canyon	53	8,796		5	114	12,065	50,615		106	71,752
Lower Chevelon Canyon		22				4,266	6,649		170	11,108
Lower Clear Creek					7	1,326	104		40	1,477
Oso Draw	199	637		72	1,369	811	6,568			9,656
Phoenix Park Wash-Dry Lake		71				6,334	12,079	1,139	101	19,723
Rye Creek-Tonto Creek			1,394			1,091	789	1,566	127	4,967
Salome Creek			6,913		445	2,292	4,684	18,226	386	32,946
Salt River-Theodore Roosevelt Lake			15			31	16	45		108
Show Low Creek		1,438			556	2,624	17,945	595	236	23,394
Spring Creek			7,579			2,231	2,095	19,381	160	31,446
Upper Chevelon Canyon		1,217		375	6,479	25,914	67,414		1,420	102,820
Upper Clear Creek	888	292		2,564	22,943	13,915	95,881		3,428	139,911
Upper North Fork White River	14				79		234			327
Upper Silver Creek	0	2,043			776	1,210	6,435			10,464
Walnut Creek		66					9			75
West Clear Creek	141	1,211		4	492	9,059	80,097	43	103	91,151
Grand Total	1,440	18,843	24,996	3,120	49,299	135,062	556,304	148,069	14,558	951,691

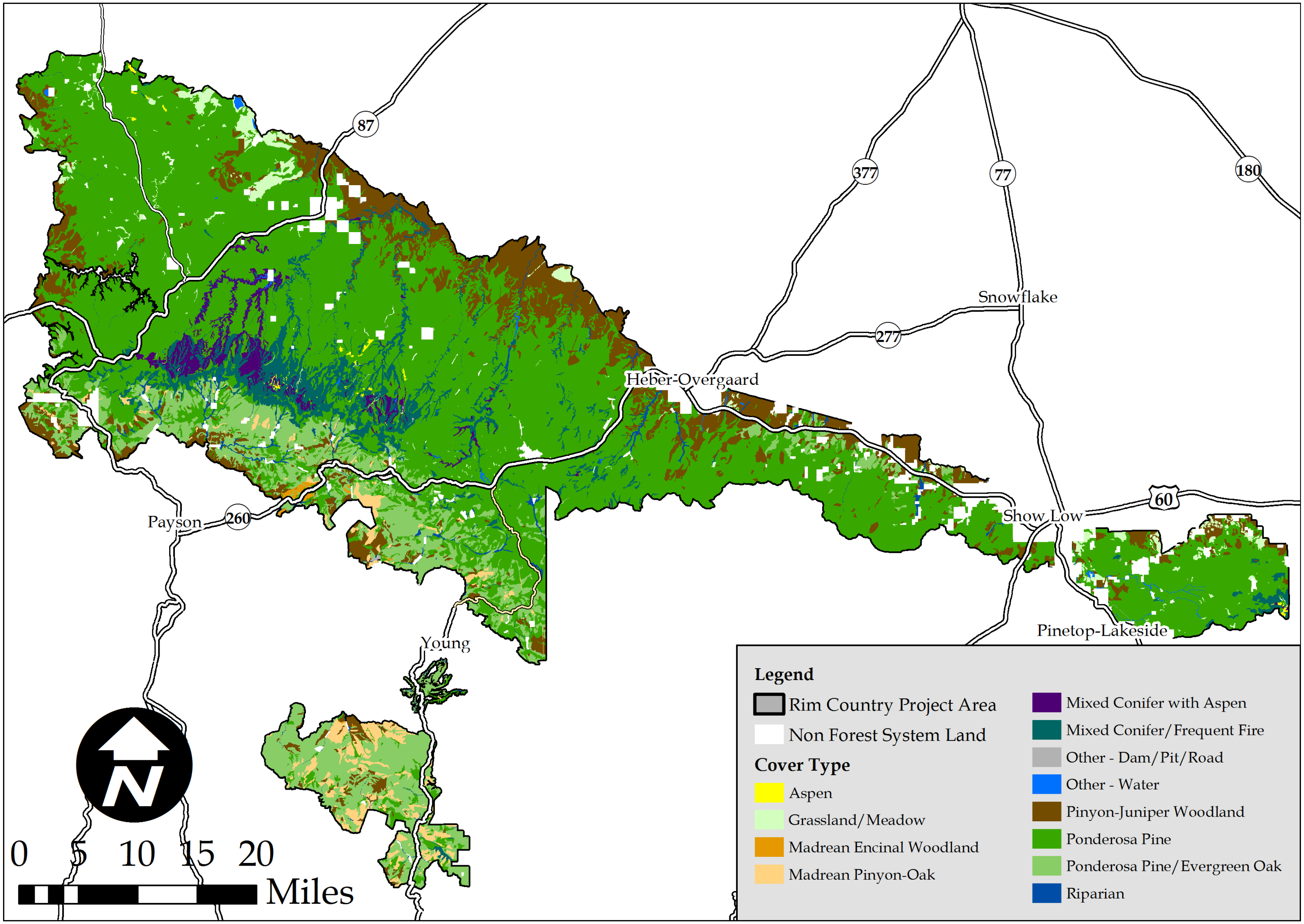
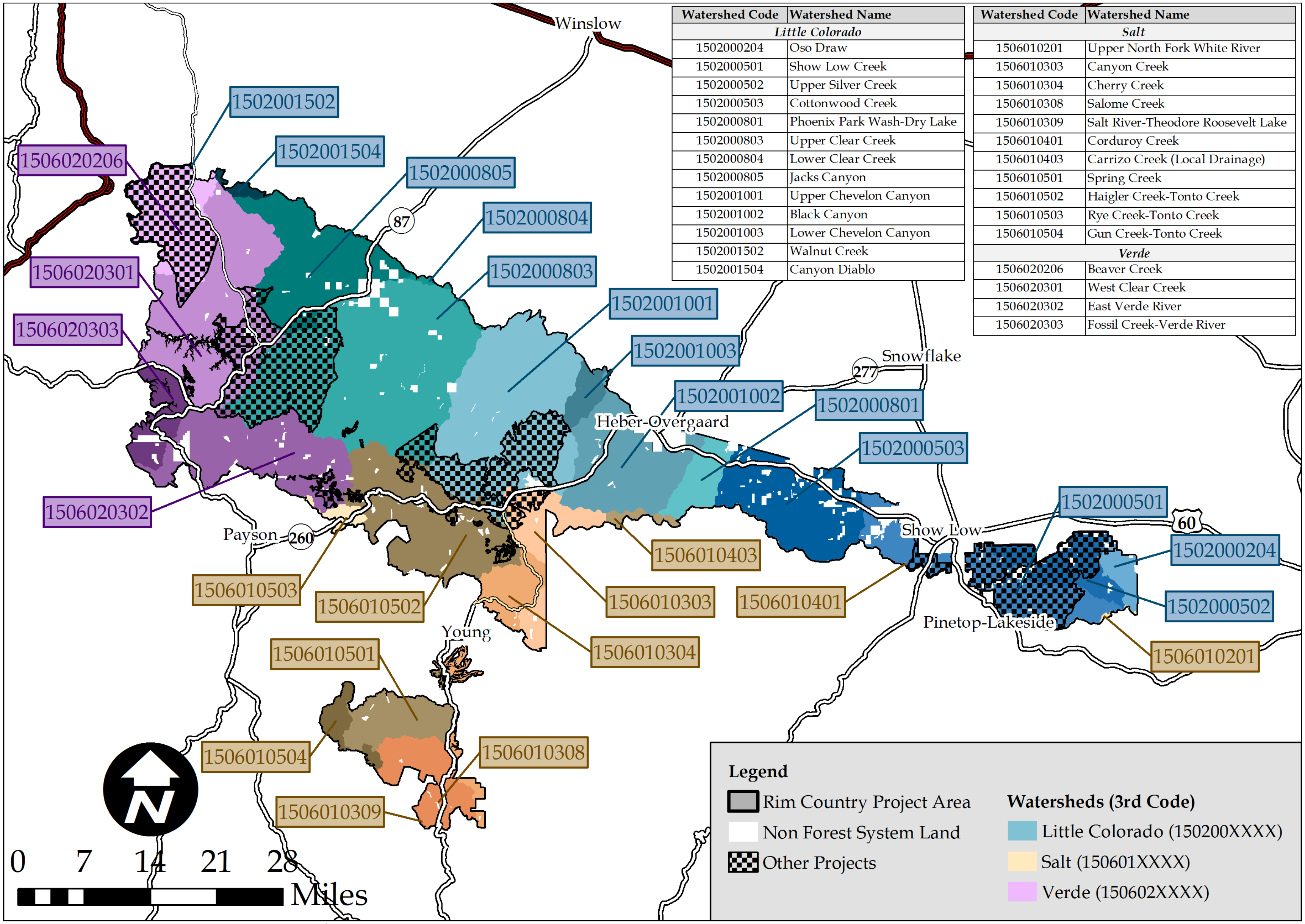


Figure 3-1 – Existing Condition – Cover Type



Watershed Code	Watershed Name
Little Colorado	
1502000204	Oso Draw
1502000501	Show Low Creek
1502000502	Upper Silver Creek
1502000503	Cottonwood Creek
1502000801	Phoenix Park Wash-Dry Lake
1502000803	Upper Clear Creek
1502000804	Lower Clear Creek
1502000805	Jacks Canyon
1502001001	Upper Chevelon Canyon
1502001002	Black Canyon
1502001003	Lower Chevelon Canyon
1502001502	Walnut Creek
1502001504	Canyon Diablo

Watershed Code	Watershed Name
Salt	
1506010201	Upper North Fork White River
1506010303	Canyon Creek
1506010304	Cherry Creek
1506010308	Salome Creek
1506010309	Salt River-Theodore Roosevelt Lake
1506010401	Corduroy Creek
1506010403	Carrizo Creek (Local Drainage)
1506010501	Spring Creek
1506010502	Haigler Creek-Tonto Creek
1506010503	Rye Creek-Tonto Creek
1506010504	Gun Creek-Tonto Creek
Verde	
1506020206	Beaver Creek
1506020301	West Clear Creek
1506020302	East Verde River
1506020303	Fossil Creek-Verde River

Figure 3-2 – Existing Condition – 5th HUC Watersheds

Table 11. Existing Condition - Cover type by Forest

Cover Type	Coconino	Sitgreaves	Tonto	Grand Total
Aspen	635	805		1,440
Grassland/Meadow	12,292	6,526	25	18,843
Madrean Woodland			24,996	24,996
Mixed Conifer with Aspen	1,809	1,311		3,120
Mixed Conifer/Frequent Fire	16,648	21,207	11,444	49,299
Pinyon-Juniper Woodland	29,074	80,027	25,961	135,062
Ponderosa Pine	196,976	281,548	77,779	556,304
Ponderosa Pine/Evergreen Oak	1,824	9,052	137,193	148,069
Riparian	2,716	5,402	6,440	14,558
Grand Total	261,974	405,878	283,839	951,691

Vegetation Structure

Uneven-aged Structure

Structure is a means to express the balance of age and size classes as well as the horizontal and vertical distribution of layers in the forest canopy. In a forested environment, vegetation structure can also include snags, down logs and woody debris, and canopy closure.

Uneven-aged forests are generally described as having three or more distinct age classes of trees (Reynolds et al. 2013) and is a measure of vertical structure within a forest. Ponderosa pine is composed of trees in structural stages that range from young to old trees and are dominated by ponderosa pine. Forest appearance is variable, but generally uneven-aged and open; occasional areas of even-aged structure are present. It is desired that uneven-aged forest structure occurs on the majority of the acres by cover type. Groups of seedlings and saplings are maintained at sufficient levels to provide a reliable source of replacement as trees grow and progress into succeeding size and age classes. It is desired to have a forest arrangement in individual trees, small clumps, and groups of trees interspersed within small, variably sized openings of grasses, forbs, and shrubs that are similar to historic patterns and discourage crown fire behavior. Currently, the arrangement of the tree cohorts (groups of trees of a similar age class) or size classes are in conditions conducive to crown fire with extremely dense and continuous overstory canopies in a closed condition and understory canopies acting as ladder fuels supporting a transition from surface fire to crown fire behavior (Tables 3-3 and 3-4).

The current condition in terms of uneven-aged structure appears by 5th HUC watershed in table 3-5. Currently 64 percent of acres across the analysis area can be considered uneven-aged. The Forest Plans as well as the MSO Recovery Plan (USDI 2012) promote the desired condition of forests composed of an uneven-aged structure where groups and clumps of trees of different size and age classes are spatially arranged across the landscape.

A size–class distribution by 5th HUC watershed (Table 3-4) shows that the majority of basal area (63 percent overall) is concentrated in the 5 to 12 inch and 12 to 18 inch size classes.

Table 12. Existing Condition – Trees per acre distribution across size classes by 5th HUC watershed

5th HUC Watershed	0-5"	5-12"	12-18"	18-24"	24"+	Total
Beaver Creek	613	86	35	12	3	750
Black Canyon	570	74	20	5	2	670
Canyon Creek	1332	88	22	5	3	1451
Canyon Diablo	1015	105	25	12	2	1159
Carrizo Creek (Local Drainage)	429	57	15	4	2	506
Cherry Creek	1048	149	35	9	3	1244
Corduroy Creek	697	57	16	4	1	775
Cottonwood Creek	632	67	16	3	1	719
East Verde River	1091	119	44	11	5	1271
Fossil Creek-Verde River	908	129	43	8	3	1091
Gun Creek-Tonto Creek	1441	147	36	9	2	1636
Haigler Creek-Tonto Creek	1292	142	42	10	5	1490
Jacks Canyon	431	99	24	6	3	563
Lower Chevelon Canyon	491	120	30	7	3	651
Lower Clear Creek	651	113	26	9	4	803
Oso Draw	1336	108	38	8	2	1492
Phoenix Park Wash-Dry Lake	520	81	20	4	2	627
Rye Creek-Tonto Creek	915	122	37	11	3	1088
Salome Creek	1058	182	40	12	3	1295
Salt River-Theodore Roosevelt Lake	1464	105	46	18	7	1640
Show Low Creek	795	80	23	6	1	905
Spring Creek	831	178	41	8	2	1059
Upper Chevelon Canyon	589	121	35	10	4	758
Upper Clear Creek	753	122	37	11	4	927
Upper North Fork White River	1875	106	42	16	4	2044
Upper Silver Creek	905	110	38	8	1	1063
Walnut Creek	59	17	15	11	7	109
West Clear Creek	559	99	41	8	3	710
Grand Total	813	114	35	9	3	973

Table 13. Existing Condition – Trees per acre distribution across size classes by cover type

Cover Type	0-5"	5-12"	12-18"	18-24"	24"+	Total
Aspen	1074	111	41	15	4	1245
Grassland/Meadow	440	130	11	9	4	595
Madrean Woodland	937	179	31	4	2	1152
Mixed Conifer with Aspen	1294	114	40	17	5	1471
Mixed Conifer/Frequent Fire	1040	108	47	14	6	1216
Pinyon-Juniper Woodland	769	116	30	7	3	925
Ponderosa Pine	686	99	33	8	3	829
Ponderosa Pine/Evergreen Oak	1157	164	36	8	3	1369
Riparian	898	127	37	11	4	1077
Grand Total	813	114	35	9	3	973

Density

Overall, basal areas are high for most cover types, especially Aspen, Dry Mixed Conifer, Ponderosa Pine/Evergreen Oak, and Mixed Conifer with Aspen. Average basal area of ponderosa pine cover type across the analysis areas is lower, largely due to the number of ponderosa pine stands that experienced stand replacing fire in the Rodeo-Chediski Fire in 2002 and are now dominated by stands with low basal area.

Table 14. Existing Condition – Basal area distribution across size classes by 5th HUC watershed

5th HUC Watershed	0-5"	5-12"	12-18"	18-24"	24"+	Total
Beaver Creek	8	34	42	28	13	124
Black Canyon	11	27	22	11	9	81
Canyon Creek	16	31	25	12	14	99
Canyon Diablo	16	37	29	27	9	118
Carrizo Creek (Local Drainage)	6	22	17	9	6	60
Cherry Creek	14	54	40	19	14	142
Corduroy Creek	15	22	18	10	3	69
Cottonwood Creek	11	25	18	8	4	66
East Verde River	15	45	51	25	25	161
Fossil Creek-Verde River	11	48	49	18	14	140
Gun Creek-Tonto Creek	11	54	41	21	10	138
Haigler Creek-Tonto Creek	17	51	48	24	25	165
Jacks Canyon	6	35	26	14	14	96
Lower Chevelon Canyon	13	44	34	17	14	121
Lower Clear Creek	8	40	31	20	23	121
Oso Draw	16	41	44	18	7	124
Phoenix Park Wash-Dry Lake	9	31	22	10	7	79
Rye Creek-Tonto Creek	12	45	42	24	18	142
Salome Creek	14	67	46	26	13	166
Salt River-Theodore Roosevelt Lake	10	40	54	38	27	170
Show Low Creek	12	30	27	13	6	87
Spring Creek	14	65	47	18	8	152
Upper Chevelon Canyon	12	44	40	22	16	133
Upper Clear Creek	12	45	43	25	18	143
Upper North Fork White River	14	43	50	36	17	160
Upper Silver Creek	14	42	44	17	8	126
Walnut Creek	3	6	19	25	30	82
West Clear Creek	8	39	46	18	11	122
Grand Total	12	42	40	20	15	129

Table 15. Basal area distribution across size classes by cover type

Cover Type	0-5"	5-12"	12-18"	18-24"	24"+	Total
Aspen	39	36	48	34	23	180
Grassland/Meadow	2	29	13	22	17	83
Madrean Woodland	15	69	35	10	9	137
Mixed Conifer with Aspen	17	41	48	40	21	166
Mixed Conifer/Frequent Fire	15	42	55	32	29	173
Pinyon-Juniper Woodland	12	40	33	16	17	119
Ponderosa Pine	10	38	38	18	12	115
Ponderosa Pine/Evergreen Oak	18	58	41	19	18	154
Riparian	13	46	43	25	18	145
Grand Total	12	42	40	20	15	129

Table 16. Existing Condition – Density related indicators of forest structure by 5th HUC watershed

5th HUC Watershed	Basal Area	Stand Density Index	Quadratic Mean Diameter
Beaver Creek	124	270	8
Black Canyon	81	186	5
Canyon Creek	99	251	4
Canyon Diablo	118	288	6
Carrizo Creek (Local Drainage)	60	140	5
Cherry Creek	142	338	5
Corduroy Creek	69	172	4
Cottonwood Creek	66	158	4
East Verde River	161	378	6
Fossil Creek-Verde River	140	325	6
Gun Creek-Tonto Creek	138	346	5
Haigler Creek-Tonto Creek	165	400	5
Jacks Canyon	96	211	8
Lower Chevelon Canyon	121	267	6
Lower Clear Creek	121	274	6
Oso Draw	124	317	5
Phoenix Park Wash-Dry Lake	79	182	5
Rye Creek-Tonto Creek	142	330	6
Salome Creek	166	388	6
Salt River-Theodore Roosevelt Lake	170	411	6
Show Low Creek	87	208	5
Spring Creek	152	351	6
Upper Chevelon Canyon	133	293	7
Upper Clear Creek	143	317	7
Upper North Fork White River	160	398	6
Upper Silver Creek	126	298	5
Walnut Creek	82	137	15
West Clear Creek	122	263	8
Grand Total	129	296	6

Table 17. Existing Condition – Density-related indicators of forest structure by cover type

Cover Type	Basal Area	Stand Density Index	Quadratic Mean Diameter
Aspen	180	416	6
Grassland/Meadow	83	193	7
Madrean Woodland	137	325	6
Mixed Conifer with Aspen	166	398	6
Mixed Conifer/Frequent Fire	173	396	6
Pinyon-Juniper Woodland	119	274	6
Ponderosa Pine	115	259	7
Ponderosa Pine/Evergreen Oak	154	374	5
Riparian	145	333	6
Grand Total	129	296	6

Large Tree and Old Tree Structure

Ponderosa pine stands of post settlement trees where the quadratic mean diameter of the top 20 percent of trees is greater than 15 inches and the basal area of trees greater that 16 inches is more than 50 square feet of basal area may be considered stands with a preponderance of large young trees (SPLYT stands). These stands occur outside of MSO PACs, MSO Recovery habitat and WUI and are being identified for their distinctive forest structure. Information on SPLYT stands across 5th HUC watershed is shown in Tables XXXX and XXXX.

Table 18. Existing Condition - SPLYT statistics by 5th HUC watershed

5th HUC Watershed	Acres	Basal Area >16"	QMD of Top 20% of Trees
Beaver Creek	498	81	19
Black Canyon	2,330	71	18
Canyon Creek	10	64	18
Carrizo Creek (Local Drainage)	151	70	20
Cherry Creek	539	74	18
Corduroy Creek	2	66	19
Cottonwood Creek	642	59	19
East Verde River	1,577	92	20
Fossil Creek-Verde River	1,432	70	21
Gun Creek-Tonto Creek	120	65	15
Haigler Creek-Tonto Creek	2,056	67	17
Jacks Canyon	1,545	62	20
Lower Chevelon Canyon	351	65	20
Oso Draw	227	57	18
Phoenix Park Wash-Dry Lake	392	61	17
Rye Creek-Tonto Creek	238	68	18
Salome Creek	594	101	19
Salt River-Theodore Roosevelt Lake	16	109	19
Show Low Creek	229	70	20
Spring Creek	64	68	15
Upper Chevelon Canyon	8,465	84	19
Upper Clear Creek	8,141	82	19
Upper Silver Creek	93	83	18
West Clear Creek	6,554	72	19
Grand Total	36,265	77	19

Forest Process

Forest Health

For additional information on forest health within the Rim Country Project area, consult the Forest Health Protection Specialist Report in the Appendix.

Insects

A general bark beetle hazard model for southwestern ponderosa pine based exclusively on the tree density relationships developed in a Dendroctonus hazard model was validated by Chojnacky et al. (2000) The model indicates that stands of ponderosa pine within the analysis area with a relative density below 30 percent of SDImax have a low hazard rating and stands between 30 and 40 percent of SDImax have a moderate hazard rating. Using these relative density thresholds, approximately 16 percent of the PP, PP/EO and MC/FF stands area has a low bark beetle hazard rating, while 8 percent of the area has a moderate rating and the remaining 76 percent has a high hazard of beetle attack (Table XXXX).

Table 21. Existing Condition - Bark beetle hazard rating and dwarf mistletoe severity rating by 5th HUC watershed

	Beetle Hazard Rating				Dwarf Mistletoe Severity Rating			
5th HUC Watershed	Low	Moderate	High	Grand Total	Low	Moderate	High	Grand Total
Beaver Creek	32%	6%	63%	100%	63%	35%	3%	100%
Black Canyon	41%	8%	51%	100%	80%	19%	0%	100%
Canyon Creek	31%	4%	65%	100%	58%	32%	11%	100%
Canyon Diablo	32%	0%	67%	100%	68%	30%	1%	100%
Carrizo Creek (Local Drainage)	50%	3%	47%	100%	69%	31%	0%	100%
Cherry Creek	2%	8%	90%	100%	50%	46%	4%	100%
Corduroy Creek	59%	0%	41%	100%	73%	27%	0%	100%
Cottonwood Creek	58%	7%	35%	100%	85%	15%	0%	100%
East Verde River	5%	3%	91%	100%	70%	22%	7%	100%
Fossil Creek-Verde River	11%	5%	84%	100%	53%	41%	6%	100%
Gun Creek-Tonto Creek	2%	0%	98%	100%	100%	0%	0%	100%
Haigler Creek-Tonto Creek	4%	1%	95%	100%	53%	40%	7%	100%
Jacks Canyon	35%	19%	46%	100%	96%	3%	0%	100%
Lower Chevelon Canyon	3%	2%	96%	100%	95%	4%	0%	100%
Lower Clear Creek	0%	3%	97%	100%	100%	0%	0%	100%
Oso Draw	14%	3%	83%	100%	62%	37%	1%	100%
Phoenix Park Wash-Dry Lake	43%	12%	45%	100%	73%	27%	0%	100%
Rye Creek-Tonto Creek	32%	8%	59%	100%	94%	6%	0%	100%
Salome Creek	4%	3%	93%	100%	91%	6%	3%	100%
Salt River-Theodore Roosevelt Lake	0%	24%	76%	100%	100%	0%	0%	100%
Show Low Creek	48%	3%	49%	100%	73%	27%	0%	100%
Spring Creek	11%	0%	89%	100%	95%	5%	0%	100%
Upper Chevelon Canyon	13%	8%	79%	100%	71%	25%	4%	100%
Upper Clear Creek	6%	5%	90%	100%	64%	28%	9%	100%
Upper North Fork White River	19%	49%	32%	100%	10%	71%	19%	100%
Upper Silver Creek	29%	4%	67%	100%	59%	36%	5%	100%
Walnut Creek	95%	5%	0%	100%	0%	100%	0%	100%
West Clear Creek	16%	16%	68%	100%	77%	21%	2%	100%
Grand Total	19%	7%	74%	100%	72%	23%	4%	100%

Table 22. Existing Condition - Bark beetle hazard rating and dwarf mistletoe severity rating across cover types

	Beetle Hazard Rating				Dwarf Mistletoe Severity Rating			
Cover Type	Low	Moderate	High	Grand Total	Low or None	Moderate	High	Grand Total
Aspen	0%	5%	95%	100%	80%	20%	0%	100%
Grassland/Meadow	100%	0%	0%	100%	95%	5%	0%	100%
Madrean Woodland	18%	6%	76%	100%	92%	5%	3%	100%
Mixed Conifer with Aspen	6%	0%	94%	100%	66%	12%	22%	100%
Mixed Conifer/Frequent Fire	2%	2%	96%	100%	56%	34%	9%	100%
Pinyon-Juniper Woodland	26%	2%	72%	100%	98%	2%	0%	100%
Ponderosa Pine	20%	10%	70%	100%	67%	28%	5%	100%
Ponderosa Pine/Evergreen Oak	6%	3%	90%	100%	75%	22%	3%	100%
Riparian	19%	3%	78%	100%	74%	18%	8%	100%
Grand Total	19%	7%	74%	100%	72%	23%	4%	100%

Pathogens-Dwarf Mistletoe

Conklin and Fairweather (2010) indicate that stands with less than 20 percent of the ponderosa pine trees infected can be considered a light infection, stands with 20-80 percent can be considered moderately infected while stands with greater than 80 percent of trees infected with dwarf mistletoe are classified as severe. Table 3-7 classifies stands within these categories by 5th HUC watershed. At moderate and severe infection levels there is evidence of decreased tree vigor, increased susceptibility to insect infestations, and stress related mortality (i.e., drought) that accompany a changing climate.

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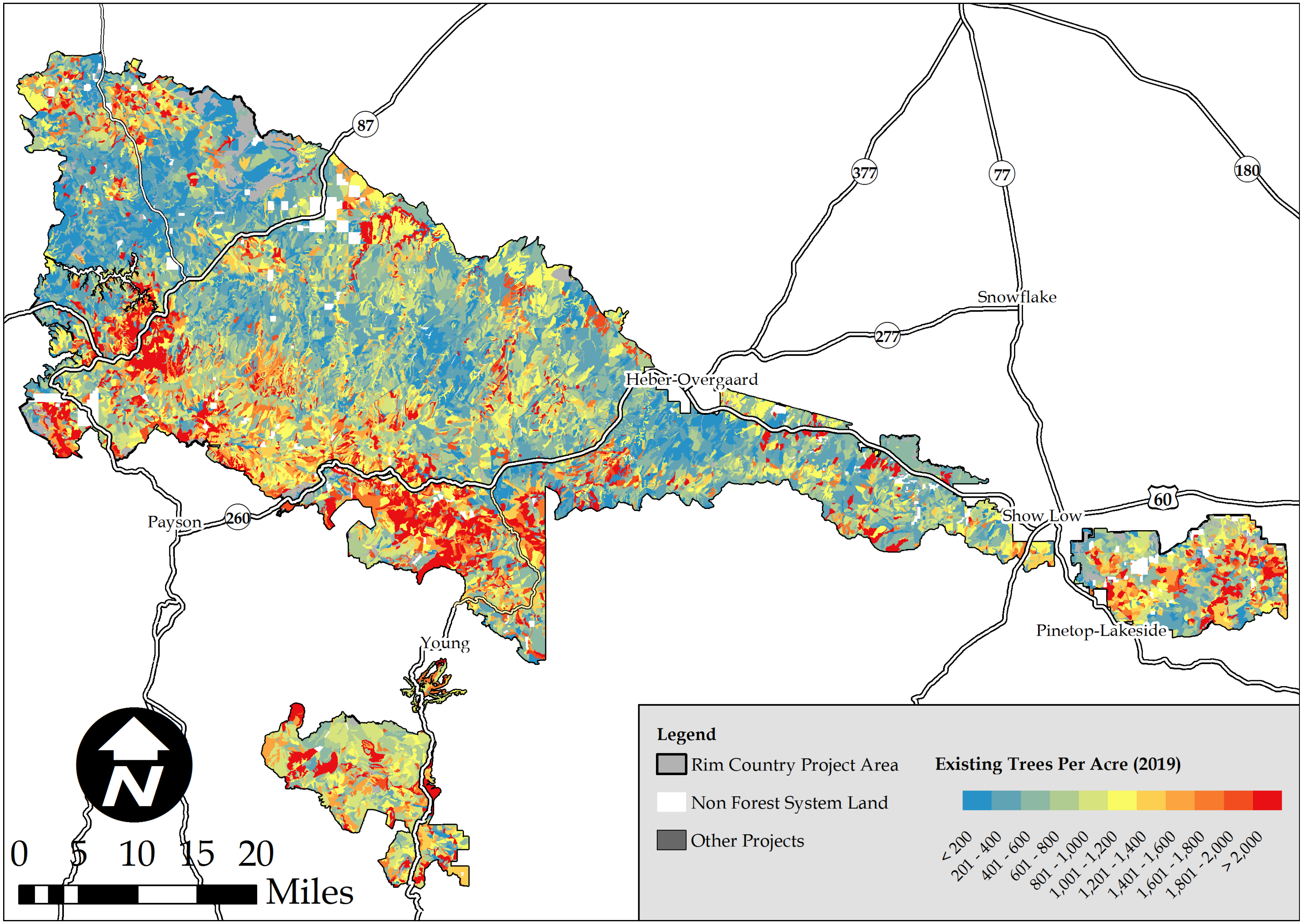

Figure 6 – Existing Condition – Trees per Acre

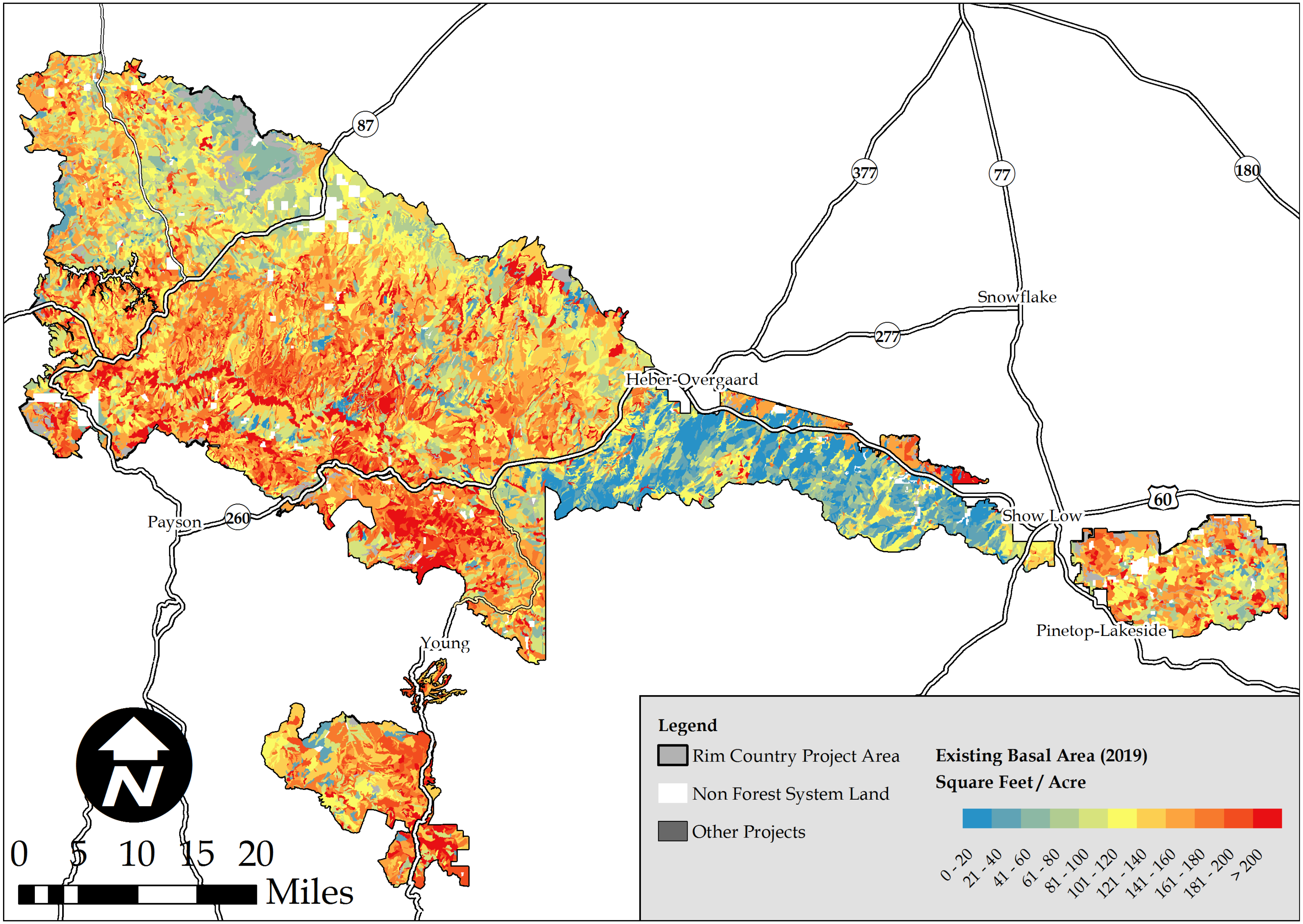

Figure 7. Existing Condition – Basal Area

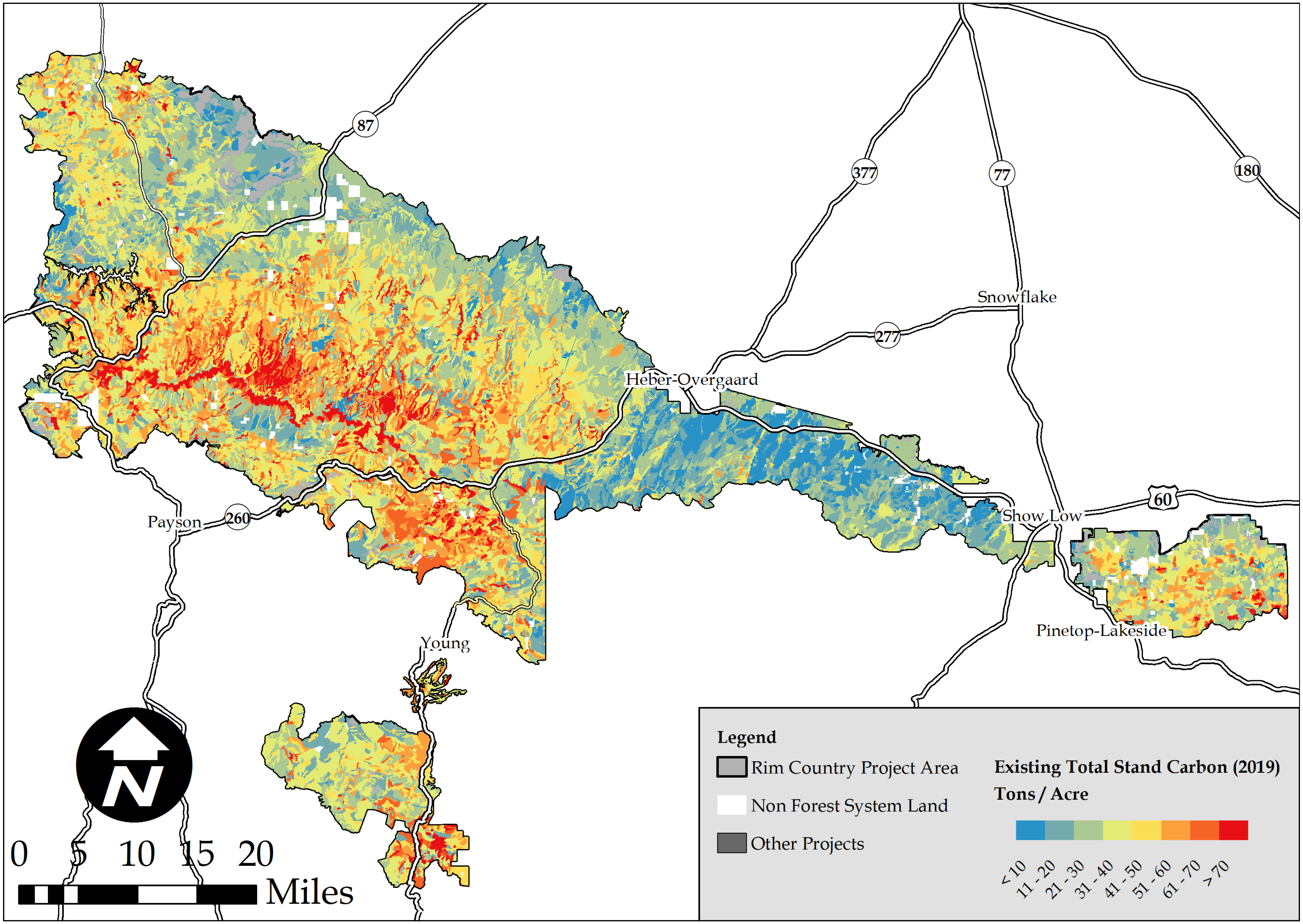

Figure 9. Existing Condition – Total Stand Carbon

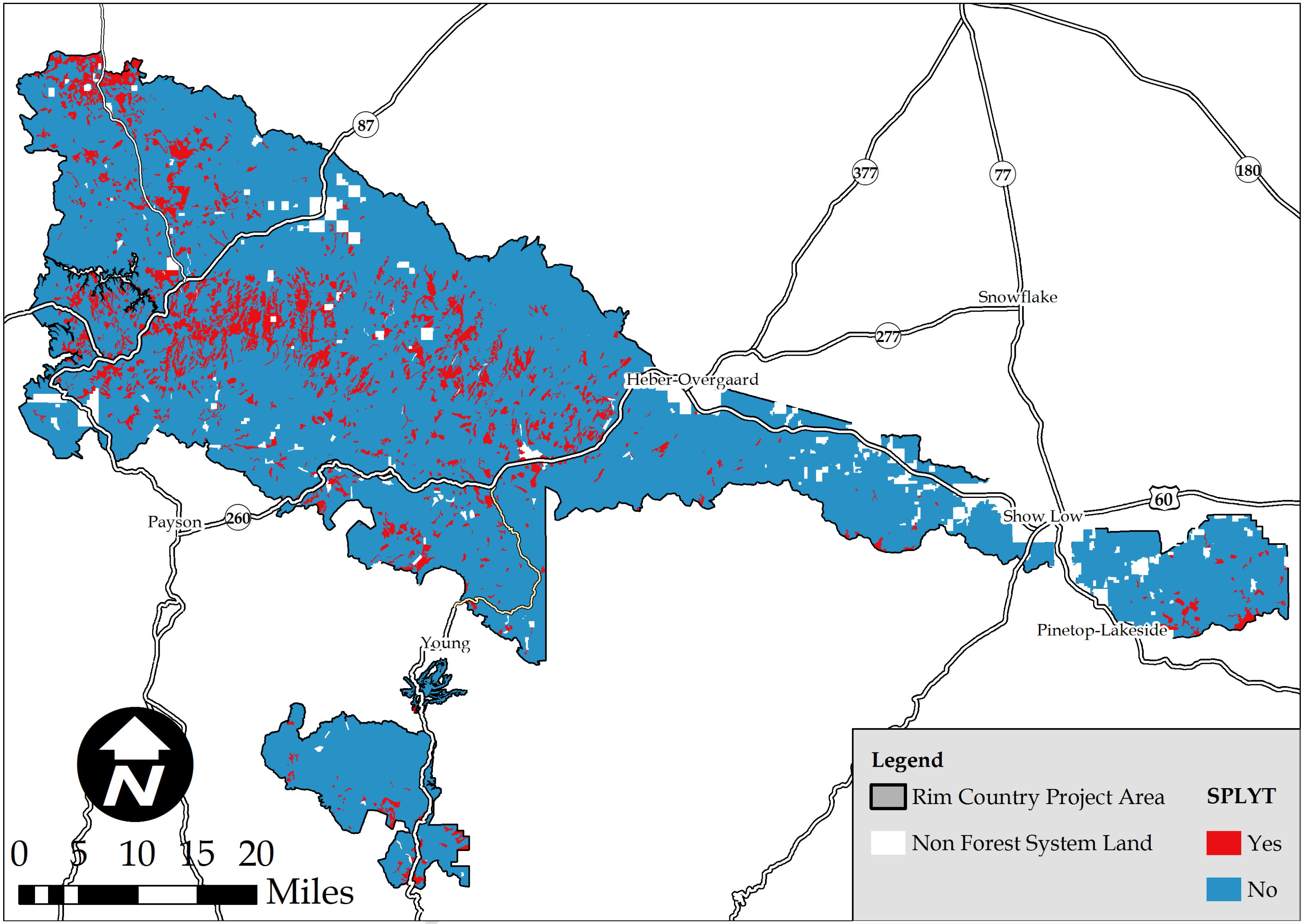

Figure 10. Existing Condition – SPLYT Stands

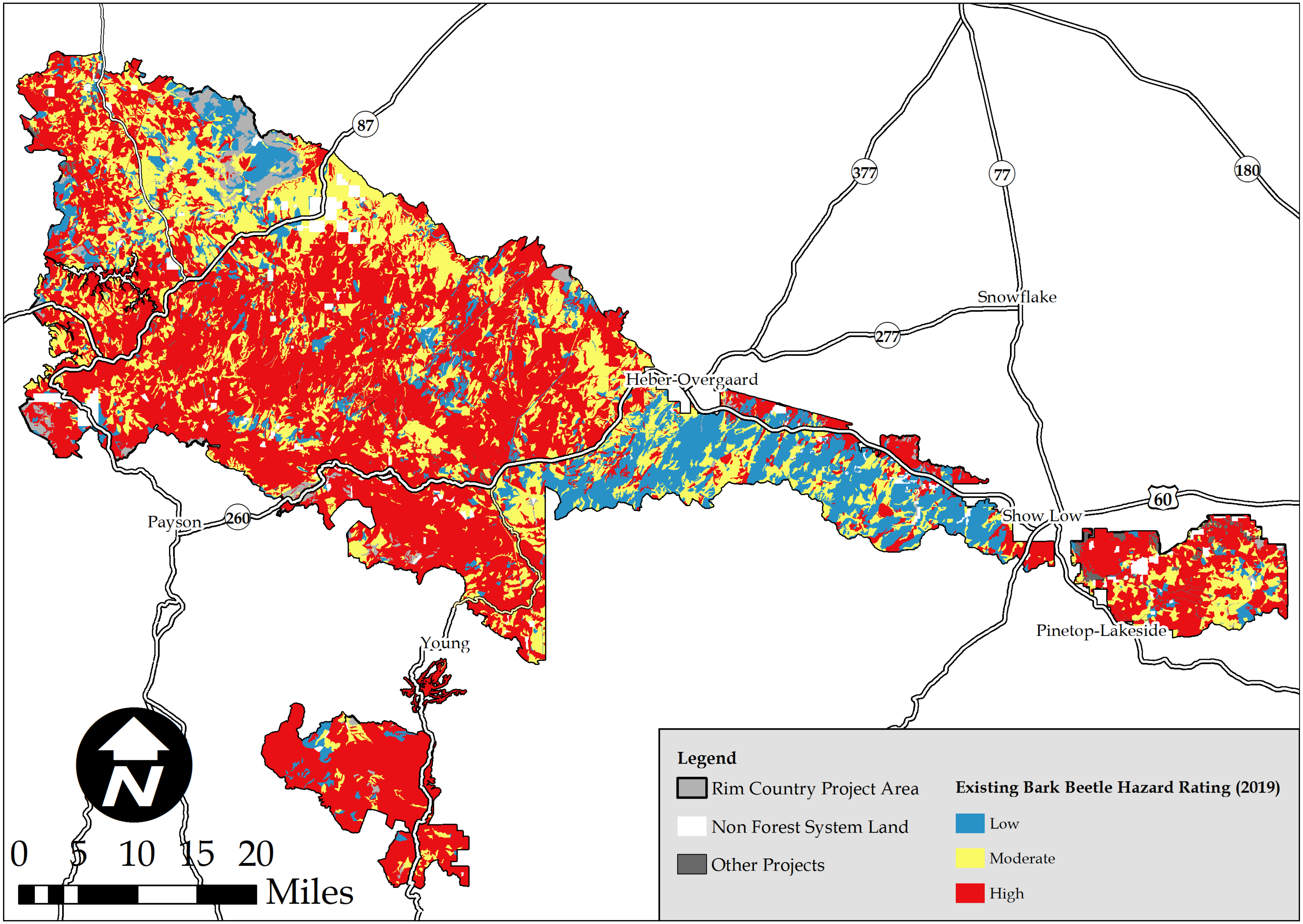

Figure 11. Existing Condition – Bark Beetle Hazard Rating

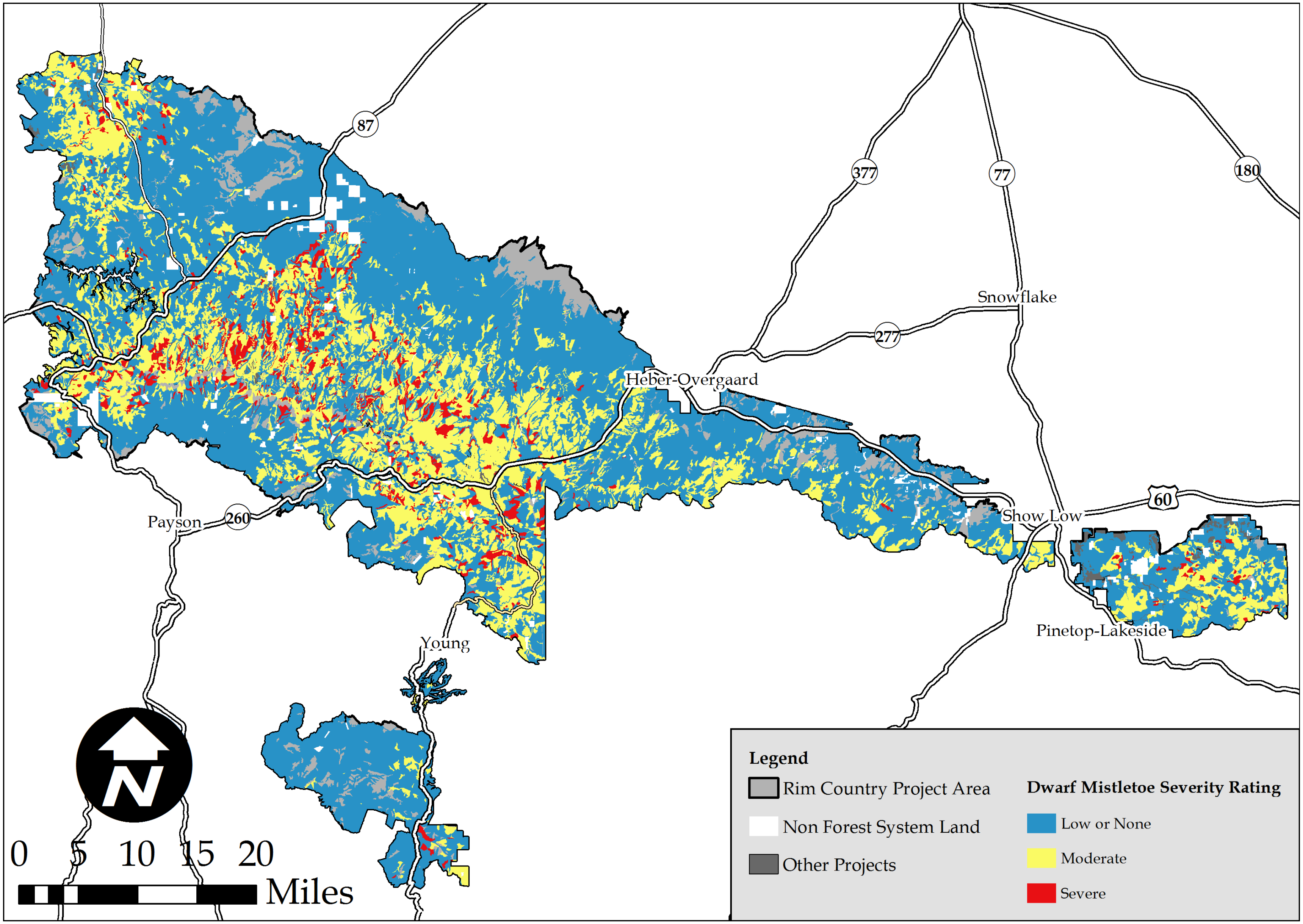

Figure 12. Existing Condition – Dwarf Mistletoe Severity Rating

Issues/Indicators/Analysis Topics

Issues

Issues are statements of cause and effect, linking environmental effects to proposed activities. Comments from the public, the 4FRI Stakeholder Group, other agencies, tribes, and FS personnel were used to formulate issues concerning the proposed action. All comments received were reviewed and analyzed by the interdisciplinary team to "…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review…" (Council on Environmental Quality, Sec. 1506.3; 40 CFR 1501.7(a) (3)).

The public comments received during the scoping period from June 27 to August 11, 2016 presented 10 issues that are points of intense debate or dispute, inside the scope of the Proposed Action, and relevant to the decision to be made for the 4FRI Rim Country Project. These key issues are used to formulate the alternatives for the Rim Country analysis.

Issue 1 – Treatments in MSO PACs

The Proposed Action may have negative effects on Mexican spotted owl (MSO) by cutting trees up to 17.9 inches in diameter in MSO protected activity centers (PACs). The Forest Service should act conservatively to protect MSO habitat and consider all cautions identified in the revised Recovery Plan for MSO (USDI, 2012). There is a concern about how MSO will respond to the removal of trees up to 17.9 inches in diameter, given a lack of monitoring data.

How Issue 1 is addressed:

This issue will be addressed in the effects analysis for all alternatives, and with design features and conservation measures as outlined in the 2012 revised MSO Recovery Plan to apply to treatments in MSO PACs in all action alternatives. The wildlife analysis will reference all available monitoring information from the 1st 4FRI EIS and from other sources across the region.

Indicators/Measures:

Indicators will include changes in the amount and quality of MSO nest/roost habitat within PACs. Specific measures include acres of PAC habitat improved or altered by changes in stand density of large-diameter, percent canopy closure, and amounts of coarse woody debris (CWD) before and after treatments.

Issue 2 – Treatments in Goshawk Habitat

The Proposed Action may have negative effects on northern goshawk and canopy-dependent species by reducing late seral, dense understory, and old growth habitat. Specifically, there is a concern that treatments will result in a reduced mix of densities and cover types, including later seral stages.

How Issue 2 is addressed:

This issue will be addressed in the effects analysis for all alternatives, and with design features and conservation measures as outlined in the most current management recommendations to apply to treatments in northern goshawk habitat in all action alternatives. Forest plan standards and guidelines for northern goshawk will be applied.

Indicators/Measures:

Indicators will include changes in the amount and quality of goshawk nesting and foraging habitat. Specific measures include acres of nest and post-fledgling family area (PFA) habitat improved by management activities, change in basal area, canopy cover by seral stage, and/or the distribution and quantities of tree densities, tree group sizes, and interspaces in General Forest.

- Acres of PFA improved
- Acres of goshawk nest areas improved
- Acres of General Forest improved

Issue 3 – Large Tree Retention

The Proposed Action may cause the loss of large trees which may significantly affect old growth recruitment. Commenters requested that proposed management actions in old growth, future old growth (large young trees), and high-canopy patches be very explicit, and that no old growth trees be cut.

How Issue 3 is addressed:

This issue will be addressed in the effects analysis for all alternatives. Large tree retention will be addressed with treatment design and location, design features, mitigation measures, and BMPs to retain old growth and groups of large trees in all action alternatives. The Old Growth Implementation Plan and Large Tree Implementation Plan (OTIP/LTIP) as modified and informed by the Old Growth Protection and Large Tree Retention Strategy (OGP/LTRS) as developed by the 4FRI Stakeholder Group will be used to address this issue.

Indicators/Measures:

- Number of acres of stands meeting criteria for SPLYT designation.

Significant Issues Responded to in Alternatives to the Proposed Action

Issue 4 – Dwarf Mistletoe Mitigation

The Proposed Action includes dwarf mistletoe treatments that may remove the largest trees in some stands. There is also a concern that more dwarf mistletoe mitigation is needed to improve forest vigor, overall health, and resiliency to climate change. Commenters requested that the scale and intensity of mistletoe mitigation be more clearly defined as far as scale, that where it occurs at natural levels it be allowed to remain to provide essential food and occupancy needs to wildlife, and that the mitigation treatments not focus on removing the largest trees.

How Issue 4 is addressed:

This issue will be addressed in the effects analysis for all alternatives. Dwarf mistletoe mitigation will be addressed with treatment design and location, design features, mitigation measures, and BMPs to retain some dwarf mistletoe as a natural component for wildlife and place limits on removal of large infected trees. The alternatives will propose a range of mitigation treatments.

Indicators/Measures:

- Acres of severe dwarf mistletoe mitigation proposed

- Percent of acres in dwarf mistletoe severity rating classes

Issue 5 – Smoke/Air Quality

The proposed prescribed burning may have negative effects on air quality and human health. Some commenters are concerned that the smoke from prescribed burns will degrade air quality and the health of northern Arizona residents.

How Issue 5 is addressed:

Alternative 4 was partially developed to respond to this issue. It includes fewer acres of prescribed burning. It will be addressed to a greater extent in a separate considered-but-eliminated-from detailed-study alternative that proposes even less prescribed fire. This issue will be addressed in the effects analysis for all alternatives. Design features and/or mitigation measures will be developed to reduce effects on air quality from prescribed fires.

Indicators/Measures:

The potential for emissions (including mercury) within communities that are within or in close proximity to the project area will be evaluated in quantitative emission modeling and qualitative interpretation. The pollutants to be modeled include the six listed in the Clean Air Act for which there are National Ambient Air Quality Standards: carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter less than 10 microns in size (PM 10), particulate matter less than 2.5 microns in size (PM 2.5), ozone (O_2), and sulfur dioxide (SO_2). There will be a discussion on the ecological effects of smoke, and the socioeconomic analysis will evaluate the effects of smoke on the quality of life and tourism.

Issue 6 – Economics

The Proposed Action does not include measures to make it economically viable. Commenters stated that a wide range of options should be considered in the alternatives that would allow for biomass removal where economically feasible but would also allow other options to dispose of uneconomically feasible biomass.

How Issue 6 is addressed:

Alternatives 3 and 4 respond to this issue. Alternative 3 maximizes mechanical thinning with higher intensity treatments, and offering more treatment area for industry. Alternative 4 optimizes treatment areas for both ecological restoration and economics, concentrating treatments in the optimal areas. This issue will be addressed in the effects analysis for all alternatives, both in terms of economic viability and balancing economics with ecosystem restoration. Parts of this issue will be included in the analysis in this EIS and others will be addressed during implementation.

Indicators/Measures:

- Volume of wood products (ccfs and biomass dry tons) available for removal by restoration activities.
- Unit and overall project net treatment costs.
- Mill delivered value of wood products from restoration activities.
- Economic efficiency (project benefits/value less project costs).

- Changes in employment (annual jobs created) and labor income.

Issue 7 – Roads

The miles of temporary roads in the Proposed Action may negatively affect watershed and stream conditions, and wildlife habitat and connectivity. Commenters asked that the Forest Service limit road networks to those roads needed for access and management. Commenters requested an alternative that dramatically reduces temporary road mileage.

How Issue 7 is addressed:

Alternative 4 was partially developed to respond to this issue. It includes the least number of miles of temporary roads. Design features and/or mitigation measures will be developed to reduce effects on watersheds, streams, and wildlife habitat. This issue will be addressed in the effects analysis for all alternatives.

Indicators/Measures:

Indicators will include the range of temporary roads that may be needed in each of the alternatives, measured by the approximate number of miles of temporary roads proposed in each alternative.

Summary of Alternatives and Resource Protection Measures (Best Management Practices, Design Features, Mitigation Measures)

Table 23. Design Features and Best Management Practices for Silviculture

Design Feature Number	Silviculture Feature Code	Design Feature	Intent
321	SI001	Non-commercial tree thinning is allowed only as required to adjust fuel loads to implement a low- to moderate-severity burn to promote growth of deciduous trees and shrubs, such as aspen, cottonwood, willow, other deciduous species, and associated meadows.	To provide desired fire behavior and desired vegetation composition
322	SI002	A phased approach can be used to complete light thinning with lop/scatter so slash does not have to be piled or disposed of mechanically.	To facilitate desired fuel conditions for broadcast burning
323	SI003	All snags will be maintained within the AMZ unless deemed a hazard tree.	To provide habitat for snag-dependent wildlife and future coarse woody debris.
324	SI004	To protect legacy trees, thinning from below is allowed, If conifers are even-aged pole, sapling, or mid-seral with no legacy trees, thin existing trees to the degree necessary to promote a low- to moderate-severity burn.	To facilitate desired fuel conditions for broadcast burning
327	SI005	Where livestock or wildlife grazing could be a threat to restoration of riparian deciduous vegetation and an immediate moderate-severity burn would consume large amounts of felled trees, consider delaying the burn and leaving felled trees in place to create grazing barriers to help assure plant growth.	To create grazing barriers and assure desirable vegetation response
328	SI006	If in an existing grazing allotment, projects in this category shall be accompanied by livestock grazing practices that promote the attainment of moderate-severity burn objectives.	To facilitate desired fuel conditions for broadcast burning
367	SI007	Exclosure fencing to prevent utilization of plantings by deer, elk, and livestock is permitted.	To provide desired vegetation composition in riparian areas
330	SI008	Source trees for placement in stream restoration should come from but are not limited to: over or fully stocked upland and riparian stands, hazard trees, trees that have fallen naturally and are still suitable, trees generated from administrative sites (maintenance, expansion, or new construction), and hardwood restoration.	To maintain forest structure and facilitate riparian restoration activities
331	SI009	Danger trees, hazard trees, and trees killed through fire, insects, disease, blow-down and other means can be felled and used for in-channel placement regardless of live-tree stocking levels.	To facilitate riparian restoration activities
332	SI010	Identified wildlife trees shall not be felled.	To maintain nest/roost habitat.
333	SI011	Trees may be removed by cable, ground-based equipment, horses or helicopters.	To facilitate riparian restoration activities
335	SI012	Trees may be stockpiled for future instream restoration projects.	To facilitate riparian restoration activities
336	SI013	The project manager for an aquatic restoration activity will coordinate with a wildlife biologist in tree-removal planning efforts.	To assure protection of wildlife habitat features
347	SI014	Remove juniper to natural stocking levels where Forest Service determines that juniper trees are expanding into neighboring plant communities to the detriment of other native riparian vegetation, soil, or streamflow.	To maintain desired vegetation composition in riparian areas and wetlands
348	SI015	"For each area evaluated for juniper treatments, interdisciplinary teams would discuss the following questions in order to identify the attributed of an area and select the appropriate treatments: • What kind of site (potential natural vegetation, soils)? • Successional state of site? • Components that need to be restored? • How units may fit into the overall landscape mosaic? • Long-term goals and objectives?"	To maintain desired vegetation composition in riparian areas and wetlands
355	SI016	Do not cut old-growth juniper, which typically has several of the following features: sparse limbs, dead limbed or spiked-tops, deeply furrowed and fibrous bark, branches covered with bright-green arboreal lichens, noticeable decay of cambium layer at base of tree, and limited terminal leader growth in upper branches.	To provide future snag and coarse woody debris habitat.
356	SI017	Felled trees may be left in place, lower limbs may be cut and scattered, or all or part of trees may be used for streambank or wetland restoration in order to provide surface roughness and bank stabilization or as necessary to protect riparian or wetland shrubs from grazing by livestock or wildlife (e.g. jackstraw barriers)	To facilitate riparian restoration
357	SI018	Felled trees may be placed into stream channels and floodplains to promote channel aggradation as long as such actions do not negatively impact use of spawning gravels or increase width to depth ratios.	To facilitate riparian restoration
358	SI019	On steep or south-facing slopes, where ground vegetation is sparse, leave felled juniper in sufficient quantities to promote reestablishment of vegetation and prevent erosion.	To provide soil resource protection in wetlands and riparian areas
359	SI020	If seeding is a part of the action, consider whether seeding would be most appropriate before or after juniper treatment.	To provide desired vegetation composition in riparian areas and wetlands
361	SI021	Experienced silviculturists, botanists, ecologists, or associated technicians shall be involved in designing vegetation treatments.	To provide desired vegetation composition in riparian areas and wetlands
362	SI022	Species to be planted will be of the same species that naturally occur in the project area. Acquire native seed or plant sources as close to the watershed as possible	To improve planting success.
363	SI023	Tree and shrub species, willow cuttings, as well as sedge and rush mats to be used as transplant material shall come from outside the bankfull width, typically in terraces (abandoned floodplains), or where such plants are abundant.	To provide desired vegetation composition in riparian areas
364	SI024	Sedge and rush mats should be sized to prevent their movement during high flow events.	To minimize streambank erosion
365	SI025	Concentrate plantings above the bankfull elevation.	To provide desired vegetation composition in riparian areas
366	SI026	Removal of native and non-native vegetation that will compete with plantings is permitted.	To provide desired vegetation composition in riparian areas

Environmental Consequences

The following analysis displays the direct, indirect and cumulative effects of three alternatives, No Action, Proposed Action and the Focused Alternative for the analysis period (2019-2039). In order to reflect a site specific analysis, data from individual stands was used to calculate stand metrics. In order to scale these metrics up to a landscape level analysis, stand data was aggregated up to the 5th HUC watershed and then to the project area. The effects analysis period modeled is from 2019 through 2039.

Project Area scale. At this scale, stand metrics are averaged across the entire project area. General trends in vegetation change and effects of treatments are visible over time, but due to the aggregation of cover types and watersheds some of the effects are somewhat muted. This scale is used to generally summarize and compare the effects of treatments across the landscape

5th HUC watershed scale. At this scale, stand metrics are averaged by 5th HUC watershed. Finer changes in vegetation condition become visible as well as the level of heterogeneity in vegetation condition as well as treatment effects across the landscape.

Project Area Scale

Alternative 1 – No Action

During the analysis period (2019-2039) the number of trees per acre would decrease across the analysis area, while basal area and SDI would increase somewhat. The number of trees per acre and basal area and SDI would move further away from the desired condition. The number of trees per acre, and basal area are outside of Desired Conditions over much of the analysis area and under the no action alternative, this trend would be expected to continue. The balance of even-aged structure and uneven-aged structure would remain relatively unchanged.

The increase in basal area would likely be skewed toward the larger size classes as larger trees continue to shade out and suppress smaller trees. Suppression and density-dependent mortality would like occur in the smaller size classes. Coarse woody debris, down logs, and snags would all likely increase as a result of continued tree mortality. The amount of basal area in trees greater than 16" would increase and additional stands would meet SPLYT criteria. More acres of forested stands would continue to grow in closed conditions and susceptibility to crown fire would increase. Bark beetle hazard as well as dwarf mistletoe infection severity would continue to increase. Without disturbance, the stands within the analysis area would continue to accrue more biomass during the analysis period. However, as fire hazard, insect hazard, and dwarf mistletoe severity increase, so would the potential for large-scale disturbances that would result in large-scale loss of biomass.

Under the no action alternative, it would be possible for lightening ignited wildfires to be managed for resource benefits across the analysis area. Management of naturally-caused fires for resource benefit could result in changes to forest structure or reductions in small trees that would move some areas to desired conditions for density, and in some rare circumstances could burn at moderate or high severity to improve forest structure in some patches. However, management of naturally-ignited fires on the landscape for resource benefits may be difficult over large areas given that the current condition of the landscape can more easily facilitate a fire growing from low severity to high severity. Thus, the use of this tool to move vegetation conditions toward desired conditions by killing small trees and creating small openings would be limited to circumstances where the risk of high severity fire is low. Additional information on the use of naturally ignited fire can be found in the Fire Ecology Specialist Report (USDA 2019x).

Alternative 2 – Proposed Action

During the analysis period, the number of trees per acre, basal area, and SDI would decrease considerably as a result of the thinning and prescribed fire activities. These indicators would trend toward our desired conditions. In general, stands would move toward a more uneven-aged size class distribution across the landscape as smaller trees are removed and larger trees grow into larger size classes. The protection of the majority of large and old trees, may produce even-aged stands in some cases. However, as treatments are applied on the ground, the use of the large and old tree implementation plans in accordance with an uneven-aged thinning strategy would be able to produce uneven-aged conditions across much of the landscape.

Modeling indicates that the amount of basal area in trees greater than 16" would increase as a result of the proposed action, though not as rapidly as in the no action alternative. With design features in place during implementation, large trees meeting the large and old tree implementation plan criteria would be retained, resulting in more large trees being left at the expense of smaller tree sizes. This would allow the acreage of stands meeting SPLYT criteria to increase. The majority of stands would be classified as open with susceptibility to crown fire being reduced, meeting the desired condition. Bark beetle hazard as well as dwarf mistletoe infection severity would be significantly reduced, meeting or approaching the desired condition. Fire hazard and insect hazard would be reduced as well as the potential for large scale disturbances, creating additional stability and resilience in the forested system.

With the increased heterogeneity of the forest structure created by implementing the proposed action within the forest stands (i.e., reduced tree densities, more uneven-aged conditions, more acreage of trees configured into groups and clumps), resilience to fire, drought, and insects would be improved over the existing condition, meeting the project purpose and need, and trending towards desired conditions.

Alternative 3 – Focused Alternative

In general, the effects of the focused alternative would be similar to the effects of the modified proposed action, with a muted effect due to the fewer number of acres treated. During the analysis period, the number of trees per acre, basal area, and SDI would decrease as a result of the thinning and prescribed fire activities. These indicators would generally trend toward our desired conditions and within NRV, but only in the stands treated. In general, treated stands would move toward a more uneven-aged size class distribution across the landscape as smaller trees are removed and larger trees grow into larger size classes. The protection of the majority of large and old trees, may produce even-aged stands in some cases. However, as treatments are applied on the ground, the use of the large and old tree implementation plans in accordance with an uneven-aged thinning strategy would be able to produce uneven-aged conditions across much of the landscape. In untreated stands, the balance of even-aged structure and uneven-aged structure would remain relatively unchanged.

Modeling indicates that basal area in trees greater than 16" would increase in treated stands as a result of the Focused Action. With design features in place during implementation, large trees meeting the large and old tree implementation plan criteria would be retained, resulting in more large trees being left at the expense of smaller tree sizes. This would allow the acreage of stands meeting SPLYT criteria to actually increase in treated areas. The portion of stands considered open would increase, approaching the desired condition, and susceptibility to crown fire would be reduced. Bark beetle hazard as well as dwarf mistletoe infection severity would be significantly reduced, meeting or approaching the desired condition, though this effects would only be apparent in treated stands. As fire hazard and insect hazard would be reduced, the potential for large scale disturbances would also be reduced.

Table 24. Project Area Averages for Density and Structure-related Indicator Measures for all Alternatives

		Basal Area	Stand Density Index	Quadratic Mean Diameter
Alt 1	2019	129	296	6.2
	2029	140	312	6.8
	2039	150	324	7.3
Alt 2	2019	129	296	6.2
	2029	65	116	11.0
	2039	62	103	13.3
Alt 3	2019	129	296	6.2
	2029	87	172	9.8
	2039	89	170	11.5

Table 25. Distribution of trees per acre across size classes for all alternatives

		0-5"	5-12"	12-18"	18-24"	24"+	Total
Alt 1	2019	813	114	35	9	3	973
	2029	713	117	37	10	4	881
	2039	621	121	39	12	4	797
Alt 2	2019	813	114	35	9	3	973
	2029	97	27	15	8	3	151
	2039	48	18	14	8	4	92
Alt 3	2019	813	114	35	9	3	973
	2029	281	54	21	9	3	368
	2039	222	50	21	9	4	307

Table 26. Distribution of basal area across size classes for all alternatives

		0-5"	5-12"	12-18"	18-24"	24"+	Total
Alt 1	2019	12	42	40	20	15	129
	2029	14	43	43	24	17	140
	2039	15	43	46	27	19	150
Alt 2	2019	12	42	40	20	15	129
	2029	2	11	19	18	15	65
	2039	1	8	17	19	18	62
Alt 3	2019	12	42	40	20	15	129
	2029	5	20	25	20	16	87
	2039	6	19	25	21	18	89

Table 27. Acres meeting criteria for identification as a Stand with a Preponderance of Large Young Trees (SPLYT) for all alternatives

		Acres	BA >16"	QMD Top 20%
Alt 1	2019	36,265	77	19
	2029	51,855	80	19
	2039	80,139	80	19
Alt 2	2019	36,265	77	19
	2029	47,828	69	23
	2039	64,774	70	24
Alt 3	2019	36,265	77	19
	2029	50,961	71	22
	2039	72,424	72	22

Table 29. Project Area Averages for Forest Health Related Indicator Measures for all Alternatives

		Beetle Hazard Rating			Dwarf Mistletoe Severity		
		Low	Mod	High	Low	Mod	High
Alt 1	2019	19%	7%	74%	75%	22%	4%
	2029	16%	6%	78%	67%	26%	6%
	2039	13%	6%	82%	66%	25%	9%
Alt 2	2019	19%	7%	74%	75%	22%	4%
	2029	77%	12%	11%	69%	30%	2%
	2039	83%	9%	8%	66%	31%	3%
Alt 3	2019	19%	7%	74%	75%	22%	4%
	2029	49%	12%	39%	68%	30%	2%
	2039	50%	10%	40%	66%	30%	4%

Alternative 1 – No Action

Direct and Indirect Effects

Under Alternative 1 no acres would receive either prescribed cutting or prescribed fire treatment. Although this alternative does appear to meet some of the desired conditions identified in the Forest Plan concerning forest structure, it would not move the forest forward in initiating the re-establishment of a fire-adapted, resilient, diverse, and sustainable forest ecosystem. For example, based on a broad array of research, current stand conditions would continue to develop so that the overabundance of trees in the smaller size classes (0-5 and 5-12 inch size classes) at the landscape scale, but they would likely develop at a slower rate due to increased competition and water stress. At the same time, the slow transition of intermediate and mature forests would lead to an increasing lack of young, developing forests. In the likely case of one or more large disturbance events (e.g., wildfire, drought, insects), the result would be an over-abundance of young forests. For a more thorough analysis of the effects of larges disturbance such as uncharacteristically large or severe wildfires, consult the Fire Ecology Specialist Report (USDA 2019).

Without treatment, stands in the analysis area would be much less resilient to disturbances such as multi-year drought, insects and disease such as bark beetle and mistletoe, and wildfire (Abella, et al., 2007). Increased drought stress and insect attacks are often associated with increased tree density, altered tree spatial arrangement, and shifted forest composition that have resulted from fire exclusion, grazing, and past logging. These changes in forest structure may exacerbate tree mortality due to increased competition among trees (Kane, Kolb, & McMillin, 2014, p. 171). At the fine scale, these disturbances would likely result in a greater mortality rate for areas with dense forest, which include groups and clumps of large trees (Zhang, Ritchie, Maguire, & Oliver, 2013).

Table 30. Alternative 1 – No Action – Density and structure-related indicator measures by 5th HUC watershed

	2019			2029			2039		
5th HUC Watershed	BA	SDI	QMD	BA	SDI	QMD	BA	SDI	QMD
Beaver Creek	124	270	8.2	134	282	8.8	141	290	9.3
Black Canyon	81	186	5.3	95	212	6.0	108	235	6.8
Canyon Creek	99	251	4.2	115	284	4.8	130	309	5.5
Canyon Diablo	118	288	5.6	131	309	6.1	142	323	6.6
Carrizo Creek (Local Drainage)	60	140	4.7	76	172	5.6	93	202	6.5
Cherry Creek	142	338	5.4	152	352	5.9	159	360	6.2
Corduroy Creek	69	172	4.0	85	206	4.7	101	235	5.3
Cottonwood Creek	66	158	4.4	81	189	5.1	97	219	5.8
East Verde River	161	378	5.6	169	387	6.0	175	391	6.3
Fossil Creek-Verde River	140	325	6.3	148	334	6.7	153	338	7.1
Gun Creek-Tonto Creek	138	346	4.8	146	356	5.2	152	362	5.6
Haigler Creek-Tonto Creek	165	400	5.3	174	409	5.7	180	414	6.1
Jacks Canyon	96	211	7.5	108	229	8.2	118	245	8.8
Lower Chevelon Canyon	121	267	6.5	134	286	7.0	143	298	7.5
Lower Clear Creek	121	274	6.1	132	290	6.6	141	303	7.0
Oso Draw	124	317	4.8	139	339	5.3	151	356	5.9
Phoenix Park Wash-Dry Lake	79	182	5.0	92	207	5.7	105	230	6.4
Rye Creek-Tonto Creek	142	330	6.1	149	338	6.5	154	342	6.7
Salome Creek	166	388	5.7	174	397	6.1	179	400	6.4
Salt River-Theodore Roosevelt Lake	170	411	5.7	176	413	6.2	180	414	6.5
Show Low Creek	87	208	4.8	101	234	5.5	114	256	6.1
Spring Creek	152	351	5.6	161	362	6.0	168	369	6.4
Upper Chevelon Canyon	133	293	6.9	144	308	7.6	154	318	8.2
Upper Clear Creek	143	317	6.7	154	332	7.3	164	342	7.9
Upper North Fork White River	160	398	5.9	171	407	6.4	182	416	7.1
Upper Silver Creek	126	298	5.5	140	318	6.1	153	333	6.7
Walnut Creek	82	137	14.5	88	143	15.2	91	145	16.0
West Clear Creek	122	263	8.1	133	278	8.7	142	288	9.3
Grand Total	129	296	6.2	140	312	6.8	150	324	7.3

Table 31. Alternative 1 – No Action – Distribution of trees per acre across size classes by 5th HUC watershed

	2019						2029						2039					
5th HUC Watershed	0-5"	5-12"	12-18"	18-24"	24"+	Total	0-5"	5-12"	12-18"	18-24"	24"+	Total	0-5"	5-12"	12-18"	18-24"	24"+	Total
Beaver Creek	613	86	35	12	3	750	550	80	37	14	4	686	487	80	38	16	4	626
Black Canyon	570	74	20	5	2	670	499	84	23	6	2	615	424	100	26	7	3	560
Canyon Creek	1332	88	22	5	3	1451	1148	102	24	7	3	1284	909	132	26	7	3	1077
Canyon Diablo	1015	105	25	12	2	1159	875	134	28	13	3	1052	743	136	32	13	4	927
Carrizo Creek (Local Drainage)	429	57	15	4	2	506	396	63	19	4	2	485	326	102	22	6	2	459
Cherry Creek	1048	149	35	9	3	1244	924	147	38	10	3	1123	812	141	40	11	3	1007
Corduroy Creek	697	57	16	4	1	775	640	81	19	5	1	747	580	91	21	6	2	700
Cottonwood Creek	632	67	16	3	1	719	586	74	19	4	1	685	528	85	22	5	2	642
East Verde River	1091	119	44	11	5	1271	971	120	45	13	5	1154	863	131	45	14	6	1059
Fossil Creek-Verde River	908	129	43	8	3	1091	816	124	47	9	3	1000	734	121	47	11	3	917
Gun Creek-Tonto Creek	1441	147	36	9	2	1636	1298	143	38	11	3	1493	1164	134	39	12	3	1352
Haigler Creek-Tonto Creek	1292	142	42	10	5	1490	1132	142	43	12	5	1333	995	146	44	13	5	1203
Jacks Canyon	431	99	24	6	3	563	389	103	28	7	4	531	349	106	31	8	4	499
Lower Chevelon Canyon	491	120	30	7	3	651	425	138	34	9	3	609	353	154	37	10	4	557
Lower Clear Creek	651	113	26	9	4	803	593	115	28	10	5	751	541	115	31	10	5	702
Oso Draw	1336	108	38	8	2	1492	1162	108	41	11	2	1323	986	111	42	13	3	1155
Phoenix Park Wash-Dry Lake	520	81	20	4	2	627	484	83	24	5	2	598	437	85	29	6	2	559
Rye Creek-Tonto Creek	915	122	37	11	3	1088	825	123	38	12	4	1002	743	126	40	13	4	925
Salome Creek	1058	182	40	12	3	1295	955	170	45	13	3	1185	870	160	47	14	3	1094
Salt River-Theodore Roosevelt Lake	1464	105	46	18	7	1640	1315	99	43	20	7	1483	1193	88	44	22	8	1355
Show Low Creek	795	80	23	6	1	905	704	91	25	7	2	829	615	94	27	9	2	747
Spring Creek	831	178	41	8	2	1059	736	173	44	10	2	966	652	170	46	12	2	882
Upper Chevelon Canyon	589	121	35	10	4	758	495	129	38	12	4	677	415	131	41	13	5	605
Upper Clear Creek	753	122	37	11	4	927	652	126	40	13	5	835	565	125	42	14	5	752
Upper North Fork White River	1875	106	42	16	4	2044	1596	95	41	21	4	1758	1346	95	43	24	6	1514
Upper Silver Creek	905	110	38	8	1	1063	765	122	41	11	2	940	632	131	42	14	2	822
Walnut Creek	59	17	15	11	7	109	54	14	14	12	8	102	37	21	14	12	8	93
West Clear Creek	559	99	41	8	3	710	482	97	44	10	3	636	411	97	45	12	3	568
Grand Total	813	114	35	9	3	973	713	117	37	10	4	881	621	121	39	12	4	797

Table 32. Alternative 1 – No Action – Distribution of basal area by size across size classes by 5th HUC watershed

	2019						2029						2039					
5th HUC Watershed	0-5"	5-12"	12-18"	18-24"	24"+	Total	0-5"	5-12"	12-18"	18-24"	24"+	Total	0-5"	5-12"	12-18"	18-24"	24"+	Total
Beaver Creek	8	34	42	28	13	124	9	32	45	33	15	134	9	31	45	37	18	141
Black Canyon	11	27	22	11	9	81	15	29	27	13	10	95	18	32	30	16	12	108
Canyon Creek	16	31	25	12	14	99	23	34	28	15	15	115	27	40	31	17	15	130
Canyon Diablo	16	37	29	27	9	118	15	43	32	30	12	131	16	45	36	31	14	142
Carrizo Creek (Local Drainage)	6	22	17	9	6	60	13	23	21	10	8	76	14	31	25	14	9	93
Cherry Creek	14	54	40	19	14	142	16	54	43	23	15	152	18	53	46	26	16	159
Corduroy Creek	15	22	18	10	3	69	20	27	21	12	6	85	28	29	24	13	7	101
Cottonwood Creek	11	25	18	8	4	66	18	27	22	9	5	81	24	29	25	12	6	97
East Verde River	15	45	51	25	25	161	16	44	52	30	26	169	16	46	54	32	28	175
Fossil Creek-Verde River	11	48	49	18	14	140	12	46	53	21	15	148	13	45	54	25	17	153
Gun Creek-Tonto Creek	11	54	41	21	10	138	12	54	44	24	12	146	14	52	46	27	13	152
Haigler Creek-Tonto Creek	17	51	48	24	25	165	19	51	50	28	26	174	20	52	52	30	28	180
Jacks Canyon	6	35	26	14	14	96	7	37	32	16	16	108	7	39	36	19	18	118
Lower Chevelon Canyon	13	44	34	17	14	121	12	47	39	20	15	134	10	51	43	22	18	143
Lower Clear Creek	8	40	31	20	23	121	9	43	32	23	25	132	10	43	36	24	28	141
Oso Draw	16	41	44	18	7	124	18	40	48	25	8	139	21	39	50	30	11	151
Phoenix Park Wash-Dry Lake	9	31	22	10	7	79	13	32	28	11	9	92	17	31	33	13	10	105
Rye Creek-Tonto Creek	12	45	42	24	18	142	12	46	44	26	21	149	12	46	46	28	22	154
Salome Creek	14	67	46	26	13	166	14	65	51	30	14	174	15	62	54	32	15	179
Salt River-Theodore Roosevelt Lake	10	40	54	38	27	170	10	40	52	44	29	176	10	36	53	49	31	180
Show Low Creek	12	30	27	13	6	87	16	32	29	17	7	101	21	33	31	20	9	114
Spring Creek	14	65	47	18	8	152	14	64	51	22	10	161	14	64	54	26	10	168
Upper Chevelon Canyon	12	44	40	22	16	133	11	45	44	26	18	144	11	45	47	30	20	154
Upper Clear Creek	12	45	43	25	18	143	13	46	46	30	20	154	13	45	49	33	23	164
Upper North Fork White River	14	43	50	36	17	160	16	38	49	48	20	171	18	33	50	54	27	182
Upper Silver Creek	14	42	44	17	8	126	14	44	49	24	10	140	15	45	50	31	12	153
Walnut Creek	3	6	19	25	30	82	4	5	17	27	34	87	3	5	18	29	36	91
West Clear Creek	8	39	46	18	11	122	8	39	51	22	13	133	9	38	54	27	15	142
Grand Total	12	42	40	20	15	129	14	43	43	24	17	140	15	43	46	27	19	150

Table 33. Alternative 1 – No Action - Acres meeting SPLYT criteria by 5th HUC watershed

	2019			2029			2039		
5th HUC Watershed	Acres	BA >16"	QMD Top 20%	Acres	BA >16"	QMD Top 20%	Acres	BA >16"	QMD Top 20%
Beaver Creek	498	81	19	407	93	19	278	101	21
Black Canyon	2,330	71	18	2,767	73	18	4,784	73	19
Canyon Creek	10	64	18	113	70	18	164	71	17
Carrizo Creek (Local Drainage)	151	70	20	181	72	19	292	75	18
Cherry Creek	539	74	18	558	75	19	657	73	18
Corduroy Creek	2	66	19	2	72	18	2	84	19
Cottonwood Creek	642	59	19	951	62	18	1,009	70	18
East Verde River	1,577	92	20	1,766	95	19	2,475	82	19
Fossil Creek-Verde River	1,432	70	21	2,432	76	20	3,084	81	20
Gun Creek-Tonto Creek	120	65	15	120	113	16	120	137	17
Haigler Creek-Tonto Creek	2,056	67	17	1,486	75	18	1,658	74	18
Jacks Canyon	1,545	62	20	1,817	69	20	4,290	68	19
Lower Chevelon Canyon	351	65	20	1,444	60	19	2,375	62	18
Oso Draw	227	57	18	365	71	17	526	75	18
Phoenix Park Wash-Dry Lake	392	61	17	626	61	17	916	65	19
Rye Creek-Tonto Creek	238	68	18	238	74	18	239	79	19
Salome Creek	594	101	19	664	109	18	645	121	19
Salt River-Theodore Roosevelt Lake	16	109	19	16	125	20	16	138	20
Show Low Creek	229	70	20	306	82	18	380	83	19
Spring Creek	64	68	15	64	101	16	64	137	17
Upper Chevelon Canyon	8,465	84	19	13,441	80	19	19,559	83	19
Upper Clear Creek	8,141	82	19	11,993	85	19	20,634	85	19
Upper Silver Creek	93	83	18	220	86	18	358	83	18
West Clear Creek	6,554	72	19	9,879	74	19	15,615	76	20
Grand Total	36,265	77	19	51,855	80	19	80,139	80	19

Table 35. Alternative 1 – No Action - Forest health related indicator measures by 5th HUC watershed

	2019						2029						2039					
	Beetle Hazard Rating			Dwarf Mistletoe Severity Rating			Beetle Hazard Rating			Dwarf Mistletoe Severity Rating			Beetle Hazard Rating			Dwarf Mistletoe Severity Rating		
5th HUC Watershed	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High
Beaver Creek	32%	6%	63%	69%	29%	2%	31%	3%	65%	67%	26%	7%	31%	3%	66%	67%	23%	10%
Black Canyon	41%	8%	51%	81%	19%	0%	32%	10%	58%	71%	27%	1%	27%	9%	65%	68%	29%	2%
Canyon Creek	31%	4%	65%	59%	31%	11%	20%	6%	74%	48%	39%	13%	18%	2%	79%	48%	36%	16%
Canyon Diablo	32%	0%	67%	73%	26%	1%	27%	5%	68%	69%	23%	9%	23%	10%	68%	64%	26%	10%
Carrizo Creek (Local Drainage)	50%	3%	47%	69%	31%	0%	29%	18%	53%	45%	55%	0%	23%	13%	64%	45%	55%	1%
Cherry Creek	2%	8%	90%	51%	45%	4%	0%	2%	98%	44%	49%	7%	0%	2%	98%	43%	48%	9%
Corduroy Creek	59%	0%	41%	75%	25%	0%	51%	8%	41%	58%	42%	0%	22%	30%	49%	58%	38%	4%
Cottonwood Creek	58%	7%	35%	87%	13%	0%	46%	9%	45%	78%	22%	1%	29%	17%	54%	75%	22%	3%
East Verde River	5%	3%	91%	73%	20%	7%	4%	4%	92%	67%	23%	10%	4%	0%	96%	65%	18%	17%
Fossil Creek-Verde River	11%	5%	84%	58%	36%	6%	11%	4%	85%	53%	35%	12%	11%	4%	85%	51%	31%	18%
Gun Creek-Tonto Creek	2%	0%	98%	100%	0%	0%	2%	0%	98%	99%	1%	0%	0%	2%	98%	99%	1%	0%
Haigler Creek-Tonto Creek	4%	1%	95%	55%	38%	7%	3%	1%	96%	50%	39%	12%	3%	1%	96%	50%	33%	17%
Jacks Canyon	35%	19%	46%	97%	3%	0%	33%	12%	56%	95%	4%	1%	30%	7%	62%	94%	4%	1%
Lower Chevelon Canyon	3%	2%	96%	96%	4%	0%	3%	1%	96%	85%	15%	0%	2%	0%	97%	83%	17%	0%
Lower Clear Creek	0%	3%	97%	100%	0%	0%	0%	3%	97%	100%	0%	0%	0%	0%	100%	100%	0%	0%
Oso Draw	14%	3%	83%	66%	33%	1%	14%	2%	84%	58%	39%	3%	12%	2%	86%	57%	34%	9%
Phoenix Park Wash-Dry Lake	43%	12%	45%	74%	26%	0%	34%	7%	59%	68%	30%	2%	30%	6%	64%	67%	26%	7%
Rye Creek-Tonto Creek	32%	8%	59%	96%	4%	0%	32%	8%	59%	93%	6%	1%	32%	0%	68%	93%	5%	2%
Salome Creek	4%	3%	93%	92%	5%	3%	3%	3%	94%	85%	12%	3%	1%	4%	94%	85%	11%	3%
Salt River-Theodore Roosevelt Lake	0%	24%	76%	100%	0%	0%	0%	24%	76%	85%	15%	0%	0%	24%	76%	85%	15%	0%
Show Low Creek	48%	3%	49%	78%	22%	0%	39%	10%	51%	68%	28%	4%	27%	15%	58%	63%	26%	12%
Spring Creek	11%	0%	89%	95%	5%	0%	11%	0%	89%	93%	7%	0%	1%	10%	89%	93%	7%	0%
Upper Chevelon Canyon	13%	8%	79%	74%	22%	4%	11%	7%	83%	63%	31%	7%	10%	3%	87%	62%	30%	9%
Upper Clear Creek	6%	5%	90%	64%	27%	9%	4%	4%	92%	54%	33%	13%	3%	4%	94%	52%	32%	16%
Upper North Fork White River	19%	49%	32%	10%	71%	19%	19%	17%	64%	2%	78%	20%	19%	17%	64%	2%	59%	39%
Upper Silver Creek	29%	4%	67%	68%	28%	4%	29%	3%	68%	58%	35%	7%	27%	2%	70%	57%	31%	12%
Walnut Creek	95%	5%	0%	88%	12%	0%	95%	0%	5%	88%	12%	0%	95%	0%	5%	88%	5%	7%
West Clear Creek	16%	16%	68%	78%	20%	2%	14%	10%	76%	73%	24%	4%	11%	9%	80%	71%	23%	5%
Grand Total	19%	7%	74%	75%	22%	4%	16%	6%	78%	67%	26%	6%	13%	6%	82%	66%	25%	9%

Composition

Forest composition is not expected to change dramatically under this alternative if there are no large-scale disturbances such as wildfire or epidemic-level insect outbreaks. Ponderosa pine would still be the dominant cover type within the analysis area. Mixed conifer would make up a moderate proportion of the analysis area, though the composition of shade tolerant species such as white fir may increase considerably in this forest type. Juniper, grasslands, and other hardwoods would continue to make up a minor part of the analysis area. Without wildfire or other types of disturbance, aspen would continue to decline, as normal succession pressures continue to favor conifer establishment. This continued encroachment may result in the loss of aspen from parts or all of the analysis area. Climatic models for the southwestern U.S. predict continued warming, greater variability in precipitation, and increased severity and longevity of drought. These climatic changes would likely contribute to continued and perhaps increasing tree mortality, which may lead to large shifts and contractions in the range of dominant trees throughout much of the region (Kane, Kolb, & McMillin, 2014).

In general, overstory density would increase and understory species richness would decline significantly (Korb & Springer, 2003). Without treatment, understory grass vigor would be expected to be reduced. Less sunlight would reach the forest floor. As a result, understory diversity would decrease, which would reduce the overall biodiversity found in frequent-fire forests.

Structure

Uneven-aged Structure

Uneven-aged forest structure is the Desired Condition. Under this alternative, there is little change to forest structure (Figure 3-3). Some trees will grow into larger size classes, but the overall the portion of stands that can be considered uneven-aged remains unchanged. The uncharacteristically high number of trees in the smaller and medium size classes provide excessive competition with larger trees in the stand, slowing growth and limiting diameter growth of the largest trees in the stand. While this meets the Desired Condition, it provides little improvement over the Existing Condition into the future.

While this indicator meets the desired conditions for uneven-aged structure in the forest plans, this does not account for the possibility of an uncharacteristic wildfire or other substantial disturbance event, such as a beetle outbreak or long-term drought. There are an abundance of small diameter trees across the analysis area, far above historic conditions. Because of the current structure, including overstocked forests and ladder fuels created when smaller trees grow directly beneath the canopy of larger trees, the current landscape would be less resilient if a catastrophic event were to occur. Many, if not most, of the trees would be killed, resulting in large areas lacking live trees. Natural regeneration or reforestation planting would create large even-aged, young forests, with little structural diversity for the foreseeable future.

Density

Measure of density in this analysis include trees per acre, basal area and stand density index. The overall tree density continues to remain very high under this alternative, averaging nearly 1,000 trees per acre through much of the area (Table 3-10). All 5th HUC watersheds currently do not meet the desired condition for trees per acre. In general trees are overrepresented in the smaller size classes and underrepresented in the larger size classes. Smaller trees and their aggregated spatial pattern on the landscape has resulted in dense thickets of “dog-haired” pine. While there would be some density-related mortality in the smaller trees as time goes by, this trend of “dog-haired” thickets of pine is expected to continue into the foreseeable future under this alternative. Across the analysis area, forested stands would continue to be dominated by small diameter trees into the future. This tree density would result in reduced tree growth and increased mortality, especially in older trees, stagnated nutrient cycles, decreased herbaceous and shrub forage quality and quantity (Covington & Moore, 1994a). Without cutting or fire disturbances, tree regeneration would be inhibited and the trend would be a shift to the larger size classes maintaining extremely dense conditions that are not resilient to disturbances such as fire, insects, and climate.

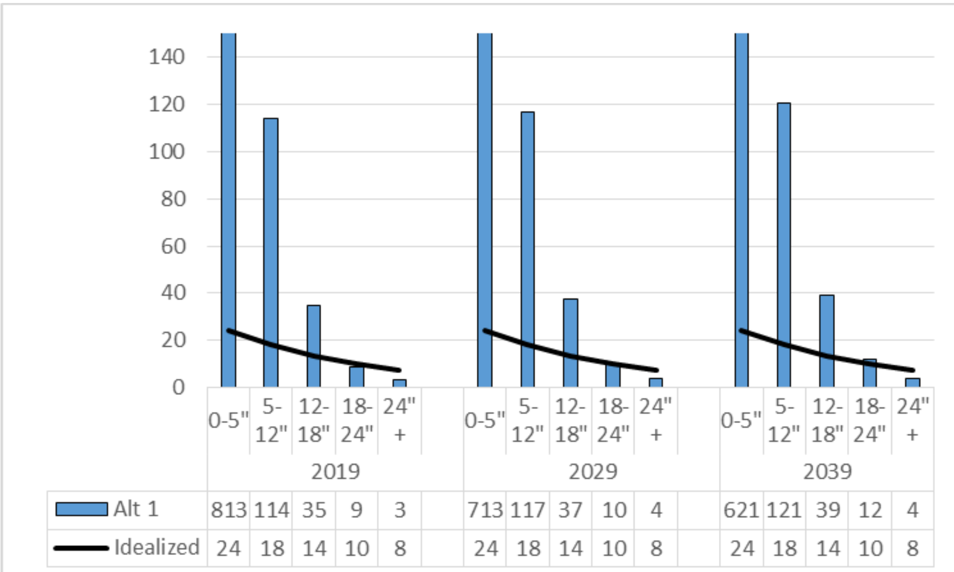

Figure 13. Alternative 1 – No Action – Distribution of trees per acres across size classes across the project area as well as an idealized distribution of trees per acre

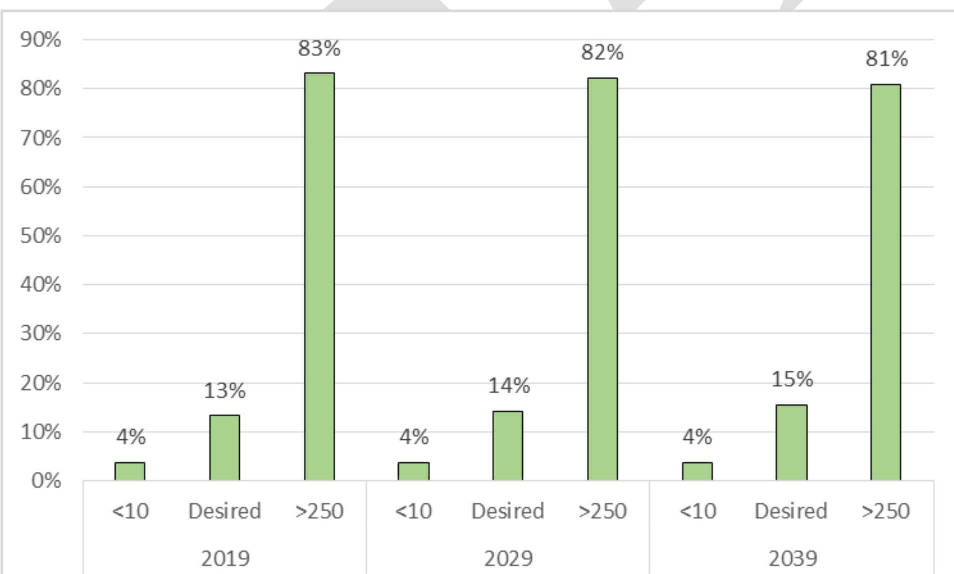

Figure 14. Alternative 1 – No Action – Percent of acres meeting desired condition for trees per acre across the project area

The desired condition is to retain a basal area of between 30 and 90 square feet per acre across most habitat types outside of MSO habitat. For a more thorough analysis of the effects of this alternative within MSO habitat as well as northern goshawk habitat, consult the Wildlife Specialist Report (USDA 2019). While the Forest Plans provide a desired condition with a range of basal areas ranging from 20 to

180 square feet per acre depending on cover type, for this analysis, at the project level, for ease of comparison of effects between alternatives, 30 to 90 square feet per acre is the breakpoint for the resource measure. For both mixed conifer and ponderosa pine cover types it is desired to maintain basal area at less than 90 square feet per acre, though exceptions exist to provide heterogeneity across the landscape as well as specific wildlife needs for dense and closed canopy forest conditions. For a thorough description of these considerations consult the Implementation Plan (Appendix XX).

Under the No Action alternative, basal areas across the analysis area would average 129 square feet per acre, ranging from 60 square feet per acre in the Carrizo Creek watershed, which has experienced a considerable amount of uncharacteristic severity wildfire, to 166 square feet per acre in the Salome watershed, and Haigler Creek-Tonto Creek watershed, dominated by dense ponderosa pine evergreen oak cover type. This excessive stocking is expected to increase to, on average, 150 square feet per acre by 2039. Currently only 19 percent of acreage meets the desired condition for basal area. The percentage of stands that meet the desired condition would be reduced to 12 percent by 2039 under the No Action alternative.

Continuous tree growth would allow for forest stand densities to depart further from the desired condition. This would result in increasing competition for limited resources (water, light, growing space, and soil nutrients). Competition-induced mortality and growth stagnation would continue to increase, along with susceptibility to potential insect and disease outbreaks. The current conditions and effects of no action over the next thirty years support a shift away from frequent, low severity surface fires to increasingly larger high severity intensity crown fires (Cooper, 1960) (Swetnam, 1990) (Covington & Moore, 1994a) (Kolb, Wagner, & Covington, 1994) (Swetnam & Baisan, 1996). For more information consunt the Fire Ecology Specialist Report (USDA 2019). These conditions would not meet the purpose and need for fire-adapted, resilient, diverse, and sustainable forest ecosystems.

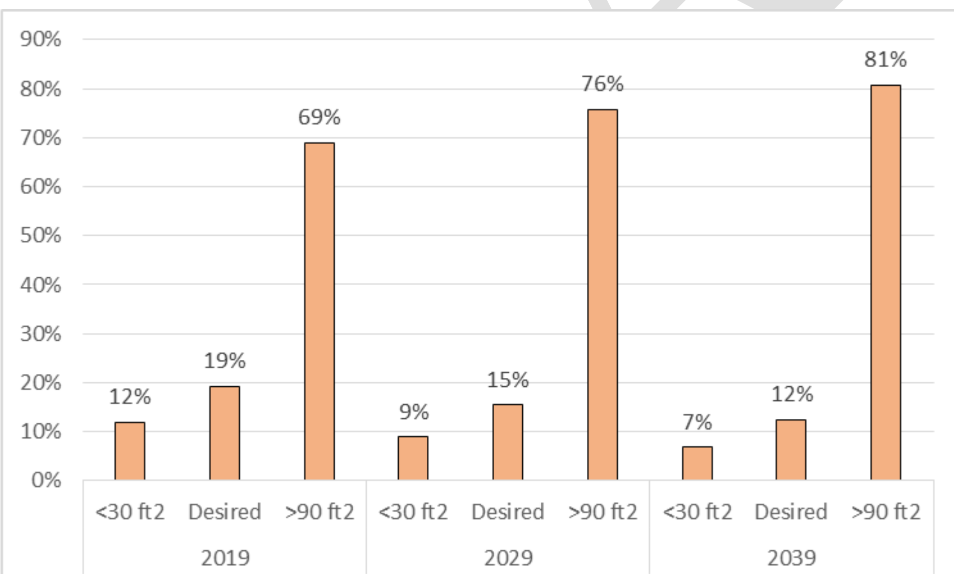

Figure 15. Alternative 1 - No Action – Percent of acres meeting desired condition for basal area across the project area.

Stand Density Index (SDI) is a measure of relative stand density based on the number of trees per acre and the mean diameter (Long 1995). Percent SDImax expresses the actual density in a stand relative to a theoretical maximum density possible for trees of that diameter and species (SDIMax is 450 for this analysi). SDI is a good indicator of how site resources are being used by taking both average tree size and trees per acre into account. SDImax represents an empirically-based estimate of the maximum combination of quadratic mean diameter and density which can exist for any stand of a particular forest type.

Currently across the analysis area, SDI averages 296 or 66 percent of SDImax and is considered in the zone where density related mortality is prominent and approaching the zone where imminent mortality will occur. Values range from 140 in the Carrizo Creek watershed, which has experienced a considerable amount of uncharacteristically severe wildfire to 400 in the Haigler Creek-Tonto Creek watershed which has a substantial amount of the ponderosa pine evergreen oak cover type. Overall, SDI and its relation to SDImax continues to increase to 324 or 70 percent of SDImax by 2039. In relation the desired condition, currently 15 percent of acres within the analysis area meet desired condition for SDI. This number would decrease to 11 percent by 2039.

Over time, with no action, continuous tree growth will allow forest stand densities to remain high and extremely high on the majority of acres (Das et al. 2001). This would result in increased susceptibility to insect epidemics, particularly bark beetles and intense individual tree competition and competition-induced mortality, decreased individual tree diameter growth and stand volume, and forage production over time and further departure from the desired condition.

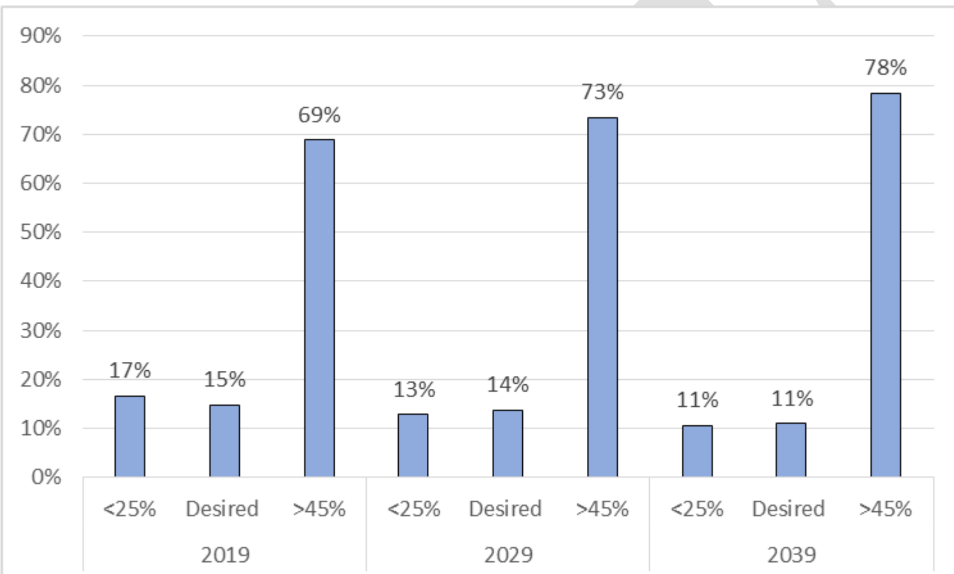

Figure 16. Alternative 1 - No Action – Percent of stands meeting the desired condition for stand density index

Large Tree and Old Tree Structure

Stands of post settlement trees where the quadratic mean diameter of the top 20 percent of trees is greater than 15"and the basal area of trees greater that 16" is more than 50 feet of basal area can be considered stands with a preponderance of large young trees (SPLYT stands). These stands occur outside of MSO PACs, MSO Recovery habitat and WUI and are being identified for their distinctive forest structure.

Under this alternative, no trees would be removed through cutting. Therefore, all large and old trees are expected to remain, except they are likely to be more susceptible to mortality from drought, pests, and disease as well as wildfire (Das et al. 2011, Ritchie et al, 2008). Across all 5th HUC watersheds in the analysis area the number of acres meeting SPLYT criteria is currently estimated to be 36,265 acres with a QMD of the top 20 percent of trees to be 19 inches. This number would increase to 80,139 acres by 2039 with a QMD of the top 20 percent of trees remaining at 19 inches. This is the result of current trees continuing to increase in diameter growth and does not take into account the potential mortality from drought, insects, disease and wildfire.

This alternative would also result in higher risk of mortality, especially for larger trees, because of an increasing risk of infection from pests or disease (Fischer et al, 2010), high severity or uncharacteristic wildfire (Coop et al, 2016) (Fiedler et al, 2010), or increased drought stress from competition (Erickson & Waring, 2014). A number of studies have found that higher forest density leaves large and old trees more susceptible to mortality. Erickson and Waring (2014) concluded that, "treatments removing small, neighboring trees may be critical in maintaining old ponderosa in the landscape, particularly under future climate change and increasing drought frequency in the western USA." Modifying forest conditions to facilitate low severity fire on the landscape has been identified as a key condition to preventing increased mortality of large and old trees over the next several decades (Fiedler et al. 2007, Kolb et. al. 2007, Ritchie et. al. 2008). Thus, while this alternative may increase the amount of large and old trees based on model results, these results do not account for the likely substantial loss of old and large trees as a result of various forest disturbances (such as uncharacteristically severe wildfire), which would decrease the amount of old and large trees in the analysis area.

Under this alternative it is possible that one or more naturally caused wildfires will be managed to benefit forest resources. Depending on the ability to manage one or more naturally caused fires based on values at risk, fuel, and weather conditions under this alternative some wildfires could result in small openings that decrease areas of intermediate aged trees, which would then contribute to establishment of a new young cohort of trees. Management of naturally caused fires under this alternative may also have the effect of reducing basal area and SDI by killing small trees or groups of small and/or intermediate aged trees. These fires could also result in mortality of some large and old trees or large patches of high severity mortality. Based on those areas in recent wildfires that have been managed for resource benefits, this effect may be very limited across the landscape. The current condition of the Forest would limit the ability to manage naturally-occurring wildfires in the analysis area at low to moderate-intensity levels without potential unacceptable effects on values at risk.

Forest Process

Insects

Under the No Action Alternative the proportion of acreage with a high hazard rating for bark beetles would increase from 74 percent to 82 percent, a considerable majority of the landscape. The proportion of acreage with a low or moderate hazard rating would decrease. Some large watersheds such as Upper Clear Creek, Haigler Creek-Tonto Creek and East Verde River are currently over 90 percent high hazard for bark beetles. The existing condition is departed from the desired condition and would further depart between 2019 and 2039 as basal area and SDI continue to increase beyond the Desired Condition.

Drought, coupled with high tree densities, can lower resistance to beetle attacks. Bark beetle population dynamics suggest that homogenous, dense, even-aged stands are highly susceptible to beetle outbreaks. Susceptibility to western pine beetle would slowly increase over time. Areas with the greatest likelihood of infestation are those stands with densities greater than 120 square feet of basal area and average stand diameters greater than 12 inches dbh. Susceptibility to Ips would continue to increase with activity most likely occurring in response to a drought or a snow or ice event that creates fresh pine debris.

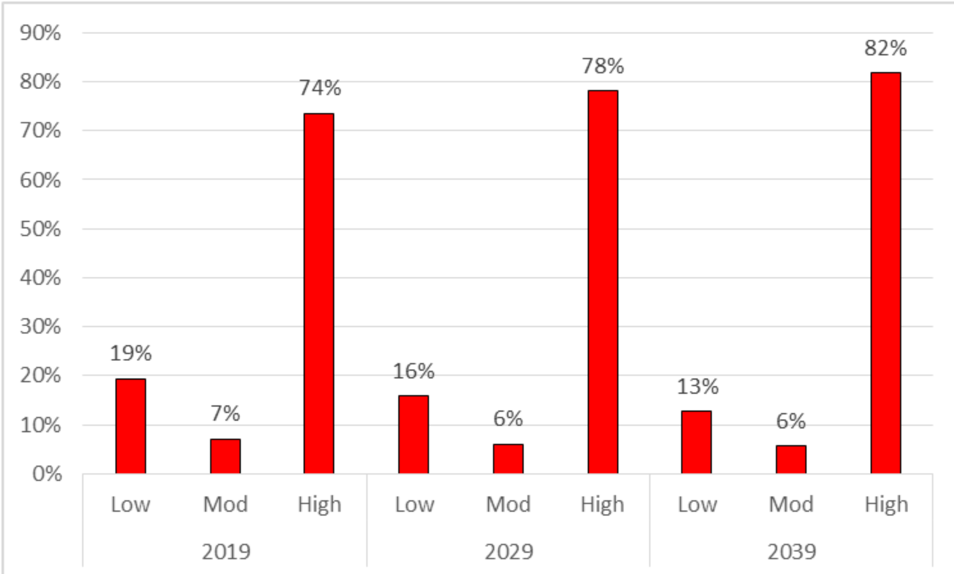

Figure 17. Alternative 1 - No Action Alternative – Distribution of Bark Beetle Hazard Rating classes across the project area.

Disease

Across the analysis area, approximately 75 percent of the area is not infected or has a low infection level, 22 percent has a moderate severity rating and 4 percent has a high severity rating. This distribution shifts to higher severity ratings over time; by 2039, 25 percent of acres are classified as moderate and 9 percent of acres are classified as severe by 2039. This is an indication that mistletoe infection is intensifying and spreading over time. Dwarf mistletoe infections would not be reduced and may intensify in infected trees and the surrounding trees, reducing the growth, vigor, and longevity of ponderosa pine. Though most of the analysis area meets the desired condition of having a low or no dwarf mistletoe severity, 34 percent of the analysis area would have a moderate or severe dwarf mistletoe severity rating by 2039 and would not meet the desired condition. Stands would further depart from the desired condition over time as infected stands intensify their infections and infect adjacent areas (Conklin and Fairweather 2010).

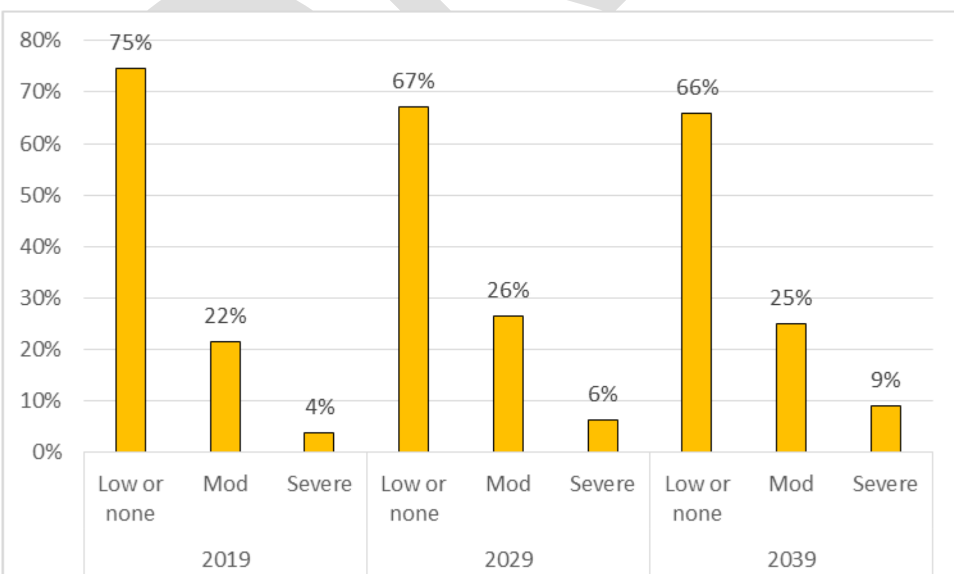

Figure 18. Alternative 1 - No Action Alternative – Dwarf Mistletoe Severity Rating classes across the project area

Fire Adaptation

For a more thorough discussion of this alternative in terms of fire adaptation, consult the Fire Ecology Specialist Report (USDA 2019). In general, this alternative does not support the purpose and need to develop or return to a forest ecosystem that is fire-adapted, resilient, diverse, and sustainable. This alternative would continue to support the current shift away from frequent, low severity surface fires to conditions that are more likely to support increasingly larger high severity crown fires (Cooper 1960) (Swetnam 1990) (Covington and Moore, 1994a) (Kolb et al 1994) (Swetnam and Baisan, 1996). The current forest structure is quite different from conditions from the NRV of the native microbes, plants, and animals living in western ponderosa pine and dry mixed conifer forests (Covington and Moore 1994a, Reynolds et al 2013). As a result, this project area would remain susceptible to undesirable fire behavior and effect, and other disturbance agents, such as bark beetles and disease, over time.

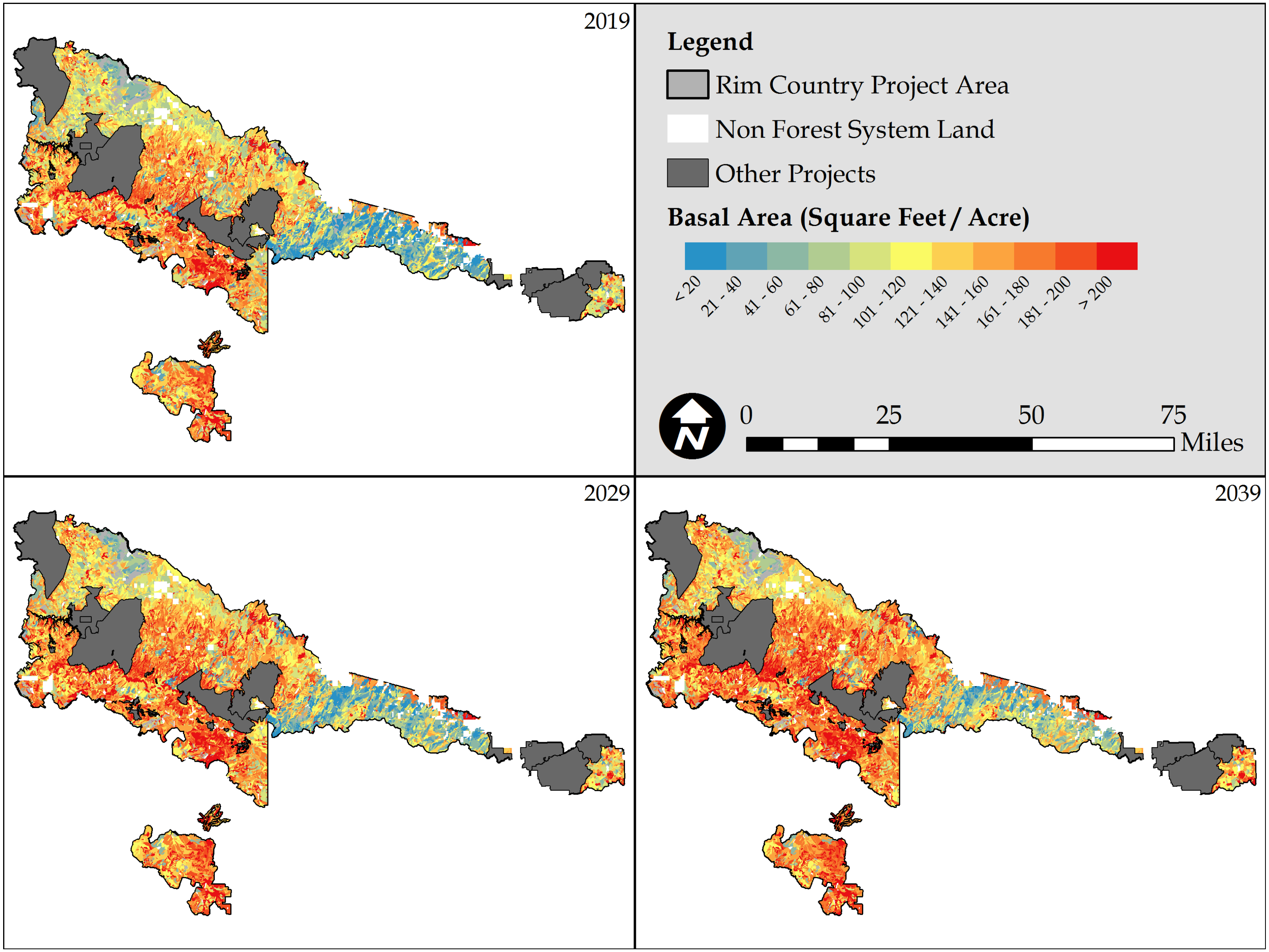

Figure 19. Alternative 1 – Basal Area

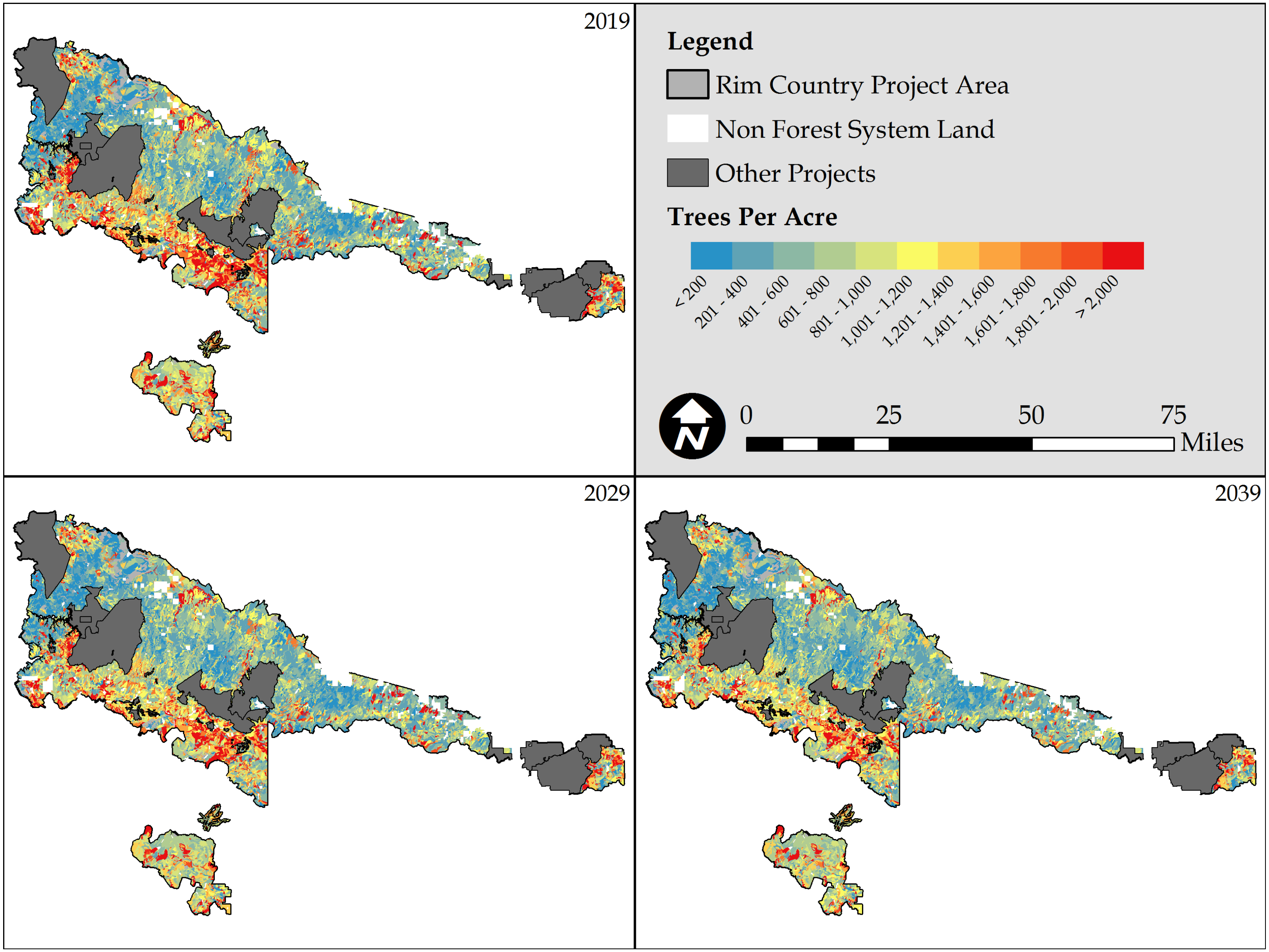

Figure 20. Alternative 1 –Trees per Acre

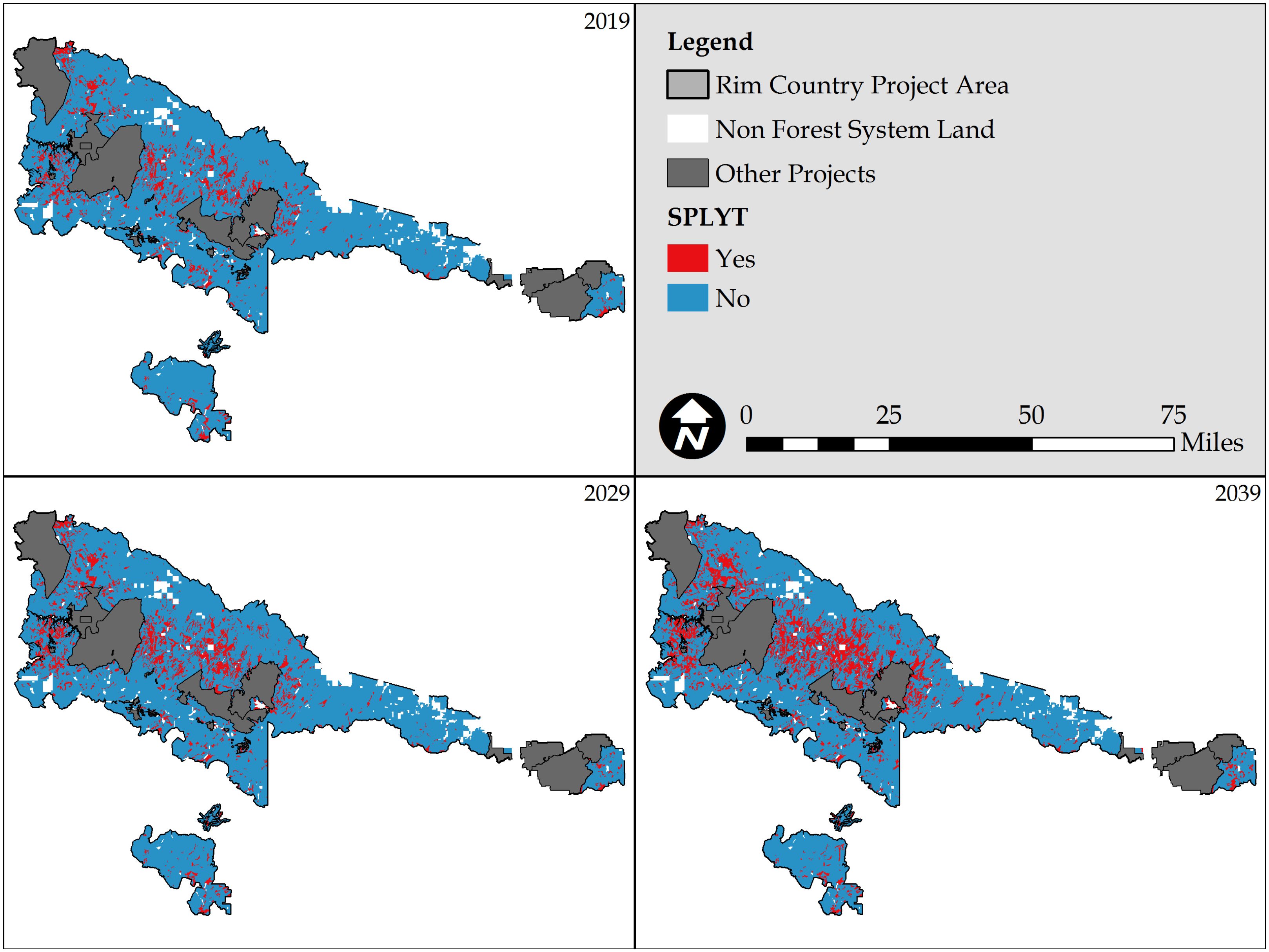

Figure 23. Alternative 1 –SPLYT Stands

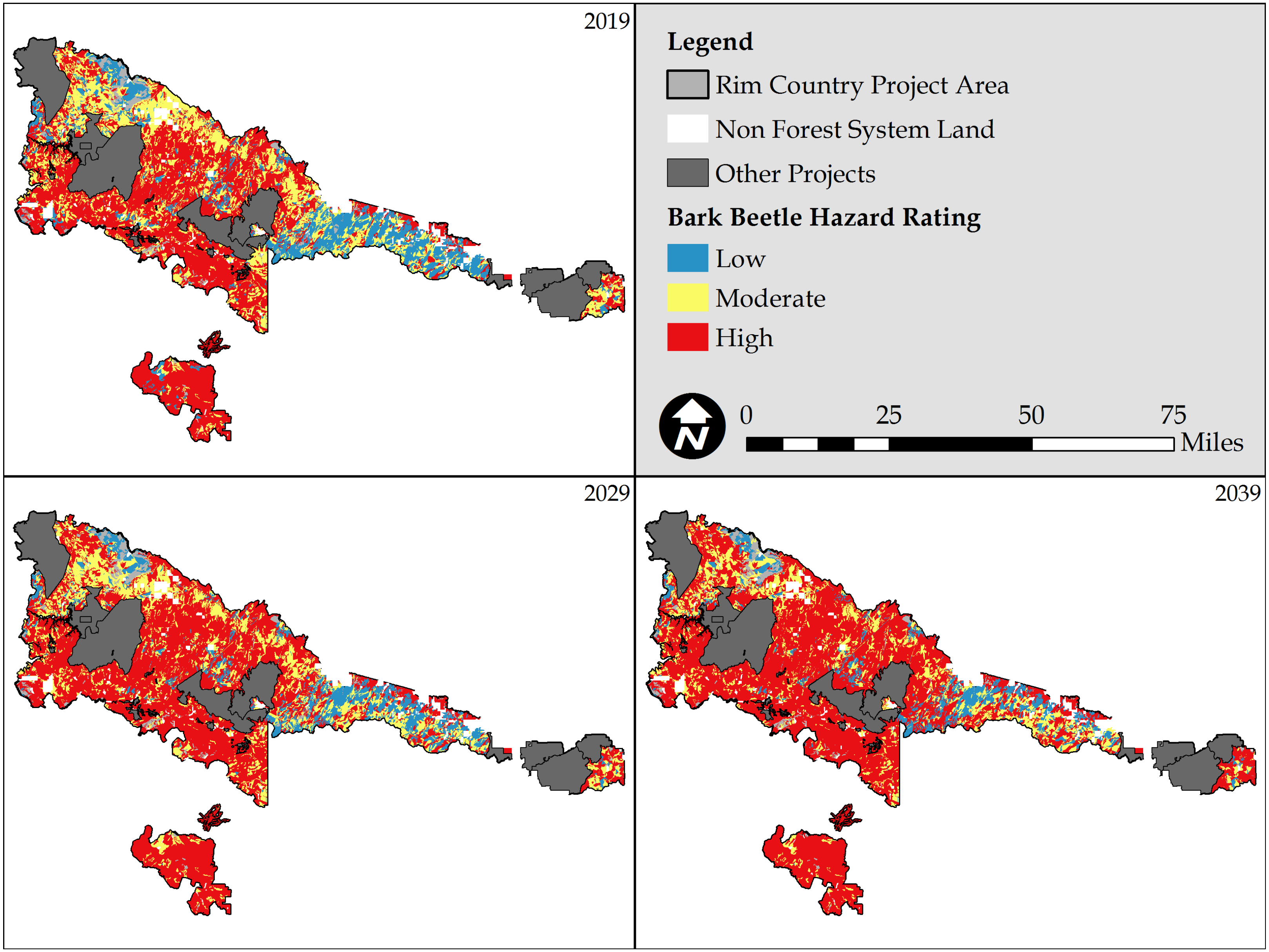

Figure 24. Alternative 1 – Bark Beetle Hazard Rating

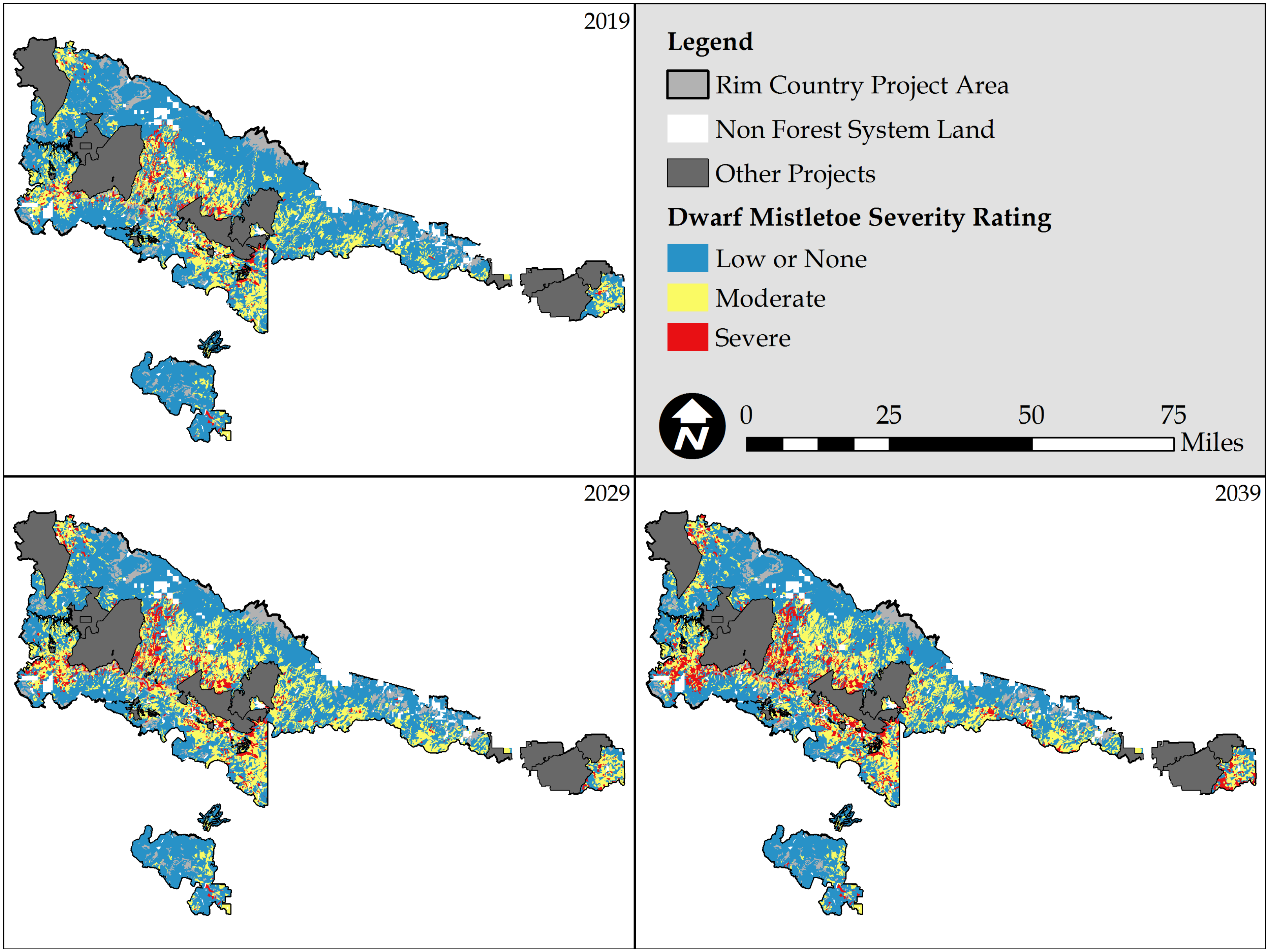

Figure 25. Alternative 1 – Dwarf Mistletoe Severity Rating

Alternative 2 – Proposed Action

Direct and Indirect Effects

Under Alternative 2, prescribed cutting and/or prescribed fire treatment would be applied in order to move towards or meet the desired conditions. This alternative meets or moves the project area toward the desired conditions identified in the Forest Plans and moves the project area forward in initiating the re-establishment of a fire-adapted, resilient, diverse, and sustainable forest ecosystem. The distribution of trees across size classes is more representative of a historic size class distribution as many trees in the smaller size classes have been removed or burned. At a landscape scale forest composition, structure, pattern, and process would all be improved. For a more thorough analysis of the effects of this alternative on the wildfire hazard, consult the Fire Ecology Specialist Report (USDA 2019).

Stand and landscape resilience to disturbances such as multi-year drought, pests, and disease such as bark beetle and mistletoe, and undesirable fire effects would increase (Abella, et al. 2007) as density would be reduced under this alternative. Drought stress and insect attacks associated with increased tree density, altered tree spatial arrangement, would be reduced. These changes in forest structure would reduce tree mortality due to decreased competition among trees (Kane et al, 2014). At the fine scale, forest structure and pattern would be improved as vegetation management activities would maintain or improve the level of tree aggregation (groups and clumps of trees) as existing groups are maintained and new groups are created (Zhang et al, 2013).

Table 37. Alternative 2 – Proposed Action – Density and structure-related indicator measures by 5th HUC watershed

	2019			2029			2039		
5th HUC Watershed	BA	SDI	QMD	BA	SDI	QMD	BA	SDI	QMD
Beaver Creek	124	270	8.2	56	102	14.0	56	91	16.3
Black Canyon	81	186	5.3	38	69	9.8	38	62	12.1
Canyon Creek	99	251	4.2	53	104	8.4	51	92	10.8
Canyon Diablo	118	288	5.6	73	145	9.6	67	115	12.5
Carrizo Creek (Local Drainage)	60	140	4.7	37	69	8.5	38	65	11.4
Cherry Creek	142	338	5.4	62	110	10.9	58	96	13.3
Corduroy Creek	69	172	4.0	31	63	7.2	31	56	9.9
Cottonwood Creek	66	158	4.4	28	54	8.0	26	45	10.4
East Verde River	161	378	5.6	72	127	11.5	68	108	14.0
Fossil Creek-Verde River	140	325	6.3	61	111	11.0	59	96	13.6
Gun Creek-Tonto Creek	138	346	4.8	53	90	11.5	47	76	13.0
Haigler Creek-Tonto Creek	165	400	5.3	77	139	11.1	73	120	13.7
Jacks Canyon	96	211	7.5	53	98	11.5	51	86	13.7
Lower Chevelon Canyon	121	267	6.5	42	71	11.8	39	61	14.0
Lower Clear Creek	121	274	6.1	41	72	11.2	25	41	12.8
Oso Draw	124	317	4.8	59	117	9.6	59	104	12.3
Phoenix Park Wash-Dry Lake	79	182	5.0	36	66	8.9	36	59	11.5
Rye Creek-Tonto Creek	142	330	6.1	61	104	11.8	55	88	13.9
Salome Creek	166	388	5.7	69	121	11.8	63	104	13.4
Salt River-Theodore Roosevelt Lake	170	411	5.7	75	122	13.7	64	98	15.3
Show Low Creek	87	208	4.8	37	69	9.2	36	60	11.4
Spring Creek	152	351	5.6	54	95	11.4	49	80	13.0
Upper Chevelon Canyon	133	293	6.9	74	134	11.0	71	121	13.0
Upper Clear Creek	143	317	6.7	84	151	11.4	84	139	13.5
Upper North Fork White River	160	398	5.9	92	166	12.2	95	153	15.2
Upper Silver Creek	126	298	5.5	43	81	11.2	43	72	14.3
Walnut Creek	82	137	14.5	41	51	26.0	41	51	25.6
West Clear Creek	122	263	8.1	61	110	11.9	61	100	14.3
Grand Total	129	296	6.2	65	116	11.0	62	103	13.3

Table 38. Alternative 2 - Proposed Action – Distribution of trees per acre across size classes by 5th HUC watershed

	2019						2029						2039					
5th HUC Watershed	0-5"	5-12"	12-18"	18-24"	24"+	Total	0-5"	5-12"	12-18"	18-24"	24"+	Total	0-5"	5-12"	12-18"	18-24"	24"+	Total
Beaver Creek	613	86	35	12	3	750	130	15	10	8	4	167	52	10	9	8	5	84
Black Canyon	570	74	20	5	2	670	58	13	10	4	2	88	27	8	9	5	2	51
Canyon Creek	1332	88	22	5	3	1451	169	27	12	5	2	216	78	21	12	6	3	119
Canyon Diablo	1015	105	25	12	2	1159	167	64	15	9	3	259	54	25	16	9	3	109
Carrizo Creek (Local Drainage)	429	57	15	4	2	506	63	15	10	4	2	94	27	11	9	5	2	55
Cherry Creek	1048	149	35	9	3	1244	81	23	15	8	2	130	34	14	14	9	3	73
Corduroy Creek	697	57	16	4	1	775	94	13	8	4	1	120	47	7	8	4	2	68
Cottonwood Creek	632	67	16	3	1	719	75	13	9	3	1	100	25	7	8	3	1	44
East Verde River	1091	119	44	11	5	1271	79	20	17	10	4	129	31	13	14	9	4	72
Fossil Creek-Verde River	908	129	43	8	3	1091	87	18	17	8	3	133	40	11	15	8	4	78
Gun Creek-Tonto Creek	1441	147	36	9	2	1636	46	19	14	8	2	89	21	11	11	8	2	54
Haigler Creek-Tonto Creek	1292	142	42	10	5	1490	128	26	18	10	4	185	59	17	16	9	5	106
Jacks Canyon	431	99	24	6	3	563	76	28	12	5	3	125	35	18	11	5	4	73
Lower Chevelon Canyon	491	120	30	7	3	651	35	12	10	5	3	65	14	7	9	5	3	37
Lower Clear Creek	651	113	26	9	4	803	53	21	8	4	3	88	35	9	5	2	2	52
Oso Draw	1336	108	38	8	2	1492	192	27	15	8	2	244	92	19	14	9	3	137
Phoenix Park Wash-Dry Lake	520	81	20	4	2	627	56	14	11	4	2	86	21	8	11	5	2	46
Rye Creek-Tonto Creek	915	122	37	11	3	1088	46	15	13	9	4	87	22	9	11	8	4	54
Salome Creek	1058	182	40	12	3	1295	66	28	18	10	2	125	28	18	16	10	3	75
Salt River-Theodore Roosevelt Lake	1464	105	46	18	7	1640	34	17	14	14	4	84	10	10	11	13	3	48
Show Low Creek	795	80	23	6	1	905	87	15	8	5	2	117	35	9	8	6	2	59
Spring Creek	831	178	41	8	2	1059	42	25	16	8	2	92	21	14	13	8	2	58
Upper Chevelon Canyon	589	121	35	10	4	758	103	37	18	9	4	171	62	26	17	9	4	118
Upper Clear Creek	753	122	37	11	4	927	120	42	19	10	5	195	73	31	18	10	5	138
Upper North Fork White River	1875	106	42	16	4	2044	134	18	19	17	5	193	55	11	17	17	7	106
Upper Silver Creek	905	110	38	8	1	1063	88	18	10	6	2	123	34	13	9	6	2	64
Walnut Creek	59	17	15	11	7	109	1	0	0	2	8	11	2	0	0	1	9	11
West Clear Creek	559	99	41	8	3	710	89	22	16	8	3	138	38	14	15	8	4	78
Grand Total	813	114	35	9	3	973	97	27	15	8	3	151	48	18	14	8	4	92

Table 39. Alternative 2 – Proposed Action – Distribution of basal area by size across size classes by 5th HUC watershed

	2019						2029						2039					
5th HUC Watershed	0-5"	5-12"	12-18"	18-24"	24"+	Total	0-5"	5-12"	12-18"	18-24"	24"+	Total	0-5"	5-12"	12-18"	18-24"	24"+	Total
Beaver Creek	8	34	42	28	13	124	2	6	12	20	16	56	1	4	11	20	20	56
Black Canyon	11	27	22	11	9	81	1	6	12	10	9	39	1	4	12	11	10	38
Canyon Creek	16	31	25	12	14	99	3	10	14	12	13	53	2	8	14	13	14	51
Canyon Diablo	16	37	29	27	9	118	2	19	18	22	11	73	1	11	19	22	14	67
Carrizo Creek (Local Drainage)	6	22	17	9	6	60	1	7	12	10	8	37	1	5	11	12	10	38
Cherry Creek	14	54	40	19	14	142	1	10	18	19	13	62	1	6	17	20	14	58
Corduroy Creek	15	22	18	10	3	69	2	6	9	9	5	31	2	4	9	9	8	31
Cottonwood Creek	11	25	18	8	4	66	2	6	10	6	4	28	1	3	10	7	5	26
East Verde River	15	45	51	25	25	161	1	8	20	22	20	72	1	6	18	22	22	68
Fossil Creek-Verde River	11	48	49	18	14	140	1	8	21	18	14	61	0	5	18	19	17	59
Gun Creek-Tonto Creek	11	54	41	21	10	138	1	8	17	19	9	53	0	5	14	19	9	47
Haigler Creek-Tonto Creek	17	51	48	24	25	165	2	11	21	22	22	77	1	7	19	22	23	73
Jacks Canyon	6	35	26	14	14	96	1	11	14	12	15	53	1	8	13	12	17	51
Lower Chevelon Canyon	13	44	34	17	14	121	0	6	13	11	12	42	0	3	11	11	13	39
Lower Clear Creek	8	40	31	20	23	121	0	8	9	8	15	41	0	4	6	4	11	25
Oso Draw	16	41	44	18	7	124	4	10	19	18	8	59	3	7	17	20	11	59
Phoenix Park Wash-Dry Lake	9	31	22	10	7	79	1	7	12	9	7	36	1	4	13	11	8	36
Rye Creek-Tonto Creek	12	45	42	24	18	142	1	6	15	20	19	61	0	4	13	19	18	55
Salome Creek	14	67	46	26	13	166	1	13	21	23	11	69	1	8	20	23	12	64
Salt River-Theodore Roosevelt Lake	10	40	54	38	27	170	0	9	18	31	17	75	0	6	13	31	14	64
Show Low Creek	12	30	27	13	6	87	2	6	10	12	7	37	1	4	9	13	9	36
Spring Creek	14	65	47	18	8	152	1	11	19	17	7	54	0	6	16	19	8	49
Upper Chevelon Canyon	12	44	40	22	16	133	2	14	21	20	16	74	1	10	20	21	18	71
Upper Clear Creek	12	45	43	25	18	143	2	16	23	24	20	84	1	12	22	24	24	84
Upper North Fork White River	14	43	50	36	17	160	2	8	23	38	21	92	1	5	20	40	28	95
Upper Silver Creek	14	42	44	17	8	126	2	7	12	13	9	43	1	5	11	15	12	43
Walnut Creek	3	6	19	25	30	82	0	0	0	6	35	40	0	0	0	2	38	40
West Clear Creek	8	39	46	18	11	122	1	10	20	18	13	61	1	6	18	20	16	61
Grand Total	12	42	40	20	15	129	2	11	19	18	15	65	1	8	17	19	18	62

Table 40. Alternative 2 – Proposed Action - Acres meeting SPLYT criteria by 5th HUC watershed

	2019			2029			2039		
5th HUC Watershed	Acres	BA >16"	QMD Top 20%	Acres	BA >16"	QMD Top 20%	Acres	BA >16"	QMD Top 20%
Beaver Creek	498	81	19	454	71	22	481	74	23
Black Canyon	2,330	71	18	2,442	66	23	3,819	66	24
Canyon Creek	10	64	18	523	62	23	523	70	24
Canyon Diablo	-	-	-	60	54	20	60	59	21
Carrizo Creek (Local Drainage)	151	70	20	158	61	23	201	63	23
Cherry Creek	539	74	18	540	60	23	577	64	24
Corduroy Creek	2	66	19	2	57	23	2	64	23
Cottonwood Creek	642	59	19	715	64	24	901	66	24
East Verde River	1,577	92	20	2,230	77	24	2,493	78	25
Fossil Creek-Verde River	1,432	70	21	1,618	68	23	2,366	68	24
Gun Creek-Tonto Creek	120	65	15	120	55	22	120	69	24
Haigler Creek-Tonto Creek	2,056	67	17	1,961	59	23	2,076	62	24
Jacks Canyon	1,545	62	20	2,170	66	22	2,670	67	24
Lower Chevelon Canyon	351	65	20	582	63	24	1,743	59	24
Oso Draw	227	57	18	458	61	22	652	64	23
Phoenix Park Wash-Dry Lake	392	61	17	335	57	23	820	56	22
Rye Creek-Tonto Creek	238	68	18	250	57	22	250	59	23
Salome Creek	594	101	19	670	69	23	792	69	23
Salt River-Theodore Roosevelt Lake	16	109	19	16	78	22	16	81	23
Show Low Creek	229	70	20	822	63	22	912	67	23
Spring Creek	64	68	15	313	57	21	313	64	22
Upper Chevelon Canyon	8,465	84	19	11,421	73	24	16,262	71	24
Upper Clear Creek	8,141	82	19	11,640	72	23	16,177	72	24
Upper North Fork White River	-	-	-	7	88	23	7	95	24
Upper Silver Creek	93	83	18	126	60	22	262	62	22
West Clear Creek	6,554	72	19	8,196	67	22	10,278	69	23
Grand Total	36,265	77	19	47,828	69	23	64,774	70	24

Table 42. Alternative 2 – Proposed Action - Forest health related indicator measures by 5th HUC watershed

	2019						2029						2039					
	Beetle Hazard Rating			Dwarf Mistletoe Severity Rating			Beetle Hazard Rating			Dwarf Mistletoe Severity Rating			Beetle Hazard Rating			Dwarf Mistletoe Severity Rating		
5th HUC Watershed	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High
Beaver Creek	32%	6%	63%	69%	29%	2%	74%	13%	13%	67%	31%	2%	80%	10%	10%	66%	31%	3%
Black Canyon	41%	8%	51%	81%	19%	0%	89%	6%	5%	74%	26%	0%	91%	6%	3%	69%	31%	1%
Canyon Creek	31%	4%	65%	59%	31%	11%	79%	12%	9%	53%	43%	4%	87%	4%	9%	48%	48%	4%
Canyon Diablo	32%	0%	67%	73%	26%	1%	57%	12%	31%	72%	24%	4%	64%	16%	21%	66%	31%	4%
Carrizo Creek (Local Drainage)	50%	3%	47%	69%	31%	0%	81%	12%	7%	56%	44%	0%	81%	12%	6%	44%	55%	0%
Cherry Creek	2%	8%	90%	51%	45%	4%	85%	8%	8%	47%	52%	1%	87%	7%	5%	40%	58%	2%
Corduroy Creek	59%	0%	41%	75%	25%	0%	87%	13%	0%	59%	41%	0%	100%	0%	0%	58%	30%	12%
Cottonwood Creek	58%	7%	35%	87%	13%	0%	97%	3%	0%	79%	21%	1%	99%	1%	0%	77%	22%	1%
East Verde River	5%	3%	91%	73%	20%	7%	75%	14%	11%	68%	27%	5%	84%	7%	9%	67%	27%	6%
Fossil Creek-Verde River	11%	5%	84%	58%	36%	6%	71%	18%	11%	53%	44%	3%	80%	12%	8%	51%	43%	6%
Gun Creek-Tonto Creek	2%	0%	98%	100%	0%	0%	92%	5%	3%	99%	1%	0%	95%	2%	3%	99%	1%	0%
Haigler Creek-Tonto Creek	4%	1%	95%	55%	38%	7%	69%	14%	17%	54%	44%	3%	77%	10%	13%	51%	44%	6%
Jacks Canyon	35%	19%	46%	97%	3%	0%	85%	9%	6%	96%	4%	0%	89%	9%	2%	94%	5%	0%
Lower Chevelon Canyon	3%	2%	96%	96%	4%	0%	91%	8%	1%	82%	18%	0%	94%	4%	1%	82%	18%	0%
Lower Clear Creek	0%	3%	97%	100%	0%	0%	100%	0%	0%	100%	0%	0%	100%	0%	0%	100%	0%	0%
Oso Draw	14%	3%	83%	66%	33%	1%	73%	14%	12%	64%	36%	0%	82%	8%	10%	58%	40%	1%
Phoenix Park Wash-Dry Lake	43%	12%	45%	74%	26%	0%	94%	4%	2%	69%	31%	0%	97%	0%	2%	68%	31%	1%
Rye Creek-Tonto Creek	32%	8%	59%	96%	4%	0%	91%	7%	2%	94%	6%	0%	95%	3%	2%	93%	7%	0%
Salome Creek	4%	3%	93%	92%	5%	3%	78%	11%	12%	88%	11%	2%	82%	9%	9%	85%	13%	2%
Salt River-Theodore Roosevelt Lake	0%	24%	76%	100%	0%	0%	82%	17%	1%	85%	15%	0%	82%	17%	1%	85%	15%	0%
Show Low Creek	48%	3%	49%	78%	22%	0%	80%	15%	5%	66%	34%	0%	93%	3%	4%	63%	35%	2%
Spring Creek	11%	0%	89%	95%	5%	0%	89%	8%	3%	94%	6%	0%	93%	5%	2%	93%	7%	0%
Upper Chevelon Canyon	13%	8%	79%	74%	22%	4%	75%	13%	13%	64%	35%	1%	78%	12%	10%	61%	36%	3%
Upper Clear Creek	6%	5%	90%	64%	27%	9%	60%	18%	21%	55%	42%	3%	66%	17%	18%	52%	42%	5%
Upper North Fork White River	19%	49%	32%	10%	71%	19%	68%	12%	20%	2%	98%	0%	71%	21%	8%	2%	98%	0%
Upper Silver Creek	29%	4%	67%	68%	28%	4%	82%	10%	8%	61%	38%	1%	87%	6%	6%	55%	43%	3%
Walnut Creek	95%	5%	0%	88%	12%	0%	100%	0%	0%	88%	12%	0%	100%	0%	0%	88%	12%	0%
West Clear Creek	16%	16%	68%	78%	20%	2%	72%	16%	12%	73%	26%	1%	79%	13%	8%	71%	28%	1%
Grand Total	19%	7%	74%	75%	22%	4%	77%	12%	11%	69%	30%	2%	83%	9%	8%	66%	31%	3%

Composition

Forest composition would improve under this alternative. Ponderosa pine would still be the dominant forest cover type. Mixed conifer would continue to make up a moderate proportion of the analysis area. As a result of prescribed cutting and prescribed fire, prevalence of later seral species such as white fir and corkbark fir in forested stands would be reduced and would better represent their role in the NRV. Pinyon juniper woodlands and oak species would continue to make up a considerable part of the analysis area. The treatment of conifer encroached grasslands would expand their range to more fully represent the Desired Condition to reestablish their historical extent. The protection and improvement of aspen stands would promote regeneration and reduce inter-tree competition and improve their condition under this alternative; however aspen is one of the species predicted to be most affected by a changing climate. The condition of less common but important species such as maple and Emory oak would be improved through the cutting of other species such as juniper and other species.

This analysis has considered the effects of a changing climate. Though this alternative would result in a landscape more resilient to climate change, climatic models for the southwestern U.S. predict continued warming, greater variability in precipitation, and increased drought. These climatic changes would likely contribute to some level of tree mortality; however, considerably less than the No Action Alternative. A changing climate may lead to large shifts and contractions in the range of dominant trees throughout much of the region (Kane et al, 2014).

Structure

Uneven-aged Structure

Uneven-aged forest are defined as forests composed of three or more distinct age classes of trees, either intimately mixed or in small groups. The Desired Condition is for uneven-aged forest structure to occur on a majority of acres. Under this alternative, there is considerable change to forest structure (Figure 3-12). Across the project, evenaged structure would dominate the landscape with a balance of trees in smaller, medium and larger size classes. The proportion of stands with uneven-ageed structure would increase into the future. This alternative would meet the Desired Condition for uneven-aged structure in the Forest Plans and forest structure would more closely resemble the NRV. Modeling indicates that some stands would move towards more even-aged conditions in the dominant cover types proposed for treatment as a result of removal of trees from the smaller size classes and retention of trees in the larger size classes. Modeling the most intense extent of the range of the prescribed treatment, combined with the protection of large and old trees, produced even-aged stands of larger trees in some cases. However, as treatments are applied on the ground, the use of the large and old tree implementation plans, in accordance with an uneven-aged thinning strategy, would be able to produce uneven-aged conditions across much of the landscape. Individual tree growth would increase and trees would move into larger size classes as a result of a reduction in individual tree competition. Naturally-occurring regeneration would provide additional vertical structure over time.

An additional, and potentially more substantial, benefit to forest structure would be a reduction in the possibility of an uncharacteristic wildfire or other substantial disturbance event, such as a beetle outbreak or long-term drought. Under this alternative stands would be more resistant to uncharacteristic fire and insect outbreaks and more resilient to drought. The balance of size classes and uneven-aged structure would provide conditions favorable to restoration of a natural fire regime.

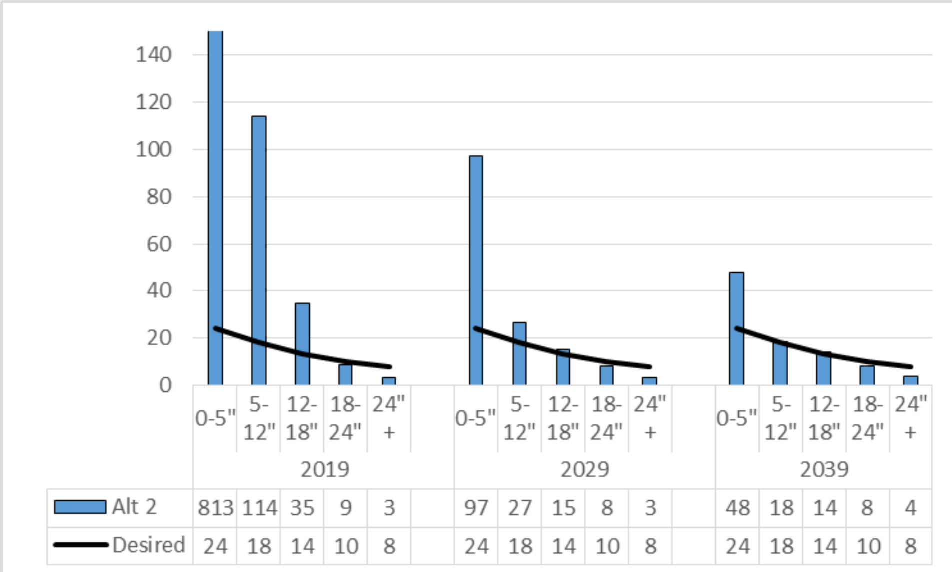

Figure 26. Alternative 2 – Proposed Action – Distribution of trees per acres across size classes across the project area Vegetation Structural Stage

Density

Measure of density in this analysis include trees per acre, basal area and stand density index. With prescribed thinning and fire, there would be considerable change to the size class distribution in the near future. The Proposed Action would effectively meet the desired condition for trees per acre with a balance across size classes. The overall tree density would decrease considerably under this alternative, from 973 in 2019 to 151 in 2029 and 92 by 2039 (Table 3-10).

While the initial reduction in trees per acre would result from a combination of mechanical and prescribed fire activities, the reduction after 2029 can be attributed to the recurring prescribed fires over time. Prescribed fires with higher or lower severity (e.g., burning under hotter or cooler and/or wetter conditions) from 2029 to 2039 could be implemented to maintain a higher or lower number of trees per acre in the smaller size classes if desired. The reduction in tree density would increase individual tree growth and reduce density dependent tree mortality. Understory grasses, forbs herbs and shrubs would increase in quantity (Covington & Moore 1994a).

The desired condition is to retain a basal area of between 30 to 90 square feet per acre across most habitat types outside of MSO PACs. While the Forest Plans provide a desired condition with a range of basal areas ranging from 20 to 180 square feet per acre depending on cover type, for this analysis, at the project level, for ease of comparison of effects between alternatives, 90 square feet per acre is the breakpoint for the resource measure across the analysis area. For both mixed conifer and ponderosa pine cover types it is desired to maintain basal area at less than 90 square feet per acre though exceptions exist to provide heterogeneity across the landscape as well as specific wildlife needs for dense and closed canopy forest conditions. For a more thorough analysis of the effects of this alternative within MSO and Northern goshawk habitat, consult the Wildlife Specialist Report (USDA 2019).

Under the Proposed Action alternative, basal areas across the analysis area would average 65 square feet in 2029 and 62 square feet in 2039. While currently only 19 percent of stands meet the desired condition, by the year 2029, 58 percent of stands would have met the desired condition, and by 2039, over 56 percent of stands would meet the desired condition. This would result in decreased inter-tree competition for resources such as water, light, growing space, and nutrients. Individual tree growth would increase and density dependent mortality would be dramatically reduced along with susceptibility to potential insect and disease outbreaks. These conditions would indicate a shift from the current larger and higher severity crown fires that the forest would currently experience to cooler, higher frequency, lower severity surface fires (Cooper 1960) (Swetnam 1990) (Covington & Moore, 1994a) (Kolb et al 1994) (Swetnam and Baisan 1996) that persisted prior to European settlement. The reductions in basal area would meet the desired condition and purpose and need for fire-adapted, resilient, diverse, and sustainable forest ecosystems at the landscape and watershed scales.

While all watersheds would have their average basal areas reduced to within the desired condition, some watersheds such as Gun Creek-Tonto Creek and Rye Creek-Tonto Creek would experience considerable additional mortality as a result of prescribed fire between 2029 and 2039. Prescribed fires with lower severity effects (e.g., burning under cooler and/or wetter conditions) in 2029-2039 could be implemented to maintain the desired basal area and continue to meet the desired condition.

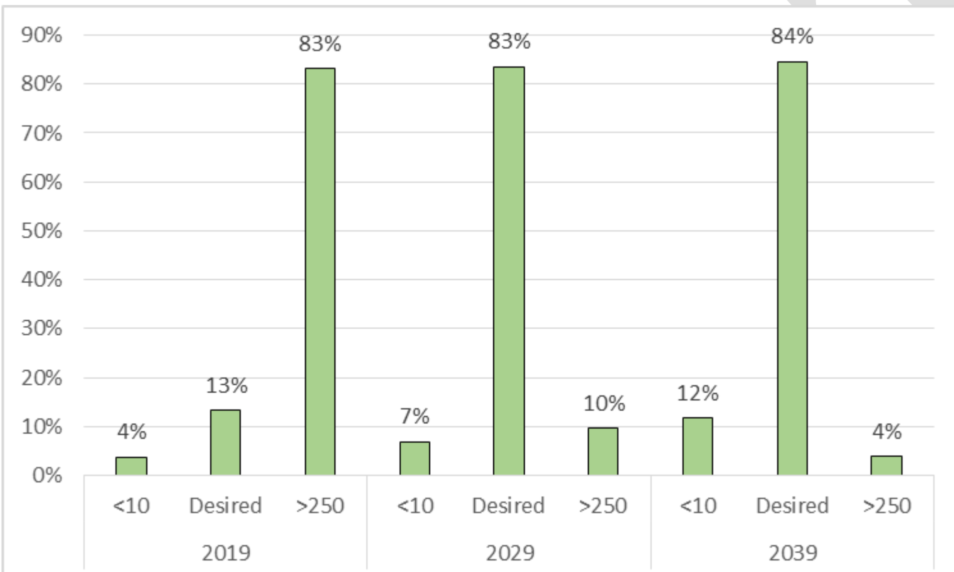

Figure 27. Alternative 2 – Proposed Action – Percent of acres meeting desired condition for trees per acre across the project area

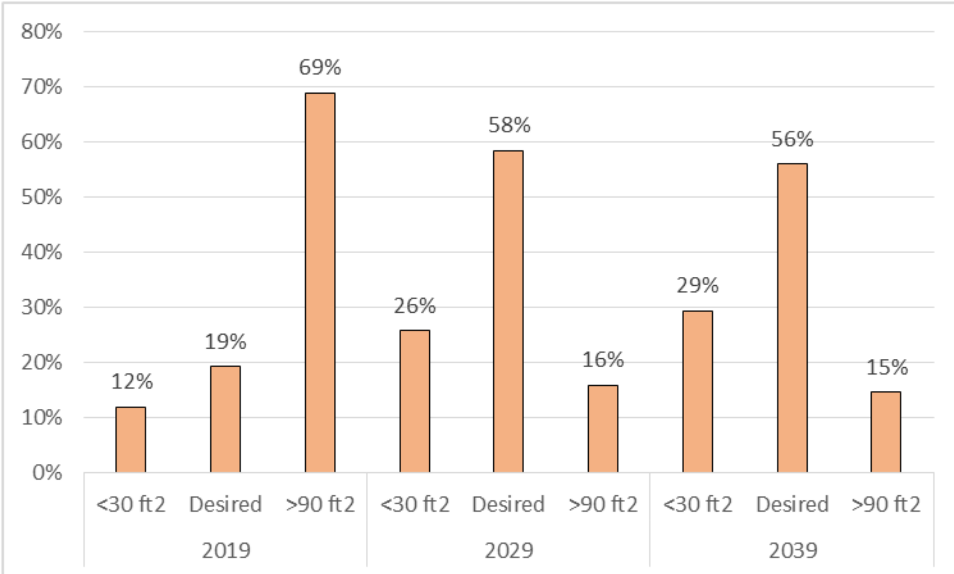

Figure 28. Alternative 2 - Proposed Action – Percent of acres meeting desired condition for basal area across the project area.

Stand Density Index (SDI) is a measure of relative stand density based on the number of trees per acre and the mean diameter (Reineke 1933, Long 1995). Percent SDImax expresses the actual density in a stand relative to a theoretical maximum density possible for trees of that diameter and species. SDI is a good indicator of how site resources are being used by taking both average tree size and trees per acre into account. SDImax represents an empirically-based estimate of the maximum combination of quadratic mean diameter and density which can exist for any stand of a particular forest type.

The desired condition for SDI is to be between 25 and 45 percent of SDIMax or between 112.5 and 202.5. Currently across the analysis area, SDI averages 296 or 66 percent of SDImax and is considered extremely high. As a result of the proposed action, SDI would be reduced to 116 or 26 percent of SDIMax by 2029 and 103 or 23 percent of SDIMax by 2039. While the proportion of acres meeting desired condition in 2019 is 15 percent, the proportion meeting the desired condition would increase to 27 percent in 2029 and to 21 percent by 2039. Prescribed fires with lower severity effects (e.g., burning under and/or wetter conditions) from 2029 to 2039 could be implemented to maintain a higher or SDI if desired. SDI values between 25 percent and 45 percent of SDIMax are associated with high understory production and intermediate levels of individual tree diameter growth as overall stand growth is concentrated on fewer number of trees than in more dense forests. Depending on the level of tree aggregation, little inter-tree competition would be occurring. Competition could still be occurring within dense tree groups.

Over time, with the proposed action, stand densities should stabilize as the reintroduction of fire returns natural disturbance processes to the landscape. This would result in reduced susceptibility to insect epidemics, particularly bark beetles, as well as reduced density dependent mortality, increased individual tree diameter growth and forage production over time, and continued attainment of the desired condition.

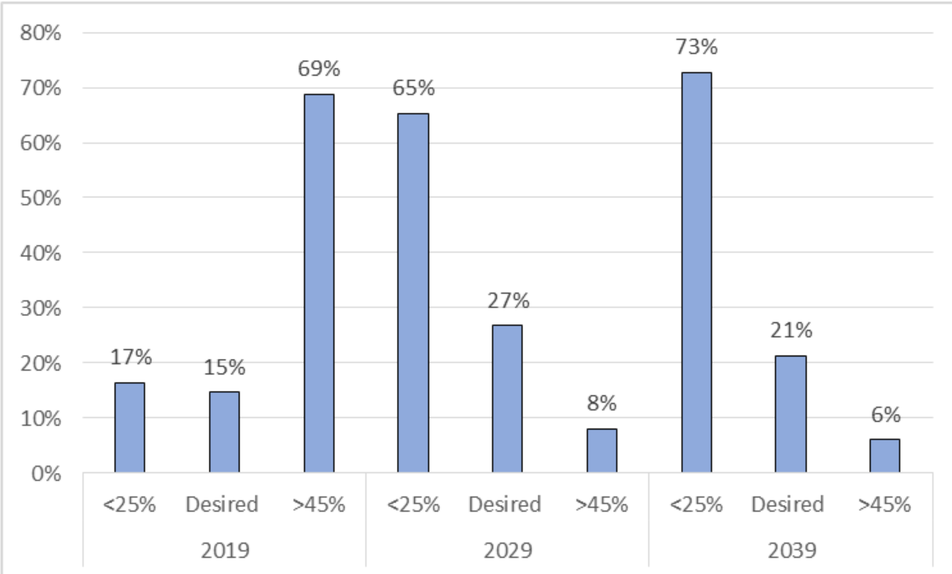

Figure 29. Alternative 2 - Proposed Action – Percent of stands meeting the desired condition for stand density index

Large Tree and Old Tree Structure

Stands of post settlement trees where the quadratic mean diameter of the top 20 percent of trees is greater than 15”and the basal area of trees greater that 16” is more than 50 feet of basal area can be considered stands with a preponderance of large young trees (SPLYT stands). These stands occur outside of MSO PACs, MSO Recovery habitat and WUI and are being identified for their distinctive forest structure.

Across all 5th HUC watersheds in the project area, the average number of acres currently meeting SPLYT criteria is 36,325 with a QMD of the top 20 percent of trees being 19 inches. Under the proposed action, this number would increase to 64,774 acres with a QMD of the top 20 percent of trees being 24 inches. While this acreage is lower than the acres meeting SPLYT criteria in 2039 for the no action alternative it does not take into the account the potential large scale mortality of trees as a result of a large fire or insect outbreak. Under this alternative, prescribed cutting and prescribed burning would occur over much of the landscape. Modeling indicates that the number of acres meeting SPLYT criteria would increase as a result of the proposed action, but at a slower rate than the Proposed Action. With design features in place during implementation, large trees meeting the large and old growth tree implementation plan criteria would be retained, resulting in more large trees being left at the expense of smaller tree sizes. This would allow the number of SPLYT acres to increase over time. During implementation, some large trees would be cut in accordance with the large and old growth tree implementation plans. Remaining larger trees would be less susceptible to mortality from drought, insects, disease, and wildlife (Das et al. 2011, Ritchie et al, 2008). This reduction in the number of SPLYT acres over the no action alternative does not take into account the application of the LTIP that would effectively increase the number of large trees remaining across the landscape.

This alternative would result in a lower risk of mortality, especially for larger trees, because of a decreasing risk of infection from pests or disease (Fischer, Waring, Hofstetter, & and Kolb, 2010), high severity or uncharacteristic wildfire (Coop et al, 2016) (Fiedler et al, 2010), or increased drought stress from competition (Erickson & Waring, 2014). A number of studies have found that lower forest density leaves large and old trees less susceptible to mortality as a result of these factors. Erickson and Waring (2014) concluded that, "treatments removing small, neighboring trees may be critical in maintaining old ponderosa in the landscape, particularly under future climate change and increasing drought frequency in the western USA." Modifying forest conditions to facilitate low severity fire on the landscape has been identified as a key condition to preventing increased mortality of large and old trees over the next several decades (Fiedler et al. 2007, Kolb et. al. 2007, Ritchie et. al. 2008). While this alternative may increase the amount of SPLYT acres at a slower rate than the No Action Alternative, the resulting forest would be far less likely to experience substantial loss of old and large trees as a result of various forest disturbances (such as uncharacteristic wildfire). A potential result of this alternative would be additional SPLYT acres than the No Action alternative in the presence of large scale disturbances.

Under this alternative, Forests would be able to manage more acres of naturally occurring wildfires for resource benefit. Forest structure, including openings, interspace, and groups and clumps of trees would allow for low to moderate fire severity that would maintain openings and have little potential effect on the vegetation resource except for trees in the smaller size classes. For a more thorough description of post treatment fire behavior consult the Fire Ecology Specialist Report in the project record.

Forest Process

Insects

Under the Proposed Action Alternative, the proportion of acreage with a high hazard rating for bark beetles would decrease from 74 percent to 111 percent in 2029 and to 8 percent by 2039. Stands with a low or moderate beetle hazard rating, the desired condition, would increase from 26 percent in 2019 to 89 percent in 2029 and then 92 per cent by 2039. This demonstrates a considerable shift towards the desired condition for this indicator. While the proportion of acreage with a moderate rating would change only slightly, the proportion of acreage with a low hazard rating would increase considerably as the analysis area approaches desired condition for this indicator.

Stands with lower tree densities and basal area are more resilient to drought and beetle attacks. Bark beetle population dynamics suggests that homogenous, dense stands are highly susceptible to beetle outbreaks. The proposed action would create heterogeneous, open, uneven-aged stands that would dramatically reduce susceptibility and maintain that reduced susceptibility over time. Susceptibility to western pine beetle would decrease over time with mechanical treatment and reintroduction of low severity surface fire. Areas with the greatest likelihood of infestation from bark beetles are areas treated at a low intensity as to not considerably affect beetle hazard rating. Additionally, areas with large amounts of slash remaining post treatment are at risk for Ips beetles. Some susceptibility to Ips would continue to increase, with activity most likely occurring in response to a drought or a snow or ice event that creates fresh pine debris.

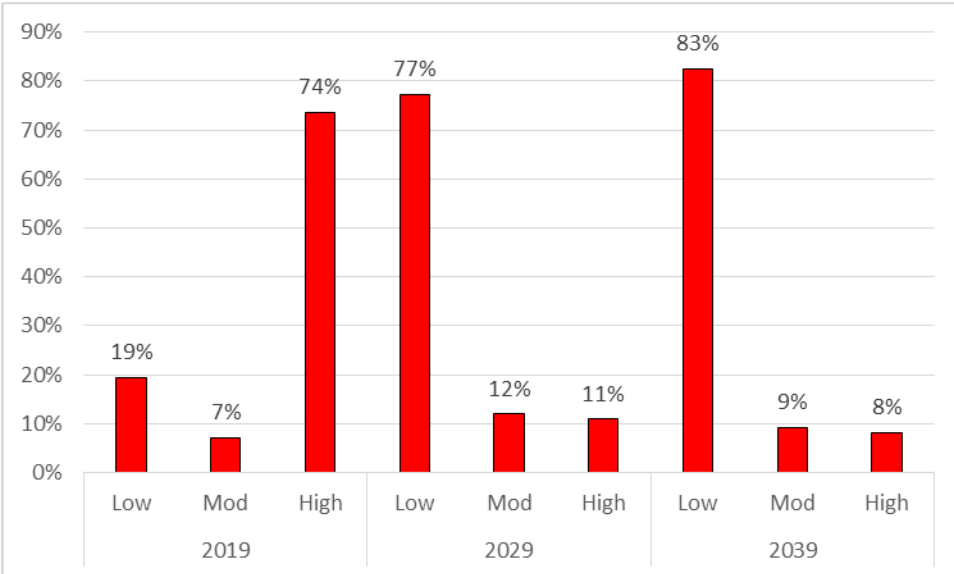

Figure 30. Alternative 2 - Proposed Action – Distribution of Bark Beetle Hazard Rating classes across the project area.

Disease

Across the analysis area, approximately 75 percent of the area would not be infected or have a low infection level, 22 percent would have a moderate severity rating, and 4 percent, or 36,058 acres, would have a high severity rating. As a result of the Proposed Action, stands with a high severity rating would drop to 2 percent and stands with a Low or None rating drop to 69 percent. Acres with a moderate rating would increase to 31 percent as infection intensification and spread occur even after mechanical treatment. Dwarf mistletoe infections may be reduced as a result of the Proposed Action but may intensify in remaining or latent infected trees, surrounding trees, and infected residual overstory trees, reducing the growth, vigor and longevity of ponderosa pine (Conklin and Fairweather 2010). However, across the analysis area, growth, longevity, and vigor of ponderosa pine trees would be increased. Though most of the analysis area would meet the desired condition of having low or no dwarf mistletoe severity, 34 percent of the analysis area would have a moderate or severe dwarf mistletoe severity rating by 2039 and would not meet the desired condition. This would be an improvement in dwarf mistletoe severity rating over the No Action Alternative by the year 2039.

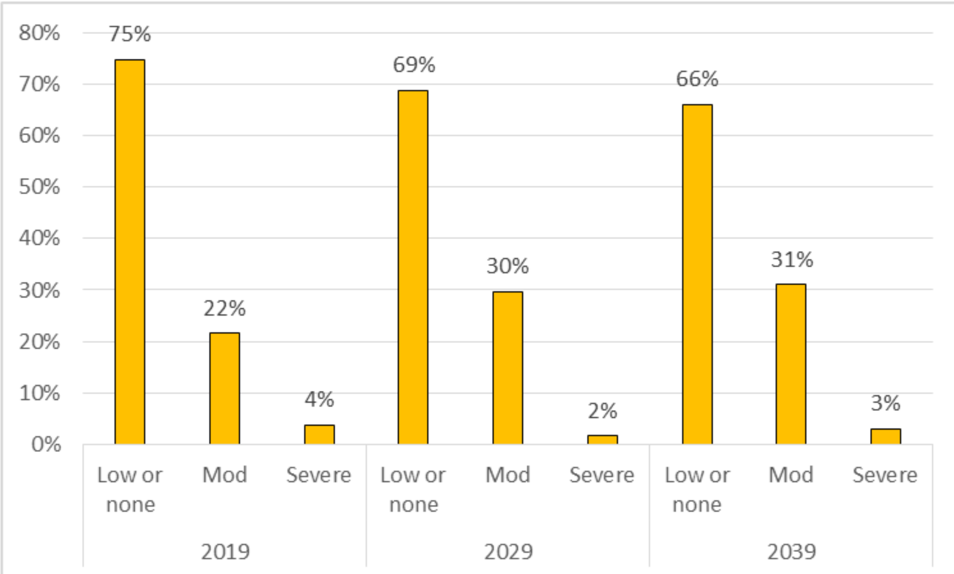

Figure 31. Alternative 2 - Proposed Action – Dwarf Mistletoe Severity Rating classes across the project area

Fire Adaptation

For a more thorough discussion of this alternative in terms of fire adaptation, consult the Fire Ecology Specialist Report (USDA 2019). In general, this alternative would support the purpose and need to develop or return to a forest ecosystem that is fire-adapted, resilient, diverse, and sustainable. This alternative would support the shift away from larger high severity crown fires to conditions that are more likely to support increasingly frequent, low severity surface fires (Cooper 1960) (Swetnam 1990) (Covington and Moore, 1994a) (Kolb et al 1994) (Swetnam and Baisan, 1996). Over time this alternative would create conditions that resemble the NRV of the native microbes, plants, and animals living in western ponderosa pine and dry mixed conifer forests (Covington and Moore 1994a, Reynolds et al 2013). As a result, the analysis area would have reduced susceptibility to undesirable fire behavior and effects as well as other disturbance agents, such as bark beetles and disease, over time.

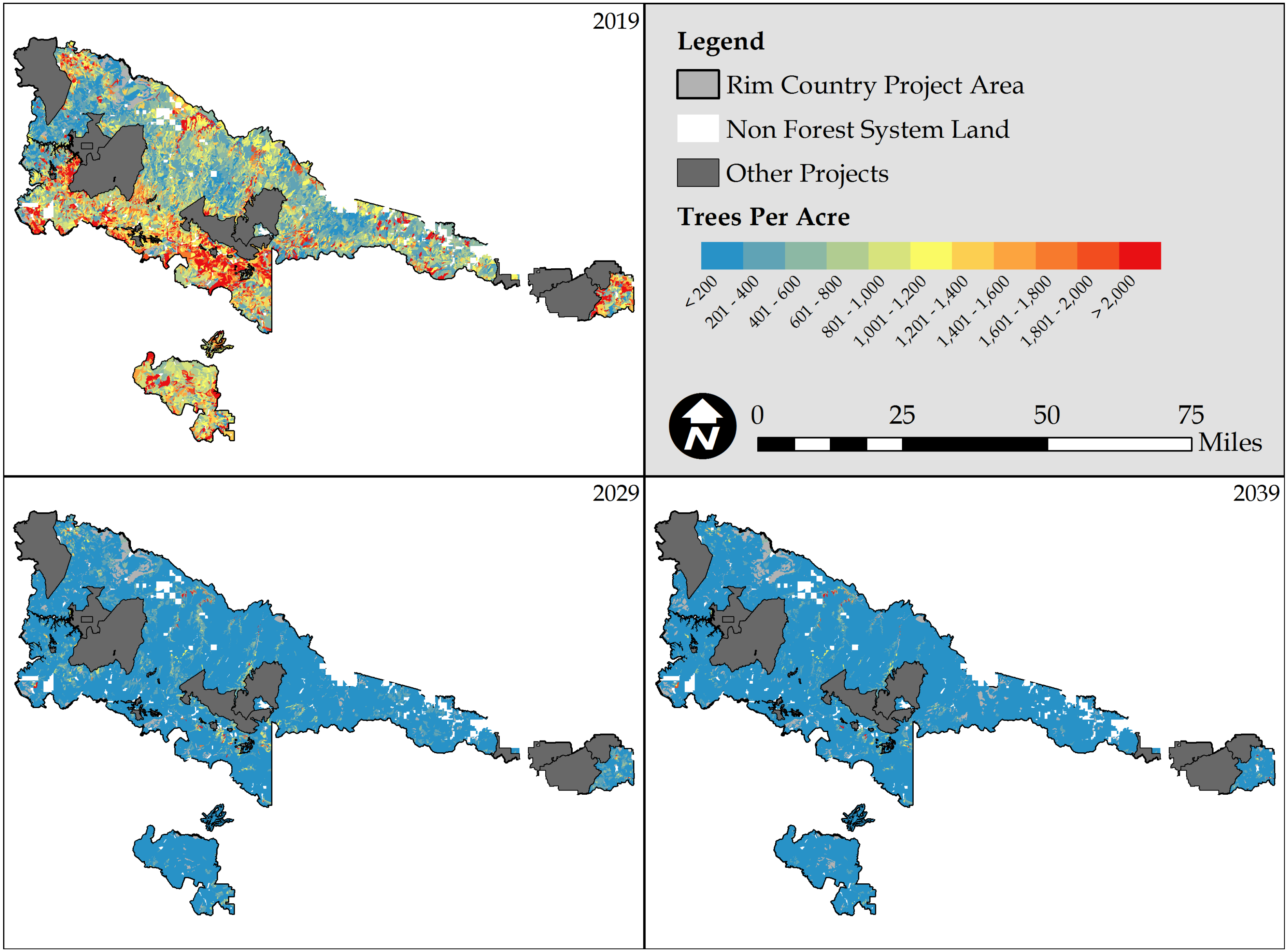

Figure 32. Alternative 2 – Trees per Acre

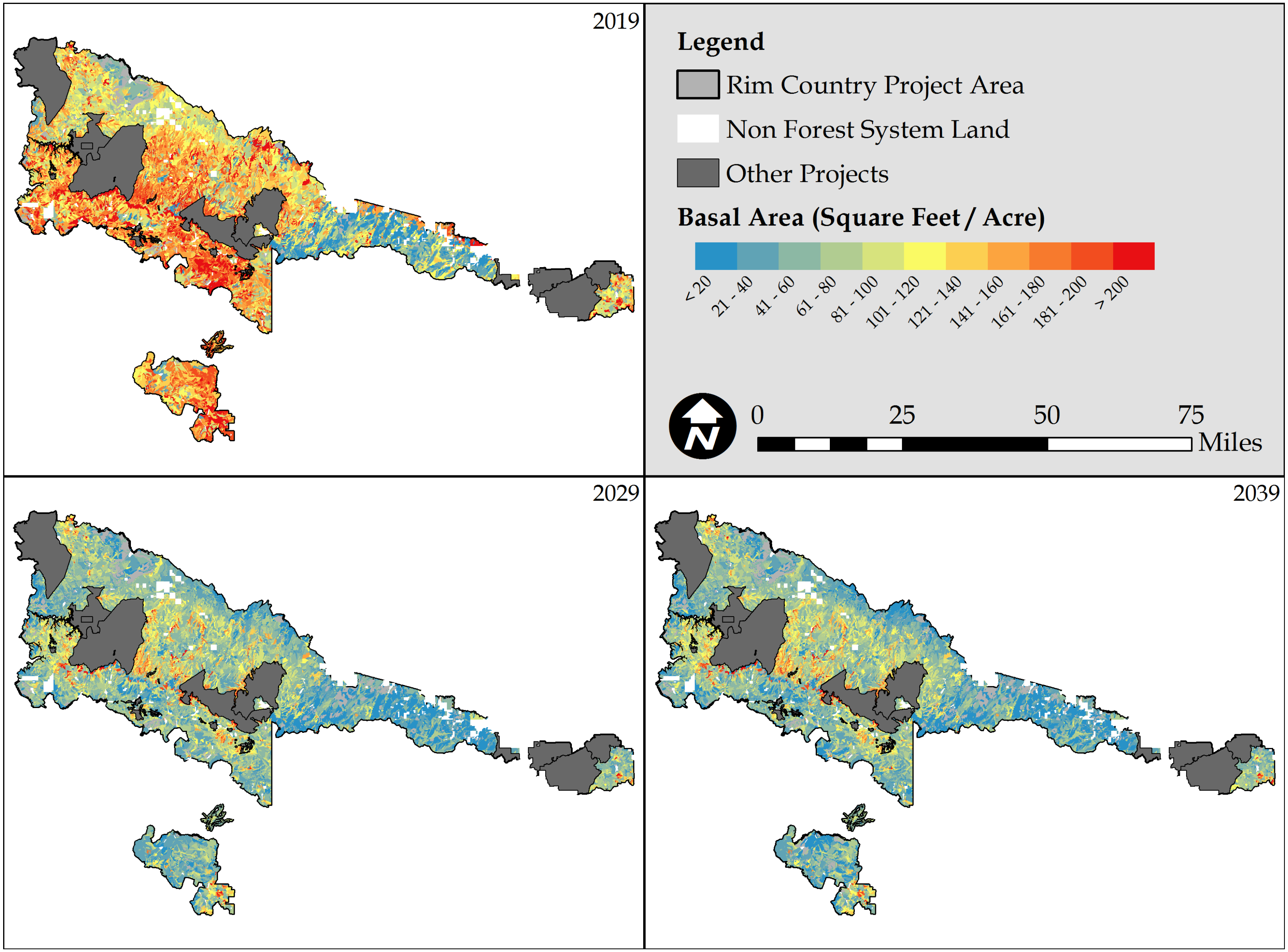

Figure 33. Alternative 2 – Basal Area

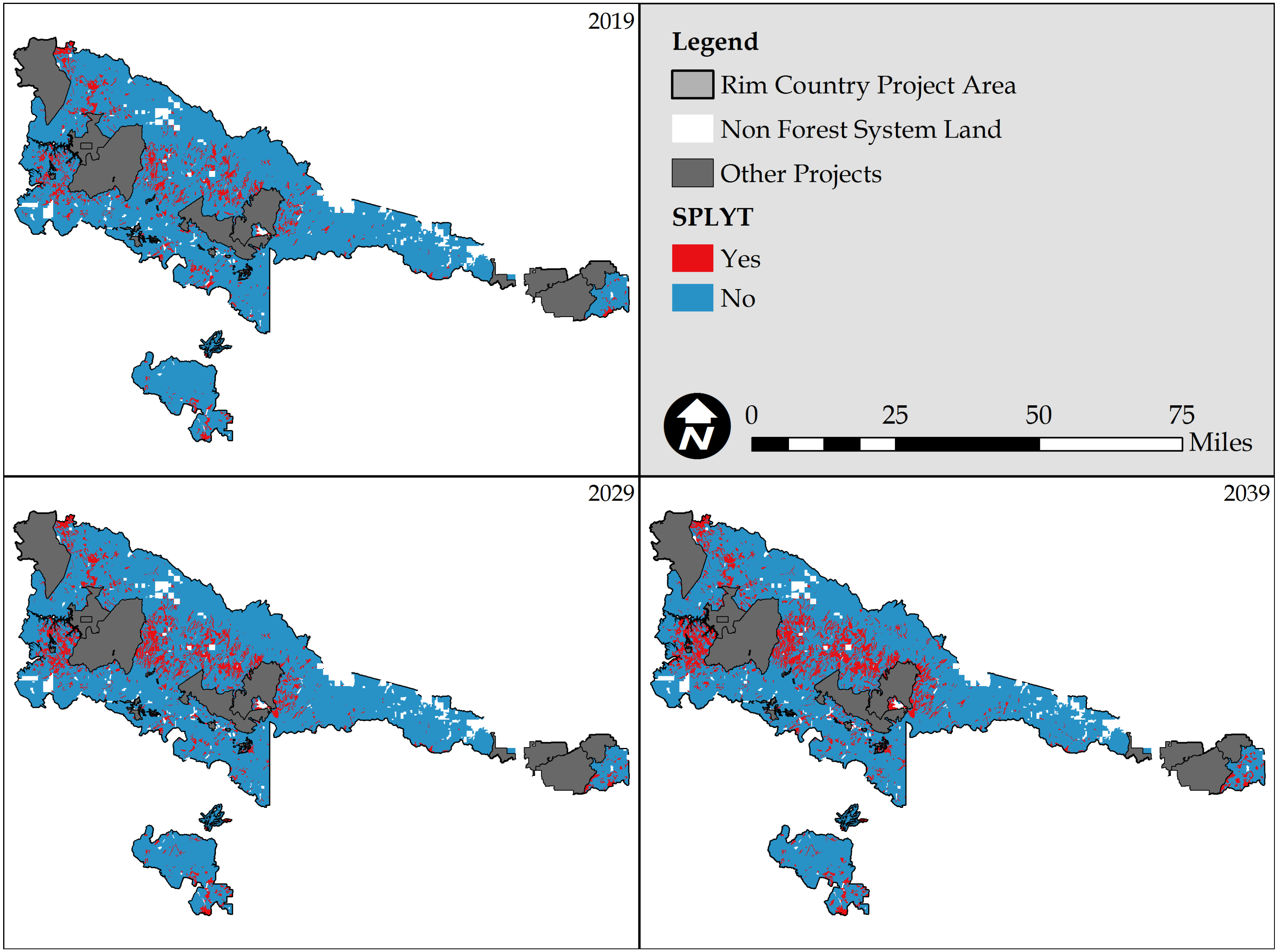

Figure 36. Alternative 2 – SPLYT Stands

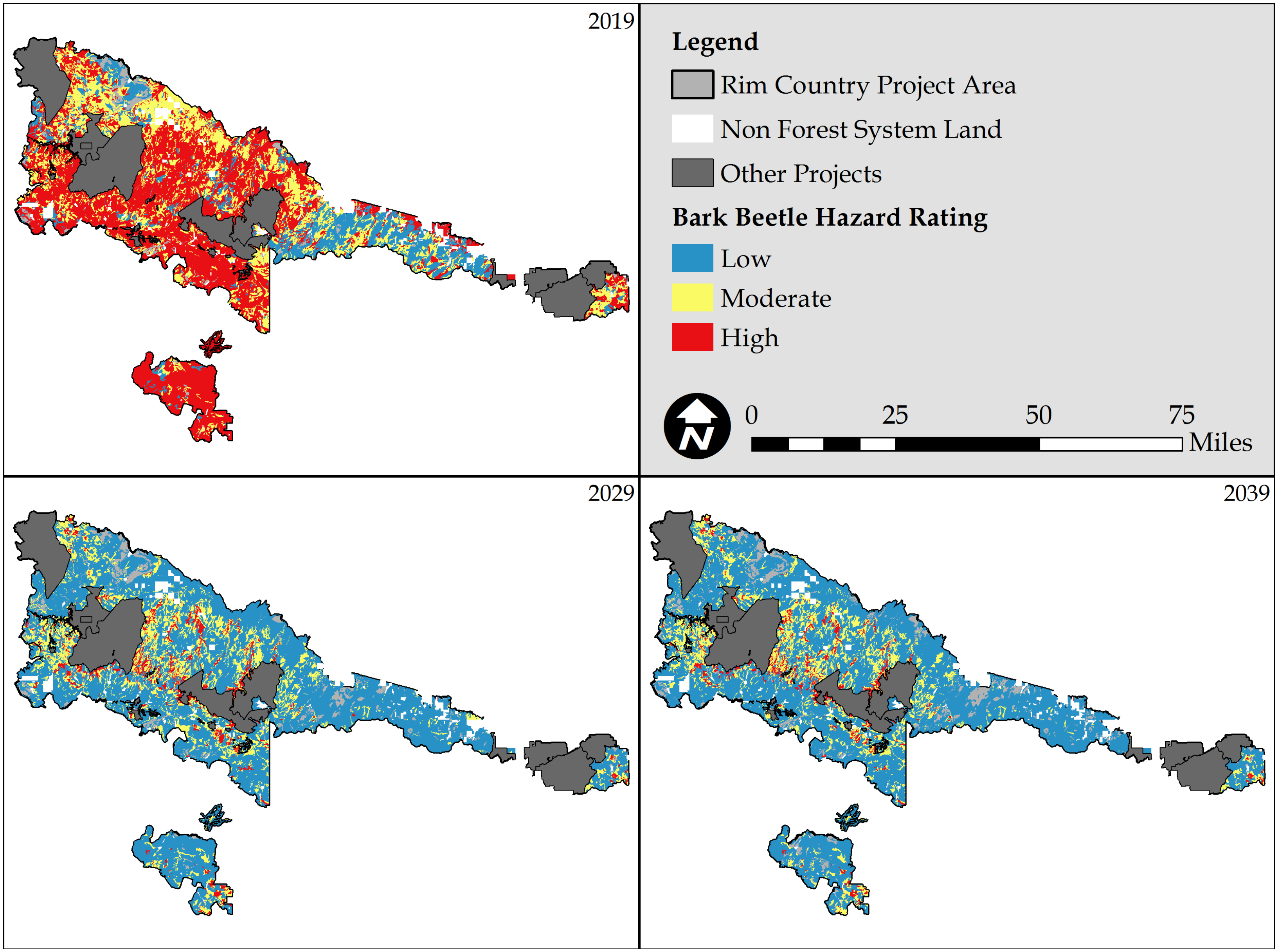

Figure 37. Alternative 2 – Bark Beetle Hazard Rating

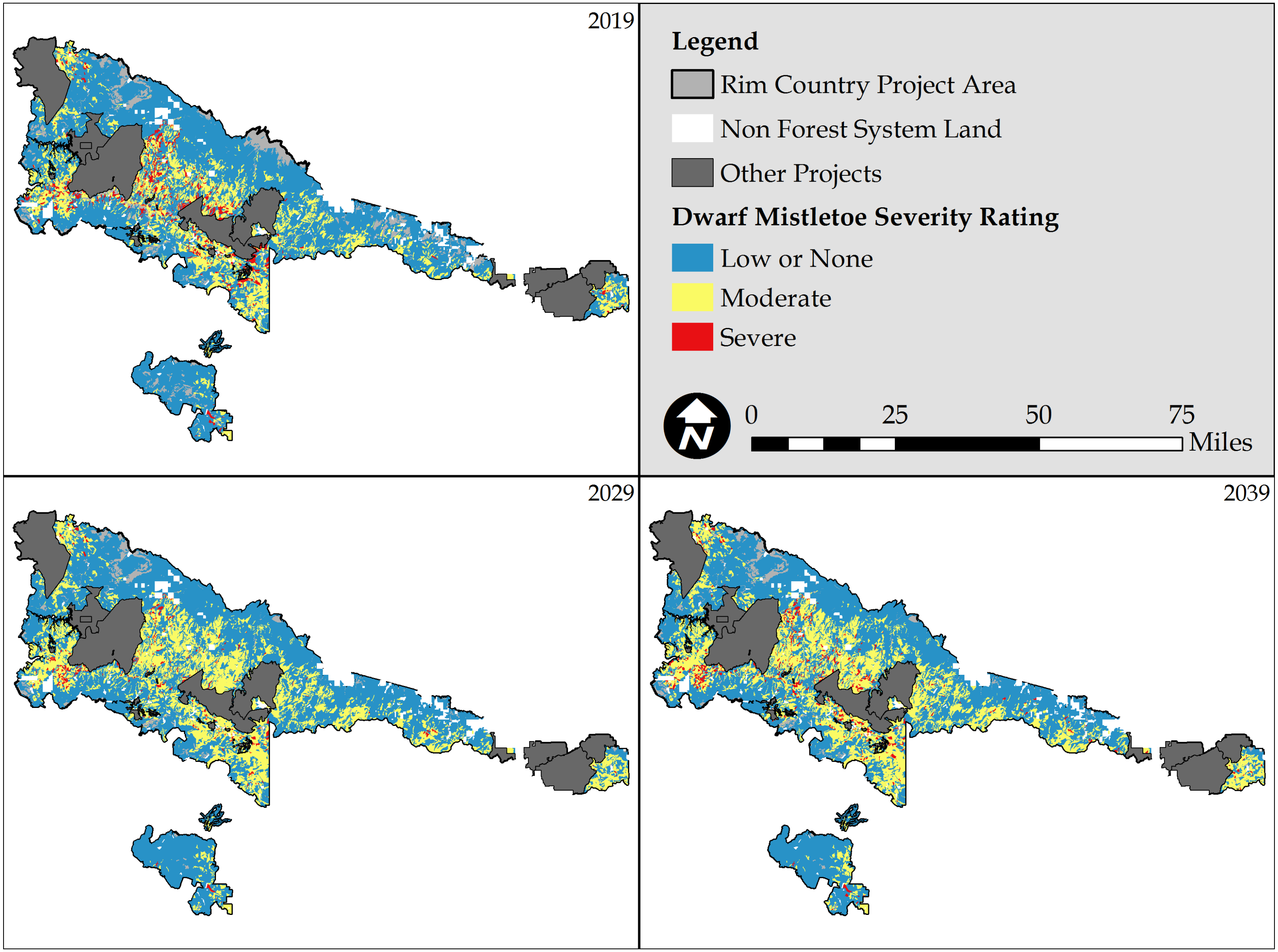

Figure 38. Alternative 2 – Dwarf Mistletoe Severity Rating

Alternative 3 – Focused Alternative

Direct and Indirect Effects

In general, many of the direct and indirect effects of Alternative 3 would fall somewhere between those of the Alternative 1 and Alternative 2 or similar to Alternative 2 with somewhat muted effects due to the limited number of acres treated. Under Alternative 3, prescribed cutting and/or prescribed fire treatment would be applied over a portion of the analysis area in order to move towards or meet the desired conditions. This alternative meets or moves the project area toward the desired conditions identified in the Forest Plans and moves the project area forward in initiating the re-establishment of a fire-adapted, resilient, diverse, and sustainable forest ecosystem over the portion of the project area that would be treated. For a more thorough analysis of the effects of this alternative on the wildfire hazard, consult the Fire Ecology Specialist Report (USDA 2019). Many other areas that did not receive treatment would not move toward the desired conditions identified for this project. The distribution of trees across size classes is more representative of a historic size class distribution as many trees in the smaller size classes have been removed or burned. At a landscape scale, forest composition, structure, pattern, and process would all be improved, but to a lesser extent than the Proposed Action.

Stand and landscape resilience to disturbances such as multi-year drought, pests and disease such as bark beetle and mistletoe, and wildfire would increase (Abella, et al. 2007), although to a lesser extent than with the Proposed Action. Drought stress and insect attacks associated with increased tree density, altered tree spatial arrangement, would be reduced. These changes in forest structure would reduce tree mortality due to decreased competition among trees in stands that were treated (Kane et al 2014). At the fine scale, forest structure and pattern would be improved in treated areas as vegetation management activities would maintain or improve the level of tree aggregation (groups and clumps of trees), and as existing groups are maintained and new groups are created (Zhang et al 2013).

Table 44. Alternative 3 – Focused Alternative – Density and structure-related indicator measures by 5th HUC watershed

	2019			2029			2039		
5th HUC Watershed	BA	SDI	QMD	BA	SDI	QMD	BA	SDI	QMD
Beaver Creek	124	270	8.2	67	128	13.3	68	121	15.2
Black Canyon	81	186	5.3	67	145	7.9	76	159	9.3
Canyon Creek	99	251	4.2	67	145	7.7	73	149	9.5
Canyon Diablo	118	288	5.6	109	251	7.6	116	253	8.9
Carrizo Creek (Local Drainage)	60	140	4.7	74	166	5.7	89	194	6.6
Cherry Creek	142	338	5.4	88	181	9.5	88	173	11.4
Corduroy Creek	69	172	4.0	85	206	4.7	101	235	5.3
Cottonwood Creek	66	158	4.4	64	146	6.1	75	166	7.3
East Verde River	161	378	5.6	89	170	10.5	88	157	12.6
Fossil Creek-Verde River	140	325	6.3	100	210	9.0	102	206	10.5
Gun Creek-Tonto Creek	138	346	4.8	133	316	6.5	137	319	7.0
Haigler Creek-Tonto Creek	165	400	5.3	86	162	10.5	83	146	12.9
Jacks Canyon	96	211	7.5	80	163	10.2	85	168	11.3
Lower Chevelon Canyon	121	267	6.5	86	177	9.8	91	181	11.2
Lower Clear Creek	121	274	6.1	115	250	7.2	119	254	7.7
Oso Draw	124	317	4.8	88	200	7.9	92	198	9.9
Phoenix Park Wash-Dry Lake	79	182	5.0	91	204	5.8	103	226	6.4
Rye Creek-Tonto Creek	142	330	6.1	70	125	11.5	65	111	13.4
Salome Creek	166	388	5.7	112	235	9.5	111	228	10.4
Salt River-Theodore Roosevelt Lake	170	411	5.7	109	242	10.5	100	226	10.7
Show Low Creek	87	208	4.8	66	151	7.4	74	162	8.6
Spring Creek	152	351	5.6	114	246	8.5	115	244	9.3
Upper Chevelon Canyon	133	293	6.9	100	198	9.7	103	194	11.4
Upper Clear Creek	143	317	6.7	89	165	11.0	90	156	13.1
Upper North Fork White River	160	398	5.9	157	366	7.7	166	372	8.6
Upper Silver Creek	126	298	5.5	68	148	9.9	73	149	12.2
Walnut Creek	82	137	14.5	41	51	26.0	41	51	25.6
West Clear Creek	122	263	8.1	90	173	11.3	94	173	12.8
Grand Total	129	296	6.2	87	172	9.8	89	170	11.5

Table 45. Alternative 3 – Focused Alternative – Distribution of trees per acre across size classes by 5th HUC watershed

	2019						2029						2039					
5th HUC Watershed	0-5"	5-12"	12-18"	18-24"	24"+	Total	0-5"	5-12"	12-18"	18-24"	24"+	Total	0-5"	5-12"	12-18"	18-24"	24"+	Total
Beaver Creek	613	86	35	12	3	750	186	26	14	9	4	238	117	21	13	9	5	165
Black Canyon	570	74	20	5	2	670	345	47	16	5	2	415	285	58	17	6	3	369
Canyon Creek	1332	88	22	5	3	1451	381	46	14	6	2	449	275	60	15	6	3	359
Canyon Diablo	1015	105	25	12	2	1159	651	115	24	10	3	803	520	111	27	10	4	673
Carrizo Creek (Local Drainage)	429	57	15	4	2	506	382	61	18	4	2	467	312	98	21	6	2	438
Cherry Creek	1048	149	35	9	3	1244	327	61	22	9	3	422	268	52	21	9	3	354
Corduroy Creek	697	57	16	4	1	775	640	81	19	5	1	747	580	91	21	6	2	700
Cottonwood Creek	632	67	16	3	1	719	438	54	16	4	1	513	383	60	18	4	1	467
East Verde River	1091	119	44	11	5	1271	221	35	21	10	4	292	164	32	20	10	5	231
Fossil Creek-Verde River	908	129	43	8	3	1091	441	49	32	9	4	534	374	45	30	10	4	463
Gun Creek-Tonto Creek	1441	147	36	9	2	1636	1092	123	35	10	3	1264	985	114	36	12	3	1149
Haigler Creek-Tonto Creek	1292	142	42	10	5	1490	194	36	21	10	4	264	121	29	19	10	4	183
Jacks Canyon	431	99	24	6	3	563	246	67	19	6	4	341	206	66	21	6	4	302
Lower Chevelon Canyon	491	120	30	7	3	651	262	73	21	7	3	366	213	78	22	7	4	324
Lower Clear Creek	651	113	26	9	4	803	494	98	24	9	4	628	448	96	26	9	5	583
Oso Draw	1336	108	38	8	2	1492	539	58	24	9	2	632	403	56	24	10	3	495
Phoenix Park Wash-Dry Lake	520	81	20	4	2	627	470	81	24	5	2	582	424	82	29	6	2	543
Rye Creek-Tonto Creek	915	122	37	11	3	1088	91	23	16	9	4	143	64	17	14	9	4	108
Salome Creek	1058	182	40	12	3	1295	476	83	28	12	3	601	422	73	28	12	3	539
Salt River-Theodore Roosevelt Lake	1464	105	46	18	7	1640	648	38	26	17	4	734	605	30	24	17	4	679
Show Low Creek	795	80	23	6	1	905	479	50	15	6	2	552	406	51	16	7	2	481
Spring Creek	831	178	41	8	2	1059	461	108	32	9	2	612	401	102	32	10	2	547
Upper Chevelon Canyon	589	121	35	10	4	758	241	72	24	10	4	351	187	66	24	11	5	292
Upper Clear Creek	753	122	37	11	4	927	189	48	20	10	5	272	139	39	20	11	5	214
Upper North Fork White River	1875	106	42	16	4	2044	1461	82	37	20	5	1606	1234	77	39	22	6	1378
Upper Silver Creek	905	110	38	8	1	1063	376	43	17	7	2	445	289	46	17	8	2	363
Walnut Creek	59	17	15	11	7	109	1	0	0	2	8	11	2	0	0	1	9	11
West Clear Creek	559	99	41	8	3	710	204	57	27	8	3	299	156	52	28	9	4	249
Grand Total	813	114	35	9	3	973	281	54	21	9	3	368	222	50	21	9	4	307

Table 46. Alternative 3 – Focused Alternative – Distribution of basal area by size across size classes by 5th HUC watershed

	2019						2029						2039					
5th HUC Watershed	0-5"	5-12"	12-18"	18-24"	24"+	Total	0-5"	5-12"	12-18"	18-24"	24"+	Total	0-5"	5-12"	12-18"	18-24"	24"+	Total
Beaver Creek	8	34	42	28	13	124	3	10	17	22	16	67	3	9	16	22	19	68
Black Canyon	11	27	22	11	9	81	11	17	18	12	10	67	13	19	20	14	11	76
Canyon Creek	16	31	25	12	14	99	10	15	17	13	12	67	10	18	18	14	13	73
Canyon Diablo	16	37	29	27	9	118	10	37	27	24	11	109	10	37	31	25	14	116
Carrizo Creek (Local Drainage)	6	22	17	9	6	60	13	22	21	10	8	74	13	30	24	13	9	89
Cherry Creek	14	54	40	19	14	142	4	24	26	20	14	88	5	21	25	22	15	88
Corduroy Creek	15	22	18	10	3	69	20	27	21	12	6	85	28	29	24	13	7	101
Cottonwood Creek	11	25	18	8	4	66	13	20	18	8	5	64	18	21	20	10	6	75
East Verde River	15	45	51	25	25	161	4	14	25	24	22	89	4	12	24	24	24	88
Fossil Creek-Verde River	11	48	49	18	14	140	6	20	37	21	17	100	6	18	36	23	19	102
Gun Creek-Tonto Creek	11	54	41	21	10	138	10	47	41	23	12	133	11	45	42	26	13	138
Haigler Creek-Tonto Creek	17	51	48	24	25	165	3	14	25	23	21	86	2	11	23	23	23	83
Jacks Canyon	6	35	26	14	14	96	4	25	22	13	16	80	4	24	24	15	18	85
Lower Chevelon Canyon	13	44	34	17	14	121	7	25	25	15	15	86	6	26	26	16	17	91
Lower Clear Creek	8	40	31	20	23	121	7	36	28	20	23	115	8	36	30	20	25	119
Oso Draw	16	41	44	18	7	124	10	21	28	20	8	88	10	20	29	23	11	93
Phoenix Park Wash-Dry Lake	9	31	22	10	7	79	12	31	27	11	9	91	17	31	33	13	10	103
Rye Creek-Tonto Creek	12	45	42	24	18	142	1	9	19	21	19	70	1	7	17	21	19	65
Salome Creek	14	67	46	26	13	166	7	33	33	27	12	112	7	29	33	28	14	111
Salt River-Theodore Roosevelt Lake	10	40	54	38	27	170	5	17	33	38	16	109	5	13	29	38	15	100
Show Low Creek	12	30	27	13	6	87	11	17	18	13	7	66	14	17	19	15	9	74
Spring Creek	14	65	47	18	8	152	8	40	37	20	9	114	8	38	37	23	9	115
Upper Chevelon Canyon	12	44	40	22	16	133	5	26	28	24	17	100	4	24	29	25	21	103
Upper Clear Creek	12	45	43	25	18	143	3	19	24	24	20	89	2	15	24	25	24	90
Upper North Fork White River	14	43	50	36	17	160	13	33	44	46	20	157	15	28	46	51	27	166
Upper Silver Creek	14	42	44	17	8	126	7	16	21	16	9	68	7	16	20	19	11	73
Walnut Creek	3	6	19	25	30	82	0	0	0	6	35	40	0	0	0	2	38	40
West Clear Creek	8	39	46	18	11	122	3	23	32	19	13	90	3	21	33	21	16	94
Grand Total	12	42	40	20	15	129	5	20	25	20	16	87	6	19	25	21	18	89

Table 47. Alternative 3 – Focused Alternative - Acres meeting SPLYT criteria by 5th HUC watershed

	2019			2029			2039		
5th HUC Watershed	Acres	BA >16"	QMD Top 20%	Acres	BA >16"	QMD Top 20%	Acres	BA >16"	QMD Top 20%
Beaver Creek	498	81	19	458	83	20	406	88	22
Black Canyon	2,330	71	18	2,437	67	21	4,079	68	21
Canyon Creek	10	64	18	100	70	20	143	71	19
Canyon Diablo	-	-	-						
Carrizo Creek (Local Drainage)	151	70	20	181	72	19	292	75	18
Cherry Creek	539	74	18	512	61	22	522	64	24
Corduroy Creek	2	66	19	2	72	18	2	84	19
Cottonwood Creek	642	59	19	916	62	19	1,009	69	19
East Verde River	1,577	92	20	2,323	76	24	2,661	75	23
Fossil Creek-Verde River	1,432	70	21	2,307	72	21	2,890	78	21
Gun Creek-Tonto Creek	120	65	15	120	113	16	120	137	17
Haigler Creek-Tonto Creek	2,056	67	17	1,793	60	23	2,030	62	23
Jacks Canyon	1,545	62	20	1,600	68	21	3,897	67	21
Lower Chevelon Canyon	351	65	20	910	64	22	2,231	62	22
Oso Draw	227	57	18	337	59	20	534	63	21
Phoenix Park Wash-Dry Lake	392	61	17	626	61	17	916	65	19
Rye Creek-Tonto Creek	238	68	18	250	61	21	250	67	21
Salome Creek	594	101	19	659	91	20	695	96	21
Salt River-Theodore Roosevelt Lake	16	109	19	16	125	20	16	138	20
Show Low Creek	229	70	20	462	73	20	520	79	21
Spring Creek	64	68	15	136	91	17	136	112	19
Upper Chevelon Canyon	8,465	84	19	11,940	71	23	17,282	71	23
Upper Clear Creek	8,141	82	19	12,185	72	23	16,694	72	24
Upper North Fork White River	-	-	-	6	103	25	6	111	26
Upper Silver Creek	93	83	18	179	69	19	408	69	20
West Clear Creek	6,554	72	19	10,507	69	21	14,684	71	21
Grand Total	36,265	77	19	50,961	71	22	72,424	72	22

Table 49. Alternative 3 – Focused Alternative - Forest health related indicator measures by 5th HUC watershed

	2019						2029						2039					
	Beetle Hazard Rating			Dwarf Mistletoe Severity Rating			Beetle Hazard Rating			Dwarf Mistletoe Severity Rating			Beetle Hazard Rating			Dwarf Mistletoe Severity Rating		
5th HUC Watershed	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High	Low	Mod	High
Beaver Creek	32%	6%	63%	69%	29%	2%	62%	12%	26%	66%	29%	4%	65%	11%	24%	66%	28%	6%
Black Canyon	41%	8%	51%	81%	19%	0%	52%	10%	37%	72%	27%	1%	49%	9%	42%	68%	30%	2%
Canyon Creek	31%	4%	65%	59%	31%	11%	60%	16%	23%	49%	46%	5%	67%	5%	28%	47%	47%	6%
Canyon Diablo	32%	0%	67%	73%	26%	1%	28%	8%	64%	71%	26%	4%	26%	10%	64%	66%	31%	4%
Carrizo Creek (Local Drainage)	50%	3%	47%	69%	31%	0%	29%	18%	53%	45%	55%	0%	23%	13%	64%	45%	55%	1%
Cherry Creek	2%	8%	90%	51%	45%	4%	64%	5%	31%	46%	52%	2%	66%	3%	30%	41%	56%	2%
Corduroy Creek	59%	0%	41%	75%	25%	0%	51%	8%	41%	58%	42%	0%	22%	30%	49%	58%	38%	4%
Cottonwood Creek	58%	7%	35%	87%	13%	0%	57%	9%	34%	78%	21%	1%	45%	14%	42%	76%	22%	2%
East Verde River	5%	3%	91%	73%	20%	7%	61%	14%	25%	67%	28%	5%	68%	7%	25%	66%	27%	7%
Fossil Creek-Verde River	11%	5%	84%	58%	36%	6%	35%	10%	55%	53%	39%	8%	38%	7%	55%	51%	37%	12%
Gun Creek-Tonto Creek	2%	0%	98%	100%	0%	0%	2%	0%	97%	99%	1%	0%	1%	2%	98%	99%	1%	0%
Haigler Creek-Tonto Creek	4%	1%	95%	55%	38%	7%	58%	13%	29%	53%	43%	3%	65%	10%	25%	50%	43%	6%
Jacks Canyon	35%	19%	46%	97%	3%	0%	48%	11%	41%	95%	5%	0%	47%	7%	46%	94%	5%	1%
Lower Chevelon Canyon	3%	2%	96%	96%	4%	0%	34%	4%	61%	83%	17%	0%	37%	2%	62%	83%	17%	0%
Lower Clear Creek	0%	3%	97%	100%	0%	0%	21%	3%	76%	100%	0%	0%	21%	0%	79%	100%	0%	0%
Oso Draw	14%	3%	83%	66%	33%	1%	48%	11%	41%	62%	37%	1%	53%	7%	40%	57%	37%	6%
Phoenix Park Wash-Dry Lake	43%	12%	45%	74%	26%	0%	34%	7%	58%	68%	30%	2%	30%	6%	64%	67%	26%	7%
Rye Creek-Tonto Creek	32%	8%	59%	96%	4%	0%	87%	5%	7%	94%	6%	0%	91%	2%	7%	93%	7%	0%
Salome Creek	4%	3%	93%	92%	5%	3%	45%	7%	47%	88%	9%	3%	47%	5%	47%	86%	11%	3%
Salt River-Theodore Roosevelt Lake	0%	24%	76%	100%	0%	0%	82%	0%	18%	85%	15%	0%	82%	0%	18%	85%	15%	0%
Show Low Creek	48%	3%	49%	78%	22%	0%	54%	9%	37%	68%	28%	4%	47%	10%	43%	63%	27%	11%
Spring Creek	11%	0%	89%	95%	5%	0%	35%	3%	61%	93%	7%	0%	29%	9%	61%	93%	7%	0%
Upper Chevelon Canyon	13%	8%	79%	74%	22%	4%	43%	13%	44%	64%	35%	1%	45%	9%	46%	61%	36%	3%
Upper Clear Creek	6%	5%	90%	64%	27%	9%	47%	18%	34%	55%	42%	3%	52%	15%	32%	52%	42%	5%
Upper North Fork White River	19%	49%	32%	10%	71%	19%	19%	19%	61%	2%	78%	20%	19%	17%	63%	2%	60%	38%
Upper Silver Creek	29%	4%	67%	68%	28%	4%	55%	5%	39%	62%	33%	5%	55%	4%	40%	57%	33%	10%
Walnut Creek	95%	5%	0%	88%	12%	0%	100%	0%	0%	88%	12%	0%	100%	0%	0%	88%	12%	0%
West Clear Creek	16%	16%	68%	78%	20%	2%	39%	14%	47%	73%	25%	2%	39%	14%	47%	71%	26%	3%
Grand Total	19%	7%	74%	75%	22%	4%	49%	12%	39%	68%	30%	2%	50%	10%	40%	66%	30%	4%

Composition

Forest composition would improve under this alternative, although to a lesser extent than the Proposed Action. Ponderosa pine would still be the dominant forest cover type. Mixed conifer would continue to make up a moderate proportion of the analysis area, however shade tolerant species such as white fir may increase compositionally in untreated stands. As a result of prescribed cutting and prescribed fire in areas proposed for treatment, prevalence of later seral species such as white fir and corkbark fir would be reduced and would better represent their role in the NRV. Pinyon Juniper woodlands and oak species would continue to make up a considerable part of the analysis area. The treatment of encroached grasslands would expand their range to more fully represent the NRV, although to a lesser extent than the Alternative 2. The protection and improvement of aspen stands would promote regeneration and reduce inter-tree competition and improve their condition under this alternative, though it is important to note that aspen is one of the species predicted to be most affected by a changing climate (XXXX cite). The condition of less common but important species such as maple and Emory oak would be improved in treated areas.

This analysis has considered the effects of a changing climate. Though this alternative would result in a landscape more resilient to climate change than the No Action Alternative, climatic models for the southwestern U.S. predict continued warming, greater variability in precipitation, and increased drought. These climatic changes would likely contribute to some level of tree mortality; however, considerably less than the No Action Alternative. A changing climate may lead to large shifts and contractions in the range of dominant trees throughout much of the region (Kane et al, 2014).

Structure

Uneven-aged Structure

It is desirable for uneven-aged forest structure to occur on a majority of acres. Under this alternative, there would be a change to forest structure (Figure 3-21) on the acres proposed for treatment, however large untreated areas would see little change to existing forest structure. This alternative would meet the Desired Condition for uneven-aged structure in the Forest Plans, however forest structure would more closely resemble NRV in treated stands. Modeling indicates that some stands would move towards more even-aged conditions in the dominant cover types proposed for treatment as a result of removal of trees from the smaller size classes and retention of trees in the larger size classes. However, as treatments are applied on the ground, the use of the large and old tree implementation plans, in accordance with an uneven-aged thinning strategy, would be able to produce uneven-aged conditions across much of the landscape. In treated stands, individual tree growth would increase and trees would move into larger size classes as a result of a reduction in individual tree competition. Naturally-occurring regeneration would provide additional vertical structure over time.

An additional, and potentially more substantial, benefit to forest structure would be a reduction in the possibility of an uncharacteristic wildfire or other substantial disturbance event, such as a beetle outbreak or long-term drought. Under this alternative, treated stands would be more resistant to uncharacteristic fire and insect outbreaks and more resilient to drought. The balance of size classes and uneven-aged structure would provide conditions favorable to restoration of a natural fire regime in the areas proposed for treatment. In areas of untreated stands, the potential for uncharacteristic fire or other substantial disturbances would persist as well as their associated effects on forest structure.

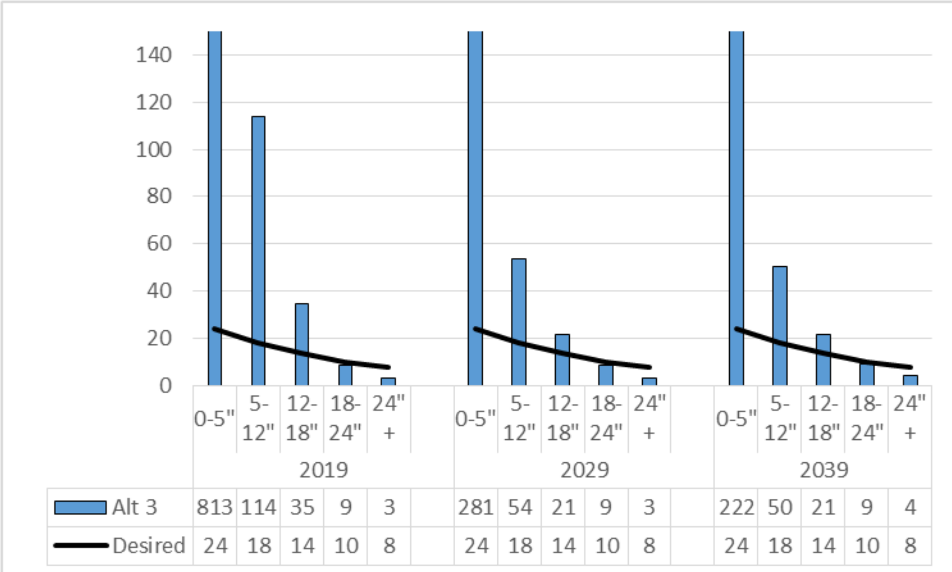

Figure 39. Alternative 3 – Focused Alternative – Distribution of trees per acres across size classes across the project area

Density

Measure of density in this analysis include trees per acre, basal area and stand density index. On a portion of the project area prescribed fire and thinning would change the size class distribution of trees. Alternative 3 would meet the desired condition on a smaller portion of acres as compared to the Proposed Action. The overall tree density would decrease under this alternative, with 973 trees per acre in 2019, 368 in 2029 and 307 trees per acre in 2039. While the initial reduction in trees per acre would result from a combination of mechanical and prescribed fire activities, the reduction after 2029 can be attributed to the recurring prescribed fire over time. Prescribed fire could more likely be used to balance the size classes at the lower end of the VSS distribution and move the landscape toward the desired condition. For example, prescribed fires with higher severity effects (e.g., burning under hotter and/or dryer conditions) from 2029 to 2039 could be implemented to maintain the desired size class distribution at the lower end and better meet the desired condition.

Similar to the Proposed Action, the reduction in tree density would increase individual tree growth and reduce density dependent tree mortality. Understory grasses, forbs, herbs, and shrubs would increase in quantity in treated areas (Covington & Moore, 1994a).

Like many of the other indicator measures, the effects of the Focused Alternative on trees per acres would resemble those of the Proposed Action, only to a lesser degree. It is important to note that this is because fewer acres would be treated compared to the Proposed Action; however those acres that would be treated would still be treated at the same intensity as the Proposed Action.

The desired condition is to retain a basal area of between 30 and 90 ft^2 per acre across most habitat types outside of MSO PACs. While the Forest Plans provide a desired condition with a range of basal areas ranging from 20 to 180 ft^2 depending on cover type, for this analysis, at the project level, for ease of comparison of effects between alternatives, 90 ft^2 is the breakpoint for the resource measure across the analysis area For both mixed conifer and ponderosa pine cover types it is desired to maintain basal area at less than 90 ft^2 though exceptions exist to provide heterogeneity across the landscape as well as specific wildlife needs for dense and closed canopy forest conditions. For a more thorough analysis of the effects of this alternative within MSO and Northern goshawk habitat, consult the Wildlife Specialist Report (USDA 2019).

Under the Focused alternative, basal areas across the analysis area average would be reduced to 87 square feet per acre in 2029 and 89square feet per acre in 2039. While currently only 13 percent of stands meet the desired condition, by the year 2029 52 percent of stands would meet the desired condition and by 2039, 55 percent of stands would meet the desired condition. This will result in decreased inter-tree competition for resources such as water, light, growing space and nutrients in treated areas. Individual tree growth will increase and density dependent mortality would be dramatically reduced along with susceptibility to potential insect and disease outbreaks. These conditions would indicate a shift from the current larger and higher intensity fires that the forest would currently experience to cooler, higher frequency, lower severity surface fires (Cooper, 1960) (Swetnam, 1990) (Covington & Moore, 1994a) (Kolb, Wagner, & Covington, 1994) (Swetnam & Baisan, 1996) that persisted prior to European settlement.

While some effects such as increased diameter growth and reduced competition would be reduced only in treated stands, other effects, such as landscape level insect hazard and fire severity, may extend to untreated areas. The reductions in basal area would allow the treated areas to meet the desired conditions and purpose and need for fire-adapted, resilient, diverse, and sustainable forest ecosystems at the landscape and watershed scales.

While some watersheds would have their average basal areas reduced to within the desired condition as a result of proposed activities, some watersheds such as Rye Creek-Tonto Creek would experience considerable additional mortality as a result of prescribed fire between 2029 and 2039. This is a similar effect as with the Proposed Action and is a result of the intensity of the prescribed fire modeled, as well as the fact that most of the acres proposed for treatment in Alternative 2 were also proposed for treatment in the Focused Alternative. Prescribed fires with lower severity effects (e.g., burning under cooler and/or wetter conditions) from 2029 to 2039 could be implemented to maintain the desired basal area and continue to meet the desired condition in some watersheds.

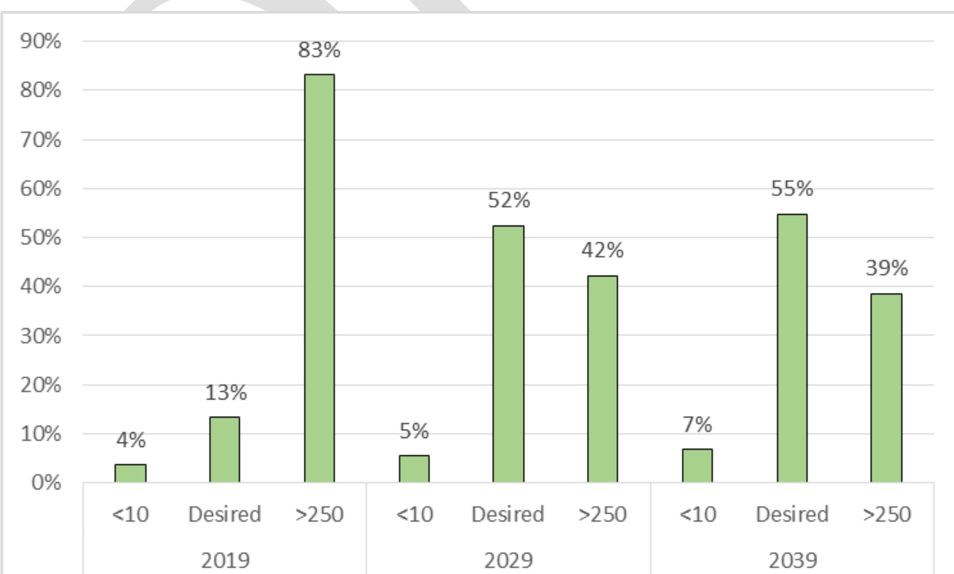

Figure 40. Alternative 3 – Focused Alternative – Percent of acres meeting desired condition for trees per acre across the project area

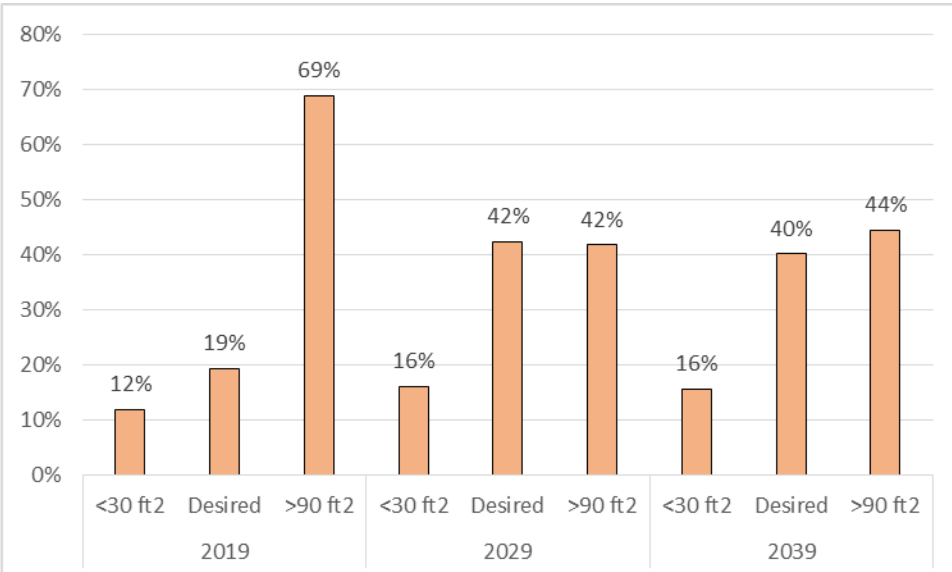

Figure 41. Alternative 3 – Focused Alternative – Percent of acres meeting desired condition for basal area across the project area

Stand Density Index (SDI) is a measure of relative stand density based on the number of trees per acre and the mean diameter (Long 1995). Percent SDImax expresses the actual density in a stand relative to a theoretical maximum density possible for trees of that diameter and species. SDI is a good indicator of how site resources are being used by taking both average tree size and trees per acre into account. SDImax represents an empirically-based estimate of the maximum combination of quadratic mean diameter and density which can exist for any stand of a particular forest type.

The desired condition for SDI is to be between 25 percent and 45 percent of SDIMax or between 112.5 and 202.5. Currently across the analysis area, SDI averages 296 or 66 percent of SDImax and is considered extremely high. As a result of Alternative 3, SDI would be reduced to 172 or 38 percent of SDIMax by 2029 and 170 or 38 percent of SDIMax by 2039. While currently 15 percent of the acres in the analysis area meet the desired condition, as a result of the Focused Alternative, 27 percent would meet the desired condition and 21 percent would in 2039.

SDI values between 25 percent and 45 percent of SDIMax are associated with maximum understory production and maximum individual tree diameter growth as overall stand growth is concentrated on fewer trees. Depending on the level of tree aggregation, little inter-tree competition would be occurring. Competition may still be occurring within dense tree groups regardless of stand level SDI values.

Over time with the Focused Alternative, stand densities should stabilize in treated areas as the reintroduction of fire returns natural disturbance processes to the landscape. This would result in reduced susceptibility to insect epidemics, particularly bark beetles as well as reduced density dependent mortality, increased individual tree diameter growth, and forage production over time and continued attainment of the desired condition.

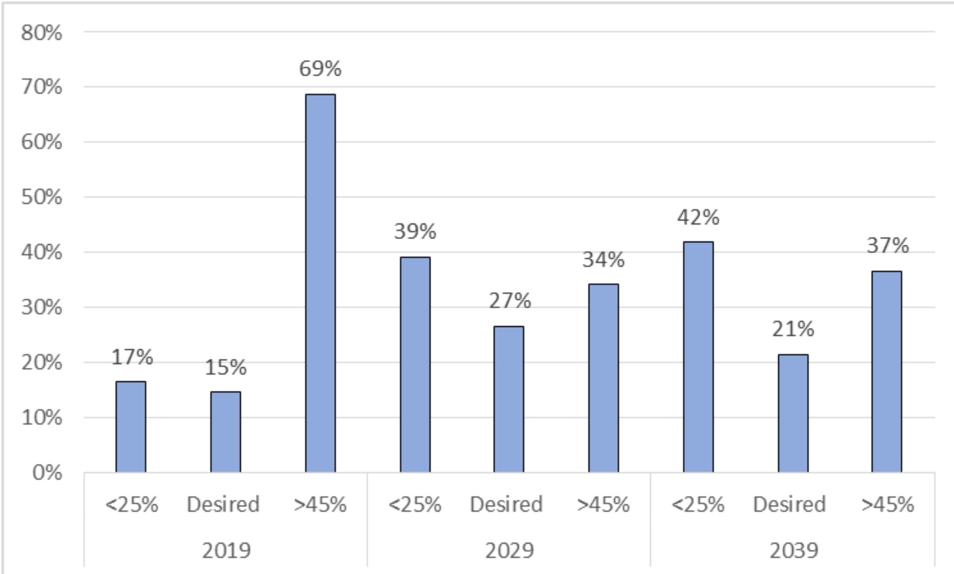

Figure 42. Alternative 3 – Focused Alternative – Percent of stands meeting the desired condition for stand density index

Large Tree and Old Tree Structure

Stands of post settlement trees where the quadratic mean diameter of the top 20 percent of trees is greater than 15 inches and the basal area of trees greater that 16 inches is more than 50 feet of basal area can be considered stands with a preponderance of large young trees (SPLYT stands). These stands occur outside of MSO PACs, MSO Recovery habitat and WUI and are being identified for their distinctive forest structure.

Currently, across all 5th HUC watersheds in the analysis area the number of acres meeting SPLYT criteria is 36,325 a QMD of the top 20 percent of trees being 19 inches. Under the focused alternative, this number would increase to 72,424 by 2039 with a QMD of the top 20 percent of trees being 22 inches. The number of acres meeting SPLYT criteria would increase as a result of the Focused Alternative, but at a slower rate than the Proposed Action. With design features in place during implementation, large trees meeting the large and old growth tree implementation plan criteria would be retained, resulting in more large trees being left at the expense of smaller tree sizes. This would allow the proportion of stands meeting desired condition for large trees to actually increase over time. During implementation, some large trees would be cut in accordance with the large and old growth tree implementation plans in order to meet the desired condition. In treated areas, remaining larger trees would be less susceptible to mortality from drought, insects, disease, and wildlife. (Das et al. 2011, Ritchie et al 2008), whereas in untreated areas, susceptibility to these disturbance agents would continue to increase. This slower rate of SPLYT acre recruitment does not take into account the application of the Large Tree Implementation Plan that would effectively increase the number of SPLYT across the landscape at the expense of trees in the smaller size classes.

This alternative would result in a lower risk of mortality in the stands that were treated, especially for larger trees, because of a decreasing risk of infection from pests or disease (Fischer et al, 2010), high-severity or uncharacteristic wildfire (Coop et al, 2016) (Fiedler et al, 2010), and drought stress from competition (Erickson & Waring, 2014). A number of studies have found that lower forest density leaves large and old trees less susceptible to mortality as a result of these factors. Erickson and Waring (2014) concluded that, "treatments removing small, neighboring trees may be critical in maintaining old ponderosa in the landscape, particularly under future climate change and increasing drought frequency in the western USA." While this alternative may increase the amount of acres meeting SPLYT criteria as a slower rate than the No Action Alternative, the acres proposed for treatment would be far less likely to experience substantial loss of old and large trees as a result of various forest disturbances (such as uncharacteristic wildfire).

In untreated areas, the effects would be similar to the no action alternative and would result in a higher risk of mortality, especially for larger trees, because of an increasing risk of infection from pests or disease (Fischer et al, 2010), high-intensity or uncharacteristic wildfire (Coop et al, 2016) (Fiedler et al, 2010) or increased drought stress from competition (Erickson & Waring, 2014). While this alternative may increase, on untreated areas, the amount of SPLYT acreage based on model results, these results do not account for the likely substantial loss of old and large trees as a result of various forest disturbances (such as uncharacteristic wildfire), which would decrease the amount of old and large trees and SPLYT acreage in the analysis area..

Forests would have the ability to manage more acres of naturally occurring wildfires to benefit forest resources, mainly within watersheds that have a considerable portion proposed for treatment. In treated areas, forest structure, including openings, interspace, and groups and clumps of trees would allow for low to moderate fire severity that would maintain opening and have little potential effect on the vegetation resource except for trees in the smaller size classes.

Under this alternative, on untreated acres where wildfires are managed for resource benefit, they may have the effect of reducing basal area and SDI by killing small trees or groups of small and/or intermediate aged trees. These fires could also result in mortality of some large and old trees. Based on those areas of recent wildfires that were managed for resource benefits, this effect would be very limited across the landscape in untreated areas. For a more thorough description of post treatment fire behavior consult the Fire Ecology Specialist Report in the project record.

Forest Process

Insects

Under this alternative, the proportion of acreage with a high hazard rating for bark beetles would decrease from 74 percent to 39 percent in 2029 and to 40 percent by 2039. The majority of acres that would remain with a high hazard rating are as a result of a lot of acres remaining untreated. While the proportion of acreage with a moderate rating would change only slightly, the proportion of acreage with a low hazard rating would increase considerably as the analysis areas approaches desired condition for this indicator. Stands with a low or moderate bark beetle rating, the desired condition, would increase from 26 percent in 2019 to 61 percent in 2039 and 60 percent by 2039

Stands with lower tree densities and basal area are more resilient to drought and beetle attacks. Bark beetle population dynamics suggests that homogenous, dense stands are highly susceptible to beetle outbreaks. The proposed action would create heterogeneous, open, uneven-aged stands that would dramatically reduce susceptibility and maintain that reduced susceptibility over time. Susceptibility to western pine beetle would decrease over time with mechanical treatment and reintroduction of low severity surface fire. Areas with the greatest likelihood of infestation from bark beetles are areas treated at a low intensity as to not considerably affect beetle hazard rating. Additionally, areas with large amounts of slash remaining post treatment are at risk for Ips beetles. Some susceptibility to Ips would continue to increase with activity most likely occurring in response to a drought or a snow or ice event that creates fresh pine debris.

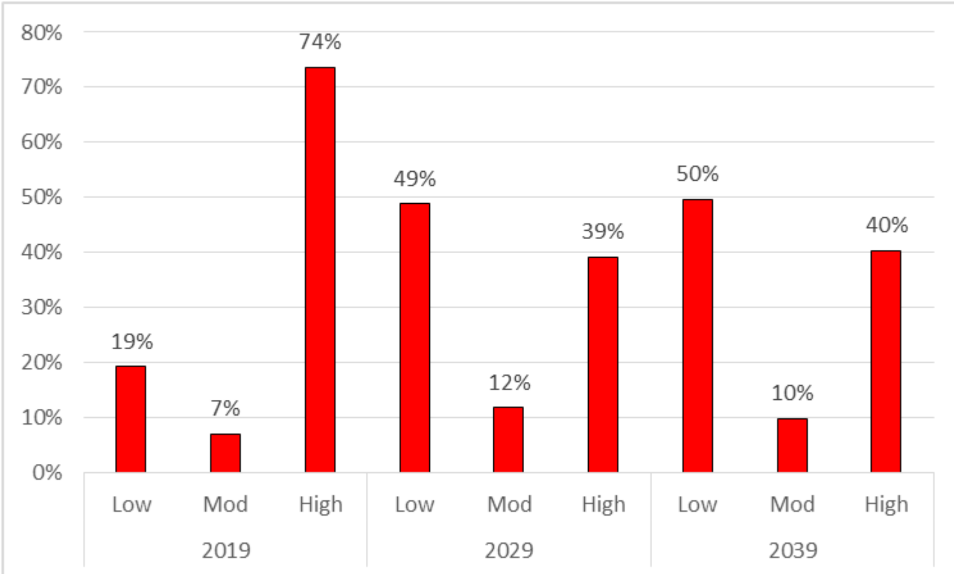

Figure 43. Alternative 3 – Focused Alternative – Distribution of Bark Beetle Hazard Rating classes across the project area

Disease

Currently, across the analysis area, approximately 75 percent of the area is not infected or has a low infection level, 22 percent has a moderate severity rating and 4 percent has a high severity rating. Initially, as a result of the Focused Alternative, stands with a high severity rating would drop to 2 percent and stands with a Low or None rating would increase to 84 percent by the year 2029. The effects of the mechanical treatment and prescribed fire would diminish over time as acres with a severe rating increase to 4 percent and acres with a Low or None rating decrease to 66 percent by 2039, as a result of infection intensification and spread occurring even after treatment over some of the analysis area. With the exception of the change in severe infection, this result would be similar to the effects from the Proposed Action.

In areas not treated under this alternative, dwarf mistletoe infections may intensify and spread to surrounding trees, reducing the growth, vigor, and longevity of ponderosa pine (Conklin and Fairweather 2010). However, across the analysis area, growth, longevity, and vigor of ponderosa pine trees would be increased, approaching the desired condition. This is an improvement in dwarf mistletoe severity rating over the No Action Alternative by the year 2039, as the reduction in severely infected stands substantially affects forest health, growth, and vigor. In the untreated and severely infected stands, mistletoe infection would intensify and spread over time. Dwarf mistletoe infections would not be reduced in these areas and may intensify in infected trees and the surrounding trees, reducing the growth, vigor, and longevity of ponderosa pine. These stands would further depart from the desired condition over time as infected stands intensify their infections and infect adjacent areas (Conklin and Fairweather 2010).

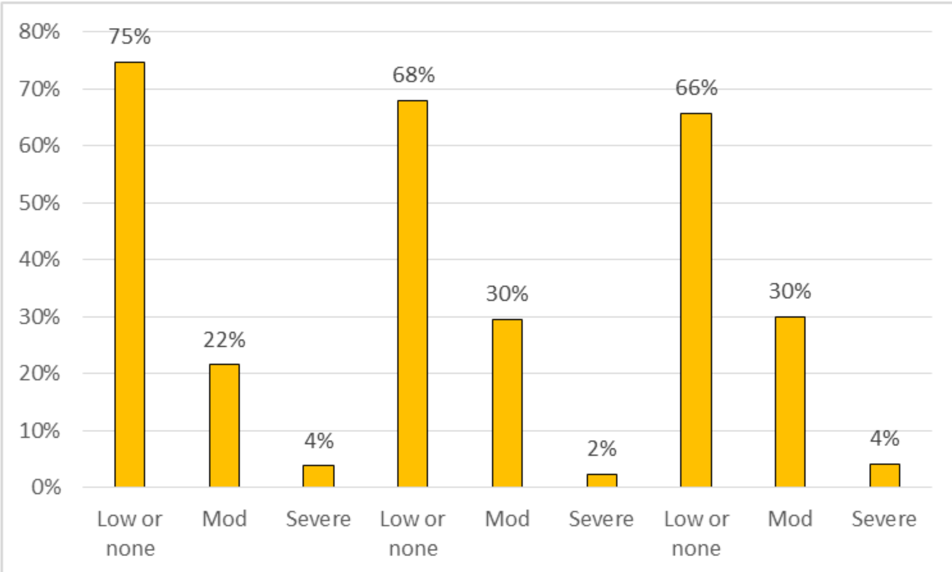

Figure 44. Alternative 3 – Focused Alternative – Dwarf Mistletoe Severity Rating classes across the project area

Fire Adaptation

For a more thorough discussion of this alternative in terms of fire adaptation, consult the Fire Ecology Specialist Report (USDA 2019). In general, this alternative does support the purpose and need to develop or return to a forest ecosystem that is fire-adapted, resilient, diverse, and sustainable. In areas where treated, this alternative would support the shift away from larger high severity fires to conditions that are more likely to support increasingly frequent, low severity surface fires (Cooper 1960) (Swetnam 1990) (Covington and Moore, 1994a) (Kolb et al 1994) (Swetnam and Baisan, 1996). Over time this alternative would create conditions that resemble the NRV of plants and animals living in western ponderosa pine and dry mixed conifer forests (Covington and Moore 1994a, Reynolds et al 2013). As a result, in areas where treated, this alternative would reduce the susceptibility to uncharacteristically severe fires and other disturbance agents, such as bark beetles and disease, over time. Many areas not treated would remain susceptible to uncharacteristically severe fires and increase in vulnerability to other disturbance agents, such as bark beetles and disease, over time.

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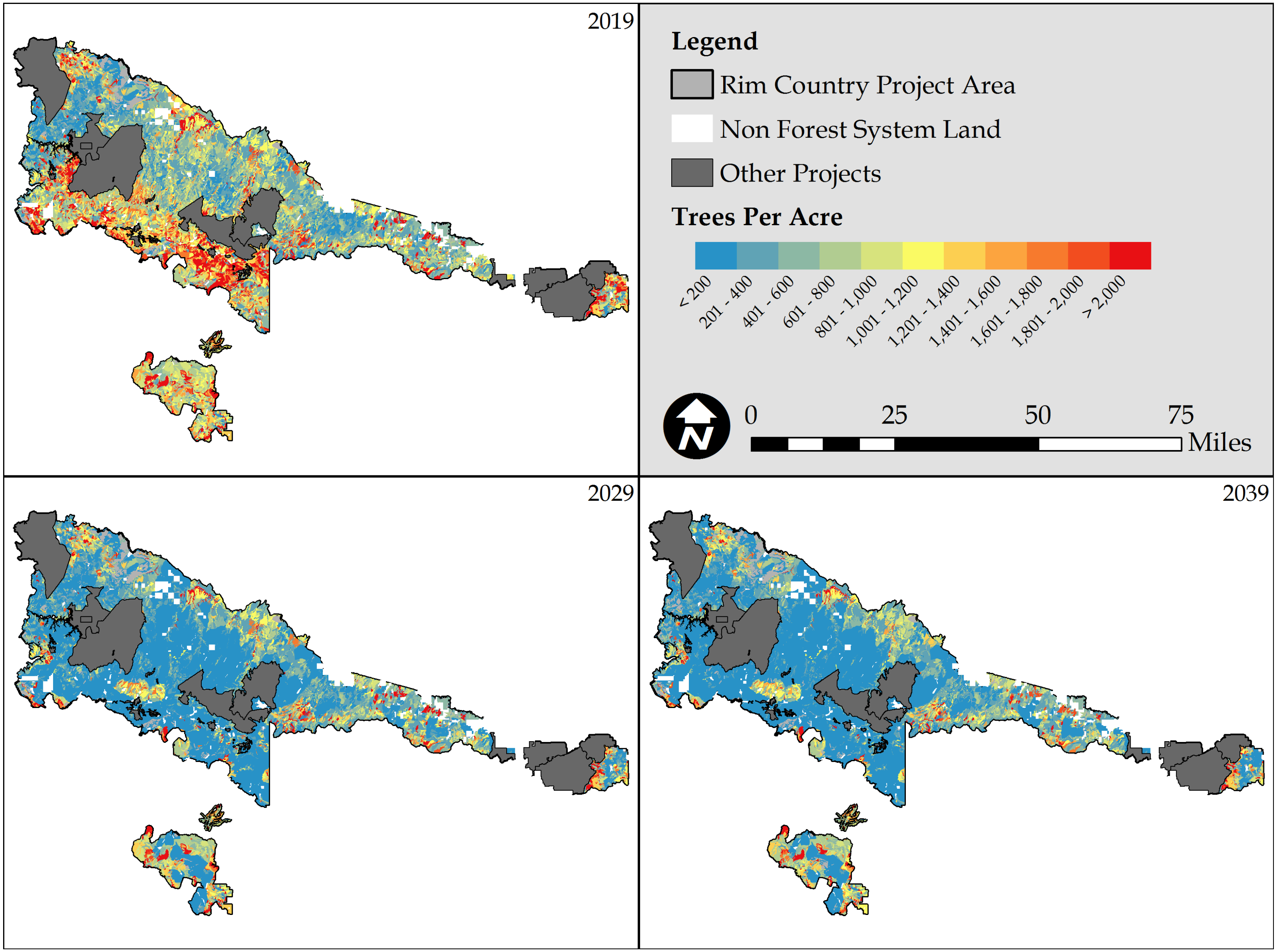


Figure 45. Alternative 3 – Trees per Acre -

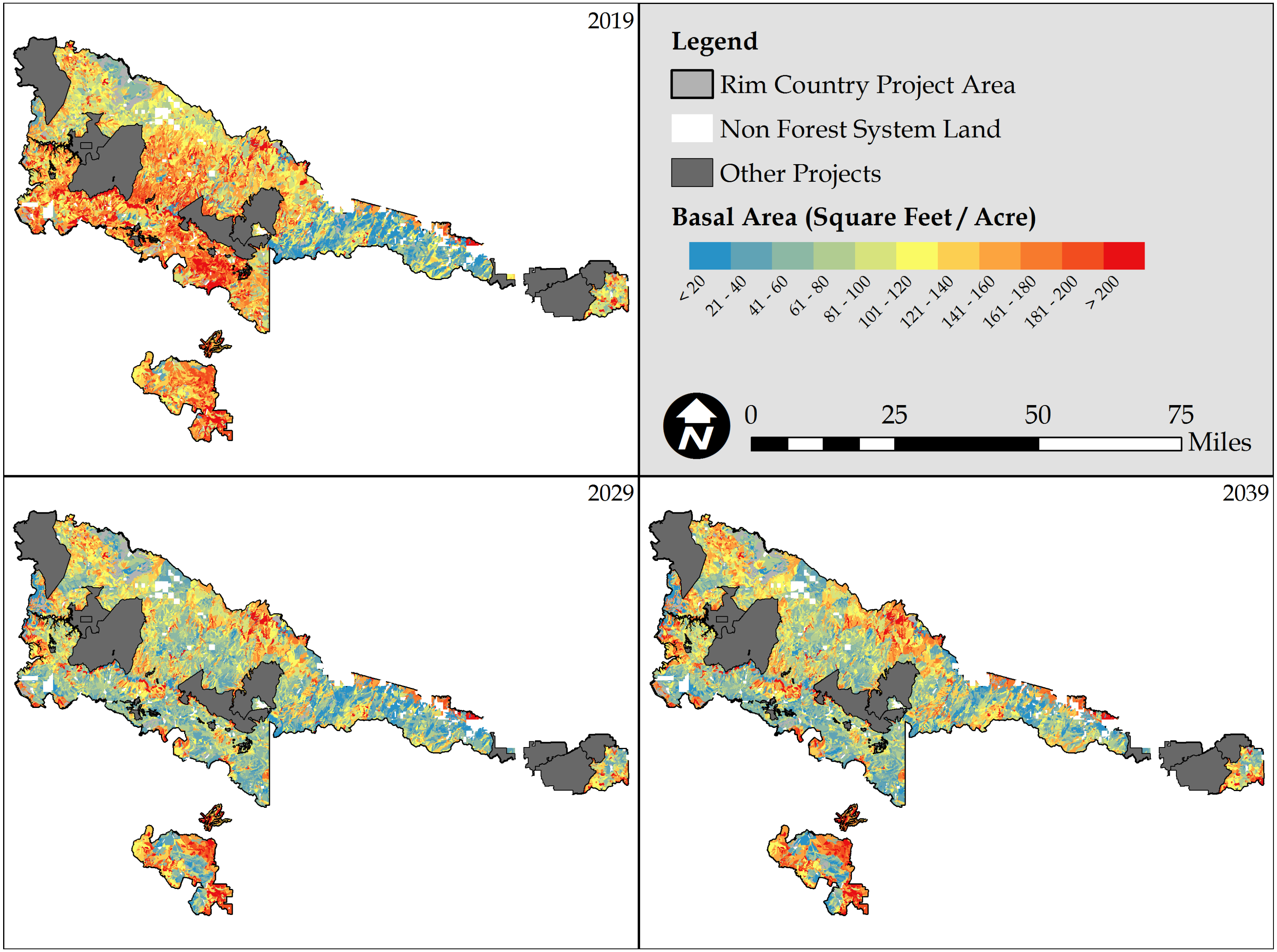


Figure 46. Alternative 3 – Basal Area

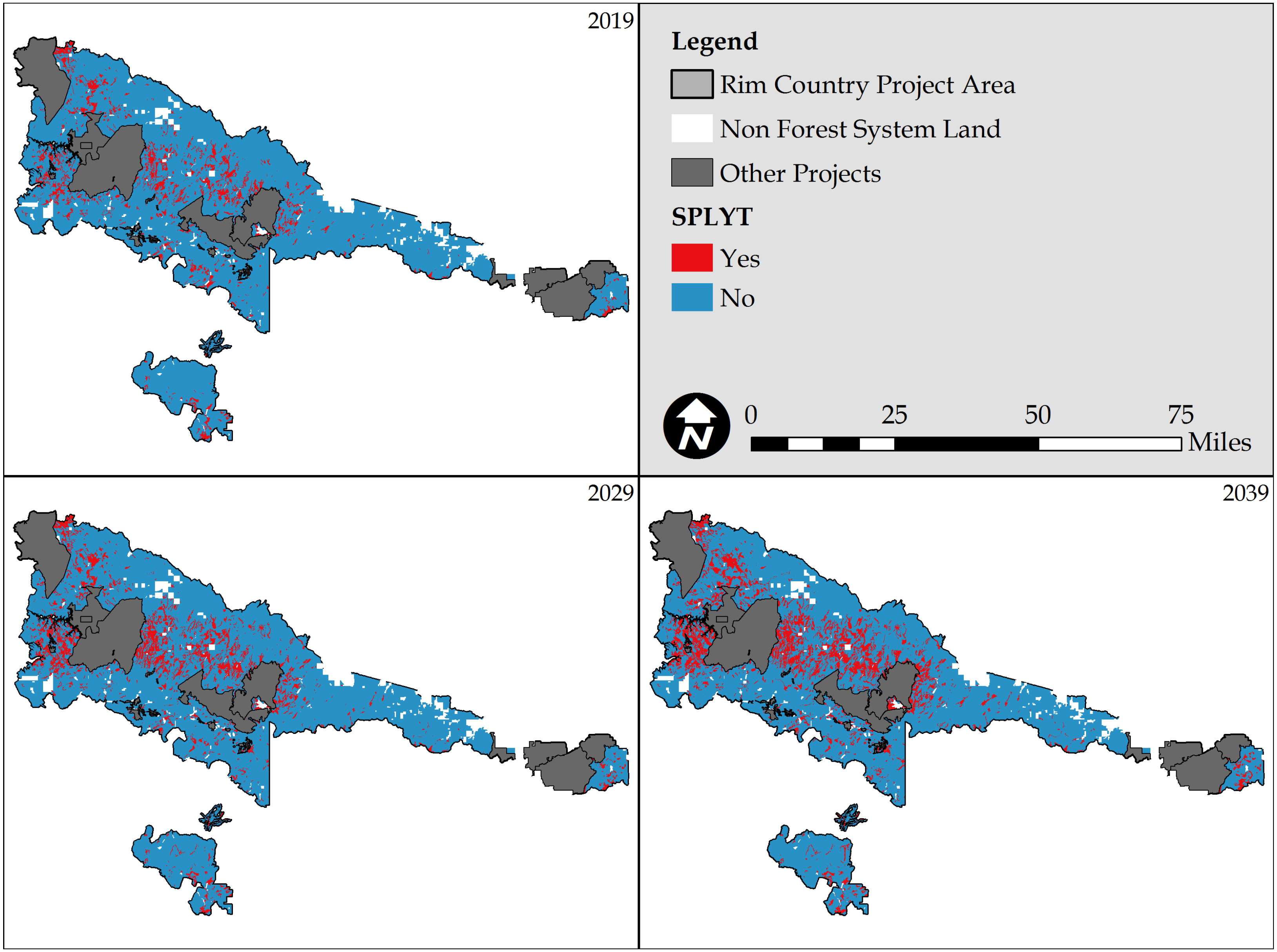


Figure 49. Alternative 3 – SPLYT Stands

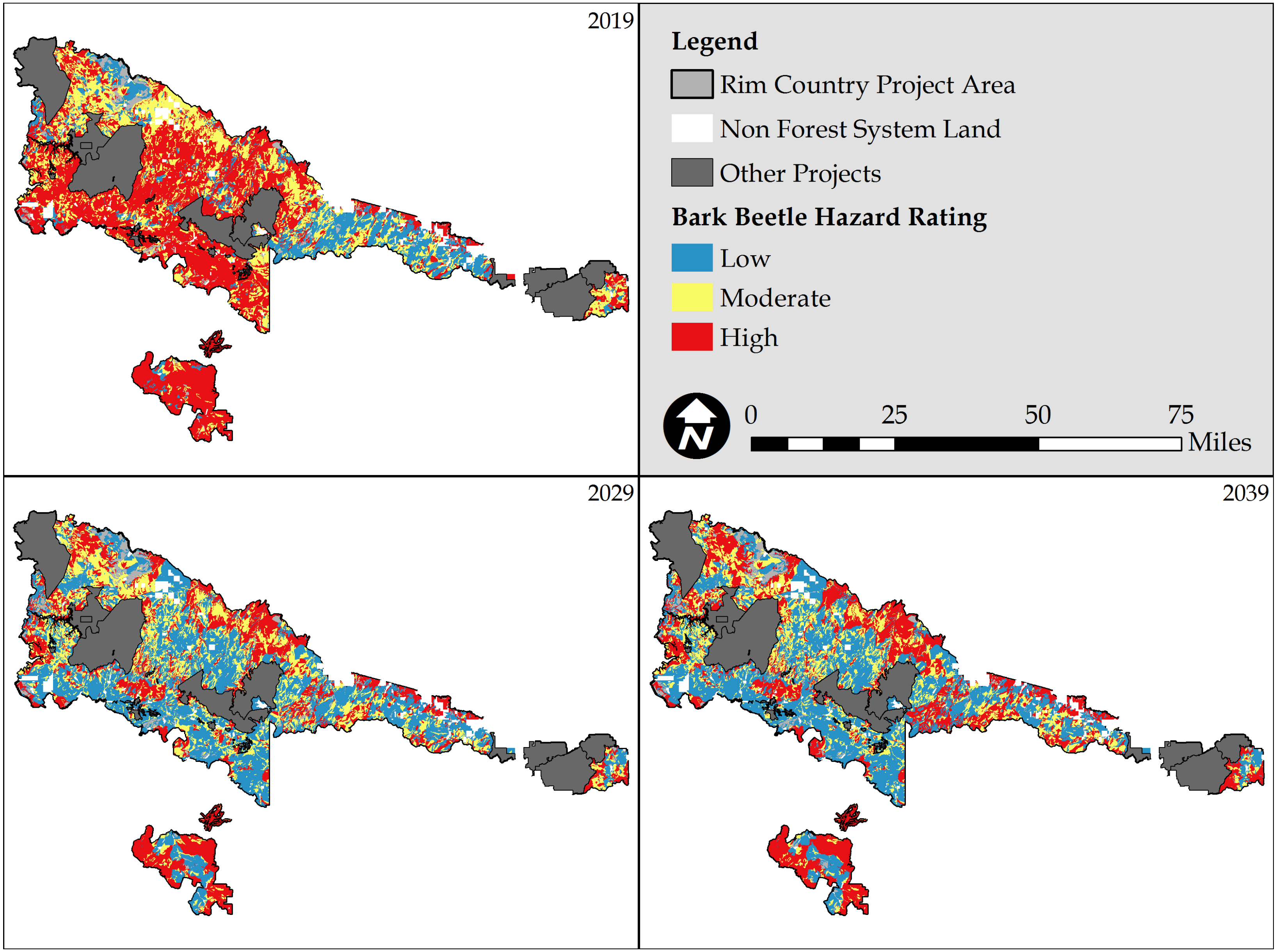


Figure 50. Alternative 3 – Bark Beetle Hazard Rating

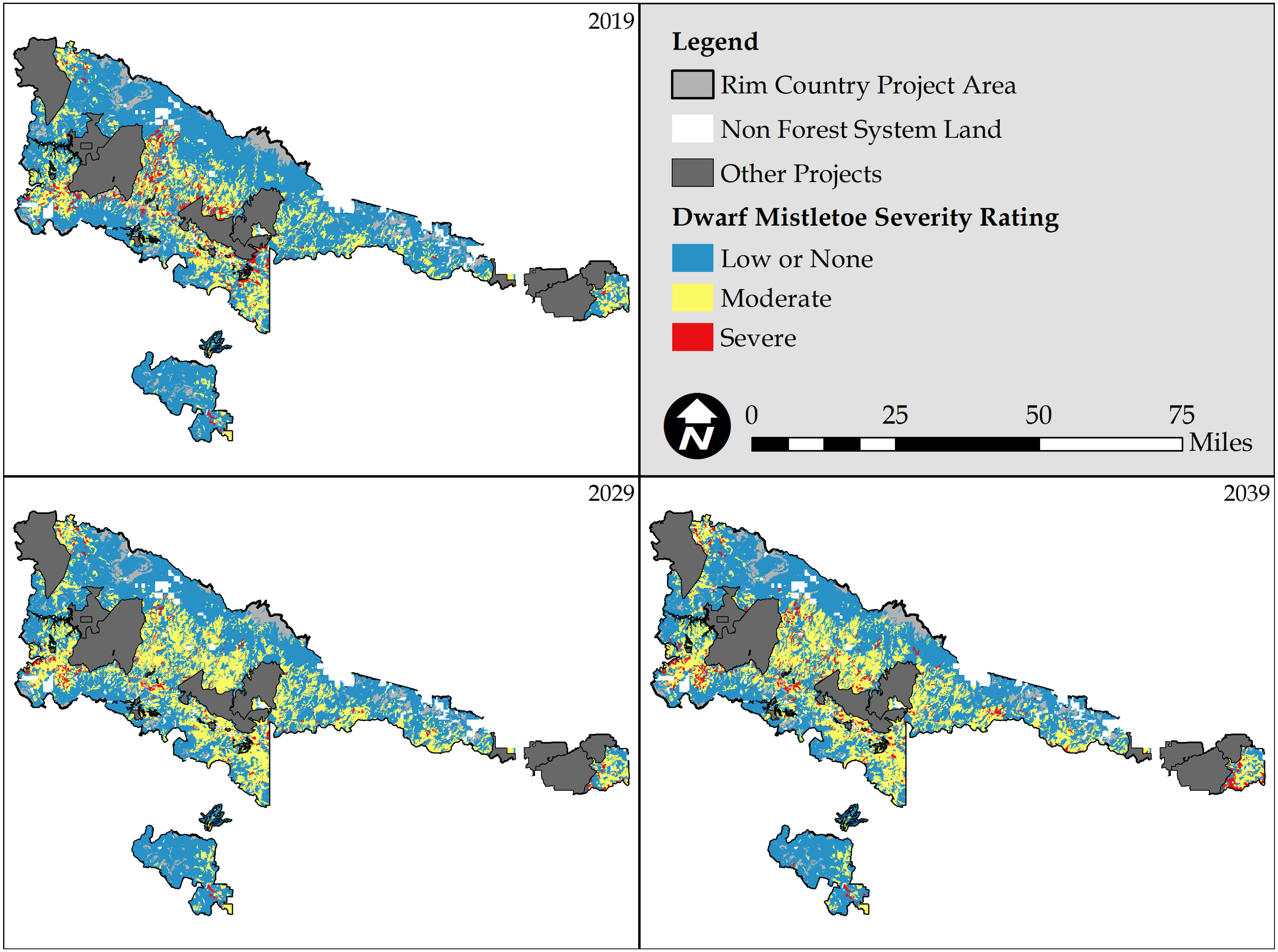


Figure 51. Alternative 3 – Dwarf Mistletoe Severity Rating

Effects Common to All Alternatives

In-woods Processing and Storage Sites (Processing Sites)

Alternative 2 and 3 propose the use of wood processing sites for wood storage, log merchandising, and chipping in order to improve the costs of removing wood and biomass from the Rim Country analysis area (Crandall et al, 2017). Twelve sites ranging from 4 to 21 acres as well as 8 additional site from within the Cragin Watershed Protection Project ranging from 5 to 15 acres have been identified for the potential use as processing sites for the Rim Country Project. A total of 20 sites totaling 207 acres were considered in this analysis

Sites were proposed base on terrain, road access, utilities, and potential impacts to resources. On these sites, most existing trees other than those that meet the large and old tree implementation plan would be removed. There will be a short term loss of productivity of forest resources such as tree volume, and forage, for about 20 years until wood processing operations are ended and sites are reclaimed and returned to timber production via natural and artificial reforestation. The processing sites have populations of merchantable timber and fuelwood species, but with the small acreage affected and with design features in place; effects to forest product resources would be temporary until revegetation occurs on the compacted soil. For additional information on the use of in woods processing sites, consult Chapter 2 of the EIS.

Table 51. In-woods processing and storage sites within Rim Country Project area considered for use in this analysis.

Site Name	Acres
FR 117, 1321	4
FR 139, 9729D	14
FR 145A, 9615X	7
FR 288, 2781	4
FR 294, 294D	19
3238, 512	20
FR 582, Hwy 87	5
FR 609, 1938	7
FR 74, 64	8
FR 81, 81E	7
9364L, FH 3	21
9731 G, Hwy 87	9
Total	128

Table 52. In-woods processing and storage sites within Cragin Watershed Protection Project area considered for use in this analysis.

Site Name	Acres
FR 141, 9398	5
FR 147, 6096/6097	5
211 Revised	15
613F	15
9033H	15
FR 95, North 9032C	10
FR 95F/396	9
9729A	5
Total	79

Rock Pits

The Rim Country Project will analyze the effects from the use of several rock pits in the project area. On the Coconino National Forest, the development, expansion, and use of nine rock pits in the Rim Country project area were analyzed in the Rock Pits Environmental Assessment for the Coconino and Kaibab National Forests (June 2016). One additional rock pit, Park Knoll, is currently being developed by Coconino County under permit. The Forest Service will have a reserve of approximately 20,000 cubic yards of material in this pit, so the potential effects from the use of this rock pit will be analyzed in the Rim Country EIS.

On the Apache-Sitgreaves National Forests, two ranger districts are in the Rim Country project area, the Lakeside and Black Mesa Ranger Districts. Surfacing material needs on the Lakeside Ranger District are met by a large county-operated rock pit under special use permit, as well as other commercial sources. On the Black Mesa Ranger District, 11 existing rock pits in the Rim Country project area are proposed for expansion to provide future material for implementation of Rim Country. Each of these rock pits are considered for 30 percent expansion of their current footprint. The potential environmental effects from the anticipated expansion of these rock pits, as well as those from their use, will be analyzed in the Rim Country EIS. The names and proposed acreage of these expanded pits appears in Table 3-17

Table 53. Proposed Pit expansion on the Apache-Sitgreaves National Forest under the Rim Country Analysis.

Pit Name	Current Acreage	Possible Increase in Acreage	Possible Future Total Acreage	Maximum pit espansion (feet)
34T	5	2	7	500
213	7	2	9	500
Pias Farm	6	2	8	500
115	7	2	9	500
717E	2	1	3	400
34B	5	2	7	500
Promontory	16	5	21	700
Carr Lake	12	4	16	600
Brookbank	1	1	2	400
Borrow	12	4	16	600
Cottonwoods Wash	6	2	8	500
Total	79	27	106	n/a

On the Tonto National Forest, all road surface material needs will be met by local commercial sources. Therefore, no effects from rock pit use on the Tonto will be analyzed in the Rim Country EIS. Figure 2-9 displays the locations of these rock pits in the Rim Country project area.

This section describes the effects of the No Action Alternative, the Proposed Action Alternative and the Focused Alternative on vegetation. The analysis includes an assessment of the changes to the existing and potential natural vegetation.

No Action Alternative

Direct and Indirect Effects

The No Action Alternative would have no direct effect on the vegetation cover types in the Analysis Area. The No Action Alternative does not propose the development of new pits or expansion of existing ones. Therefore, no vegetation would be removed in the pit areas. Increased hauling activity expected from this alternative would likely not remove any habitat

The No Action Alternative does not propose revegetation of existing pit areas. Over time, this alternative would have less area of natural vegetation when compared to the action alternatives due to the lack of artificial revegetation of existing pit areas.

An indirect effect of this alternative is a slightly lower risk of the spread of invasive species in the Analysis Area as compared to the action Alternatives. The No Action Alternative exposes less soil and disturbs less area which lessens the amount of area suitable for the establishment or spread of invasive plants. The treatment of noxious and invasive species would continue as prescribed by the three forest integrated treatment plan.

Cumulative Effects

The No Action Alternative would have no direct effect on the vegetation cover types in the Analysis Area and therefore would not contribute to the cumulative effects on vegetation across the Rim Country analysis area.

Proposed Action and Focused Alternative

Direct and Indirect Effects

The Proposed Action proposes to expand 11 existing rock pits, continue operations in the existing footprint of 9 rock pits. These actions would require removal of up to 27 acres of existing natural vegetation, primarily within ponderosa pine and pinyon-juniper plant communities that have not been analyzed under previous decisions. Vegetation removal would be dispersed across the Apache-Sitgreaves National Forests and the pit sites with new vegetation removal and would occur at different times over the next twenty years. The largest area of vegetation removal would be at the promontory pit where up to 5 acres of ponderosa pine would be removed. The smallest removal would be at the Brookbank pit site where expansion would require the removal of approximately one acre of existing vegetation. Considering that the pits would include removal of up to 27 acres within a landscape of over 2.5 million acres, the impact would be very small at the landscape scale and dispersed so as not to concentrate affects to any one type of vegetation or species.

The Proposed Action includes plans for reclamation of the pit sites following material extraction. It is likely that reclamation activities will result in establishment of ground cover with grasses and forbs in the first 1-5 years after reclamation activities; however, it will take several decades to re-establish each area with trees, which will affect vegetation in the pits in ponderosa pine vegetation the most.

Combined the effect of this alternative would be to remove vegetation on 27 acres for a period of several years, which will reset the vegetation dynamics on each of these patches of vegetation by several decades. Many of the rock pits naturally lack vegetation due to the existence of surface rock, which prevents vegetation establishment. In addition, the size and placement of proposed and existing rock pits on the landscape would be similar to natural disturbances or features that lack vegetation on the landscape. Rock pit development would occur at the scale of non-ponderosa pine inclusions such as aspen and meadows that naturally occur in northern Arizona forests. This is not to suggest that they would serve a purpose similar to other vegetation types, but the level of disturbance is unlikely to result in fragmentation of prey habitat at a level that would affect prey population levels.

The loss of 27 acres of potential habitat from rock pit development, would also contribute to loss of potential habitat from other activities such as dispersed camping, private land development, transmission line and pipeline constructions and/or maintenance, and trail and temporary road construction.

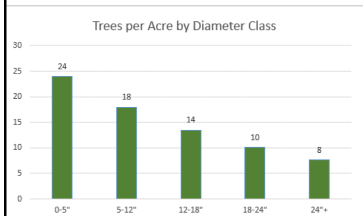
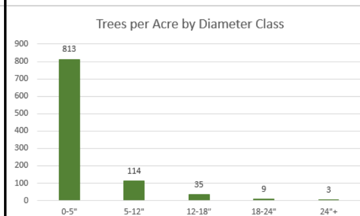
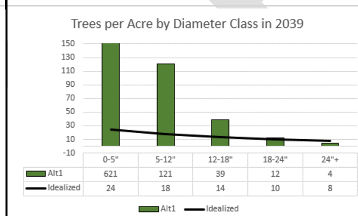
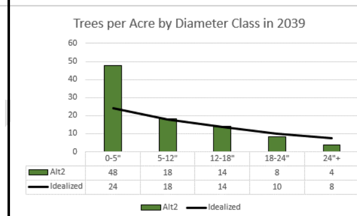
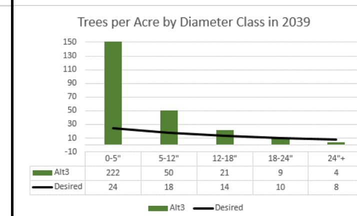
Cumulative Effects

Given the comparatively small area that would be impacted by the proposed activities, this alternative would have only a minor cumulative effect on the vegetation across the Rim Country Project Area. The effect would include the temporary reduction of vegetation cover over the next two decades. This reduction in vegetation cover contributed by the proposed action would affect a very small proportion of the landscape. Many other projects will alter vegetation by reducing the density of forests on the landscape over the next two decades as well. (Table XX 0

This would contribute along with the proposed action to the level of vegetation disturbance and reduction in ground cover at the landscape scale. Other recent management decisions such as the Coconino National Forest Changes to Motor Vehicle Use Designations Project can also contribute cumulatively with this project by cumulatively affecting of vegetation in areas designated for motor vehicle access. The rock pits are designed to connect to the forest road systems, however, none require new access, which would not cumulatively contribute to the road system of each forest.

Cumulative effects would be of greatest intensity where the removal of pit vegetation coincides with treatments that result in similar vegetation removal within the same area and timeframe. None of the proposed pit expansions or existing pits are located in areas where there have been dramatic changes in vegetation cover (e.g. uncharacteristically severe fire, intensive thinning, etc.), thus the cumulative effect of this action would be of greatest relevance at the landscape scale.

Table 54. Summarized effects of the Alternatives

	Desired Condition	Existing Condition	Alternative 1 - No Action	Alternative 2 - Proposed Action	Alternative 3 - Focused Alternative
Structure - Pattern	The majority of stands are in an open condition. Forest arrangement is in individual trees, small clumps, and groups of trees or randomly spaced trees interspersed within variably sized openings of grasses, forbs, and shrubs that are similar to historic patterns. Most forest stands in uneven-aged condition to meet forest resilience and sustainability goals while maintaining wildlife habitat. The majority of stands are in an open condition.	The majority of stands are in a closed condition and lacking groups and clumps of trees or randomly spaced trees. Grasses, forbs and shrubs are underrepresented compared to historic patterns. This is departed from historic conditions consisting of a matrix of groups, clumps and individual rendomly spaced trees with interspaces,	Stands would continue to remain in a closed condition, lacking groups and clumps of trees or randoml;y spaced trees. Grasses forbs and shrubs would continue to be underrepresented. Forest structure would continue to be departed from historic conditions.	This alternative would generally meet the desired condition. The majority of stands would be in an open condition. Forest arrangement would be in individual trees, small clumps, and groups of trees or randomly spaced trees that are similar to historic patterns and are as a result of the proposed action Most forest stands in uneven-aged condition to meet forest resilience and sustainability goals while maintaining wildlife habitat.	This alternative would generally meet the desired condition on the acres that were treated, however the acres that were not treated would resemble the conditions described in the no action alternative. Forest arrangement would resemble historic forest structure in some places, while many other areas would not meet the desired condition for forest pattern and structure
Structure - Trees per acre	Trees are distributed across size classes with total number of trees per acre between 10 and 250. Below is an idealized tree distribution across size classes totalling 73 trees per acre and carrying 90 ft^2 of basal area	Total trees per acre is higher then the desired condition and are overrepresented in the smaller diameter classes and underrepresented in the larger classes	Total trees per acre continues to remain above the desired condition. The percentage of acreage in the project within desired condition moves up from 13 percent in 2019 to 15 percent in 2039 as a result of density-dependent mortality. Tree disribution does not approximate the idealized distribution with too many trees in the smaller size classes	The percentage of acreage within desired condition for trees per acre increases dramatically from 13 percent in 2019 to 84 percent in 2049. The distribution of trees across size classes approximates the idealized distribution by 2039 better than any of the other alternatives	The percentage of acreage within desired condition for trees per acre increases from 13 percent in 2019 to 55 percent in 2039. Tree disribution does not approximate the idealized distribution with too many trees in the smaller size classes
					
Basal Area	Generally less than 90 square feet per acre to meet forest resilience goals. while maintaining wildlife habitat desired conditions. For MSO protected and nest/roost replacement habitat 110 to 120 square feet per acre is the minimum.	The current average basal area within the project area is 129 square feet per acre. High densities in terms of basal area make trees more susceptible to mortality from insects, disease, and competition and increase crown fire risk.	Average basal area would continue to increase across the project area from 129 square feet per acre in 2019 to 150 square feet per acre in 2039. The percentage of acres that would meet desired condition decreases from 19 percent in 2019 to 12 percent by 2039.	Average basal area would decrease across the project area from 129 in 2019 to 65 in 2029 and 62 in 2039. The percentage of acres that meet desired condition would increase from 19 percent in 2019 to 58 percent in 2029 and then to 56 percent in 2039	Average basal area would decrease across the project area from 129 in 2019 to 87 in 2029 and 89 in 2039. The percentage of acres that meet desired condition for basal area would increase from 19 percent in 2019 to 42 percent in 2029 and then to 40 percent in 2039
Stand Density Index	Maintain forest density between 25% and 45% of SDImax to maintain forest health and tree growth. For ponderosa pine this is between 112.5 and 202.5. For MSO protected and Nest/Roost replacement habitat, desired forest density is between 45% and 60% of SDImax or between 202.5 and 270.	Currently the average stand density index across the project area is 66% of MaxSDI. 21 percent of stands meet the desired condition for SDI. High densities in terms of stand density index make trees more susceptible to mortality from insects, disease, and competition and increase crown fire risk.	Average stand density index would continue to increase across the project area from 296 in 2019 to 324 in 2039. the percentage of acres that would meet desired condition decreases from 15 percent in 2019 to 11% in 2039	Average stand density index would decrease across the project area from 296 in 2019 to 116 in 2029 and 103 in 2039. The percentage of acres that meet desired condition would increase from 15 percent in 2019 to 27 percent in 2029 and then 21 percent in 2039	Average stand density index would decrease across the project area from 296 in 2019 to 172 in 2029 and 170 in 2039. The percentage of acres that meet desired condition would increase from 15 percent in 2019 to 27 percent in 2029 and then to 21 percent in 2039
Forest Insects	Stands in the project area are in the Low or Moderate hazard for bark beetles	Currently 74% of acreage have a high bark beetle hazard rating. The remaining 26% of stands meet the desired condition for insect hazard.	The proportion of acreage that would meet the desired condition for bark beetle hazard decreases from 26 percent in 2019 to 19 percent in 2039 as a result of increased stocking and lack of disturbance over time.	The proportion of acreage that would meet the desired condition for bark beetle hazard would increase from 26 percent in 2019 to 92 percent in 2039.	The proportion of acreage that meet the desired condition for bark beetle hazard would increase from 26 percent in 2019 to 60 percent in 2039.
Forest Disease	Stands in the project area have Low to Moderate dwarf mistletoe infection severity (Less than 20% of trees infected)	Currently 75% of acreage has a low dwarf mistletoe infection rating,. 22 percent of acres have a moderate rating and 4 percent have a severe infection rating. 5% of the project area meets the desired condition for mistletoe infection severity	The proportion of acreage with a severe dwarf mistletoe rating would increase from 4 percent in 2019 to 9 percent in 2039. The proportion of acreage that meets the desired condition decreases from 96 percent in 2019 to 91 percent in 2039.	The proportion of acreage with a severe dwarf mistletoe rating would decrease from 4 percent in 2019 to 3 percent in 2039. The proportion of acreage that meets the desired condition would increase from 96 percent in 2019 to 97 percent in 2039.	The proportion of acreage with a severe dwarf mistletoe rating remains essentialy unchanged from 4 percent in 2019 to 4 percent in 2039. The proportion of acreage that meets the desired condition also remains unchanged from 96 percent in 2019 and 2039.

Cumulative Effects

For the cumulative effects analysis, the spatial context being considered is the 1,238,658 acre project area. Cumulative effects are discussed in terms of vegetation management and prescribed fire activities as well as the effects of wildfire that have occurred since as early as 1990 and as changes in the existing condition due to present and foreseeable activities, including the effects of the alternative being discussed. The baseline year used for this analysis is the year 2019 as the existing condition. In this analysis, all past activities and events are included in the existing condition description. In the effects discussion, post treatment refers to the time the final activity is accomplished (year 2019), "short-term" effects refers to effects over the 10-year period from the time the final activity was accomplished (year 2029). Beyond 20-years we will be considering effects as "long-term" (year 2049). All Alternatives are compared across forest boundaries (Apache-Sitgreaves, Coconino and Tonto Forests combined).

Vegetation Management Activities and Prescribed Fire

Tables 55 lists approximate acres of the various vegetation management activities, prescribed burning, and other activities that have occurred within the project area as part of vegetation management projects from as early as 1990 to 2017. This includes 469,036 acres of mechanical vegetation management activities that mainly consisted of tree thinning involving heavy equipment and 567,935 acres of prescribed fire. Additionally, 122,264 acres of other activities have occurred in the project areas including 4,645 acres of wildlife habitat improvement, 7,694 acres of range vegetation control, 39,708 acres of range vegetation manipulation, 17,475 acres of tree encroachment control, 45,561 acres of tree release and weed, 15 acres of fuel compaction, 571 acres of fuels chipping, 2,749 acres of range forage improvement, 96 acres of special products removal, 203 acres of insect control and prevention, 1,256 acres of fuel breaks, 1,238 acres of planting, 616 acres of cultural site protection, 321 acres of scarification and seeding of landings and 116 acres of pruning. For additional information on the actions considered in this cumulative effects analysis, see Chapter 3 of this EIS.

Table 55. Approximate acres of vegetation management activities and prescribed fire within and adjacent to the cumulative effects area 1990-2017

Project Name	Year	Mechanical	Prescribed Fire	Other Activities*	Forest
Mullen Saw timber and Whitcom Multiproduct Offerings	1990	0	130	685	Apache-Sitgreaves
Jersey Horse Timber Sale	1991	1,452	351	0	Apache-Sitgreaves
Amended Elk Timber Sale	1993	834	466	0	Apache-Sitgreaves
Brookbank Multi-Product Timber Sale	1994	5,624	4,981	0	Apache-Sitgreaves
Cottonwood Wash Ecosystem Management Area	1995	516	2,447	0	Apache-Sitgreaves
Blue Ridge-Morgan	1997	14,471	14,552	0	Apache-Sitgreaves
Gentry	1997	451	191	0	Apache-Sitgreaves
Sundown Ecosystem Management Area	1997	2,075	24	7,023	Apache-Sitgreaves
Wiggins Analysis Area	1998	0	4,224	0	Apache-Sitgreaves
Show Low South (#22297)	1999	0	2,696	0	Apache-Sitgreaves
Larson Rx Burn	2001	0	3,015	0	Apache-Sitgreaves
Treatment of Dead Trees in the Rodeo-Chediski Fire (#20740)	2002	5,730	1,880	15	Apache-Sitgreaves
Heber-Overgaard WUI	2003	5,089	686	1,208	Apache-Sitgreaves
Hidden Lake Rx Burn	2003	0	2,828	0	Apache-Sitgreaves
Camp Tatiyee / Camp Grace Fuel Reduction	2004	0	172	0	Apache-Sitgreaves
Country Club Escape Route	2004	524	1,848	915	Apache-Sitgreaves
High Value Ponderosa Pine Tree Protection	2004	985	826	203	Apache-Sitgreaves
Rodeo-Chediski Fire Salvage	2004	25,913	626	1,667	Apache-Sitgreaves
Forest Lakes WUI Treatment	2005	1,691	1,645	0	Apache-Sitgreaves
Rim Top Rx Burn (formerly Woods Canyon Fuel Treatment)	2005	0	665	0	Apache-Sitgreaves
Show Low South (#4456)	2005	10	585	0	Apache-Sitgreaves
Dye Thinning	2006	247	0	0	Apache-Sitgreaves
Hilltop WUI	2006	1,534	45	616	Apache-Sitgreaves
Bruno Thinning and Slash	2009	0	70	0	Apache-Sitgreaves
Whitcom WUI	2009	925	0	0	Apache-Sitgreaves
Hilltop II Fuels Reduction	2011	0	799	616	Apache-Sitgreaves
Rodeo-Chediski Site Prep for Reforestation (#48660)	2016	0	0	0	Apache-Sitgreaves
Little Springs WUI	2003	4,376	4,227	2,500	Apache-Sitgreaves
Nagel	2005	19,611	18,231	2,802	Apache-Sitgreaves
Los Burros	2006	30,237	13,059	29	Apache-Sitgreaves
Nutrioso WUI	2006	19,476	9,870	1,254	Apache-Sitgreaves
Show Low South (#29987)	2011	3,372	0	0	Apache-Sitgreaves
Rodeo-Chediski Fire Rx Burn	2012	0	9,506	14,832	Apache-Sitgreaves
Timber Mesa/Vernon WUI	2012	18,781	39,760	20,441	Apache-Sitgreaves
Rim Lakes Forest Restoration	2013	12,483	1,335	6,447	Apache-Sitgreaves
Larson Forest Restoration	2015	1,867	0	2,516	Apache-Sitgreaves
Upper Rocky Arroyo Restoration	2016	696	5,411	3,960	Apache-Sitgreaves
Section 31 Fuels Reduction	2017	44	0	0	Apache-Sitgreaves
Pocket Baker	2000	0	5,450	0	Coconino
Blue Ridge Urban Interface	2001	416	6,225	2,325	Coconino
IMAX	2002	0	6,008	0	Coconino
Pack Rat Salvage	2004	0	0	0	Coconino
Bald Mesa Fuels Reduction	2005	2,485	5,150	0	Coconino
APS Blue Ridge 69kV Transmission Line	2005	0	1,600	0	Coconino
Good/Tule	2006	1,389	2,025	0	Coconino
Post-Tornado Resource Protection and Recovery	2011	765	0	0	Coconino
Lake Mary Road ROW Clearing (ADOT)	2016	788	0	0	Coconino
Lake Mary Meadows Two Fuel Reduction	2005	117	10,223	803	Coconino
East Clear Creek Watershed Health Improvement	2006	40,020	38,470	40,000	Coconino
Victorine 10K Area Analysis	2006	9,015	29,585	0	Coconino
Upper Beaver Creek Watershed Fuel Reduction	2010	20,608	64,000	0	Coconino
Blue Ridge Community Fire Risk Reduction	2012	0	45,000	0	Coconino
Clints Well Forest Restoration	2013	11	6,639	0	Coconino
Hutch Mountain Communication Site	2017	1	0	0	Coconino
Ridge Analysis Area	1994	33,311	0	1,094	Tonto
Lion Analysis Area	2001	5,664	6,900	664	Tonto
Verde WUI	2004	10,648	48,500	5,000	Tonto
Parallel Prescribed Burn	2014	0	4,759	0	Tonto
Pine-Strawberry WUI	2006	41,086	19,868	200	Tonto
Chamberlain Analysis Area	2008	9,044	19,000	1,675	Tonto
Christopher/Hunter WUI	2009	10,763	19,000	939	Tonto
Cherry Prescribed Burn	2012	0	6,582	0	Tonto
Myrtle WUI	2012	103,891	75,800	1,835	Tonto
Grand Total		469,036	567,935	122,264	

*Other activities include but not limited to fuels chipping, range forage improvement or manipulation, range vegetation control, wildlife habitat improvement, tree encroachment control, tree release, fuels compaction, special products removal, insect control and prevention planting, fuel break creation, cultural site protection, scarification and seeding, pruning,

Table 56. Righty of way, habitat improvement, reforestation, spring/meadow and other activities within the cumulative effects area

Project Name	Year	Mechanical	Prescribed Fire	Other Activities*	Forest
Right-of-Way (ROW) Projects with Herbicide Use					
Noxious Weeds and Hazardous Vegetation on State Highway ROWs	2004	25	0	11,005	Tonto
Grand Total for ROW Projects		25	0	11,005	
Wildlife Habitat Improvement, Grassland Restoration Projects/Allotment Projects					
Park Day Allotment	1994	2,193	0	701	Apache-Sitgreaves
Clear Creek Allotment	2000	2,397	0	3,237	Apache-Sitgreaves
Wallace Allotment	Unknown	0	0	1,747	Apache-Sitgreaves
Railroad Allotment (Formerly Carlisle Complex Vegetation Treatments)	2007	2,873	0	561	Apache-Sitgreaves
Apache Maid Grassland Restoration	2004	54,528	6,770	0	Coconino
Bar T Bar/Anderson Springs Allotment	2005	1,304	132,938	41,351	Coconino
Grand Total for Habitat and Grassland Projects		63,295	139,708	47,597	
Reforestation/Planting Projects					
Bison Reforestation	2003	356	312	583	Apache-Sitgreaves
Clay Springs Reforestation	2004	0	0	338	Apache-Sitgreaves
Jacques Marsh Elk Proof Fence & Riparian Planting	2006	0	73	0	Apache-Sitgreaves
Pierce Reforestation	2009	0	0	406	Apache-Sitgreaves
Rodeo-Chediski Riparian Planting	2010	0	0	1	Apache-Sitgreaves
Rodeo-Chediski Reforestation (#18675)	2007	0	150	1,056	Apache-Sitgreaves
Conifer Weeding for Aspen Enclosure	Unknown	65	0	0	Coconino
Grand Total for Reforestation Projects		421	535	2,384	
Spring and Meadow Restoration Projects					
Bill Dick, Foster, and Jones Springs Enhancement	2013	0	0	0	Coconino
Long Valley Work Center Meadow Restoration	2018	0	0	16	Coconino
Grand Total for Spring and Meadow Projects		0	0	16	
Other Projects					
ASNF - No NEPA docs found - various activities reported in FACTS but not tied to other named projects	Unknown	42,763	74,202	16,656	Apache-Sitgreaves
COF - No NEPA docs found - various activities reported in FACTS but not tied to other named projects	Unknown	16,049	15,175	4,695	Coconino
TNF - No NEPA docs found - various activities reported in FACTS but not tied to other named projects	Unknown	15,565	26,386	43,711	Tonto
Grapevine Interconnect (Grapevine Canyon Wind Project)	2012	0	0	0	Coconino
APS Line Maintenance	Unknown	87	0	0	Coconino
Sixteen Rock Pits and Additional Reclamation	2017	0	0	0	Coconino
Glen Canyon-Pinnacle Peak 345kV Transmission Line Vegetation Management	2014	0	0	0	Coconino
Noxious Weed Treatment Projects	2005	61,015	1,008	2,032	Tonto
Grand Total for Other Projects		135,479	116,771	67,094	
Overall Total		199,220	257,014	128,096	

*Other activities include, but not limited to pesticide control of invasives, control of range vegetation, control of tree encroachment, range cover manipulation, control of understory vegetation, wildlife habitat improvement, planting, animal damage control, tree release, site preparation, and biocontrol of invasives,

Table 57. Approximate acres of reasonably foreseeable activities within the cumulative effects area

Project Name	Mechanical	Prescribed Fire	Other Activities*	Forest
Rodeo-Chediski Mastication	301	301	0	Apache-Sitgreaves
Heber-Overgaard Insect and Disease Farm Bill CE	0	0	0	Apache-Sitgreaves
Heber Allotment	0	0	39,000	Apache-Sitgreaves
Pierce Wash Allotment- Section 18 Analysis of Vegetation Treatments	0	0	0	Apache-Sitgreaves
AGFD Fairchild Draw Elk Exclosure	0	0	0	Apache-Sitgreaves
Four Springs Trail Realignment	0	0	0	Apache-Sitgreaves
Heber-Overgaard Non-motorized Trail System	0	0	0	Apache-Sitgreaves
Navopache Electric Cooperative Trunk Line Addition	0	0	0	Apache-Sitgreaves
APS-Herbicide Use within Authorized Power Line ROWs on NFS Lands in AZ	0	0	2,136	Apache-Sitgreaves, Coconino, and Tonto
SRP-Herbicide Use within Authorized Power Line ROWs on NFS Lands in AZ	0	0	7,469	Apache-Sitgreaves, and Tonto
Cragin WPP	41,046	63,656	0	Coconino
Mogollon Rim Spring Restoration Project	0	0	5	Coconino
WAPA Glen Canyon-Rogers 230/345kV Integrated Vegetation Management	13,338	0	0	Coconino, and Tonto
Flying V&H Prescribed Fire	1,798	59,124	0	Tonto
Haigler Fuels Analysis	43,435	43,435	0	Tonto
Flying V and Flying H Allotment	10,875	0	0	Tonto
Hardscrabble Allotment Juniper Clearing	100	0	0	Tonto
New Delph Tank & Bear Tank Maintenance	0	0	0	Tonto
Pleasant Valley Northwest Grazing Allotments	0	0	0	Tonto
Red Lake Tanks	0	0	1	Tonto
Emory Oak Restoration	0	0	0	Tonto
Cragin-Payson Water Pipeline and Treatment Plant	350	0	350	Tonto
Grand Total	111,243	166,516	48,961	

Other activities include, but not limited to pesticide control of invasives, control of range vegetation, control of tree encroachment, range cover manipulation, control of understory vegetation, wildlife habitat improvement, planting, animal damage control, tree release, site preparation, and biocontrol of invasives,

Fire

Wildfires from 1943 to 2017 (Table 58) have burned on approximately 509,447 acres in or adjacent to the project area. Of these acres, it is estimated that the overall average fire severity to the vegetation was 20 percent high severity, 30 percent mixed severity and 50 percent low severity. There is wide variability among these percentages from fire to fire. For more information on the history of wildfires in the project area consult the Fire Ecology Specialist Report (USDA 2019).

Many of the wildfires that burned within the project area in the last 10 years were managed primarily for resource objectives instead of primarily for suppression (Fire Ecology and Air Quality Report), and produced primarily low-severity fire effects. The vast majority of the mechanical thinning projects in the area have decreased the potential for active crown fire and crown fire initiation on acres thinned (469,036 acres from table 55 and 199,220 from Table 56), and the potential for crown fire initiation, and high severity effects from surface fire (567,935 acres from Table 55 and 257,014 acres from Table 56). Past mechanical and prescribed fire treatments decreased the potential for crown fire by breaking up the vertical and horizontal continuity of canopy fuels.

Table 58. Wildfire acres within the project area 1943-2017

Year	Acres
1943-1989	40,994
1990-1999	37,369
2000-2009	262,531
2010-2017	168,583
Total	509,447

Timber Harvest

Past timber harvest practices influenced vegetation structure, pattern, and composition on the majority of the project area. From the late 1880s to the 1940s, logging that facilitated construction of the railroads was conducted by several lumber and timber companies in the areas of Holbrook to Flagstaff (Lightfoot 1978). By 1940, the railroads had removed much of the profitable lumber that could be easily accessed. In terms of vegetation structure, many of the largest and oldest tree sizes larger than 18" DBH were removed from many areas. Extensive regeneration with no large trees interspersed within the younger age classes occupied many of the harvested areas. The pattern on the landscape no longer resembled the Desired Condition outlined in the LRMP.

Past timber sales within the project area such as the Ridge Analysis Area (1994), and Brookbank Multi-product Timber Sale (1994), implemented prior to the Southwestern Region's 1996 amendment of forest plans, targeted the harvest of medium and large diameter trees. In some cases, all trees over 12 inches in diameter were removed. This affected the presence of pre-settlement trees and old forest structure.

Today, at the landscape (project area) scale, pre-settlement trees are underrepresented in many areas. The focus on even-aged forest management continued until the mid-1990s, leaving the legacy of current forest conditions. Approximately 50 percent of the project area that received some type of regeneration or shelterwood harvest has regenerated. Many stands are even-aged, dense, and lack age class diversity. Today, the majority of acreage can be classified as young and mid-aged forests with a moderately closed to closed tree canopies.

Post 1996 Vegetation Treatments – Uneven-aged Management, Fire Hazard and Restoration

After the region-wide 1996 amendment, vegetation objectives included uneven-aged management (Figure 17) (Table 96 & 97). A review of the Forest Activity Tracking System (FACTS) timber database indicates that treatments designed to promote uneven-aged management began being recorded as early as 1991 on the Apache-Sitgreaves NF, in 1987 on the Coconino NF and 2001 on the Tonto NF. However, acres treated in this category continued to be minor in comparison to acres treated with even-aged methods until about 2005. These acres treated using uneven-aged silviculture systems should today, still be moving these acres towards their desired conditions. Acres still assigned to even-aged silviculture may, or may not, be moving towards desired conditions depending on whether or not the stands can/could be converted to an uneven-aged structure or have been successfully regenerating. Forests in the project area use even-aged management to some extent and the use of this silvicultural system is not precluded in current Forest Plans.

After 1996, the objective of most vegetation projects in the project area was to reduce the risk of high-severity fire, improve forest health (stand and tree resilience and vigor), and improve understory diversity. Retention of snags and managing for coarse woody debris was further enhanced with the 1996 amendment and made part of project requirements. The 1996 forest plan amendment also changed treatments in Gambel oak and the species was recognized for its role in managing for ecological diversity and high quality wildlife habitat.

With the exception of older projects that removed large, old trees and promoted even-aged management, most vegetation projects that contributed to the current condition within the project area occurred from 2000 to 2015. From 2000 to 2015, across the three Rim Country forests, examples of projects designed primarily to address the risk of undesirable fire behavior and effects in the project area include Heber-Overgaard WUI, Camp Tatiyee/Camp Grace Fuel Reduction, Forest Lakes WUI Treatment, Rim Top Rx Burn, Hilltop WUI, Whitcom WUI, Hilltop II Fuels Reduction, Little Springs WUI, Los Burros, Nutrioso WUI, Section 31 Fuels Reduction, Blue Ridge Urban Interface, Bald Mesa Fuels Reduction, Lake Mary

Meadows Two Fuels Reduction, Upper Beaver Creek Watershed Fuels Reduction, Verde WUI, Pine Strawberry WUI, Christopher Hunter WUI, Cherry Prescribed Burn, Myrtle WUI and Haigler Fuels Analysis among others (Table XXXX). A variety of other projects have modified vegetation for other objectives such as grassland restoration, wildlife habitat improvement, maintaining rights of way, reforestation, noxious weeds as well as transportation system management (Table 56).

Natural Disturbances – Insect and Disease

Though many of the treatments identified in Table 55 and 56 were designed to reduce hazard of insects and diseases, these natural disturbance mechanisms are still endemic in these forests. Though prescribed fire, or any fire, increases the short-term risks to bark beetle infestations, Mechanical and prescribed fire treatments have worked to reduce insect and disease risk by reducing density in terms of basal area, stand density index and trees per acre. Historic treatments as well as the treatments in the Rim Country analysis have worked together to reduce insect and disease risks. A comprehensive account of insect and disease activity occurring within the project area and cumulative effects area was provided by USDA Forest Health Protection (USDA 2016). Much of the information in that report comes from a combination of the Historical Reports for the three forests (Lynch et al. 2008, 2010, 2015), and aerial detection survey (ADS) data collected every year by Forest Health Protection (FHP) (USDA, Forest Service 2018).

For the Rim Country Project area, ADS indicates that activity of most agents has been relatively low for the past five years. In fact, much of the recent insect activity mapped in the project area occurred during the drought years from 2001-2005. Treatments listed in Table 55 and 56 have maintained these low levels and additional treatments in the Rim Country Project should improve the resilience of these forested systems. More details on the specific agents are discussed within their specific forest type below. We should also note that there are many insects and diseases which cause little damage or tree mortality (Furniss and Carolin 1977). Their effects are not considered extensive and will not be discussed in this cumulative effects analysis.

Generally speaking, current stands of ponderosa pine and mixed conifer are much denser with smaller average diameters than what was historically present prior to European settlement (Covington and Moore 1994). This change in stand structure appears to have favored certain insects and diseases, primarily bark beetles and Southwestern dwarf mistletoe. Details on these are provided below. Root rot pathogens, although not specifically discussed by forest type, are present in all forest types. Root diseases can cause direct tree mortality and are often associated with secondary mortality such as bark beetle attacks (Fairweather et al 2013). Root diseases are often missed during surveys because their deleterious effects are gradual. Some management activities in the cumulative effects area have targeted trees with root rot and reduced its prevalence.

Bark Beetles

The primary two genera found in ponderosa pine, *Dendroctonus* spp. and *Ips,* spp. are capable of causing substantial tree mortality. Historical activity of mountain pine beetle in ponderosa pine in Arizona has been limited to areas on the North Rim of the Grand Canyon (Blackman 1931, Lynch et al. 2008). There are also multiple species of Ips beetles found in the ponderosa pine forests of north central Arizona (Williams et al. 2008).

Historical reports indicate that both the size of bark beetle outbreaks and the beetle species involved in the outbreaks have shifted since the early part of the century. Most tree mortality in the ponderosa pine early in the 1900s was predominately attributed to beetles in the Dendroctonus genus. While periodic Ips attacks were also reported on all three forests, earlier Ips outbreaks were localized events, associated with slash management issues from forest management activities, windthrow, and drought. In contrast, the widespread, landscape-level tree mortality which occurred across the Rim Country Project area in the early 2000's was primarily attributed to Ips species, and correlated with a widespread drought. Within infected ponderosa pine stands, all three forests experienced substantial tree mortality from this outbreak with stand basal area declining by 32%, 62% and 37% for the Coconino, Tonto, and Apache-Sitgreaves National Forests, respectively (Negrón et al. 2009). Also observed was a reduction in tree density, SDI and average tree diameter. Probability of tree mortality was positively correlated with initial tree density and negatively correlated with elevation and initial average tree diameter (Negrón et al. 2009).

Dwarf Mistletoe

Southwestern dwarf mistletoe incidence has increased on all three Forests, with an estimated 47%, 52% and 32% of commercial acres infected in the 1980s for, the Tonto, Apache-Sitgreaves, and Coconino National Forests, respectively, versus only 19% 41%, and 30%, respectively, in the 1950s (Lynch et al.) High dwarf mistletoe ratings increase tree stress and the likelihood of Ips attacks during drought (Kenaley et al. 2006, 2008). The prevalence of Southwestern dwarf mistletoe seems to be particularly high along the Mogollon Rim. For instance, incidence of mistletoe is higher on the Mogollon Ranger district than on any other district on the Coconino (48% of commercial timber infected) and is higher on the Black Mesa district than on the Lakeside district (Hessburg and Beatty 1985, as reviewed in Lynch et al. 2008, 2010). Denser stand conditions and fire suppression have increased mistletoe abundance in current forest stands, despite the fact that its distribution has likely not changed extensively (Dahms and Geils 1997).

Alternative 1 – No Action

Alternative 1 is the no action alternative as required by 40 CFR 1502.14(c). There would be no changes in current management and the forest plans would continue to be implemented. The effects of 469,036 acres of mechanical vegetation treatments, 567,935 acres of prescribed fire and 122,264 acres of other activities in the form of past and ongoing projects would continue to impact the landscape. Approximately 111,243 acres of vegetation treatments, 166,516 acres of prescribed fire projects, and 48,961 acres of other activities would continue to be implemented in the reasonably foreseeable future within and adjacent to the project area. It is expected that when these actions are completed that these acres will be moving towards the desired conditions. Alternative 1 is the point of reference for assessing action alternatives 2-3. The thinning and prescribed fires treatments in the prior 10-year period were designed to set up the stands to reach their desired conditions according to the then-approved forest plans. In conjunction with mechanical treatments, there were prescribed fire only treatments designed as fuels treatments to reduce surface fuels as well as reduce ladder fuels and crown fire risks. To those ends, the prior treatments will move the acres toward their desired conditions.

Timber Harvest

Past timber harvest practices influenced vegetation structure, pattern, and composition on the majority of the project area. The focus on even-aged forest management continued until the mid-1990s, leaving the legacy of current forest conditions. Approximately 50 percent of the project area that received some type of regeneration or shelterwood harvest has regenerated. Many of these stands are two-aged, dense, and lack age class diversity as a result of these historic practices. Historically, wildfire would have maintained a diverse matrix of age class diversification. Reintroduction of an historical fire return interval will aid in converting, and maintaining, an uneven-aged forest at the landscape level. Currently planned forest treatments should move these stands towards a trajectory for their desired conditions. Untreated stands will continue to move away from desired conditions as densities increase, beetle risks increases and risks of crown fire increase. Under this alternative the potential for uncharacteristically large scale wildfires that dramatically impact the landscape is increased.

The Cragin Watershed Protection Project on the Coconino National Forest was decided in 2018 and will mechanically treat 41,046 acres and use prescribed fire on 63,656 to move stands in that project area towards the desired condition. In most cases, fuels reduction treatments do not necessarily provide adequate change in stand structure and do little to move towards desired conditions. However, fuels treatments following mechanical treatments to balance age classes provide the best chance to set these stands on a trajectory towards desired conditions. The Haigler Fuels Analysis on the Tonto National Forest planned to treat over 43,000 acres with mechanical and prescribed fire, but is still in the scoping phase and no impacts can be assigned other than to say that there is a need to reduce high fuel loadings and return to a natural regime.

Forest Structure

In Alternative 1, the no action alternative, few treatments would be implemented to create a mosaic of interspaces and tree groups. In locations not identified for treatment under other decisions, existing interspace would continue to be reduced by expanding tree crowns and increased tree densities. Understory vegetation response would be suppressed. The risk of undesirable fire ane/or effects would continue to increase. Any large scale tree mortality occurring has the potential to enhance interspace and create tree groups. While the Forests in the project area have an emphasis to favor uneven-aged management, this silvicultural system does not assure interspaces and groups. These Forests have latitude to create openings and groups but have not implemented large areas of openness to date except within WUI treatments. In terms of a mosaic of interspaces and tree groups at the landscape level the prior treatments have not significantly moved the forest towards the desired conditions at this time.

Forest Structure - All age and size classes represented

Prior thinning treatments with restoration objectives were similar to the goshawk habitat and MSO restricted other habitat treatments proposed under the first EIS as well as this project and have resulted in similar diversity in age and size class, and should move these stands towards desired conditions. Uncharacteristically severe wildfires caused large scale mortality across all age and size classes resulting in a non-stocked or single age class representation. Wildfires that burned with a low severity and prescribed burn only treatments had similar effects to forest structure as the post thinning prescribed fires. Restoration treatments and 4FRI treatments are designed to lessen the probability of these uncharacteristically severe wildfires.

The main objective of thinning with a fuels reduction emphasis was to reduce canopy fuels and the potential for crown fire initiation. Generally, this type of treatment focused on removal of trees in the subordinate crown positions and retaining those trees in the dominant and co-dominant crown positions and any pre-settlement trees. This type of treatment resulted in a moderately open canopy, even-aged forest structure with very little age and size class diversity. Prescribed burning and mechanical fuels treatments associated with the above thinning treatments resulted in periodic tree mortality of seedling/sapling size trees and susceptible pre-settlement trees further reducing age class diversity.

Old Forest Structure

Many prior thinning treatments retained pre-settlement trees and the largest post-settlement trees. Sanitation treatments may have removed some old forest structure. Prescribed burning and low severity wildfire resulted in periodic tree mortality of susceptible pre-settlement trees. Mixed and high severity wildfire killed a large proportion of the old forest structure. Powerline treatments removed any old forest structure that was a hazard to the powerline.

Old forest structure has been reduced over many years by past management practices. The change in direction in 1996 to manage more for an uneven-aged stand structure will aid the forest to reach the Desired Conditions over time. The structure of the past and most of the proposed treatments, while planned out as uneven-aged treatments, will have a distinctly different spatial layout than is being planned in this project. Treatments designed in the Rim Country project have identified distinct interspaces of varying sizes with groups of varying sizes as well as randomly spaced trees to aid in forest diversity (horizontal and vertical) while at the same time breaking up areas of continuous canopy to reduce risks to crown fire. Past uneven-aged treatments will have trees more uniformly spaced with more of a closed canopy (moderately closed to closed).

Forest Process

Past thinning treatments resulted in low to moderate stand density index, which is associated with minimum competition between trees, and maximum individual tree growth. This in turn had a beneficial effect of improved forest growth, and reducing the potential for density and bark beetle related mortality. Thinning treatments also removed dwarf mistletoe infected trees reducing the percent of trees infected as well as potentially creating conditions that slowed or inhibited mistletoe spread. Prescribed fire and low severity wildfire also led to localized reduction of forest density and dwarf mistletoe infection. The thinning treatments reduced risks associated with dense forest conditions and improved resilience to the impacts of large scale disturbance under drier and warmer conditions.

Alternatives 2 and 3

Alternative 2 restoration treatments would contribute an additional 953,130 acres toward improving forest health and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions.

Alternative 3 restoration treatments would contribute an additional 529,060 acres toward improving forest health and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions.

Prescribed Fire

Prescribed fire is considered to be an integral component to stand treatments and is a necessary complimentary treatment to mechanical treatments to attain and maintain the desired conditions. Without prescribed fires it would be more difficult to maintain desired conditions or reduce unintended results from uncharacteristically high wildland fire at the landscape level. Approximately 40,000 acres of prescribed fire would be implemented annually across the analysis area from a combination of this project as well as other projects such as Cragin Watershed Protection Project and the Haigler Fuels Analysis. See Fire Specialist Report for details.

For the analysis period, prescribed fire over the acres (Tables 55 and 56) of broadcast burns reduced fuels, modified fire behavior, and lowered crown fire risks. The majority of these acres occurred since 2004 and many may require reintroduction of a prescribed fire within the next 5 years in order to maintain the benefits of the prior burn. The proposed acres of mechanical treatment and/or prescribed fire of the Rim Country 4FRI project (953,130acres in Alternative 2 and 529,060 acres in Alternative 3), combined with the reasonably foreseeable treatments proposed (Table 57, 166,516 acres) will reduce uncharacteristically severe fire behavior on approximately 1,119,646 acres in Alternative 2 and 695,576 acres in Alternative 3 over the next 20 years. The prior treatments should allow prescribed fire-only treatments, with burns within the same stands as this project, to reduce emissions. The synergy between the prior treatments and the proposed treatments offer some of the best possible outcomes to reduce undesirable fire behavior and/or effects in these treatment areas.

Forest Structure

From the 1970s until 1996 treatments were designed primarily to manage for even-aged stand structure. These stands today are going to be treated to move them towards an uneven-aged structure where possible. Treatments after 1996 had an uneven-aged silviculture emphasis and those treatments would have helped to move those stands towards their desired conditions at the time of treatment. Prior treatments (Tables 55 and 56) have reduced densities within and outside PFAs, but very little treatment has occurred within MSO PACs and Cores. Stands treated prior to 1996 will need treatment within this proposal as the project moves these stands towards an uneven-aged structure and putting them on a trajectory to achieve their Desired Conditions.

Most treatments on the Apache-Sitgreaves, Coconino and Tonto National Forests, with the exception of the 1st 4FRI EIS, left the forest with denser stands when compared to the proposed restoration treatments in this project. Spatially, the prior treatments, until recently, tried to leave a uniform distribution of trees with only natural canopy gaps and meadows for openings. Currently proposed restoration prescriptions will leave a more open forest, post treatment, than was prescribed in past treatments, with distinct interspaces, groups, and regeneration openings of varying sizes as well as randomly spaced trees across the landscape to enhance structural diversity. Planned interspaces will average between 10 to 90% at the stand level from closed forests to open grasslands. The proposed restoration treatments are a departure from past management and have desired conditions for interspaces and groups that will move these stands towards the LMPs Desired Conditions.

Forest Health

Density related mortality -

Stand density is a dominant factor affecting the overall health and vigor of conifer forests in the western US (SAF 2005) and high stand densities leads to reduced ecosystem resilience (Reynolds et al 2013). Prior treatments have used prescriptions, both even-aged and uneven-aged, to reduce stand densities. Table 55 and 56 lists some of the treatments complete in the analysis area during the analysis period and most all vegetation manipulation treatments were designed to reduce stand densities to some extent. Even with the reduced stand densities some stands were susceptible to the drought period during the early 2000's. This is probably an indicator of stand behavior at these treatment densities in context with climate change. Because of these treatments these stands have moved towards the desired conditions. However, not all were designed as a restoration treatment, especially those implemented earlier in the analysis period. Therefore, these stands may not be moving towards the restoration desired conditions of this project and could be treated again in order to aid in moving them to their desired conditions, or onto a trajectory to achieve the desired conditions.

Proposed treatments in the foreseeable future (Table 57) will be more closely allied with a restoration-based desired condition and prescription. The newly published Forest Plans of the Coconino and Apache-Sitgreaves National Forests clearly spell out the intent to treat widely across the forest with a restoration desired condition. The foreseeable acreages for projects such as Cragin Watershed Protection Project and the Haigler Fuels Analysis show the intent of the forests as they go forward with the Forest Plans. The combined Rim Country treatments (Table 55 and 56) and the foreseeable treatments (Table 57) will move a considerable portion of the landscape towards a desired condition of reduced stand densities with an open grass/forb/shrub matrix in a heterogeneous landscape. These changes will occur in both alternatives, however in alternative 3 the movement toward the desired condition will only occur on the treated acres.

Bark beetle related mortality –

Bark beetles are normal endemic insects in ponderosa pine and mixed conifer communities and the pine type has evolved with such disturbances (Reynolds et al 2013). But when conditions are conducive to beetle outbreaks insects can become a strong determining factor in stand structure and composition that can become even more pronounced during and following extended droughts and under dense stand conditions (Reynolds et al 2013, Negrón 1997). Consult USDA (2014) for a history of epidemic bark beetle infestations within the analysis are from the 50's thru 2014. The current stand structures reflects the occurrences of these epidemic outbreaks.

Prior treatments within the analysis area were completed with a desire to reduce hazardous fuels and reduce stand densities. The drought period from 2000 until now has challenged many stands with bark beetle infestations. The current stand conditions are still dense in many stands as attested to by their high SDIs. Post 1996 treatments were effective in reducing density related mortality. Even with the reduced stand densities some stands were susceptible to the drought period during the early 2000's. Proposed treatments will further restructure stands towards the restoration-based desired condition and this should aid in relieving further stresses. Because bark beetles can fly considerable distances and have multiple generations in one season, treatments outside, and adjacent to, the analysis area have an important influence of beetle activity within the analysis area.

Dwarf mistletoe infection –
Activities identified in Table 55, 56 and 57 treated acres mechanically and with the use of prescribed fire. Many of these treatments had a considerable effect on the distribution, but more importantly, the abundance of dwarf mistletoe. Mitigation strategies for dwarf mistletoe (DM) attempt to reduce stand dwarf mistletoe ratings (DMR) and not individual tree ratings (DMI) (i.e., pruning or fire). Where DM is present, silviculture prescriptions prioritize removal of infected trees (at or above a predetermined infection level). Due to the limited transmissivity of dwarf mistletoe, treatment of stands outside the analysis area do not have as great a potential impact as do stands adjacent to the analysis area. While seeds of the dwarf mistletoe are forcibly ejected the spread of DM is slow by comparison. But infection from outside of the analysis from adjacent stands and into stands within the analysis area is possible. The impact of these outside infections will have little impact to growth or mortality to the overall analysis area.

Prior treatments within the analysis area will have reduced, but not eliminated, DM from the treated stands. The DM infections will continue to slowly intensify. Foreseeable treatments will potentially reduce infection levels further and will benefit the overall analysis area in terms of reduce growth, reduced tree vigor, and reduced bark beetle risks. Where possible, the Rim Country project will target DM infected stands for the more intense treatment levels, and this will lower the infection level. Infected trees can grow at near the rate of uninfected trees on good sites if individual tree infections remain at or below a dwarf mistletoe rate of 3 (Hoffman 2010). Treatments will move most stands towards desired conditions. However, DM is a natural component of the ponderosa pine community and eradication is neither desirable nor possible, and latent infections (those not visible at the time of treatment) will remain within the stands.

Other Direct and Indirect Effects:

Climate change

Risks associated with dense forest conditions would be reduced and resilience to the impacts of large scale disturbance under drier and warmer conditions would be improved by implementing the treatments proposed under alternatives 2 and 3. Prior treatments will benefit the forest by reducing densities and reducing stresses associated with completion. Treated forest will be more resilient to climate change than untreated forest (Kerhoulas et al 2013). Within-forest carbon stocks would be reduced under alternatives 2 and 3, however large scale stand replacing wildfires such as the Rodeo-Chedeski and Wallow fires that emit enormous amounts of carbon dioxide would be less likely to occur. Individual tree growth would improve, resulting in larger average trees size and increased carbon storage over time offsetting short term losses of carbon removed through the mechanical thinning. Some of the carbon biomass removed by mechanical thinning would be sequestered for a considerable period of time in the form of forest products.

Residual Tree Damage

Some damage to residual trees would be expected in Alternatives 2 and 3 with the felling, tractor yarding and piling operations associated with mechanical treatments in ponderosa pine. Damage rates should be similar or less than current silviculture practices due to the more open conditions created. The Proposed Action would result in the most potential damage because of the extensive harvesting in overly dense stands. Damage would be minimized through contract administration, on-site inspections, and proper harvest methods. All piling and/or low-severity burning treatments would reduce understory stocking and reduce inter-tree competition as well as stimulate understory vegetation (shrubs, forbs, grasses). Prescribed fire is expected to damage some residual trees and increases short-term risks to low level bark beetle activity.

Effects from Forest Plan Amendment(s)

Tonto NF Plan Amendment (1): Mexican Spotted owl: The 1985 Tonto Forest Plan, as amended, includes direction from the former (1995) Mexican Spotted Owl Recovery Plan. There is a need for the Rim Country analysis to be in alignment with the management direction provided in the revised Recovery Plan and the other forest plans that are part of this landscape EIS. A project-specific plan amendment was written in order to bring the Tonto FP into alignment and is included in Appendix 1.

Tonto NF Plan Amendment (2): Ponderosa pine vegetation types: There is a need for the Rim Country analysis to be in alignment with the Apache-Sitgreaves and Coconino NF revised forest plan management direction. The revised forest plans reflect a change in conditions since the 1980s including acknowledgement that vegetation conditions (structure, composition, and function) are divergent from reference conditions and forest conditions indicate a substantial departure from the natural fire regime. The revised plans use the latest best available science and information. Because a final Tonto National Forest revised forest plan is not expected until 2019, an amendment is needed to:

* Replace forest plan standards and guidelines for ponderosa pine/bunchgrass, ponderosa pine/Gambel oak, ponderosa pine/evergreen oak, dry mixed conifer and old growth with desired conditions and guidelines

* Add a desired condition for the percentage of interspaces within uneven-aged stands to facilitate restoration.

* Add the desired interspaces distance between tree groups.

* Add a definition to the forest plan glossary for the terms interspaces and openings.

Other Agencies and Individuals Consulted

Acronyms

ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
AZGFD	Arizona Game and Fish Department
AMS	Analysis of the Management Situation
ASQ	Allowable Sale Quantity
BAER	Burned Area Emergency Response

BLM	Bureau of Land Management
BMP	Best Management Practice
CCF	100 Cubic Feet
CCVA	Climate Change Vulnerability Assessment
CER	Comprehensive Evaluation Report
CFI	Community Forest Intermix
CFR	Code of Federal Regulations
CWPP	Community Wildfire Protection Plan
DBH	Diameter at Breast Height
DRC	Diameter at Root Collar
DMCF	Dry Mixed Conifer Forest
EI	Ecological Indicator
EPA	Environmental Protection Agency
EO	Executive Order
ERU	Ecological Response Unit
ESA	Endangered Species Act
FHA	Federal Highway Administration
FIA	Forest Inventory Analysis
FR	Federal Register
FSH	Forest Service Manual
FSM	Forest Service Handbook
GIS	Geographical Information System
GTR	General Technical Report
HUC	Hydrologic Unit Code
IRA	Inventoried Roadless Area
MIS	Management Indicator Species
MSO	Mexican Spotted Owl
MVUM	Motor Vehicle Use Map
NEPA	National Environmental Policy Act
NF	National Forest
NFMA	National Forest Management Act
NFS	National Forest System
NPS	Non-Point source
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NRT	National Recreation Trail
NVUM	National Visitor Use Monitoring
OHV	Off-Highway Vehicle

Commonly Used Acronyms

PAC	Protected Activity Center
PFA	Post-Fledging Family Area
PFC	Proper Functioning Condition
PNVT	Potential Natural Vegetation Type
RMRS	Rocky Mountain Research Station
RNA	Research Natural Area
ROS	Recreation Opportunity Spectrum
SAD	Sudden Aspen Decline
TCP	Traditional Cultural Property
TES	Terrestrial Ecosystem Survey
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USFS	United States Forest Service
WQA	Wildlife Quiet Area

WUI	Wildland Urban Interface
BA	Basal Area (square feet per acre)
SDI	Stand Density Index

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