



United States
Department of
Agriculture

Forest
Service

Southwestern
Region



Silviculture Specialist Report Coconino and Kaibab National Forests¹ Four Forest Restoration Initiative



October 24, 2014
Revised April 15, 2015

Prepared by:
Neil McCusker, Richard Gonzalez & Randy Fuller
Certified Silviculturist

Randy Fuller Ph.D.

¹ Coconino NF Ranger Districts: Flagstaff, Mogollon and Red Rock
Kaibab NF Ranger Districts: Williams and Tusayan

Content

Purpose and Need for Action.....	2
Legal Requirements.....	2
Kaibab National Forest Plan Revision.....	3
Guidelines for Management Activities in Ponderosa Pine Communities (KFP)	4
Coconino National Forest	10
Mexican Spotted Owl Recovery Plan	11
Elements that relate to forest vegetation operations for the Mexican spotted owl include:.....	11
Elements that relate to forest vegetation operations for the Northern Goshawk include: ...	13
4FRI Coconino/Kaibab EIS – Purpose and Need for Action.....	14
Silviculture Analysis Questions to be Answered and Key Issues Addressed.....	14
4FRI Coconino/Kaibab EIS - Silviculture Area of Analysis	16
Methodology, Assumptions and Limitations	20
Limitations	26
4FRI Coconino/Kaibab EIS - Silviculture Affected Environment Existing Conditions.....	27
Changes from the Draft Environmental Impact Statement (DEIS)	27
Other Literature Reviewed.....	30
Historical Context of the Existing Condition.....	34
Grazing.....	34
Logging.....	35
Fires and Fire Suppression.....	37
Insects and Disease	37
Summary of the post-European settlement era ecological changes in terms of forest structure, pattern and composition.....	41
Existing Condition – Cover Types.....	41
Non-Forest Cover Types	42
Forest Cover Types	42
Forest Structure (VSS, Density, Canopy Cover, Openness).....	46
Vegetation Structural Stage.....	46
Canopy Cover and Openness	51
Mexican Spotted Owl and Northern Goshawk Habitat.....	56
Forest Density and Structure – Mexican Spotted Owl.....	57
Forest Structure - Old Growth.....	68
Forest Health.....	75
Aspen	75
Bark Beetles.....	75
Dwarf Mistletoe	77
Salt damage.....	77
Climate Change.....	78

Desired Conditions	78
Supporting Science	78
Natural Range of Variability	79
Species Composition.....	80
Tree Density and Distribution.....	81
Forest Openings and the Grass/Forb/Shrub Vegetation Matrix	82
Sustainability and Resilience	82
Desired Conditions – General.....	83
Coconino Desired Conditions – MSO Habitat.....	84
Pine-Oak Restricted MSO Habitat.....	84
Pine-Oak Protected MSO Habitat.....	84
MSO Habitat - Desired Forest Density and Habitat Components	84
Kaibab Desired Conditions – MSO Habitat.....	85
Desired Conditions – Goshawk Habitat - Coconino.....	86
Ponderosa Pine Goshawk Nest Areas	86
Ponderosa Pine Goshawk Post-Fledging Family Area (PFA) Habitat	86
Ponderosa Pine Landscapes Outside Goshawk PFA (LOPFA) Habitat	87
Goshawk Habitat - Desired Forest Structure, Density and Habitat Components	87
Desired Conditions – Goshawk Habitat - Kaibab	88
Desired Conditions – Old Growth - Coconino.....	89
Desired Conditions – Old Growth - Kaibab.....	89
4FRI Coconino/Kaibab EIS - Vegetation Effects Analysis.....	90
Spatial and Temporal Context for Project Level Effects Analysis.....	90
Alternative A – No Action	90
Direct and Indirect Effects – Alternative A.....	90
Alternative B - Proposed Action.....	113
Alternative C (Preferred Alternative).....	138
Alternative D.....	158
Alternative E	179
Special Case Canopy Cover – Alternatives C and E	199
Summary of Direct and Indirect Effects	200
Summary of Mosaic of Interspaces and Tree Groups of Varying Sizes and Shapes	209
Mosaic of Interspaces and Tree Groups of Varying Sizes and Shapes.....	209
Summary of Openness	211
Cumulative Effects – All Alternatives.....	213
Alternative A.....	227
Alternatives B - D	232
Alternative E	240
Managing for High Canopy Cover on 46,091 acres	250
Slide Fire (2014) (Appendix H).....	254
Reasonably Foreseeable Projects With Insufficient Information for Analysis	254

References	258
Appendix A – Implementation Plan.....	272
Appendix D - Natural Range of Variability Comparison by Treatment Type (Alt B).....	395
Appendix E - Natural Range of Variability Comparison by Treatment Type (Alt C).....	425
Appendix F - Natural Range of Variability Comparison by Treatment Type (Alt D).....	457
Appendix G - Natural Range of Variability Comparison by Treatment Type (Alt E)	486
Silvicultural Consequences of Slide Fire	522

List of Tables

Table 1. Summary of analysis area Acres by RU and SU	20
Table 2. Summary of Acres and Percent of Total by Data Type, RU and National Forests within the Analysis area.....	21
Table 3. Proposed Action FVS Treatment Modeling Assumptions by Treatment Type.....	24
Table 4. Analysis area Cover Type Acres by Restoration Unit.....	45
Table 5: Description of Vegetation Structural Stages (VSS).....	47
Table 6. Existing Dominant VSS by PP Analysis area and Restoration Unit (507,839 Acres).....	48
Table 7. Relationships of Forest Density to Forest Stand Development and Tree Characteristics.....	50
Table 8. Stocking Guides to Meet Tree Group Canopy Cover Requirements Within Goshawk Habitat Areas Outside of PFAs (LOPFA)	52
Table 9 Stocking Guides to Meet Tree Group Canopy Cover Requirements Within Goshawk PFAs.....	53
Table 10 Existing Openness Classification for Ponderosa Pine.....	55
Table 11. Mexican Spotted Owl Habitat Stratification within the Analysis area (Acres within each RU)	56
Table 12. Northern Goshawk Habitat Stratification within the Analysis area (Acres by RU)	57
Table 13. Existing Spotted Owl Habitat Forest Structure and Habitat Components	59
Table 14. Existing Goshawk Nest/PFA Habitat Forest Structure and Habitat Components ...	61
Table 15. Existing Goshawk LOPFA Habitat Forest Structure and Habitat Components	62
Table 16. Existing Forest Structure – Goshawk LOPFA Even-Aged Stands Percent of Area by Vegetative Structural Stages (VSS).	64
Table 17. Existing Forest Structure – Goshawk LOPFA Uneven-Aged Stands Percent of Area by Vegetative Structural Stages (VSS).	65
Table 18. Existing Forest Structure – Goshawk PFA/Nest* Even-aged Stands Percent of Area by Vegetative Structural Stages (VSS).	66
Table 19. Existing Forest Structure – Goshawk PFA/Nest* Uneven-aged Stands Percent of Area by Vegetative Structural Stages (VSS).....	67
Table 20. 4FRI Analysis area ponderosa pine old growth acres and percent by restoration sub- unit/unit.....	71
Table 21. Existing 4FRI Analysis area of Ponderosa Pine Old Growth Structural Attributes	72
Table 22. Coconino NF Project area ponderosa pine old growth acres and percent by restoration unit/forest.....	73
Table 23. Project area pinyon-juniper old growth acres and percent by forest.....	74
Table 24. Existing 4FRI analysis area Pinyon-Juniper acres of Old Growth Structural Attributes	74
Table 25. Existing Ponderosa Pine Beetle Hazard Rating (Percent of area in each RU).....	76

Table 26. Dwarf Mistletoe Infection Level.....	77
Table 27. Ranges of reference conditions for ponderosa pine in the southwestern United States from studies detailed in RMRS-GTR-310 (Reynolds et al, 2013).	80
Table 28. MSO Habitat Desired Forest Density and Habitat Components.....	85
Table 29. Average Desired Condition - Stand Structure Ponderosa Pine Goshawk PFA Habitat	87
Table 30. Average Desired Condition - Stand Structure Ponderosa Pine Goshawk LOPFA Habitat.....	88
Table 31. Characterizes the desired range of forest density and habitat components.	88
Table 32.. Alternative A - 2020 and 2050 Spotted Owl Habitat Forest Structure and Habitat Components	91
Table 33. Alternative A – 2020 and 2050 Goshawk Nest/PFA Habitat Forest Structure and Habitat Components	92
Table 34: Alternative A – 2020 and 2050 Goshawk LOPFA Habitat Forest Structure and Habitat Components	94
Table 35. Alternative A - 2020 and 2050 VSS Distribution for Goshawk LOPFA Even-Aged Stands Percent of Area by Vegetative Structural Stages.	95
Table 36. Alternative A - 2020 and 2050 VSS Distribution for Goshawk LOPFA Uneven-aged Stands Percent of Area by Vegetative Structural Stage.....	98
Table 37 Alternative A - 2020 and 2050 VSS Distribution for Goshawk PFA Even-aged Stands Percent of Area by Vegetative Structural Stage.....	100
Table 38 Alternative A - Distribution for Goshawk PFA Uneven-Aged Stands Percent Area by VSS	102
Table 39. Alternative A – 2020 and 2050 Ponderosa Pine OG Structural Attributes by Restoration Unit.....	105
Table 40. Alternative A – 2020 and 2050 Pinyon-Juniper Old Growth Structural Attributes by Restoration Unit.....	106
Table 41. Alternative A – 2020 and 2050 Beetle Hazard Rating (Percent of Areas)	108
Table 42. Alternative A – 2020 and 2050 Dwarf Mistletoe Infection Level	108
Table 43. Alternative B mechanical treatment and prescribed fire acres by restoration unit (RU).....	114
Table 44. Alternative B summary of Acres proposed for treatments in ponderosa pine goshawk habitat	116
Table 45. Alternative B summary of acres of treatments in ponderosa pine MSO habitat	116
Table 46. Alternative B - 2020 and 2050 Spotted Owl Habitat Forest Structure and Habitat Components	118
Table 47. Alternative B - Goshawk Nest/PFA Habitat Forest Structure and Habitat Components	119
Table 48. Alternative B - Goshawk LOPFA Habitat Forest Structure and Habitat Components	120
Table 49. Alternative B - 2020 and 2050 VSS Distribution for Goshawk LOPFA Even-Aged Stands Percent of Area by Vegetative Structural Stages	121
Table 50. Alternative B - 2020 and 2050 VSS Distribution for Goshawk LOPFA Uneven-Aged Stands Percent of Area by Vegetative Structural Stage	123
Table 51. Alternative B - 2020 and 2050 VSS Distribution for Goshawk PFA Even-aged Stands Percent of Area by Vegetative Structural Stage.....	125
Table 52. Alternative B - 2020 and 2050 VSS Distribution for Goshawk PFA Uneven-aged Stands Percent of Area by Vegetative Structural Stage.....	126

Table 53. Alternative B – 2020 and 2050 Ponderosa Pine OG Structural Attributes by Restoration Unit.....	128
Table 54. Alternative B – 2020 and 2050 Pinyon-Juniper Allocated Old Growth Structural Attributes by Restoration Unit.....	129
Table 55. Alternative B – Post Treatment Openness Classification for Ponderosa Pine	130
Table 56. Alternative B - summary of ponderosa pine treatment acres by their relative ability to attain a mosaic of interspaces and tree groups.....	131
Table 57. Alternative B - Estimated 2020 and 2050 Beetle Hazard Rating (Percent of Area)	133
Table 58. Alternative B Estimated Post Treatment and Long Term Dwarf Mistletoe Infection Level	134
Table 59. Alternative C mechanical treatment and prescribed fire acres by restoration unit (RU).....	141
Table 60. Alternative C summary of Acres Proposed for treatments in ponderosa pine goshawk habitat	143
Table 61. Alternative C summary acres of treatments in ponderosa pine MSO habitat.....	143
Table 62. Alternative C - 2020 and 2050 Spotted Owl Habitat Forest Structure and Habitat Components	145
Table 63. Alternative C - 2020 and 2050 VSS Distribution Differences Compared to Alternative B Percent of Area by Vegetative Structural Stages	146
Table 64. Alternative C –OG Structural Attributes by Restoration Unit.....	148
Table 65. Alternative C – Post Treatment Openness Classification for Ponderosa Pine	149
Table 66. Alternative C summary of ponderosa pine treatment acres by their relative ability to attain a mosaic of interspaces and tree groups.....	151
Table 67. Alternative C Estimated Post Treatment and Long Term Beetle Hazard Rating (Percent of Area).....	153
Table 68. Alternative C Estimated Post Treatment and Long Term Dwarf Mistletoe Infection Level	154
Table 69. Alternative D mechanical treatment and prescribed fire acres by restoration unit (RU).....	159
Table 70. Alternative D summary of acres proposed for treatments in ponderosa pine goshawk habitat	161
Table 71. Alternative D summary of treatments in ponderosa pine MSO habitat	162
Table 72. Alternative D - 2020 and 2050 Spotted Owl Habitat Forest Structure and Habitat Components	163
Table 73. Alternative D - Average Goshawk Nest/PFA Habitat Structural Attributes	164
Table 74. Alternative D - Average Goshawk LOPFA Habitat Structural Attributes	165
Table 75. Alternative D - 2020 and 2050 VSS Distribution Differences Compared to Alternative B Percent of Area by Vegetative Structural Stage.....	167
Table 76. Alternative D –OG Structural Attributes by Restoration Unit	169
Table 77. Alternative D – Post Treatment Openness Classification for Ponderosa Pine	171
Table 78. Alternative D summary of ponderosa pine treatment acres by their relative ability to attain a mosaic of interspaces and tree groups.....	172
Table 79. Alternative D - Estimated 2020 and 2050 Beetle Hazard Rating.....	174
Table 80. Alternative D Estimated Post Treatment and Long Term Dwarf Mistletoe Infection Level	175
Table 81. Alternative E mechanical treatment and prescribed fire acres by restoration unit (RU).....	181

Table 82. Alternative E summary of Acres Proposed for treatments in ponderosa pine goshawk habitat	183
Table 83. Alternative E summary of treatment acres in ponderosa pine MSO habitat	183
Table 84. Alternative E - 2020 and 2050 Spotted Owl Habitat Forest Structure and Habitat Components	185
Table 85 Alternative E - 2020 and 2050 VSS Distribution Differences Compared to Alternative B Percent of Area by Vegetative Structural Stage.....	187
Table 86. Alternative E –OG Structural Attributes by Restoration Unit.....	189
Table 87. Alternative E – Post Treatment Openness Classification for Ponderosa Pine.....	191
Table 88. Alternative E summary of ponderosa pine treatment acres by their relative ability to attain a mosaic of interspaces and tree groups.....	193
Table 89. Alternative E Estimated Post Treatment and Long Term Beetle Hazard Rating (Percent of Area).....	195
Table 90. Alternative E Estimated Post Treatment and Long Term Dwarf Mistletoe Infection Level	196
Table 91. Comparison of Effects by Alternative	201
Table 92. 2001 to 2013 – Approximate Acres of Vegetation Management Activities and Prescribed Fire within or Adjacent to Project Area.....	213
Table 93. Estimated acres of vegetation management activities potentially affecting 4Fri proposed treatments for RU6.....	214
Table 94. Large wildfires in or near the southern portion of the project area from 2001 – 2014.	215
Table 95. Wildfires in Restoration Unit 6.	216
Table 96. Summary of past projects that have influenced existing conditions (2000 to 2013)	221
Table 97. Summary of past vegetation and prescribed fire project acres (2000 to 2013) adjacent to the project area	224
Table 98. Acres affected by insect and disease outbreaks by forest (within project area)	227
Table 99. Goshawk treatments and acres to be measured at the stand level	251
Table 100. Reasonably foreseeable vegetation and ground-disturbing projects within and adjacent to project area	255
Table 101. Annual implementation checklist.....	274
Table 102. Planned acres by treatment type and restoration unit (RU)	275
Table 103. NEPA, NFMA, ESA, CFLR Act compliance evaluation.....	277
Table 104. Supporting documentation checklist	279
Table 105. Minimum desired conditions for pine-oak forest areas managed for Recovery nesting/roosting habitat (USDI FWS 2012).....	282
Table 106. Percent of trees, tree groups, and interspaces by treatment intensity (landscapes outside of goshawk post-fledging areas)	286
Table 107. Landscapes outside of goshawk post-fledging areas wildland-urban interface and uneven-aged treatments stocking guidelines for tree groups	287
Table 108. Interspace percent and width in Landscapes Outside of Goshawk Post-fledging Areas wildland-urban interface (WUI) and uneven-aged (UEA) treatments.....	288
Table 109. Percent of area occupied by trees, tree groups, and interspace in landscapes outside of goshawk post-fledging areas intermediate thin (IT)	289
Table 110. Stocking guidelines for VSS 4 to 6 tree groups in landscapes outside of goshawk post- fledging areas intermediate thin (IT) treatments.....	291
Table 111. Percent and width of interspace in landscapes outside of goshawk post-fledging areas intermediate thin (IT) treatments.....	291

Table 112 Stocking guidelines for tree groups in landscapes outside of goshawk post-fledging areas stand improvement (SI) treatments	292
Table 113. Interspace percent and width landscapes outside of goshawk post-fledging areas stand improvement (SI) treatments	292
Table 114. Stocking guidelines for VSS 4 to VSS 6 tree groups in landscapes outside of goshawk post-fledging areas pine-sage treatments.....	294
Table 115. Percent of area occupied by individual trees, tree groups, and interspace in dispersal post-fledging family areas / post-fledging family areas uneven-aged (UEA) treatments.....	297
Table 116. Stocking guidelines for tree groups in dispersal post-fledging family areas / post-fledging family areas wildland-urban interface and uneven-aged treatments	299
Table 117. Interspace percent and width in dispersal post-fledging family areas / post-fledging family areas wildland-urban interface and uneven-aged (UEA) treatments.....	300
Table 118. Percent of area occupied by trees and interspace for dispersal post-fledging family areas / post-fledging family areas intermediate thin (IT).....	301
Table 119. Dispersal post-fledging family areas / post-fledging family areas intermediate thin (IT) treatments stocking guidelines for VSS 4 – 6 tree groups	302
Table 120. Interspace percent and width in dispersal post-fledging family areas / post-fledging family areas intermediate thin (IT).....	303
Table 121. Percent of area occupied by individual trees, tree groups, and interspaces in dispersal post-fledging family areas / post-fledging family areas stand improvement (SI) treatments.....	304
Table 122. Stocking guidelines for tree groups in dispersal post-fledging family areas / post-fledging family areas stand improvement (SI) treatments.....	305
Table 123 Interspace percent and width in dispersal post-fledging family areas / post-fledging family areas stand improvement (SI) treatments	306
Table 124. Stocking guidelines for VSS 4–6 tree groups in dispersal post-fledging family areas / post-fledging family areas pine-sage treatments	308
Table 125. Minimum structural attributes in suitable goshawk nest stands*.....	309
Table 126. Section B decision matrix for establishing tree groups, interspace, and regeneration openings	313
Table 127. Section E the relationship between treatment intensity, tree group density, and overall average density	327
Table 128. Project Consistency to the Forest Plan Desired Conditions, Standards and Guidelines	339
Table 129. Acres by Treatment and RAVG Class (Alt C) (Mark Nigrelli)	517
Table 130. RAVG Class of Basal Area Loss by Fire Severity	517
Table 131 Proposed Treatments Affected By Slide by Basal Area Mortality	522
Table 132. Crosswalk 2012 to 1995 MSO Recovery Plan to 4FRI	526
Table 133 Table III.B.1 from the 1995 MSO Recovery Plan (The Pine-oak row is of interest to this project).....	547
Table 134 Table C3 from the 2012 MSO Recovery Plan. Of interest for this project is the Pine-oak row.	548
Table 135: Table C3 from the 2012 MSO Recovery Plan. Of interest for this project is the Pine-oak row.	550
Table 136 Timber suitability calculation for the Kaibab & Coconino NF	554
Table 137. Alternative B ponderosa pine treatments	555
Table 138. Alternative C ponderosa pine treatments	556
Table 139. Alternative D ponderosa pine treatments	556

Table 140. Alternative E ponderosa pine treatments.....	557
Table 141. Cover Type Acres by Restoration Unit.....	557
Table 142. Summary of CFN forest plan amendments by alternative and theme (FEIS Appendix B).....	558

List of Figures

Figure 1. Four Forest Restoration Initiative (4FRI) project area	18
Figure 2. Restoration Units (RU) within the Project Area	19
Figure 3: From: Oliver 2005, Fig. 1.....	32
Figure 4 is the stocking guides, per diameter class, that will be used to meet canopy cover requirements in tree groups within goshawk LOPFA habitat.	53
Figure 5 Typical stocking of a one acre group to meet PFA canopy cover desired condition. ** Densities are equivalent to 50% canopy cover	54
Figure 6: Stratification of ponderosa pine forested lands, other cover types and non-forested land.	56
Figure 7. MSO Guidelines From 2012 Recovery Plan	86
Figure 8. Alternative B general locations of mechanical and prescribed fire treatments.....	113
Figure 9. Alternative B mechanical and prescribed fire treatments in goshawk and MSO habitat	115
Figure 10. Alternative C mechanical and prescribed fire treatments	139
Figure 11. Alternative C mechanical and prescribed fire treatments in goshawk and MSO habitat	142
Figure 12. Alternative D mechanical and prescribed fire treatments.....	158
Figure 13. Alternative D mechanical and prescribed fire treatments in goshawk and MSO habitat	160
Figure 14. Alternative E mechanical and prescribed fire treatments	180
Figure 15. Alternative E mechanical and prescribed fire treatments in goshawk & MSO habitat	182
Figure 16. Pre-1996 vegetation and prescribed fire projects within the project area.....	220
Figure 17. General locations of past projects (post-1996) within the project area	225
Figure 18. Managing for Higher Canopy Cover	253
Figure 19. General locations of foreseeable projects within or adjacent to the project area	257
Figure 20: Overview of Southern EIS area showing relationship of Slide fire to project (Mary Lata, Slide Fire Ecology Report, 2014)	516
Figure 21. RVAG Map with Evaluation Route (Mark Nigrelli).....	518
Figure 22. Low Fire Intensity Burn with Fern Response.....	519
Figure 23. RAVG 11-25% Class with moderate severity burn (Photo by Mary Lata).....	520
Figure 24: RAVG 26-50% (BAER, 2014)	521
Figure 25: RAVG >51% High severity fire effects (Mary Lata).....	521
Figure 26. Spatial distributions of observed seedling density (Bonnet, 2005)	522
Figure 27. One, of many stand configurations meeting the 1995 MSO Recovery Plan criteria.	551
Figure 28. One, of many stand configurations meeting the 2012 MSO Recover Plan criteria.	551

Silviculture Specialist Report

Four-Forest Restoration Initiative

Introduction

The objective of the project is to restore forest structure, pattern, composition, diversity and landscape heterogeneity, within the ponderosa pine (*Pinus ponderosa*) ecosystem that will lead to increased forest resiliency and function. The intent of the 4FRI project is to obtain a high level of vegetative responses that will increase ecosystem diversity by increasing horizontal and vertical heterogeneity. Restoration initiates or accelerates ecosystem recovery with respect to ecological health, integrity, and sustainability (Reynolds et al 2013). Resiliency increases the ability of the ponderosa pine forest to survive natural disturbances such as insects, diseases, fire, and climate change (FSM 2020.5) without changing its inherent function (SER 2004). Restoration activities proposed with this project are expected to put the project area on a trajectory towards comprehensive, landscape-scale restoration, with benefits that include improved vegetation biodiversity, wildlife habitat, soil productivity, and watershed function, as well as increased forest structure heterogeneity.

Silviculture is 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, shrub) density, structure, and diseases, such as dwarf mistletoe, are the primary forest conditions that can be affected by silvicultural treatments. Stand composition can be altered with silvicultural treatments by manipulating a stand to create early seral¹ stage conditions.

The silviculture specialist report describes the existing vegetation condition and summarizes the forestland and cover types meeting definitions for Mexican spotted owl (MSO) and northern goshawk habitats. It compares those conditions to the desired vegetation conditions for the project area and illustrates the need for change. The report describes the proposed treatments and the effects of those treatments on the vegetation resource by characterizing the post treatment condition over time for each alternative. The report also evaluates each alternative in terms of moving toward the desired vegetation conditions.

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. Literature reviewed and cited is listed in the appendix.

¹ Seral – a temporal or intermediate stage in the process of succession (SAF 1998)

- Modeling using currently acceptable analysis. The vegetation management was analyzed using the current Forest Vegetation Simulation model. The model uses Stand Visualization Systems, and stand summary statistics to predict future stand structure, density, and composition.
- Professional knowledge, judgment and experience. The primary specialist who conducted the vegetation management analysis was Neil McCusker. Richard Gonzalez and Dr. Randy Fuller were secondary. 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.

Purpose and Need for Action

The purpose and need for proposing an action was determined by comparing the objectives and desired conditions in the Coconino NF and Kaibab NF Land Resource and Management Plans (forest plans) to the existing conditions related to forest resiliency and forest function.

Legal Requirements

Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528-531): Requires that national forest lands shall be administered for a variety of multiple uses, and that all resources shall be maintained as renewable in perpetuity for regular periodic output of several products and services at a sustainable level

National Environmental Policy Act (NEPA) of 1969 (16 U.S.C. 4321 et seq.): Established procedures for making decisions, disclosure of effects, and public involvement on all major federal actions

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)

National Forest Management Act of 1976 (NFMA): The Coconino forest plan was developed in accordance with NFMA, as expressed by the 1982 planning rule

Healthy Forests Restoration Act (HFRA) of 2003 (16 U.S.C. at 1611-6591)

Federal Land Assistance Management and Enhancement Act (FLAME) of 2009 (Title V of Division A of P.L. 111-88)

Omnibus Public Land Management Act of 2009 (Title IV – Forest Landscape Restoration of PL 111-11)

Collaborative Forest Landscape Restoration Fund (CFLR)

Coconino National Forest (USDA 1987, as updated 2011)

National Forest System Land Management Planning (36 CFR Part 219) (2012 Planning Rule)

Kaibab National Forest (USDA 2014)

Kaibab National Forest Plan Revision

During the process of developing this silviculture report, and after the collected data was analyzed, the Kaibab National Forest approved and implemented a new forest plan (USDA, 2014): Land and Resource Management Plan for the Kaibab National Forest. While the change in forest plan did not change the planned treatments or treated acres under the 4FRI program, it did necessitate a change in the way some analysis attributes are discussed and displayed. The 2014 Kaibab Forest Plan changed definitions and desired conditions within the project area (i.e., old growth, VSS, canopy cover, Uneven-aged management emphasis, etc.). On the Kaibab NF, the project area includes guidelines for pinyon-juniper, aspen, grasslands and all forested communities in the form of Desired Conditions.

Desired Conditions (Goals) describe the aspirational picture for the Kaibab NF. Goals, as required by the 1982 Planning Rule provisions, are articulated as “desired conditions” in this plan. They are the ecological and socioeconomic attributes toward which management of the land and resources of the plan area are directed. They are not commitments or final decisions approving projects or activities; rather, they guide the development of projects and activities. They have been written to contain enough specificity to allow for determining progress toward their achievement. Projects are designed to maintain or move toward desired conditions and to be consistent with the plan over the long term. In some cases, goals/desired conditions may only be achievable over hundreds of years (KFP page 5). For ease of understanding, the discussions and tables that follow display some of the Kaibab information in the same format as the Coconino. References to “KFP” mean the 2014 Kaibab Forest Plan and “CFP” mean the 1987 (as amended 1996) Coconino Forest Plan. The change in plans required a further clarification of consistency of Kaibab forest plan Standards, Guidelines and desired conditions for the project (Appendix B).

The Kaibab National Forest completed a Comprehensive Evaluation Report (CER) (USDA Forest Service 2009) and CER Supplement (USDA Forest Service 2010) to meet the requirements of the Analysis of the Management Situation (AMS).

As stated in the Kaibab Forest Plan:

The CER/AMS and subsequent management reviews considered this information along with the Forest Service mission, Forest role and contributions, and anticipated demands. They identified four areas where there were priority needs for change in program direction. These are to:

- Modify forest structure and species composition to restore or maintain sustainability and restore historic fire regimes
- Protect and regenerate aspen to ensure long-term healthy aspen populations
- Protect and restore natural waters and wetlands to ensure healthy riparian communities
- Restore grasslands by reducing tree encroachment and restoring fire

This silviculture report, as outlined in the Introduction, is consistent with the Kaibab NF’s four stated priority area needs. Furthermore, the Kaibab Forest Plan goes on to state:

“On the Williams and Tusayan Ranger Districts, much of the restoration work needed to attain desired conditions is likely to be implemented through the Four Forest Restoration Initiative (4FRI). The 4FRI is a large-scale, collaboratively driven project with the goal of restoring forest ecosystems on portions of the Coconino, Kaibab, Apache-Sitgreaves, and Tonto National Forests.

Coordination with the 4FRI planning effort has been ongoing to ensure consistency with this plan.” (KFP, page 20)

Guidelines for Management Activities in Ponderosa Pine Communities (KFP)

This plan emphasizes restoration of ponderosa pine forests because these forests are highly departed from desired conditions and were identified as a priority need for change. Projects in ponderosa pine are aimed at restoring forest structure and process (e.g. natural disturbances such as low-severity fire and dwarf mistletoe, watershed function, and nutrient cycling).

Fine-scale (10 acres or less) Desired Conditions for Ponderosa Pine

- Trees typically occur in irregularly shaped groups and are variably spaced with some tight clumps. Trees within groups are of similar or variable ages and may contain species other than ponderosa pine.
- Tree groups are made up of clumps of various age classes and size classes that typically occur in areas less than one acre, but may be larger, such as on north-facing slopes.
- Crowns of trees within the mid-aged to old groups are interlocking or nearly interlocking and consist of approximately 2 to 40 trees per group.
- The interspaces between groups are variably shaped and comprised of native grass/forb/shrub mix possibly containing individual trees or snags. Regeneration openings occur as a mosaic and are similar in size to nearby groups.
- Organic ground cover and herbaceous vegetation provide protection for soil and moisture infiltration, and contribute to plant and animal diversity and ecosystem function. Herbaceous vegetation reflects the site potential.
- Where historically occurring, Gambel oak (*Quercus gambelii*) thickets with various diameter stems and low growing, shrubby oak are present. These thickets provide forage, cover, and habitat for species that depend on them such as small mammals, foliage nesting birds, deer, and elk. Gambel oak mast (acorns) provides food for wildlife species. Large tree form oaks, snags, and partial snags with hollow boles or limbs are present.
- Where Gambel oak comprises more than 10 percent of the basal area, it can be common for canopy cover to be greater than 40 percent.
- Isolated infestations of Southwestern dwarf mistletoe may occur, but the degree of severity and amount of mortality varies among the infected trees. Witches’ brooms may form on infected trees, providing habitat and food for wildlife and invertebrate species.
- Fires generally burn as surface fires, but singletree torching and isolated group torching can be common.

Mid-scale (100 to 1,000 acres) Desired Conditions for Ponderosa Pine

- The ponderosa pine forest vegetation community is characterized by variation in the size and number of tree groups depending on elevation, soil type, aspect, and site productivity. The mosaic of tree groups generally comprises an uneven-aged forest with all age classes and structural stages present. Stands are dominated by ponderosa pine, but other native hardwood and conifer species occur. The more biologically productive sites contain more trees per group and more groups per area.

- Basal area within forested areas generally ranges from 20 to 80 square feet per acre, with larger trees (i.e. >18 inches in diameter) contributing the greatest percent of the total basal area
- Interspaces with native grass/forb/shrub vegetation are variably shaped typically ranging from 10 to 70 percent of area, with more open conditions typically occurring on less productive sites
- Forest conditions in some areas contain 10 to 20 percent higher basal area in mid- to old-aged tree groups than in the general forest (e.g., goshawk post-fledging family areas, Mexican spotted owl nesting/roosting habitat, drainages, and steep north-facing slopes)
- Patches of even-aged forest structure are present, but infrequent. Disturbances sustain the overall variation in age and structural diversity
- Snags and green snags 18 inches in diameter at breast height (d.b.h.) or greater average 1 to 2 per acre. Snags and green snags of various sizes and forms are common
- Downed logs (greater than 12 inches diameter at mid-point and greater than 8 feet long) average 3 logs per acre. Coarse woody debris greater than 3 inches in diameter (including downed logs), ranges from 3 to 10 tons per acre
- Fires burn primarily on the forest floor and typically do not spread between tree groups as crown fire

Landscape-scale (over 10,000 acres) Desired Conditions for Ponderosa Pine

- The ponderosa pine forest vegetation community is a mosaic of forest conditions composed of structural stages ranging from young to old trees. The forest is generally uneven-aged and open. Groups of old trees mix with groups of younger trees. Occasional areas of even-aged structure are present. Denser tree conditions exist in some locations such as north-facing slopes, canyons, and drainage bottoms
- The ponderosa pine forest is composed predominantly of vigorous trees, but declining trees are present. Snags, green snags, and coarse woody debris occur across the landscape.
- Where it naturally occurs, Gambel oak is present with all structure classes represented. It is reproducing and maintaining or expanding its presence within its natural range of variability.
- Old growth 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, snags, coarse woody debris, and structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbances (e.g., fire, insect/disease, tree growth and mortality)
- The landscape is a functioning ecosystem that contains all components, processes, and conditions associated with endemic levels of disturbances (e.g., fire, dwarf mistletoe, insects, diseases, lightning, drought, and wind)
- Forest vegetation conditions are resilient to the frequency, extent, and severity of disturbances and climate variability. Grasses and needle cast provide the fine flashy fuels needed to maintain the natural fire regime. Fire and other disturbances are sufficient to maintain desired overall tree density, structure, species composition, coarse woody debris fuel loads, and nutrient cycling

- The risk of uncharacteristic high-severity fire and associated loss of key ecosystem components is low
- Frequent, low-severity fires (Fire Regime I) occur across the entire landscape with a return interval of 0 to 35 years

Objectives for Ponderosa Pine

- To make progress toward the desired conditions and reduce the potential for active crown fire in ponderosa pine communities at a rate that would maintain the desired conditions over time
- Mechanically thin 11,000 to 19,000 acres annually
- Treat an average of 13,000 to 55,000 acres annually, using a combination of prescribed fire and naturally ignited wildfires

Desired Conditions for Pinyon-juniper Woodlands

- Pinyon-juniper woodland (persistent) is characterized by even-aged patches of pinyon and juniper that, at the landscape level, form uneven-aged woodlands. Tree density and canopy cover are high, shrubs are sparse to moderate, and herbaceous cover is low and discontinuous due to soil and other site conditions.
- Some very old trees (>300-years old) are present.
- Disturbances rarely affect the composition, structure, and function. Insects, disease, and mistletoe occur at endemic levels. Fire disturbance is infrequent and variable due to lack of continuous ground cover.
- Fires are mixed to high severity, but generally stand replacing, occurring infrequently at intervals of 200 years or more (Fire Regime V).

Guidelines for Management Activities in Pinyon-juniper Communities

The pinyon-juniper vegetation communities (pinyon-juniper grassland, shrubland, or woodland) should be determined before developing project proposals to ensure the applicable desired conditions are applied. (KFP, page 15)

Restoration efforts should emphasize the retention of groups of mature trees where they occurred historically. (KFP, page 15)

Where pinyon-juniper obligate species occur (e.g. gray vireo), project design should retain key habitat features including snags, and partially dead or dying trees, and downed logs. (KFP, page 15)

Pinyon-juniper communities should maintain tree densities that maximize herbaceous plant growth and wildlife species diversity typical for their respective community subtype. (KFP, page 15)

Project design for vegetation management activities should prioritize analysis areas along known wildlife corridors, in the wildland-urban interface, and in historic openings. (KFP, page 15)

Restoration treatments in pinyon-juniper should be rotated over time and various successional stages to maximize wildlife habitat and diversity. (KFP, page 15)

Guidelines for Aspen Management

Use small patch clearcuts (less than 5 acres in size), conifer removal, and wildland fire to stimulate aspen sprouting in areas that have or previously had aspen. (KFP, page 29)

Protect aspen trees 10 inches or greater DBH (both live and dead) during project activities, except where they may pose a risk to safety, fences, or regeneration efforts. (KFP, page 29)

Regularly inspect and maintain fences while aspen recovers. Remove fences when no longer needed. (KFP, page 29)

Standards for Vegetation Management in All Forested Communities

The maximum size opening that may be created in one harvest operation for the purpose of creating an even-aged stand shall not exceed 40 acres except when it is following a large-scale disturbance event such as a stand replacing fire, wind storm, or insect or disease outbreak. (KFP, page 30)

When openings are created with the intent of regeneration, effort shall be made to ensure that lands can be adequately restocked within 5 years of final harvest. (KFP, page 30)

Clearcutting shall only be used where it is the optimum harvesting method for making progress towards the desired conditions. (KFP, page 30)

Guidelines for Vegetation Management in All Forested Communities

Projects in forested communities that change stand structure should generally retain at least historic frequencies of trees by species across broad age and diameter classes at the mid-scale. As such, the largest and oldest trees are usually retained. (KFP, page 30)

On suitable timberlands, projects should retain somewhat higher frequencies of trees across broad diameter classes to allow for future tree harvest. (KFP, page 30)

Project design should manage for replacement structural stages to assure continuous representation of old growth over time. (KFP, page 30)

Project design and treatment prescriptions should generally not remove:

1. Large, old ponderosa pine trees with reddish-yellow, wide platy bark, flattened tops, with moderate to full crowns and large drooping or gnarled limbs (e.g. Thomson's age class 4, Dunning's tree class 5 and/or Keen's Tree Class 4, A & B (appendix C). (KFP, page 30)
2. Mature trees with large dwarf mistletoe induced witches' brooms suitable for wildlife nesting, caching, and denning, except where retaining such trees would prevent the desired development of Uneven-aged conditions over time. (KFP, page 30)
3. Large snags, partial snags, and trees (>18 inches DBH) with broken tops, cavities, sloughing bark, lightning scars >4 inches wide, and large stick nests (>18 inches in diameter). (KFP, page 30)
4. Gambel oak >8 inches, diameter at root collar (d.r.c.). (KFP, page 30)
5. Known bat roost trees. (KFP, page 30)

The location and layout of vegetation management activities should effectively disconnect large expanses of continuous predicted active crown fire. (KFP, page 30)

Vegetation management prescriptions should provide for sufficient canopy breaks to limit crown fire spread between groups, allow for the redevelopment and maintenance of a robust understory, and mimic the spatial arrangement of the reference conditions. (KFP, page 30)

Vegetation management activities in mixed conifer forests should incorporate experimental design features and monitoring to accelerate learning and adaptive management. Trees established after 1890 should generally not be retained in areas where biophysical conditions would have supported stable openings over time. (KFP, page 30)

Vegetation management activities should meet or exceed goals for scenic beauty (scenic integrity objectives) by creating natural patterns, structure and composition of trees, shrubs, grasses, and other plants. (KFP, page 31)

Vegetation management should favor the development of native understory species in areas where they have the potential to establish and grow. (KFP, page 31)

Even-aged silvicultural practices may be used as a strategy for achieving the desired conditions over the long term, such as bringing dwarf mistletoe infection levels to within a sustainable range, or old tree retention. (KFP, page 31)

Seed and plants used for revegetation should originate from the appropriate PNVNT and general ecoregion (i.e. southern Colorado Plateau) as the project area. (KFP, page 31)

Heavy equipment and log decks should not be staged in montane meadows. (KFP, page 31)

Guidelines for Restoring Grasslands

Pronghorn fence crossings should be installed along known movement corridors. (KFP, page 32)

Prior to implementation of grassland restoration treatments, consideration should be given to making the residual firewood available for personal collection. (KFP, page 32)

In areas where native herbaceous cover is sparse and seed sources do not exist, seeding should be considered. (KFP, page 32)

Guidelines for Wildlife Management

Project activities and special uses should be designed and implemented to maintain refugia and critical life cycle needs of wildlife, particularly for raptors. (KFP, page 49)

Project activities and special uses should incorporate recommended measures for golden eagle management such as temporary closures to limit human disturbance in the vicinity of golden eagle nests. (KFP, page 49)

Potentially disturbing project-related activities should be restricted within 300 yards of active raptor nest sites between April 1 and August 15. (KFP, page 49)

Guidelines for Threatened, Endangered, and Sensitive Species

Project activities and special uses occurring within federally listed species habitat should integrate habitat management objectives and species protection measures from approved recovery plans. (KFP, page 51)

Project activities and special uses should be designed and implemented to maintain refugia and critical life cycle needs of Forest Service Sensitive Species. (KFP, page 51)

Activities occurring near areas used by bald eagles should follow recommendations identified in the National Bald Eagle Management Guidelines and Arizona Conservation Assessment and Strategy for the Bald Eagle. (KFP, page 51)

A minimum of six goshawk nest areas (known and replacement) should be located per territory. Nest and replacement nest areas should generally be located in drainages, at the base of slopes, and on northerly (NW to NE) aspects. Nest areas should generally be 25 to 30 acres in size. (KFP, page 51)

Goshawk PFAs (post-fledging family areas) of approximately 420 acres in size should be designated surrounding the nest sites. (KFP, page 52)

Potentially disturbing project-related activities should be minimized in occupied goshawk nest areas during nesting season of March 1 through September 30 (KFP, page 52)

Coconino National Forest

The Coconino NF plan sets direction by the use of Mission, Goals, and Objectives. The mission, goals, and objectives for the Forest are realized by applying groups of management activities to specific units of land. Groups of management activities are called "Prescriptions" and the land units are called "Management Areas". Prescriptions are management practices selected and scheduled to apply to a specific area to attain multiple-use and other goals and objectives. A management area is a unit of land where a given prescription is to be applied. The direction of the Coconino FP is more prescriptive when compared to the Kaibab FP.

The project area includes 23 Management Areas (MA) as described in the Coconino NF forest plan (CFP, pp. 46 to 206-113). Ponderosa pine and mixed conifer on less than 40 percent slopes (MA-03) makes up approximately 194,464 acres of the project area. Lake Mary Watershed (MA 35), West (MA-38), Doney (MA-33) Cinder Hills (MA 13), unsuitable timber land (MA 6) and Deadman Wash (MA 32) comprise another 108,724 acres in the project area. The remaining 14 management area acres within the project areas range from as few as 15 acres (Developed Recreation Sites MA 15) to approximately 8,968 acres in the Craters MA (MA 31).

Insect and Disease Management - Cuts are designed to eliminate or reduce dwarf mistletoe infections to manageable levels (CFP, page70).

Integrated Stand Management (ISM) - Establish and maintain stand diversity through ISM to provide suitable habitat for wildlife in lands suitable for timber production, while maintaining or enhancing timber resource production and timber age class distribution (CFP, page70).

Manage the approximately 12,100 acres identified as the pine-aspen capability area for aspen, on a regulated, sustained-yield basis to maintain aspen as a component of the Forest (CFP, MA3, page 118).

Uneven-aged management will be emphasized (CFP, MA3, page 123).

Manage oak to improve wildlife habitat. Maintain oak components wherever they occur (CFP, MA3, page 131).

The alligator juniper component of the ponderosa pine is managed primarily for maintaining and enhancing wildlife habitat (CFP, MA3, page 132).

Reduce competition between closely spaced trees in some areas, to promote future large trees faster and to achieve desired tree sizes and canopy closures outlined in the Forest Plan (Mexican spotted owl and northern goshawk habitat guidelines) (CFP, page 206-75).

Reduce competition between closely spaced trees in some areas to promote health and resistance to insects and disease (CFP, page 206-75).

Vegetation Management Practices for ponderosa pine, oak and aspen vegetation types as it applies to Uneven-aged harvest systems, stand improvement thinning, intermediate thinning, and prescribed burning (CFP, page 242-19).

Mexican Spotted Owl Recovery Plan

Language specific to the 1995 MSO recovery plan (USDIFWS, 1995) is incorporated into the CFP, as amended. The 1995 MSO Recovery Plan formed the basis of the MSO analysis in the 4FRI Coconino NF and Kaibab NF DEIS when it was released for a 60-day comment period in March of 2013. The DEIS included plan amendments that were developed to ensure the preferred alternative (alternative C in the DEIS) would be consistent with the wording in the Coconino and former Kaibab forest plans incorporated from the 1995 recovery plan (the only recovery plan existing at the time of the DEIS development). The FWS participated in meetings, field reviews, and development of treatment objectives to ensure the 4FRI project met the intent of the Revised 2012 MSO Recovery Plan (USDIFWS, 2012) that was under development at that time. Shortly after the 4FRI DEIS was sent to the government printer in December 2012, which was the culmination of approximately two years of developing treatment strategies, building databases, summarizing treatment effects, and analyzing model outputs, the FWS released the Revised Recovery Plan (USDIFWS 2012). Because of the enormity of this effort, the FWS agreed to use the wording and metrics of the original MSO recovery plan in the Biological Assessment submitted to the FWS in February of 2014. While the analysis below retains some of the terminology and guidelines specific to the former recovery plan, the FWS evaluated the effects of the proposed actions on spotted owls based on the 2012 Revised Recovery Plan. Consistency with the revised MSO Recovery Plan was documented in the Biological Opinion as part of consultation with the FWS (Wildlife Report Consultation Appendix). A crosswalk between the 1995 and 2012 MSO Recovery Plans can be found in the Appendix J and in the Wildlife Specialist Report. This silviculture specialist report utilizes terminology consistent with the Coconino Forest plan and the 4FRI DEIS. See Appendix B of the Silviculture Specialist report for further clarification of consistency of Kaibab forest plan and the project.

Elements that relate to forest vegetation operations for the Mexican spotted owl include:

Provide three levels of habitat management- protected, restricted, and other forest and woodland types to achieve a diversity of habitat conditions across the landscape. Protected areas include delineated protected activity centers; mixed conifer and pine-oak forests with slopes greater than 40% where timber harvest has not occurred in the last 20 years; and reserved lands that include wilderness, primitive areas, research natural areas, wild and scenic rivers, and congressionally recognized wilderness study areas. Restricted areas include all mixed-conifer, pine-oak, and riparian outside of protected areas.²

² The current Coconino National Forest Plan is no longer in alignment with the revised MSO Recovery Plan 2012.

Protected Activity Centers (PACs):

Allow no timber harvest except for fuelwood and fire risk abatement in established PACS. Allow no timber harvest except for fire risk abatement in mixed-conifer and pine-oak forests on slopes greater than 40% where timber harvest has not occurred in the last 20 years.

Use combinations of thinning trees less than 9 inches in diameter, mechanical fuel treatment and prescribed fire to mitigate fire risk in the remained of the PAC outside the 100 acre “no treatment” area.

Large woody debris, snags, clumps of broadleaf wood vegetation should be retained and hardwood trees larger than 10 inches at the root collar.

Limit human activity in PACs during the breeding season (March 1 through August 31).

Restricted and Target/Threshold Areas (Mixed conifer, pine-oak, and riparian forests):

Restricted

Manage to ensure a sustained level of owl nest/roost habitat well distributed across the landscape. Create replacement owl/roost habitat where appropriate while providing a diversity of stand conditions across the landscape to ensure habitat for a diversity of prey species.

Emphasize Uneven-aged management silvicultural systems. However, both even-aged and Uneven-aged systems can be used where appropriate to provide variation in existing stand structure and species diversity.

Retain all trees greater than 24 inches DBH.

In pine-oak forests, retain existing large oaks and promote growth of additional oaks.

Encourage prescribed fire and unintended ignitions to reduce hazardous fuel accumulation. Thinning from below may be desirable or necessary before burning to reduce ladder fuels and the risk of crown fire.

Retain substantive amounts of key habitat components: snags 18 inches in diameter and larger, down logs over 12 inches midpoint diameter, hardwoods for retention, recruitment, and replacement of large hardwoods.

Riparian areas: Emphasize maintenance and restoration of healthy riparian ecosystems through conformance with Coconino forest plan riparian standards and guidelines. 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 Target/Threshold Conditions

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

Criteria for target/threshold 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 target/threshold conditions. These are summarized in Table III.B.1 (FWS 1995) (See Appendix J in this report).

Elements that relate to forest vegetation operations for the Northern Goshawk include:

Landscapes Outside Goshawk PFAs (LOPFA):

Elements that relate to northern goshawk forest habitat apply to the forest and woodland communities described below that are outside of Mexican spotted owl protected and restricted areas:

Manage for Uneven-age forest conditions for live trees and retain live reserve trees, snags, downed logs, and woody debris levels throughout woodland, ponderosa pine, mixed conifer, and spruce-fir forest cover types. Manage for old age trees so that as much old forest structure as possible is sustained over time across the landscape. Sustain a mosaic of vegetation densities (overstory and understory), age classes and species composition across the landscape.

Limit human activity in or near nest sites and Post-Fledgling Family Areas (PFAs) during the breeding season (March 1 through September 30).

The distribution of vegetation structural stages for ponderosa pine, mixed conifer and spruce-fir is 10% grass/forb/shrub (VSS 1), 10% seedling-sapling (VSS 2), 20% young forest (VSS 3), 20% mid-aged forest (VSS 4), 20% mature forest (VSS 5), 20% old forest (VSS 6). Distribution of habitat structures should be evaluated at the ecosystem management area level, at the midscale such as drainage, and at the small scale of site.

Ponderosa pine canopy cover for mid-aged forest (VSS 4) should average 40+%, mature forest (VSS 5) should average 40+%, and old forest (VSS 6) should average 40+%. Maximum opening size is up to 4 acres with a maximum width of up to 200 feet. Retain 1 group of reserve trees per acre of 3-5 trees per group for openings greater than 1 acre in size. Leave at least 2 snags per acre, 3 large downed logs per acre, and 5-7 tons of woody debris per acre. Snags are 18 inches or larger DBH and 30 feet or larger in height, downed logs are 12 inches in diameter and at least 8 feet long, woody debris is 3 inches or larger on the forest floor, canopy cover is measured with vertical crown projection on average across the landscape.

Identify and manage dispersal PFA (dPFA) and nest habitat at 2 to 2.5 mile spacing across the landscape.

Within PFAs:

Ponderosa pine: canopy cover for mid-aged forest (VSS 4) should average 1/3 60+% and 2/3 50+%. Mature (VSS 5) and old forest (VSS 6) should average 50+%.

Within Nesting Areas:

Thin from below with non-uniform spacing and use hand tools and fire to reduce fuel loads. Lopping and scattering of thinning debris is preferred if prescribed fire cannot be used. Piling of debris should be limited.

Elements that relate to forest vegetation operations for old growth:

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

All analyses should be at multiple scales-one scale above and one scale below the ecosystem management areas.

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.

4FRI Coconino/Kaibab EIS – Purpose and Need for Action

Silviculture Analysis Questions to be Answered and Key Issues Addressed

The Four Forest Restoration Initiative (4FRI) purpose and need for proposing an action was determined by comparing the goals and objectives in the Coconino NF and the Desired Conditions in Kaibab NF Land Resource and Management Plan (forest plans) to the existing conditions related to forest resiliency and forest function. Where plan information was dated or not explicit, local research and the best available science were utilized. See Appendix B for further clarification of consistency of Kaibab forest plan and the project metrics.

Between the time the data collection, data gap analysis, data analysis, and DEIS was completed and the FEIS was started the Kaibab National Forest completed and signed their new forest plan in 2014. All of the data analysis for this report was completed under the guidance of the older Kaibab and still current Coconino Forest Plan (1987, amended). All sections, alternative discussions, tables, and summaries were updated to reflect the changes in the new Kaibab Land and Resource Plan (2014). Discussions about how the different forest plans effected the outcomes of the various treatments and alternatives. Consistency is shown for this project with the Coconino Forest Plan and the new Kaibab Forest Plan (2014).

The following are analysis questions and corresponding evaluation criteria specific to the vegetation resource. These analysis questions will be tracked throughout the effects analysis in order to address whether, or to what degree, the project meets purpose and need objectives.

1. How would treatments move vegetation structure towards desired conditions by creating a mosaic of interspaces (openness) and tree groups of varying sizes?
 - a. Acres by treatment intensity.
2. How would treatments move towards a diverse forest structure with all age and size classes represented.
 - a. MSO habitat size class representation; Goshawk habitat structural stage representation (CFP). Goshawk habitat structural stage (VSS)s are no longer a guideline in the Kaibab forest plan (2014). Both forests emphasize Uneven-aged management (CFP, pages 23, 65-4, 123, 130) (KFP, pages 17, 19, 22, 23, 30).
3. How would treatments sustain old age (pre-settlement) trees by implementing an old tree retention strategy
 - a. MSO, goshawk habitat, large tree, and old tree forest structure representation (CFP) and the preference for Uneven-aged management (CNF, KNF).
4. How would treatments meet the objective of managing for old forest structure overtime across the landscape moving towards 1996 forest plan amendment for old growth standards of 20 percent at a forest EMA scale(CFN), and moving forest structure overtime towards Uneven-aged across the landscape (KFP).
 - a. Percent of forest at, or moving towards, Uneven-aged structure (KFP).
 - b. Percent of area moving toward old growth criteria (CFP).
 - c. MSO and goshawk habitat mature and old forest structural stage representation (CFP).
5. How would treatments improve forest health by reducing the potential for stand density-related mortality, by reducing bark beetle hazard and by reducing the level of dwarf mistletoe infection?
 - a. Monitoring percentage of area by beetle risk rating. (CFN)
 - b. Restoration activities would be prioritized in the areas identified by the Kaibab Forest Health Focus (Sisk, 2009) (KFP)
 - c. Percent of area by infected by dwarf mistletoe, average percent of trees infected and average infection within individual trees.
6. How would treatments move towards desired conditions for vegetation diversity and composition by maintaining and promoting Gambel oak, aspen, grasslands, and pine-sage?
 - a. Acres of treatments that would maintain and promote grasslands, Gambel oak, aspen and pine sage.

Issues serve to highlight effects or unintended consequences that may occur from the proposed action, giving opportunities during the analysis to reduce adverse effects and compare trade-offs for the decision-maker and public to understand. Key issues pertaining to silviculture identified during scoping and the indicators used to evaluate the issue are:

1. Measuring canopy cover in goshawk habitat at the group level is of concern.

- a. Pre-treatment and post-treatment distribution of habitat structure within goshawk habitat evaluated at four scales: ponderosa pine extent, restoration unit, restoration subunit, and strata (groups of like stands with like treatments) (CNF).
 - b. Pre-treatment and post-treatment distribution of size and age classes are at, or moving towards, Uneven-aged structure (KNF).
- 2. The large tree retention strategy (LTRS) developed by some 4FRI stakeholders was not included in the proposed action.
 - a. Quantitative pre-treatment and post-treatment three-level analysis for Mexican spotted owl, goshawk, old growth, and vegetation structural stage (VSS) for goshawk habitat at the landscape scale (ponderosa pine vegetation type) to gauge movement towards restoration-desired conditions (CFP).
 - b. Forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest (e.g., goshawk post-fledging family areas, Mexican spotted owl nesting/roosting habitat, drainages, and steep north-facing slopes) (KFP, page 18).
- 3. Pre-treatment and post-treatment distribution of size and age classes are at, or moving towards, Uneven-aged structure ((KFP)
 - a) Overall habitat structure and forest density metrics (basal area, stand density index and trees per acre) averaged to a per-acre basis with averages including interspaces, canopy gaps, and all forest structural stages.
 - b) Openness analysis to convey the percentage of the forested area that would be managed as interspace.
 - c) Tree group density stocking guides that will be used to meet the tree group cover requirements within goshawk LOPFA and PFA habitat.

4FRI Coconino/Kaibab EIS - Silviculture Area of Analysis

The 988,764-acre EIS project area is located on the Williams and Tusayan districts of the Kaibab NF and on the Flagstaff, Mogollon Rim and Red Rock districts of the Coconino NF (Figure 1). Of the 988,764 acre total, approximately 399,847 acres have been excluded from this proposal and therefore are not analyzed in detail. Areas excluded include approximately 213,090 acre analyzed in separate vegetation analyses; approximately 30,000 acres located in special management areas such as wilderness, research natural areas, inventoried roadless areas, and experimental forest; and approximately 145,000 acres that are non-Forest Service administered lands. The, analysis area, minus exclusions, is approximately 588,716 acres (Table 1). The focus of this project is on restoration of resistance, resiliency, and ecological function within the ponderosa pine forest within the analysis area. This report analyzes conditions of the ponderosa pine cover type within the analysis area.

The project area is extensive; therefore, the 4FRI team stratified the landscape into six restoration units. A restoration unit (RU) is a contiguous geographic area that ranges from 46,000 to 333,000 acres in size. A need for change (vegetation structure, pattern, spatial arrangement, potential for destructive fire behavior and effects) was identified for each RU.

RU 1 and 2 include portions of the Flagstaff, Mogollon and Red Rock ranger districts (CFP). RU 1 is generally located south of I-40 and east of I-17 and RU 2 is generally located west of I-17 and south of the Mogollon Rim. RU 3 includes portions of the Williams district (KFP), Flagstaff and Red Rock districts (CFP) and is generally located south of I-40 and west of I-17. RU 4 includes portions of the Flagstaff district and the Williams district. It is generally located north of I-40 and west of Highway 180. Communities near proposed treatments include Flagstaff, Munds Park, Mormon Lake, Tusayan and Williams, Arizona. Please note, few treatments are proposed in RU 2 since most of this RU is not ponderosa pine.

The team further stratified each RU (Figure 2) into several sub-units that range from 4,000 to 109,000 acres Both units (RU and sub-units) are based on 6th code watershed boundaries, state and forest transportation systems, and the Forest's administrative boundaries (Table 1).

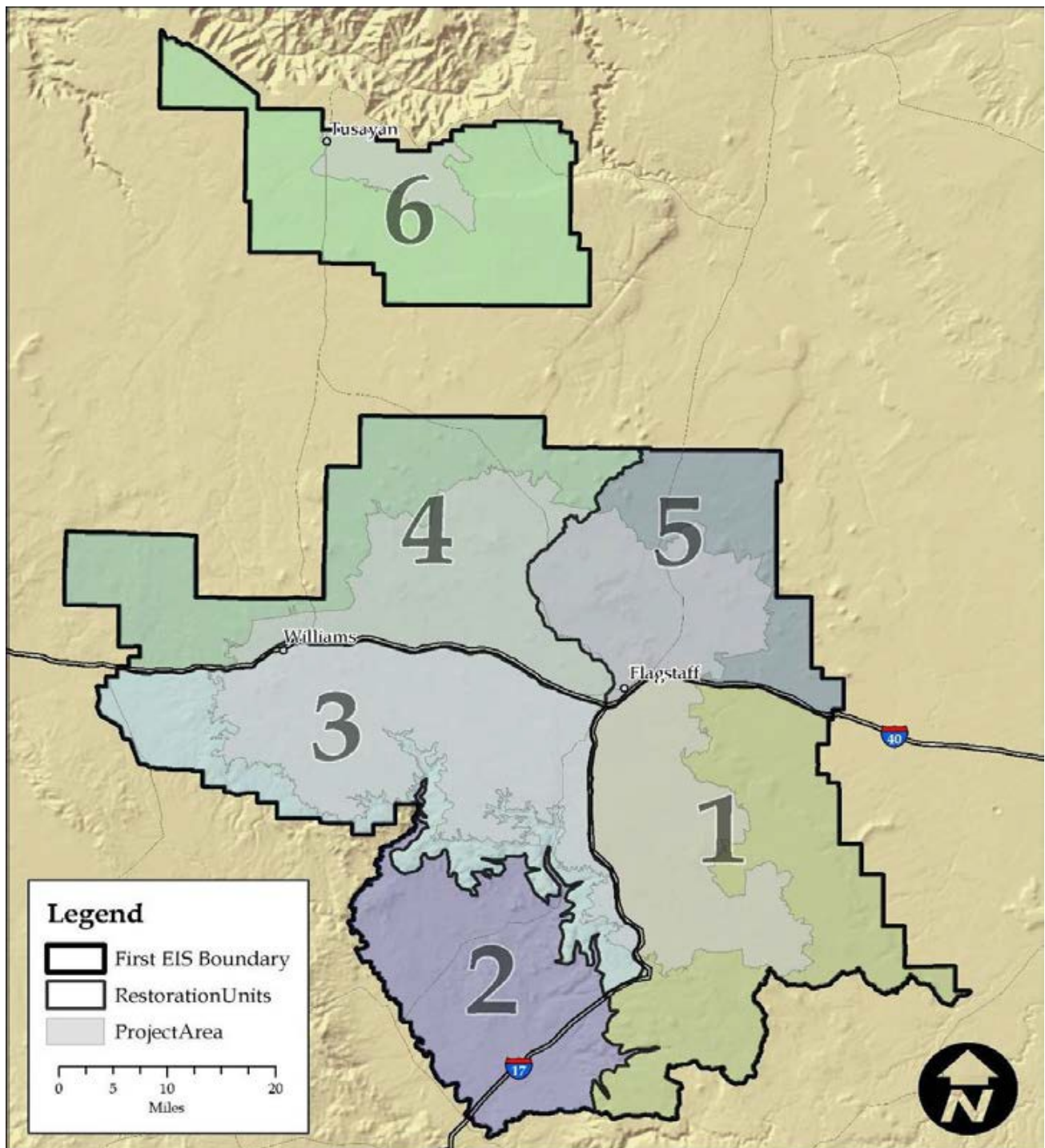


Figure 1. Four Forest Restoration Initiative (4FRI) project area

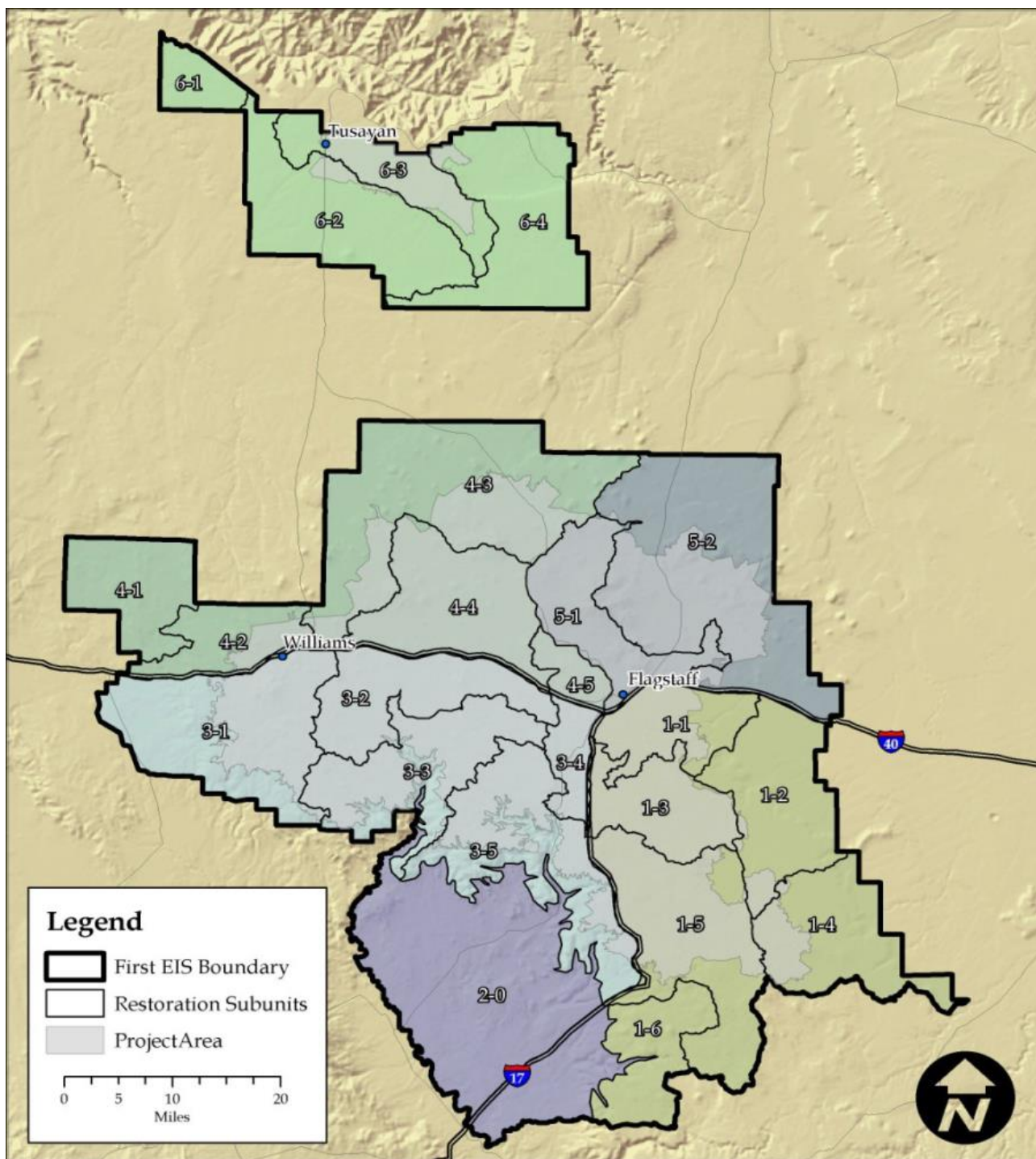


Figure 2. Restoration Units (RU) within the Project Area

Table 1. Summary of analysis area Acres by RU and SU

RU1 Subunits	Acres	RU3 Subunits	Acres	RU4 Subunits	Acres	RU5 Subunits	Acres	RU6 Subunits	Acres
1-1	10,170	3-1	23,175	4-1	0	5-1	21,437	6-1	0
1-2	8,054	3-2	32,826	4-2	10,227	5-2	53,459	6-2	5,552
1-3	39,798	3-3	48,462	4-3	67,045			6-3	34,156
1-4	18,326	3-4	9,019	4-4	81,541			6-4	3,870
1-5	78,246	3-5	36,392	4-5	6,961				
Total RU 1	154,594	Total RU 3	149,874	Total RU 4	165,774	Total RU 5	74,896	Total RU 6	43,578
								Grand Total	588,716

Methodology, Assumptions and Limitations

The basic unit for characterizing of vegetation conditions is the stand. All lands within the Coconino and Kaibab National Forests are delineated into stands based on similar characteristics such as vegetation type, slope, aspect, tree density, species composition and management history. Stands vary in size depending upon their uniformity; usually from 10 acres up to several hundred acres. Spatial and general vegetation information about each stand is stored in the stand database for each forest.

Discussion on 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% in the case of rounding percentages or miles, and <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.

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 the Most Similar Neighbor (MSN) Analysis computer program within the INFORMS model. The INFORMS model is a software system designed to facilitate project-level and landscape level project planning (Crookston et. al. 2002). The MSN program was used to impute vegetative attributes measured in one stand to another stand without vegetative data. MSN analysis uses satellite imagery, spatial relationships, and topographic information to match a target site (a stand without data) to the nearest reference site (a stand with data) with the greatest similarity in vegetative characteristics. Tree data from the reference site is then assigned to the target site. The quality of MSN imputations is controlled by the extent to which the sample of reference observations covers the range of variation of the target observations. For this project area, the reference observations adequately cover the majority of forested conditions within the ponderosa pine cover type. However, there are very few reference observations for the other cover types therefore the imputations within these cover types have limited reliability. Approximately 34 percent of analysis area has stand data and the MSN analysis was used to impute data for the rest of the analysis area. Of the acres imputed by MSN, 89 percent meets the criteria for being an OK imputation. Table 2 summarizes the category of the data for the forested areas within the analysis area by RU and national forest.

Table 2. Summary of Acres and Percent of Total by Data Type, RU and National Forests within the Analysis area

	Percent of Total RU Coconino				Percent of Total RU Kaibab			
Data Category	RU 1	RU 3	RU 4	RU 5	RU 3	RU 4	RU 6	Total Acres (% of Forested)
Non-Forested	17%	3%	16%	12%	22%	30%	<1%	50,435
Ponderosa Pine Reference Data	27%	7%	5%	1%	26%	20%	14%	173,390
Other Forest Types Reference Data	15%	<1%	<1%	0%	40%	24%	20%	3,820
Total Reference Data:								177,210 (33%)
Ponderosa Pine MSN OK Imputation	32%	14%	14%	12%	9%	14%	5%	303,384

	Percent of Total RU Coconino				Percent of Total RU Kaibab			
Data Category	RU 1	RU 3	RU 4	RU 5	RU 3	RU 4	RU 6	Total Acres (% of Forested)
Other Forest Types MSN OK Imputation	2%	9%	<1%	25%	19%	36%	8%	19,025
Total MSN OK Imputation:								322,409 (60%)
Ponderosa Pine MSN Poor Imputation	4%	8%	15%	67%	1%	4%	<1%	25,040
Other Forest Types MSN Poor Imputation	11%	<1%	0%	74%	7%	6%	<1%	6,003
Total MSN Poor Imputation:								31,043 (6%)
Total Forested Acres:								538,280

All of the stand data was then compiled into a database and modeled in the Forest Vegetation Simulator (FVS), a distance independent tree growth and yield model. All data was updated to the base year 2010. 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 and growth following treatment for each alternative up to the year 2050.

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 2002). The FVS is an individual tree, distance independent growth and yield model with linkable modules called extensions, which simulate various insect and pathogen impacts, fire effects, fuel loading, snag dynamics, 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 2008). 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 2008). 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 2008).

For simulation purposes, each data set was grouped by current forest type, VSS code, site class and treatment type. Simulations were developed for each treatment based on desired conditions. 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 VSS size class, dwarf mistletoe infection, 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. The averaged computed attributes from FVS were also used to calculate other attributes such as dominate VSS size class, canopy cover (Crookston and Stage 1999) and even-aged or Uneven-aged structure. All of these attributes were then compiled into an “effects” database by alternative and used to analyze and display the direct and indirect effects to the vegetation resource.

The following is a list of general modeling assumptions. Table 3 lists modeling assumptions specific to each treatment type in the proposed action.

- All tree data was grown to the common year of 2010 and is considered to represent the existing condition.
- All tree cutting and removal was modeled in the year 2012.
- Two prescribed burns were modeled, the first in the year 2015 and the second in 2019, with the exception of the aspen treatment which modeled one prescribed burn in the year 2015.
- After treatment, the tree data was grown to the common year of 2020 and is considered to represent the post treatment condition.
- The tree data does not indicate tree age. Simulations 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”; or mid-aged trees that are larger than 17.9”; or mature trees that are less than 18”.
- Within this project area, the majority of ponderosa pine trees that meet the old tree definition are ≥ 18 ”. On the ground cutting prescriptions will follow the Old Tree Implementation Strategy (OTIS) and trees larger than 18” that do not meet the OTIS criteria may be cut during implementation.
- The modeling assumptions attempted to meet the spirit of the Large Tree Retention Strategy within the limitations of a non-spatially explicit model. On the ground cutting prescriptions will follow the LTRS as adopted under this EIS and could result in trees larger than 18” being cut during implementation.
- All cutting simulations assume 15% of the cut stems are left on site and 10% 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.

- Default parameters within the model were used to predict tree growth, mortality, and dwarf mistletoe infection intensification.
- 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.

Table 3. Proposed Action FVS Treatment Modeling Assumptions by Treatment Type

Treatment Type	Thinning Intensity	Thinning Cutting Control	Group Selection	Prescribed Burning	Regeneration
Aspen	NA	NA	Cut all PP $\leq 5''$ Cut PP 5'' to 24'' from below to total PP canopy cover of 10%	2015 – Low to moderate intensity; 70% of area; FFE estimates mortality.	Autosprout aspen based on disturbance and species composition.
LOPFA – UEA	10	Cut PP 0'' to 18'' across diameter range to total PP SDI of 160	Cut all PP $\leq 18''$; Cut 25% of PP 18-24''	2015 – Low intensity; 70% of area; Mortality fixed 2019 – Low intensity; 50% of area; FFE estimates mortality	No sprout; Within thinning - PP natural regen based on change from pre-cut/burn to post-cut/burn density; Within group selection – PP natural regen 50 TPA after 2015 Rx burn and 150 TPA after 2019 Rx burn.
LOPFA – UEA	25	Cut PP 0'' to 18'' across diameter range to total PP SDI of 130			
LOPFA – UEA	40	Cut PP 0'' to 18'' across diameter range to total PP SDI of 100			
LOPFA – UEA	55	Cut PP 0'' to 18'' across diameter range to total PP SDI of 90			
PFA - UEA	10	Cut PP 0'' to 18'' across diameter range to total PP SDI of 180			
PFA - UEA	25	Cut PP 0'' to 18'' across diameter range to total PP SDI of 160			
PFA - UEA	40	Cut PP 0'' to 18'' across diameter range to total PP SDI of 135			
IT	10	Cut PP 0'' to 18'' from below to total PP SDI of 180; Cutting preference by mistletoe rating.	NA	2015 – Low intensity; 70% of area; Mortality fixed 2019 – Low intensity; 50% of area; FFE estimates mortality	No sprout; PP natural regen based on change from pre-cut/burn to post-cut/burn density;
IT	25	Cut PP 0'' to 18'' from below to total PP SDI of 160; Cutting preference by mistletoe rating.	NA		
IT	40	Cut PP 0'' to 18'' from below to total PP SDI of 135; Cutting preference by mistletoe rating.	NA		
SI	10	Cut PP 0'' to 18'' across diameter range to total PP SDI of 150	NA	2015 – Low intensity; 70% of area; Mortality fixed 2019 – Low intensity; 50% of area; FFE estimates mortality	No sprout; PP natural regen based on change from pre-cut/burn to post-cut/burn density;
SI	25	Cut PP 0'' to 18'' across diameter range to total PP SDI of 120	NA		
SI	40	Cut PP 0'' to 18'' across diameter range to total PP SDI of 90	NA		

Savanna	NA	Cut PP 0" to 18" across diameter range to total PP SDI of 50	NA	2015 – Low intensity; 70% of area; Mortality fixed 2019 – Low intensity; 50% of area; FFE estimates mortality	No sprout; PP natural regen based on change from pre-cut/burn to post-cut/burn density;
Pine Sage	NA	Cut PP 0" to 18" across diameter range to total PP SDI of 90	NA	2015 – Low intensity; 70% of area; Mortality fixed 2019 – Low intensity; 50% of area; FFE estimates mortality	No sprout; PP natural regen based on change from pre-cut/burn to post-cut/burn density;
Grassland Restoration	NA	Cut all PP ≤ 5 " Cut PP 5" to 24" from below to total PP canopy cover of 10%	NA	2015 – Low intensity; 70% of area; Mortality fixed 2019 – Low intensity; 50% of area; FFE estimates mortality	No sprout; PP natural regen based on change from pre-cut/burn to post-cut/burn density;
MSO - Restricted	NA	Cut PP 0" to 18" across diameter range to total PP SDI of 115	Cut all PP ≤ 18 "; Cut 25% of PP 18-24"	2015 – Low intensity; 70% of area; Mortality fixed 2019 – Low intensity; 50% of area; FFE estimates mortality	No sprout; Within thinning - PP natural regen based on change from pre-cut/burn to post-cut/burn density; Within group selection – PP natural regen 50 TPA after 2015 Rx burn and 150 TPA after 2019 Rx burn.
MSO - Target	NA	Cut PP 0" to 18" across diameter range to total PP SDI of 180; Adjusted to maintain average post treatment BA at 150+ if average pre-treatment BA is 150+.	NA	2015 – Intensity fixed, very low; 70% of area; Mortality fixed 2019 – Intensity fixed, very low; 70% of area; Mortality fixed	No sprout; PP natural regen based on change from pre-cut/burn to post-cut/burn density;
MSO - Threshold	NA	Cut PP 0" to 18" across diameter range to total PP SDI of 180; Adjusted to maintain average post treatment BA at 150+ if average pre-treatment BA is 150+.	NA	2015 – Intensity fixed, very low; 70% of area; Mortality fixed 2019 – Intensity fixed, very low; 70% of area; Mortality fixed	No sprout; PP natural regen based on change from pre-cut/burn to post-cut/burn density;

MSO – PAC Trt Strata 1 (Southerly aspect, not pine-oak, currently <150 square feet of basal area)	NA	Cut PP 0” to designated upper diameter, across diameter range to total PP SDI of 160.	NA	2015 – Intensity fixed, very low; 70% of area; Mortality fixed 2019 – Intensity fixed, very low; 70% of area; Mortality fixed	No sprout; PP natural regen based on change from pre-cut/burn to post-cut/burn density;
MSO – PAC Trt Strata 2 (Not strata 1)	NA	Cut PP 0” to designated upper diameter, across diameter range range to total PP SDI of 200; Adjusted to maintain average post treatment BA at 150+ if average pre-treatment BA is 150+.	NA	2015 – Intensity fixed, very low; 70% of area; Mortality fixed 2019 – Intensity fixed, very low; 70% of area; Mortality fixed	No sprout; PP natural regen based on change from pre-cut/burn to post-cut/burn density;
MSO – Protected Burn Only	NA	NA	NA	2015 – Low intensity; 70% of area; FFE estimates mortality 2019 – Low intensity; 50% of area; FFE estimates mortality	No sprout; PP natural regen based on change from pre-cut/burn to post-cut/burn density;
Burn Only	NA	NA	NA	2015 – Low intensity; 70% of area; FFE estimates mortality 2019 – Low intensity; 50% of area; FFE estimates mortality	No sprout; PP natural regen based on change from pre-cut/burn to post-cut/burn density;

Limitations

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.

Dwarf mistletoe infections are difficult to detect from satellite imagery. Therefore, the MSN imputation process may have imputed stand data showing mistletoe infections to stands that are not infected and visa-versa.

FVS is not spatially explicit and cannot model tree groups and interspaces together. The modeling results are an average approximation of the desired forested structure.

Results from the FVS model depend upon sample data, validity of the model itself and assumptions made by the modeler.

Output from the FVS model used in this analysis is a characterization of the existing condition and relative change over time of management actions or no action. Absolute conditions are neither intended nor implied.

4FRI Coconino/Kaibab EIS - Silviculture Affected Environment Existing Conditions

Changes from the Draft Environmental Impact Statement (DEIS)

The 4FRI project was analyzed as a complete composite project encompassing ponderosa pine and pine-oak communities from both the Coconino and Kaibab National Forests combined. Proposed treatment analysis was on combined acres and not necessarily by forest.

New Forest Plan

Between the time the data collection, data gap analysis, data analysis, and DEIS were completed and the FEIS was started the Kaibab National Forest completed and implemented their new forest plan in 2014. All of the data analysis for this report was completed under the guidance of the older Kaibab and still current Coconino Forest Plan (1987, amended). All sections, alternative discussions, tables, and summaries were updated to reflect the changes in the new Kaibab Land and Resource Plan (2014). Discussions about how the different forest plans effected the outcomes of the various treatments and alternatives. Consistency is shown for this project with the Coconino Forest Plan and the new Kaibab Forest Plan (2014).

New MSO Recovery Plan

Between the DEIS and FEIS the U.S. Fish and Wildlife Service published a new Mexican Spotted Owl Recovery Plan (2012). All sections, alternative discussions, tables, and summaries were updated to reflect the changes in the new MSO Recovery Plan. A crosswalk was developed to show consistency between the 1995 Recovery Plan and the new 2012 MSO Recovery Plan (See Wildlife Specialist Report). Consistency between the two MSO plans are shown between the Coconino Forest Plan (1987) that still references the 1995 recovery plan and the 2012 MSO plan that is reference for the Kaibab Forest Plan (2014). Consistency is shown for this project with both the 1995 MSO plan and the 2012 MSO plan.

New Alternative E

As a result from public input a new alternative E was developed. The discussion, figures, and tables under 'Summary of Alternatives' were all expanded to include Alternative E. Alternative E was developed as a restoration treatment without the use of proposed plan amendments. Without amendments, there is no clear plan direction for the development of groups and interspaces. Discussions are a reflection of this difference.

Old Growth

Between the time of the DEIS and the FEIS the Kaibab NF released a new forest plan. Discussions within this report cover the changes in the new plan and their impacts, outcomes, and consistency with project stated purpose and needs. The Coconino NF requires "Until the forest plan is revised, allocate no less than 20 percent of each forested ecosystem management area to

old-growth...”, however, the Kaibab Forest Plan does not allocate old growth. The Kaibab NF defines old growth: “Old growth in southwestern forested ecosystems is different than the traditional definition based on northwestern infrequent fire forests. Due to large differences among Southwest forest 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 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 1989, Graham et al 1994, Helms 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 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.” Discussions, tables, summaries were updated to reflect this major difference where possible to identify by forest.

Natural Range of Variability (NRV)

In response to Northern Arizona University’s Ecological Restoration Institute, and others, tables, discussions, and an appendix of comparisons were added for the Natural Range of Variability to which proposed treatments are compared. To 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 static, but they sustained themselves across what has been called their Natural Range of Variability (NRV) (Friederici, 2004). Post-treatment effects are discussed in context to how treatments move the alternatives towards, or away from, their NVR and their planning desired conditions. An additional appendix was developed (Appendices C-G) that show the comparisons among ponderosa pine basal area, All Basal Area, ponderosa trees per acre, and all trees per acre >5” d.b.h. against their respective NRV, for each planned treatment by alternative (some 612 table/graph combinations).

Implementation Plan

The Implementation Plan was edited and revised to reflect changes in the 2012 MSO Recovery Plan, changes in the Kaibab Forest Plan and, measuring canopy cover at the stand level on 46,091 acres (response to public comment) (See Appendix A). The implementation plan has subsequently been revised based on negotiations during the objection period of the FEIS.

Canopy Cover at the Stand Level

In response to comments and feedback on the DEIS , on approximately 38,256 acres (22,772 acres on the Coconino and 15,484 acres on the Kaibab NF) of UEA 40, UEA 25, and non-WUI stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean BA greater than 70 of the VSS 4 size class and a mean TPA less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. After further negotiations during the objection period a resolution added an additional 7,835 acres of IT10 and UEA 10 treatments were included for a total of 46,091 acres. Residual stand

structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-WUI stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the planned prescription intensity range, managing for larger group sizes, and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and will achieve 40 percent canopy cover at the stand scale.

Management on 3,303 Acres of Proposed Savanna Treatments

In response to comments from the public there continues to be a conversation on large trees, issue 2. In response to comments and feedback, Alternative E best meets the concern because no savanna treatments are proposed. The implementation plan, as it relates to alternative E has been updated to clarify that most VSS 4, VSS 5 and VSS 6 would not be cut on about 3,300 acres. The 3,303 acres containing a significant number of trees in the VSS 4-6 classes, currently assigned to savanna treatments within Alternative C, will be removed from Alternative C and assigned to their analyzed Alternative E treatments. Alternative E does not include the amendments for the specific definitions for interspaces and groups, therefore while the IT40 and UEA40 are desired they may not be necessarily attainable (See project record for details). These stands, while moving towards savanna, will not attain the savanna desired conditions.

Acres Refined

After the DEIS multiple acres and analysis areas were refined:

- Flagstaff Watershed Protection Project (remove treatments within DLH/MorMtn areas,
- Remove road decommission/haul routes)
- Elden Environmental Study Area (split stand)
- Eastside treatment stands Aspen
- stands on Kendrick overlapping wilderness boundary PFAs/PACs: changes to proposed treatments AZGFD Pronghorn corridors/overpass Paired watershed study
- Eliminated small isolated stands
- Lee Butte PAC – proposed mechanical treatment changes
- Core Area Re-delineation (work on Mormon Mtn PACs)
- PFA Changes (Fort Valley, Dogtown Wash, Rosilda Springs, Mud Springs, Pomeroy)
- New PAC Bridge, nest center change upper west fork, PAC boundary change West Buzzard Pt, New PAC Weatherford2, boundary change Snowbowl Road/Pipeline
- De-PAC Weatherford, Jack Smith and Viet
- Kelly Motorized Trails (remove road decommission)
- MVUM closed roads (changes to road relocation)
- FR 133A/700F (road relocation/road decommission addition, change haul route location)

Slide Fire

The Slide Fire started the afternoon of May 20, 2014, contained on June 5th, and controlled on June 10th after burning 21,227 acres. The Slide fire burned 7,870 of 4FRI project area acres. The burning through of proposed treatment acres required an evaluation of the impact on the project.

Appendix H is the review of the Slide Fire impacts. Field observations were conducted June 25-6, 2014 to evaluate the extent of the damage within the project boundary and to field verify the RVAG map (Rapid Assessment of Vegetation condition After Wildfire): RAVG produces a map of overstory vegetation affected by fire separated into seven classes of basal area loss. The acres burned within the project boundary varied from no-burn to High Burn Severity (>90% BA lost). After field verification of the impacts depicted on the RAVG map of the now altered structure and composition, and the unknown near-term bark beetle mortality, all treatments within the burned area would be deferred for a minimum of five years. This would provide an opportunity for recovery of affected soils and vegetation prior to implementing any actions that may cause additional disturbance. The proposed treatments would not change. However, prior to implementation, appropriate resource specialists would evaluate the area to ensure that treatments are still appropriate and would meet resource objectives. Replanting should be conducted on 2,368 acres

Other Literature Reviewed

It has been cited by several individuals (Cara115-137) that Williams and Baker (2012, 2014)(referred to as W&B) did research that indicates ponderosa pine forests historically had the same, or similar, fire intensities that we see today and that forest densities approached the densities we see today. W&B proposed that current fire extents and intensities are normal when compared to their research. The contributor concludes, “The action alternatives would not restore historic fire regimes but, rather, would take forests outside of the natural, historic range of variability, compromising ecological resilience”. The bulk of the science relating to fire regimes in southwestern ponderosa pine does not agree with Williams and Baker (2012). Reynolds et al, 2013 reports that W&B had similar density numbers (trees per acre and basal area) but Reynold et al (2013) explains the relationship in competing terms of frequent fire return intervals of <35 years.

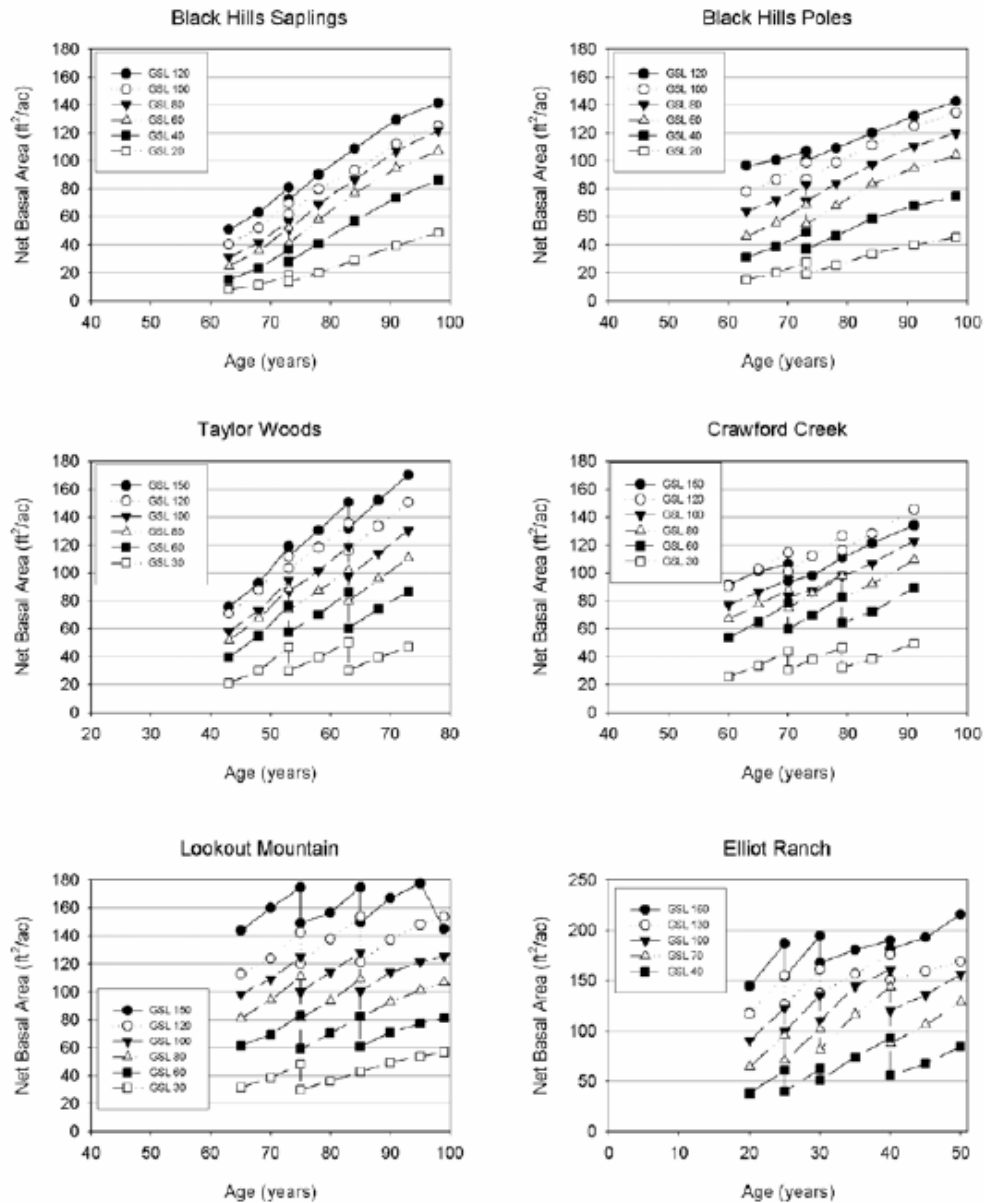
- P.J van Mantgem et al (2011), Reviews prescribed fire and changing forest structure in N. CA. Giant Forest area, Sequoia National Park. However, their studies were in such different forest types than occur in the project area, or even the southwest, that there is little that is similar to the dry low-severity, frequent-fire structure, species composition, or habitat found in Arizona or the 4FRI project area.
- W&B (2013) found the mean density of historical forests was 142-144 trees/ha (57-59 TPA), and 16-18% of forest area was dense, with > 200 trees/ha (81 TPA) which is very similar to other pre-European forest density structures and this projects projected post-treatment outcomes.
- Leiberger et al. (1904): “The light stands in many cases represent tracts which were burned clear, or nearly so, one hundred or one hundred and twenty years ago, and now are stocked chiefly with sapling growths, ranging in age from 35 to 90 years.” However, Leiberger (1904) also observed: “It is very evident that the yellow-pine stands, even where entirely untouched by the ax, 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.”

Cara115-137 believes that Oliver (2005) found that the very densest pine plots in the stocking studies increased to a basal area of 175 square feet per acre, and an SDI of around 350, and then experienced beetle mortality of only 17% of the basal area (down to about 145 square feet per acre). In the ponderosa pine plots, the densest plots increased to a basal area of about 220 with almost no beetle mortality after the stands reached about 85 years of age (Oliver 2005, Fig. 1). Oliver (2005) noted that mortality levels have “declined over the years” in the dry ponderosa pine forests as these forests have grown older and denser.

Oliver (2005) did not find that all plots within the growing stock studies suffered beetle mortality. Only three of the stocking studies ever achieved densities over 145 basal area (Taylor Woods, Lookout Mountain, and Elliot Ranch). Taylor Woods (Coconino Plateau Arizona) appears to have obtained 170 BA with no mention of beetle infestations, but “suffered breakage from a heavy wet snow at the two highest GSLs”. Oliver (2005) states that “Mortality by all agents has declined over the years” except that Lookout Mountain (eastside Oregon) was the only study plot that had recent killing by mountain pine beetles at the highest GSL near 180. Cara115-137 further states: “In the ponderosa pine plots, the densest plots increased to a basal area of about 220 with almost no beetle mortality after the stands reached about 85 years of age (Oliver 2005, Fig. “ 1 (figure 3). This is not what Oliver (2005) indicated, and to the contrary, Oliver (2005) showed that the only study plots to attain 225 BA were the Elliot Ranch plots at age 50. Oliver (2005) states that, “Mortality from mountain and western pine beetle was especially prevalent 10 to 20 years after initial thinning in the GSLs above 100 at Elliot Ranch”. Oliver (1995) stated about Elliot Ranch that, “Elliot Ranch, in contrast, was continually disturbed, either by cutting or storm damage, reaching a SDI of 245 before bark beetles began killing trees. The basal area per ha equivalent to SDI 245 at Elliot Ranch is 31 m² of basal area per ha for 415 trees per ha, 31.3 cm in average diameter (168 trees per acre, 12.3 in. in average diameter) “. Oliver (1995) concluded that: “The limiting SDI for ponderosa pine stands in northern California as defined by *Dendroctonus* bark beetles is 365 (*reviewer comment: this is 63.9% of Oliver’s stated max SDI of 571, consistent with density statements in silviculture report, pg 48*). Oliver (1995) says, “SDI 230 (*reviewer comment: this is 40% of Oliver’s stated max SDI of 571, consistent with density statements in silviculture report, pg 48*) defines a threshold for a zone of imminent bark beetle mortality within which endemic populations kill a few trees but net growth is still positive”, thereby confirming that Elliot Ranch is prone to bark beetle infestations and contrary to Cara115-137 statements otherwise. Mortality from mountain pine beetles was high at Crawford Creek where basal areas obtained 135-145 (Oliver, 2005). Thus indicating beetle infestations occurred at much lower densities than implied by Cara115-137.

It is interesting to note that Oliver’s (1995) SDI of 365 (his max SDI = 571) is 81% of maximum SDI using the 4FRI Max SDI of 450 for ponderosa pine (Silviculture Specialist Report page 32) and 4FRI says that this an area of density related mortality. Oliver’s (1995) SDI of 230 is 51% of the 4FRI maximum SDI of 450 and the silviculture report predicts little to no density related activity. The Silviculture Specialist Report states: “The reduction of bark beetle hazard promotes forest sustainability and health. Reducing bark beetle hazard is a complex set of interacting environmental and physical factor by reducing the stress and competition between individual trees, changing wind patterns within stands, disrupting pheromone patterns (Negrón et al, 2006), and reducing SDI” (page 32). The Silviculture Specialist Report further states that, “The use of 60% of max SDI by Munson and Anhold 1995 (as documented in Chojnacky et al. 2000) and the draft *Ips* hazard model developed by McMillin et al. (2011) is appropriate to display bark beetle

hazard (aka the likelihood of attack and damage by bark beetles).Chojnacky et al. 2000 indicate that increasing beetle attack is correlated with increasing SDI” (page 32).



Cara 196-200 commented that the DEIS claims to remove trees because of bark beetle risk because at “above 60% of maximum “Stand Density Index” (SDI), forest stands are at high risk of beetle mortality, and that the intensive logging proposed in the Proposed Action and the Preferred Alternative—which would directly kill and remove, through logging, most of the existing trees—is somehow necessary to prevent and reduce tree mortality”. The DEIS does not

claim on page 14 or 18 that, above 60% of maximum “Stand Density Index” (SDI), forest stands are at high risk of beetle mortality. The DEIS states on page 14 that, “Based upon established forest density/vigor relationships, density related mortality begins to occur once the forest reaches 45 to 50 percent of maximum SDI, and mortality is likely at density levels over 60 percent of maximum stand density (Long 1985)”. This statement is directly related to density related mortality not bark beetle risk. The reduction of bark beetle risk promotes forest sustainability and health. Reducing bark beetle hazard is a complex set of interacting environmental and physical factor by reducing the stress and competition between individual trees, changing wind patterns within stands, disrupting pheromone patterns (Negrón et al, 2006), and reducing SDI. The bark beetle hazard model for southwestern ponderosa pine on DEIS page 18 is based on the tree density relationships developed in the *Dendroctonus* hazard model by Munson and Anhold 1995 (as documented in Chojnacky et al. 2000) and the draft Ips hazard model developed by McMillin et al. (2011)(Silviculture Specialist Report, Page 51) . Bark Beetle Hazard or ‘susceptibility’ is the inherent characteristic of a stand of trees that affect its likelihood of attack and damage by bark beetles (McMillin et al. 2011). Cutting of trees will directly reduce the population but will reduce the hazard and risk of bark beetle outbreaks while maintaining a healthy forest. The use of 60% of max SDI by Munson and Anhold 1995 (as documented in Chojnacky et al. 2000) and the draft Ips hazard model developed by McMillin et al. (2011) is appropriate to display bark beetle hazard (aka the likelihood of attack and damage by bark beetles). Chojnacky et al. 2000 indicate that increasing beetle attack is correlated with increasing SDI...Other unknown factors independent of stand density may initially draw bark beetles to a stand, but once in a stand the beetles seek out the pockets of higher SDI. “The methods are trustworthy in predicting that once beetles enter a stand, the more dense stands with larger stand density index (SDI) can be expected to have greater beetle attack” (Chojnacky et al. 2000, pg. 10).

Cara 196-200 further states that Oliver (1995) found that, as relatively young ponderosa pine stands reached SDI levels from 300 to 365, beetle mortality reduced stand density by only about 13-20%. Mortality was near zero when SDI values were below 230 (Fig. 2 of Oliver 1995). Further, despite modest mortality as stands neared SDI of 365, the stands ultimately continued to grow more mature and more dense, reaching an SDI of 571 (100% of maximum SDI) (Fig. 1 A-C of Oliver 1995). In response, Cara 196-200 misinterpreted and misused Oliver 1995 by taking data that was appropriately used to demonstrate stand density of good sites to poor sites and developing erroneous conclusions. The ponderosa pine SDI maximums used in FVS modeling were 500 (Region 5) and 429(Region 6) for Oliver 1995. National standard for ponderosa Pine SDI max is 450. Comment #5 claim of SDI reaching 571 and it is unknown where or how this conclusion was derived. Oliver 1995 found that “Bark beetle kills created a limiting Stand Density Index of 365 which differed little between stands on poor sites east and good sites west of the crest of the Sierra Nevada and Cascade Range. Although good sites would be expected to carry a greater stand density than would poor sites, more explosive bark beetle populations and density-related stem breakage cancel this site advantage” (Oliver 1995, pg. 213). This Oliver paper demonstrates how SDI is limited to 365 for ponderosa pine when bark beetles are present in the ecosystem. Stands that approach SDI 365 usually suffer large losses from bark beetle epidemics-losses that equal or exceed periodic growth. Figure 2 suggests that beetle kills from endemic populations can begin when stands reach SDI 230 (Oliver 1995). In response, Cara 196-200 improperly interprets this paper. Oliver 1995 strictly relates to epidemic outbreaks of mountain pine beetle in Northern California and there limiting factor on stand density. Oliver 1995 argues for a beetle limiting SDI max of 365. These stand structure beetle dynamics do not occur in Northern Arizona (Negrón et al, 2006).

Cara 196-200 states further, that a Cochran and Barrett (1995) study investigated pine stands and found that, even at higher SDI levels, “there was no apparent correlation between stand density and mortality” (see p. 9 of Cochran and Barrett 1995). In that study, the highest annual growth rates were at SDI values over 200 (Figs. 14, and 18-20 of C&B 1995). In response, Cara 196-200 totally misread and misused this reference. Cochran and Barrett cannot be cited in Northern AZ, or even the southwest, because they used a max SDI for p pine of 365 instead of 450, as used in the southwest and used in this project. C&B reported mortality at SDI of 200 as only 5-10% of the basal area over 30 years. SDI 200 of max 365 SDI is 54% of max, and at that percentage, there should be more density related mortality developing than reported (non-beetle). However, comparing their 200 SDI to a max SDI of 450, as should be properly applied, then they really had only 44% of max SDI. This is the upper range for management, but there would be little density related mortality expected to develop, and this is just what C&B reported. Furthermore, they calculated their SDI figure using a different exponent of -1.77 instead of -1.605 for the SDI calculation as used in the southwest and this report. There cannot be any comparisons made to the SDI reported in Oliver (Cochran and Barrett, 2002) and the SDI used in this Silviculture report. They are based on such different fundamental values as to be non-comparable. Cochran and Barrett (1999) on the Lookout Mountain plots found that little mortality occurred below stand density index of 240 (53.3% of MaxSDI). This agrees with the expectations of density related mortality used in the 4FRI project (Silviculture Specialist Report page 48). However, Cochran and Barrett (1999) stated, “No statistical analyses of mortality were performed because numerous observations with no mortality occurred throughout subsets of the design matrix.”

Cara 169-200 comments do not relate to this project since the needs and purpose of this project are to re-establish forest structure, pattern, and composition, within the ponderosa pine ecosystem that will lead to increased forest resiliency and function, and not a bark beetle mitigation project, as Cara 196-200 would imply.

Historical Context of the Existing Condition

Natural processes and past human activities have shaped the existing vegetation condition. 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.

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 Coconino and Kaibab 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).

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 Forest Service 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 and New Mexico 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 south Kaibab 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 A.M. 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 conversion from forest to grass or 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).

Insects and Disease

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 and associated forest types (piñon-juniper and aspen) within the project area for approximately the last century (Lynch et al. 2008a and 2008b).

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.

Ponderosa Pine – 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.

Most bark beetles are considered secondary mortality agents, at endemic levels, because they prefer weakened hosts typically attacking scattered individual trees weakened by lightning, disease, old age, or competition, or they are attracted to fresh logs and slash created by logging, windthrow, or snow breakage. However, 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 (epidemic levels). 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, drought, injury, and disease, favor outbreaks.

Early reports indicate that bark beetle activity in ponderosa pine was less frequent, extensive, and 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. On the southern Kaibab National Forest, western pine beetle activity was reported in late 1970's and early 1980's. The contemporary (2000s) bark beetle outbreak is probably more severe than past outbreaks. Ponderosa pine mortality approached 100% in some stands (Gitlin et al. 2006), but averaged only 3.4% in a limited number of plots distributed across Williams Ranger District (R.D.) and Tusayan R.D. (Negrón et al. 2009).

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), and the 1950s and contemporary outbreaks being 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 even diameter class distributions to denser stands dominated by 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 the tops of large diameter trees (Furniss and Carolin 1977, Kolb et al. 2006).

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).

Pathogens – Dwarf Mistletoe

Dwarf mistletoes slowly infect stands and then persist as long as living hosts are present. Dwarf mistletoes are obligate parasites, and infected host trees weaken slowly and eventually die. Growth loss projections from the 1980s estimated 20 MMBF – 30 MMBF annually for the Coconino N.F. with similar numbers for the Kaibab N.F. (Hessburg and Beatty 1985).

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 Kaibab 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).

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. 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.

Southwestern dwarf mistletoe is dispersed throughout the project area where the incidence is 21-31% of the commercial ponderosa pine type on the northern half of the Coconino N.F. and 25-38% of the commercial ponderosa pine type on the Williams R.D (Hessburg and Beatty 1985).

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), and that current conditions are likely similar to the 1980s estimate. 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.

Pathogens – 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 Coconino and southern Kaibab National Forests. These events have typically been pinyon ips outbreaks associated with periods of drought, such as occurred in the 1950s, and more recently in the mid-1990s and 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 Coconino N.F., Kaibab N.F., and Grand Canyon N.P. 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 Coconino and Kaibab National Forests 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 since the mid-1980's on the Williams R.D. For these reasons, permanent exclusion fences have proven to be a necessity to regenerate and maintain aspen throughout these forests.

Summary of the post-European settlement era ecological changes in terms of forest structure, pattern and composition

- Open, fire-maintained pine forest structure has been altered by logging and fire suppression.
- Large, old ponderosa pines have become underrepresented.
- The remaining large, old ponderosa pines are suffering increased mortality rates as a result of competition with small trees.
- Ponderosa pine forests have increased in density as abundant tree seedlings have regenerated to infill canopy opening and replaced open, multiple age class structure with a dense single age class structure. This resulted from logging practices, protection from fire, reduction in livestock grazing, and a relatively wet climatic cycle (Schubert 1974).
- Competition for moisture and nutrients is intense in these dense stands, and results in stress that increases vulnerability to insect attack by such herbivorous insects (*stricto sensu*) as pine bark beetles (*Dendroctonus* spp.) and *Ips* beetles (Kane and Kolb, 2014).
- Dwarf mistletoe has become more widespread in some areas due to closed forest conditions and lack of low severity fire.
- Potential fire severity has changed from low to mixed and high. The risk of stand replacing fires has increased.
- Severe burns often result in increased soil erosion and invasion by nonnative species.
- Stand-replacing wildfires on ponderosa pine sites have resulted in conversion from forest to grass or shrub perpetuated for long periods or dense, even age structure. These areas will not again support old-growth pine trees for centuries.
- Coniferous trees have spread widely into grasslands and meadows.

Existing Condition – Cover Types

There are three broad categories that describe the vegetative state: 1) non-vegetated (barren), 2) non-forest, and 3) forest. The following is a description of the cover types that occur within the analysis area. Table 4 lists the acres within the analysis area by cover type.

Non-Forest Cover Types

Non-vegetated (Barren)

These areas include mines, quarries, gravel pits and rock, talus or scree, and some rights of way.

Grasslands

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 late 1800s 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 48,703 acres within the analysis area are classified as grassland cover type based on stand data (Table 4). 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. Many of the pre-settlement trees that grew along the edges of these grasslands were removed historically. These 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 Cover Types

Forest cover types (table 4) are named for the tree species that are presently (not potentially) dominant, using canopy 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. 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 cover type is collectively composed of the pinyon-juniper grassland, pinyon-juniper sagebrush, pinyon-juniper evergreen shrub and pinyon-juniper persistent woodland communities. 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 sagebrush, 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 is common; as well as one-seed, Utah, Rocky Mountain, and alligator juniper. 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.

Oak Woodlands – This community consists of Gambel oak 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 (PP)

The ponderosa pine forest vegetation community generally occurs at elevations ranging from 5,800 to 9,200 feet and, is dominated by ponderosa pine, and commonly includes other species such as oak, juniper, and pinyon. Species such as aspen, Douglas-fir, white fir, and blue spruce 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 two major sub-types: Ponderosa pine-bunchgrass and ponderosa pine-Gambel oak.

Ponderosa pine commonly grows in pure stands and currently is found in even-aged³ and Uneven-aged⁴ structural conditions across the area. The open park-like stands characteristic of the reference conditions for ponderosa pine forests promoted greater faunal 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

³ Even-aged – pertaining to a stand composed of a single age class in which the tree ages are within + 20 percent variability based upon the mature stand age (SAF 1998).

⁴ Uneven-aged – pertaining to a stand with trees of three or more distinct age classes (SAF 1998).

(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).

Gambel Oak Within Ponderosa Pine Forest

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 1996 forest plan amendment for MSO and 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 and forbs) 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 (see habitat specific density conditions in [Table 13 through Table 15](#)). For a more detailed discussion on tree overstory and herbaceous understory relationships, see the Wildlife Section in Chapter 3.

Of the 507,839 acres within the analysis area classified as a ponderosa pine cover type, 14,640 acres are on Mollisol soils - those soils with a high accumulation of surface organic matter common in grasslands. Another 300,430 acres are on Mollic integrate soils - those soils with thinner organic matter accumulations in the soils surface. Approximately 300,430 acres of the Mollic integrate have an open canopy reference condition exemplified by a mosaic of non-interlocking tree crowns and large interspaces between trees (USDA Forest Service 2007 and 2008b). The lack of fire disturbance has allowed ponderosa pine to encroach upon the interspace throughout these soil types resulting in a more continuous tree canopy.

Quaking Aspen (QA)

Within the project area, quaking aspen is limited to small patches within a larger forest matrix dominated by ponderosa pine or mixed conifer vegetation. These patches consist of a few overstory trees with a sapling understory component.

Typically, aspen reproduces asexually through root suckers that are a clone (ramet) of the original parent tree. Fire, insect, disease, wind and human disturbances regenerate this shade-intolerant species by opening up the canopy and removing conifers from the understory. Aspen has gradually declined in the southwest in part due to browsing by livestock and native wild ungulates, conifer encroachment, climate change and to a degree the absence of large predators (Ripple and Beschta 2011, Ripple and Beschta 2007, Hebblewhite et al. 2005). Without disturbance, conifers gradually overtop aspen, closing the canopy and eventually killing mature trees and reducing regeneration. Aspen is highly susceptible to browsing and disease causing death due to bark and root injuries. Aspen patches are regenerating successfully where livestock and wildlife are excluded (i.e., by fencing or other methods). Several aspen patches within the project area show signs of decline marked by mortality and dieback of crowns, similar to what has been observed across Arizona over the past several years (Fairweather et al. 2008).

Table 4. Analysis area Cover Type Acres by Restoration Unit⁵

Cover Type	RU 1	RU 3	RU 4	RU 5	RU 6	Total
Non-Vegetated						
Barren	120	134	129	1,301	48	1,732
Non-Forest Communities						
Grassland	8,226	12,796	22,661	4,928	93	48,703
Forest Communities						
Pinyon-Juniper Woodland	1,428	5,884	7,283	8,845	2,219	25,658
Oak Woodland	287	1,633	926	386	30	3,262
Ponderosa Pine	144,113	129,226	134,278	59,034	41,189	507,839
Aspen	420	201	497	403	0	1,522
Total Forested Acres:	146,248	136,944	142,984	68,668	43,437	538,280
Total Analysis area Acres:	154,594	149,874	165,774	74,896	43,578	588,716

The remainder of the existing conditions report analyzes conditions specific to the ponderosa pine cover type (588,716 acres) within the analysis area unless otherwise stated.

⁵ Numbers in this table have been rounded to the nearest acre and were summarized before rounding. Any apparent discrepancy accounts for an error of less than one percent (typically 1 acre or less).

Forest Structure (VSS, Density, Canopy Cover, Openness)

Vegetation Structural Stage

The Coconino Forest Plan describes the structure of forests using various descriptors: Vegetation Structural Stage (VSS), percent canopy cover, density, and openness basal area, trees per acre, as well as others. The 2014 Kaibab Forest Plan does not use VSS or canopy cover to describe forest structure, but instead describes structure in terms of Uneven-aged forests that are the desired conditions resulting from Uneven-aged management. The Kaibab describes Uneven-aged forests as: “forests that are composed of three or more distinct age classes of trees, either intimately mixed or in small groups”..”. And Uneven-aged management as: “the application of a combination of actions needed to simultaneously maintain continuous high forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes to provide a sustained yield of forest products”. Removal is usually prescribed by specifying the number or proportion of trees of particular size classes to retain within each area, thereby maintaining planned distribution heterogeneity of size classes. Cutting methods that develop and maintain Uneven-aged stands are singletree selection and group selection. The desired condition resulting from Uneven-aged management is: A mosaic of tree groups generally comprised of an Uneven-aged forest with all age classes and structural stages present, is generally open, with groups of old trees mixed with groups of younger trees and occasional areas of even-aged structure present (KFP, pages 17-18). The intention of the project is to obtain a high level of vegetative responses that will increase ecosystem diversity by increasing horizontal and vertical heterogeneity through restoration activities.

However, to aid in the understanding of how 4FRI will treat the forest the descriptors of forest structure of the Kaibab forests are discussed in common terms used in the 1987 Coconino Forest Plan (amended) as well.

Vegetation structural stage (VSS) is a method of describing the development stages of a stand of living trees and is a generalized description of forest tree size from seedling to old forests loosely equated to forest age. It is an integrative approach, combining vegetation and forest growth, to describe southwestern forests. Six vegetation structural stages (VSS) have been defined primarily on tree diameters and are based on the time it takes seedlings to become established and subsequent growth rates. Life expectancy of trees determines how long the oldest VSS can be maintained (Reynolds et al. 1992). These stages are: VSS 1, forests dominated by grasses, forbs and shrubs; VSS 2, forests dominated by seedlings and saplings; VSS 3, young forests; VSS 4, mid-aged forests; VSS 5, mature forests; VSS 6, old forests (Reynolds et al. 1992). The VSS classification is based on the tree size class with the highest square foot of basal area. Basal area includes all tree species. See Appendix B of the Silviculture Specialist report for further clarification of consistency of Kaibab forest plan and VSS.

The VSS classification was further combined with a measure of tree canopy density and age class heterogeneity. Tree canopy density is not a true measure of vertical crown projection; rather it is a relative measure of tree density based on relative stand density index (SDI) (Vandendriesche, 2013). Age class is a measure of the variety of age classes present in relation to the dominant age class and is an indication of canopy layers. A single storied stand resembles an even-aged

condition while multiple storied stands are considered Uneven-aged. Table 5 describes the VSS coding as defined by the Compendium of NFS Regional Vegetation Classification Algorithms (Vandendriesche 2010).

Table 5: Description of Vegetation Structural Stages (VSS)

VSS (DBH Size Class)	Structural Stage	Tree Canopy Density Category	Canopy Layers (Age Class)
1 (0-.9")	Grass/Forb/Shrub	Less than 10% tree canopy	NA
2 (1.0-4.9")	Seedling/Sapling	A – Open B – Moderately Closed C – Closed	NA
3 (5.0-11.9")	Young Forest	A – Open B – Moderately Closed C – Closed	SS – Single Story MS – Multiple Storied
4 (12.0-17.9")	Mid-age Forest	A – Open B – Moderately Closed C – Closed	SS – Single Story MS – Multiple Storied
5 (18-23.9")	Mature Forest	A – Open B – Moderately Closed C – Closed	SS – Single Story MS – Multiple Storied
6 (24"+)	Old Forest	A – Open B – Moderately Closed C – Closed	SS – Single Story MS – Multiple Storied

For example, an area classified as 4BMS would be mid-aged and multiple storied with a moderately closed tree canopy.

Table 6 displays the acres by existing dominant VSS class for the ponderosa pine within the analysis area. Much of the landscape has a closed tree canopy, dominated by a single canopy layer and one age class. Approximately 57 percent has a closed tree canopy density, and 46 percent is single storied. The young and mid-age structural stages account for approximately 82 percent of the ponderosa pine analysis area while the grass/forb and seedling saplings stages are approximately 2 percent, the mature tree stage is 10 percent and the old forest stage is 6 percent. The low representation in the seedling/sapling, mature and old classes indicates limited structural stage diversity across the landscape.

Table 6. Existing Dominant VSS by PP Analysis area and Restoration Unit (507,839 Acres)

Dominant VSS Class	RU 1	RU 3	RU 4	RU 5	RU 6	Total Acres	Percent Of Analysis area
1 and 2 (SS)	1,547	1,405	3,271	160	1,521	7,905	2%
3 A or B MS	1,099	616	2,859	7,329	7,100	19,003	4%
3 A or B SS	8,925	5,525	11,207	860	4,514	31,030	6%
3 C MS	12,489	13,018	7,438	1,636	6,307	40,888	8%
3 C SS	36,120	26,833	23,766	7,574	12,243	106,537	21%
4 A or B MS	12,361	15,288	26,003	11,558	6,216	71,426	14%
4 A or B SS	9,111	3,035	10,891	1,407	0	24,444	5%
4 C MS	27,121	23,459	14,215	2,950	97	67,842	13%
4 C SS	19,894	20,934	14,709	1,110	0	56,646	11%
5 A or B MS	6,819	8,840	13,993	8,420	0	38,072	7%
5 A or B SS	46	975	602	0	0	1,623	<1%
5 C MS	3,587	4,729	2,219	529	0	11,064	2%
5 C SS	804	1,177	1,494	173	0	3,648	1%
6 A or B MS	2,210	1,974	1,127	15,174	3,057	23,542	5%
6 A or B SS	73	27	3	0	65	167	<1%
6 C MS	1,884	1,391	481	152	69	3,977	1%
6 C SS	25	0	0	0	0	25	<1%

For the remainder of the Silviculture report, the VSS classification will be used to stratify and characterize goshawk habitat. The full VSS code will not be quantified beyond what is disclosed in table 5. The Wildlife report will be characterizing various habitats using the full VSS code based on the definitions in table 5.

Density

Stand density⁶ is the dominant factor affecting the 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). 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

⁶ Stand density – a measure of the degree of crowding of trees within stocked areas (SAF 1998)

necessary for growth (e.g., moisture, nutrients, and sunlight). Early in stand development and prior to closure of the crown canopy, individual trees are growing at their full potential due to a lack of competition with other trees. As stand development advances, relative densities increase as the size of individual trees increase and the crown canopy begins to close. 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 competition-based mortality. At this stage of stand development, trees are growing at much less than full potential.

High forest densities result in increased inter-tree competition, decreased tree health, 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 heterogeneity, decreased understory productivity and diversity, and increased fire hazard.

Measures of stand density used in this analysis are basal area, trees per acre and stand density index (SDI). Basal area (BA) is the cross-sectional area of all trees, measured in square feet per acre. 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 stands of timber. These simple measures of stocking do not give an indication of tree sizes and therefore may be biased when used to determine how site resources are being used.

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. Table 7 displays the amount of tree competition and growth based on stand density percentages (percent of maximum stand density index). Based upon established forest density/vigor relationships, density-related mortality from competition begins to occur once the forest reaches 45-50% of maximum stand density (zone 3), and mortality is likely at density levels of 60%+ of maximum stand density (zone 4).

Table 7. Relationships of Forest Density to Forest Stand Development and Tree Characteristics

% Maximum SDI*	Zone	Forest Stand Development and Tree Characteristics
0 – 24% 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 – 34% 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.
56+% 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

*Ponderosa pine SDI max basis = 450

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.

Canopy Cover and Openness

Canopy Cover

Canopy cover is “the percentage of a fixed area covered by the crowns of plants delimited by a vertical projection of the outermost perimeter of the spread of foliage” (Reynolds et al. 1992). Estimates of canopy cover as an indicator of forest density have become increasingly relevant in forest management. For example, canopy cover is often viewed as a meaningful expression of stand conditions relating to habitat suitability as well as tree overstory/herbaceous understory relationships. In the southwest, canopy cover estimates figure in management recommendations for both the Mexican spotted owl (USDI Fish and Wildlife Service 2012) and the northern goshawk (Reynolds et al. 1992).

For the Coconino NF:

LOPFA

Canopy cover guidelines apply only to mid-aged to old forest structural stages (VSS 4, VSS 5, and VSS 6) and not to grass/forb/shrub to young forest structural stages (VSS 1, VSS 2, and VSS 3) across the landscape (See proposed plan amendments for reference changes).

Ponderosa Pine: Canopy Cover for mid-aged forest (VSS 4) should average 40+%, mature forest (VSS 5) should average 40+%, and old forest (VSS 6) should average 40+%. Opening size is up to 4 acres with a maximum width of up to 200 feet.

PFA

The principle difference between within the post-fledging family area and outside the post-fledging family area is the higher canopy cover within the post-fledging family area and smaller opening size within the post-fledging family area.

Ponderosa Pine: Canopy Cover for mid-aged forest (VSS 4) should average 1/3 60+% and 2/3 50+%. Mature (VSS 5) and old forest (VSS 6) should average 50+%.

For the Kaibab NF the MSO criteria are:

“Forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest (e.g., goshawk post-fledging family areas, Mexican spotted owl nesting/roosting habitat, drainages, and steep north-facing slopes). Mexican spotted owl nesting/roosting habitat, and north-facing slopes. Interspaces with native grass, forb, and shrub vegetation typically range from 10 to 50 percent of the area. The desired condition is the 2012 MSO Recovery Plan. Goshawk nest areas are multi-aged forests dominated by large trees with interlocking crowns and are generally denser than the surrounding forest.”

The analysis and discussions were developed around the Coconino criteria for both the Kaibab and Coconino NF's.

Canopy cover is time consuming to measure and difficult to standardize to obtain consistent results with different observers. Even the definition of the term is dependent on the method of measurement. To resolve this issue for the project, we used the FVS crown width model as the

basis for developing stocking densities that would achieve desired canopy cover levels. This was accomplished by establishing ponderosa pine seedling tree groups (site index 75) within FVS, and periodically thinning the groups to determine the stocking that would achieve the desired canopy cover when the trees reached 15" DBH (midpoint of the VSS 4 size class). This stocking is considered typical for meeting the canopy cover desired conditions and stocking ranges by tree size class that are centered on this value.

These stocking levels were compared to a local study specific to Northern Arizona ponderosa pine forest (as reported by Shepperd et al 2002) that predicted canopy cover at the stand level by inferring the relationship between estimated stand basal area and canopy cover. This comparison indicated the algorithmic relationship between basal area and canopy cover. Canopy cover in the larger size classes in this comparison were generally higher when compared to FVS. Based on this comparison we chose to use the stocking indicated by FVS to meet canopy cover requirements.

The FVS developed stocking guides were then validated thru site visits to areas with variable densities and tree sizes. Comparing the stocking guides to the tree density within VSS 4, 5 and 6 sites that had interlocking or nearly interlocking tree crowns indicated following the stocking guides would meet the desired tree group canopy cover within goshawk habitat (table 8 and figure 4).

Table 8. Stocking Guides to Meet Tree Group Canopy Cover Requirements Within Goshawk Habitat Areas Outside of PFAs (LOPFA)

		Typical Number of Trees Per Group Stocking for Different Group Sizes ¹					Typical Intra-Group (within-group) Densities ¹ (All Group Acreage Sizes)	
VSS	DBH Range	1/10 acre group	1/4 acre group	1/2 acre group	3/4 acre group	1 acre group	Relative Spacing Range (feet)	Basal Area ² (ft ² /acre)
1 & 2	0 - 4.9"	19	48	96	144	193	12 – 18	N/A
3	5 - 11.9"	14	34	68	102	136	N/A	50
4*	12 - 17.9"	5	12	23	35	46	N/A	60
5*	18 - 23.9"	3	8	15	23	30	N/A	70
6*	24"+	2	5	11	16	21	N/A	85

¹These are typical values for the desired condition; variation can occur and is desired. However, ranges should center on these values. See chart below.

²Rounded to nearest 10 square feet/acre

* Densities are equivalent to 40% canopy cover.

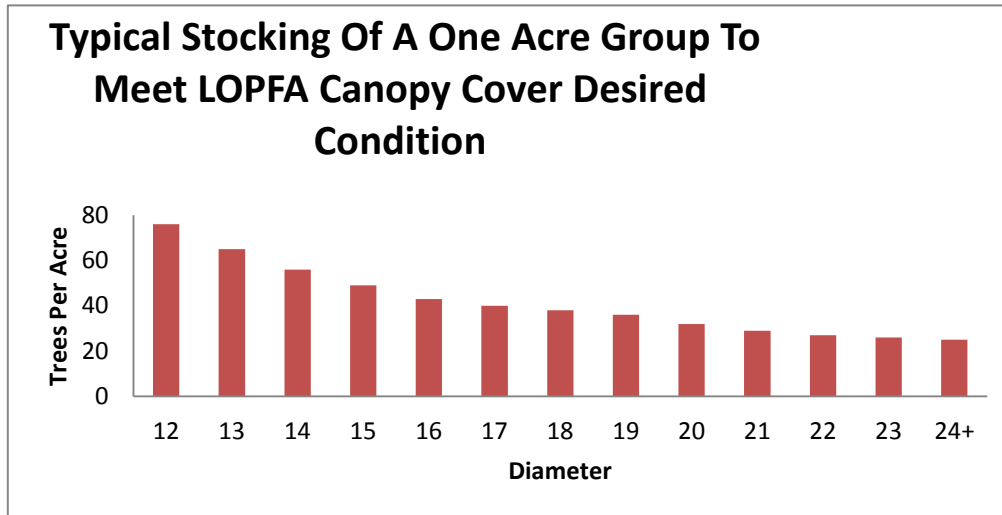


Figure 4 . Stocking Guides, per diameter class in goshawk LOPFA habitat

Figure 4 is the stocking guides, per diameter class, that will be used to meet canopy cover requirements in tree groups within goshawk LOPFA habitat. Table 9 and figure 5 are the stocking guides that will be used to meet canopy cover requirements in tree groups within goshawk PFA habitat.

Table 9 Stocking Guides to Meet Tree Group Canopy Cover Requirements Within Goshawk PFAs

VSS	DBH Range	Typical Number of Trees Per Group Stocking for Different Group Sizes ¹					Typical (within-group) Intra-Group Densities ¹ (All Group Acreage Sizes)	
		1/10 acre group	1/4 acre group	1/2 acre group	3/4 acre group	1 acre group	Relative Spacing Range (feet)	Basal Area ² (ft ² /acre)
1 & 2	0 - 4.9"	19	48	97	145	193	12 – 18	N/A
3	5 - 11.9"	14	34	68	102	136	N/A	50
4*	12 - 17.9"	7	18	35	53	70	N/A	85
5**	18 - 23.9"	4	10	20	29	39	N/A	90
6**	24"+	3	7	14	20	27	N/A	110

¹These are typical values for the desired condition; variation can occur and is desired. However, ranges should center on these values. See chart below.

²Rounded to nearest 10 square feet/acre.

* Densities are equivalent to 55% canopy cover

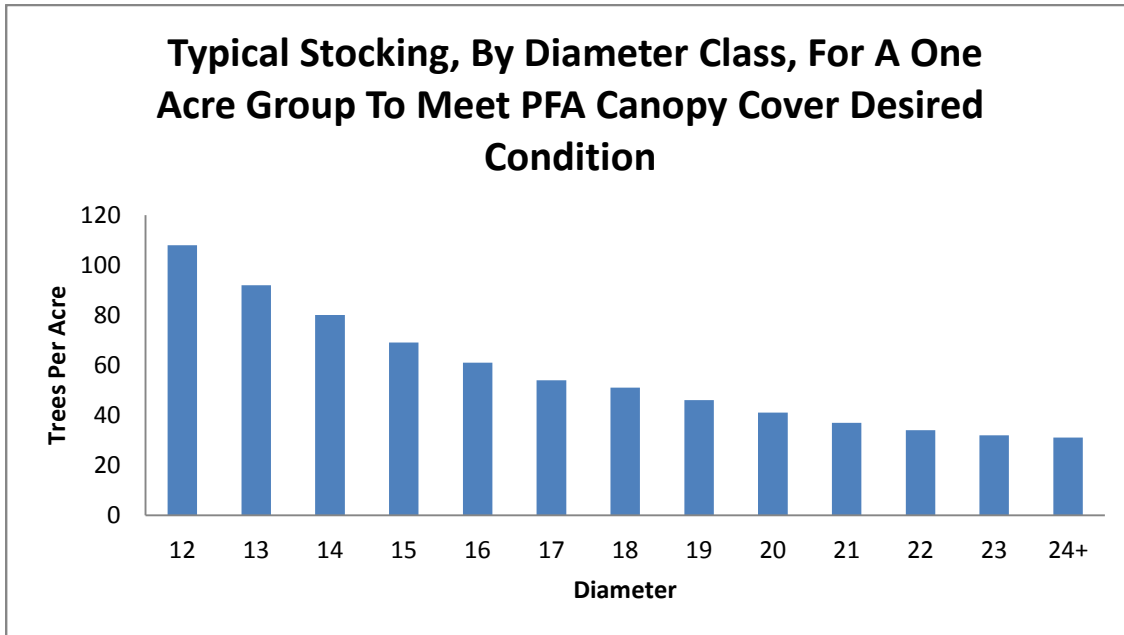


Figure 5 Typical stocking of a one acre group to meet PFA canopy cover desired condition. ** Densities are equivalent to 50% canopy cover

Openness

A key characteristic of historical ponderosa pine 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. Classifications of openness are as follows:

- Very Open = 70-90% Interspace
- Open = 40-70% Interspace
- Moderately Closed = 25-40% Interspace
- Closed = <25% 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. Therefore, the current openness within the project area was classified using the canopy density values described in table 5. Table 10 is an estimate of the percent of the analysis area by openness classification within each SU and RU for ponderosa pine.

Table 10 Existing Openness Classification for Ponderosa Pine

Restoration Unit-Subunit	Acres	Very Open	Open	Moderately Closed	Closed
1-1	8,914	1%	20%	38%	40%
1-2	6,517	2%	28%	42%	28%
1-3	36,461	0%	19%	27%	53%
1-4	17,285	1%	15%	39%	45%
1-5	74,936	0%	9%	23%	67%
1	144,113	1%	14%	28%	58%
3-1	18,805	1%	16%	34%	49%
3-2	22,885	2%	23%	40%	36%
3-3	44,426	1%	15%	21%	63%
3-4	8,920	0%	7%	17%	76%
3-5	34,190	1%	5%	17%	76%
3	129,226	1%	13%	25%	60%
4-2	7,381	2%	36%	35%	27%
4-3	55,312	6%	28%	34%	e33%
4-4	65,003	2%	17%	35%	e45%
4-5	6,581	8%	13%	36%	43%
4	134,278	4%	22%	35%	39%
5-1	18,040	21%	32%	29%	18%
5-2	40,994	7%	67%	21%	5%
5	59,034	12%	57%	23%	9%
6-2	5,069	1%	56%	e24%	20%
6-3	32,635	2%	28%	44%	26%
6-4	3,484	1%	4%	25%	71%
6	41,189	2%	30%	40%	29%
All Ponderosa Pine	507,839	3%	22%	29%	46%

Mexican Spotted Owl and Northern Goshawk Habitat

All ponderosa pine forested habitat within the analysis area was stratified to meet analysis requirements, desired conditions, and standards and guidelines in the forest plans (USDA 1987, as updated 2008 and USDA (2014) for Mexican spotted owl (MSO) and northern goshawk (NOGO) as displayed in figure 6.

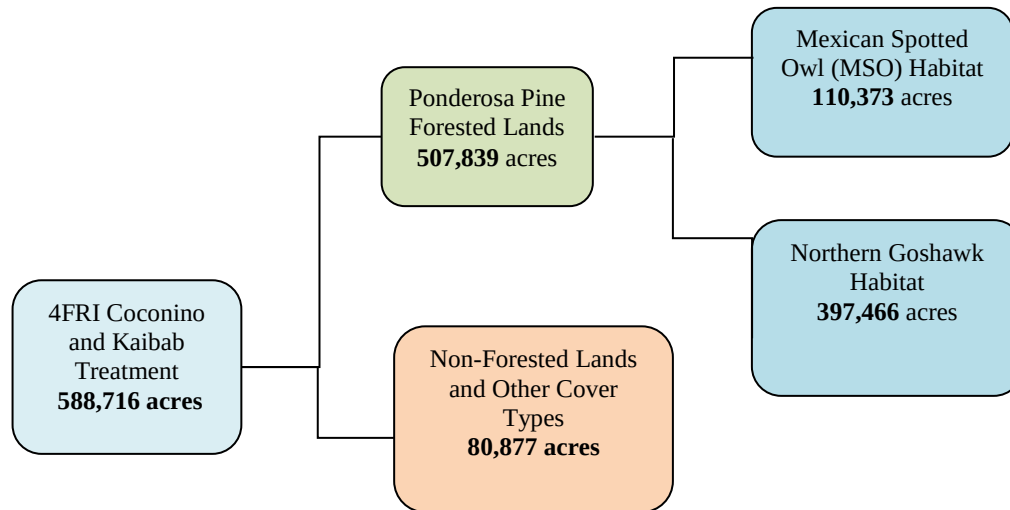


Figure 6: Stratification of ponderosa pine forested lands, other cover types and non-forested land.

Stratification of acres by habitat and forest type is displayed in table 11 (MSO) and table 12 (NOGO).

Table 11. Mexican Spotted Owl Habitat Stratification within the Analysis area (Acres within each RU)⁷

MSO Habitat	RU 1	RU 3	RU 4	RU 5	RU 6	Total
Protected Habitat						
Protected Activity Center (PAC)	28,457	4,555	555	859	0	34,426
Pine Oak >40% Slope	595	238	3	0	0	836
Total MSO Protected:	29,052	4,793	558	859	0	35,262
Restricted Habitat – Pine Oak						
Threshold	873	1,104	0	0	0	1,977

⁷ Numbers in this table have been rounded to the nearest acre and were summarized before rounding. Any apparent discrepancy accounts for an error of less than one percent.

MSO Habitat	RU 1	RU 3	RU 4	RU 5	RU 6	Total
Target	3,920	2,795	0	0	0	6,715
Restricted Other	25,710	38,527	1,576	606	0	66,419
Total MSO Restricted:	30,503	42,426	1,576	606	0	75,111
Total MSO Habitat	59,555	47,219	2,134	1,465	0	110,373

Table 12. Northern Goshawk Habitat Stratification within the Analysis area (Acres by RU)⁸

Northern Goshawk Habitat	RU 1	RU 3	RU 4	RU 5	RU 6	Total
Nest Habitat	1,126	1,247	3,489	410	616	6,840
Post-fledgling Family Area (PFA)						
Uneven-aged	2,149	1,991	3,780	888	2,607	11,415
Even-aged	1,396	2,391	6,216	929	827	11,759
Total PFA :	3,545	4,382	9,996	1,817	3,434	23,174
Total PFA and Nest	4,671	5,582	13,485	2,227	4,050	30,014
Landscapes Outside Post-fledgling Family Areas (LOPFA)						
Uneven-aged	41,479	30,013	38,981	29,757	22,816	163,045
Even-aged	38,410	46,411	79,678	25,584	14,323	204,407
Total LOPFA:	79,889	76,424	118,659	55,341	37,139	367,452
Total Goshawk Habitat	84,559	82,006	132,144	57,568	41,189	397,466

Forest Density and Structure – Mexican Spotted Owl

The Protected Activity Centers (PACs) provide the best possible owl habitat available with the nest or activity center located near the center. The restricted habitats are managed to ensure a sustained level of owl nest/roost habitat distributed across the landscape. Table 13 displays the total basal area, relative SDI, percent of the total SDI by size class, tree per acre greater than 18” and Gambel oak basal area as a percent of total basal for all MSO habitats. These structural attributes and habitat components are indicators of nest/roost characteristics as outlined in the

⁸ Numbers in this table have been rounded to the nearest acre and were summarized before rounding. Any apparent discrepancy accounts for an error of less than one percent.

Land and Resource Management Plan for the Coconino National Forest (amended) and the Kaibab National Forest (2014).

The average conditions within the restricted target/threshold MSO forest habitats currently have the minimum structural components with the exception of percent density within the 24" + size class and trees per acre in the 18 + size class. The average condition within the restricted other MSO forest habitats are also lacking in trees greater than 18" + and percent density of trees 24"+. The Gambel oak component in both habitats is close to or above the minimum of $\geq 20\%$ and they are providing the key habitat components of coarse woody debris $>12"$ and snags $\geq 18"$.

Table 13. Existing Spotted Owl Habitat Forest Structure and Habitat Components

Habitat	RU	Basal Area	% Max SDI	Avg. Percent of Total SDI by Size Class			Avg. TPA 18"+	Avg. Gambel Oak BA Percent of Total BA	Tons CWD >12"	Snags >18"
				12.0 – 17.9"	18.0 – 23.9"	24.0" +				
Restricted Target	RU 1	156	81%	30%	12%	7%	13.6	20%	1.5	0.5
	RU 3	148	79%	26%	13%	7%	13.4	24%	0.8	0.5
	All	152	80%	28%	13%	7%	13.5	22%	1.2	0.5
Restricted Threshold	RU 1	204	101%	25%	24%	3%	28.0	29%	2.0	0.5
	RU 3	185	99%	26%	19%	8%	23.7	33%	0.6	0.7
	All	193	100%	25%	21%	6%	25.6	31%	1.2	0.6
Restricted Other	RU 1	138	68%	30%	12%	7%	11.6	15%	0.3	0.4
	RU 3	137	70%	29%	13%	7%	11.6	21%	0.5	0.4
	RU 4	129	67%	28%	13%	8%	11.6	24%	0.4	0.5
	RU5	102	51%	24%	10%	9%	8.0	15%	0.2	0.4
	All	137	69%	29%	13%	7%	11.5	19%	0.4	0.4
Protected	RU 1	154	78%	31%	13%	8%	14.6	14%	0.7	0.6
	RU 3	170	82%	31%	15%	9%	18.5	12%	1.2	0.7
	RU 4	100	49%	33%	9%	5%	8.6	8%	0.4	0.4
	RU 5	132	64%	34%	14%	8%	13.2	10%	1.1	0.6
	All	155	78%	31%	14%	8%	15.0	13%	0.8	0.6

Forest Density and Structure – Goshawk Forest Habitat

The Kaibab National Forest Plan (2014, page 18) does not describe goshawk habitat in terms used by the Management Recommendations for the Northern Goshawk (GTR-217: referred to as MRNG) (Reynolds et al 1992) as does the Coconino National Forest Plan. The Kaibab Forest Plan used GTR-310 (Reynolds, 2013) and GTR-217 to inform the planning process framework for Goshawk. Therefore, the Kaibab Forest Plan achieves the desired conditions for Goshawk by achieving the desired conditions for the ponderosa pine communities. As a consequence, on the Kaibab NF, most all ponderosa pine communities are potential goshawk habitat⁹. However, for the purpose of consistency of analysis and clarity of intent the concept and use of VSS and other terms used in MRNG will be maintained in this analysis.

Kaibab NF describes goshawk habitat as:

Forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest (e.g., goshawk post-fledgling family areas, Mexican spotted owl nesting/roosting habitat, drainages, and steep north-facing slopes).

The post-fledgling family areas (PFA) consist of nest sites and adjacent habitat most likely to be used by fledglings during their early development as well as unoccupied suitable habitat within a 2 to 2.5 mile range of PFAs (dispersal PFA - dPFA). The remaining ponderosa pine forest outside of MSO protected and restricted areas and outside of goshawk PFA is considered goshawk foraging habitat and will be referred to as Landscapes Outside of Goshawk Post-fledgling Family Areas (LOPFA) for the remainder of this report.

The existing distribution of forest structure, habitat components and structural stages within northern goshawk habitat was evaluated at four scales: ponderosa pine extent, restoration unit, restoration subunit and stand. Stands of like structural characteristics and like treatments were grouped. Habitat structure and forest density metrics were averaged by strata to a per-acre basis (see Methodology, Assumptions and Limitations section of this report). Average conditions include trees, interspaces, and canopy gaps as represented by the stand data.

Table 14 and table 15 display the existing forest structure and habitat components for the goshawk forest habitat. These structural attributes and habitat components are indicators of goshawk habitat (PFA and LOPFA) characteristics as outlined in Coconino National Forest Plan (amended 2008) and the Land and Resource Management Plan for the Kaibab National Forest (2014).

⁹ While all ponderosa pine habitat is potential goshawk habitat, this does not negate the requirements mandated by the 2012 MSO Recovery Plan.

Table 14. Existing Goshawk Nest/PFA Habitat Forest Structure and Habitat Components

Restoration Subunit-Unit	Ponderosa Pine SDI % of Max.	Ponderosa pine TPA	Ponderosa Pine Basal Area	Tons CWD Total	Tons CWD >12"	Snags >18"
1-1	29%	151	67	2.8	0.1	0.3
1-2	40%	202	94	3.6	0.5	0.4
1-3	54%	226	133	4.4	0.4	0.4
1-4	57%	313	134	8.6	4.9	0.3
1-5	55%	247	131	4.8	0.5	0.6
1	52%	239	124	5.0	1.1	0.4
3-1	44%	177	107	3.3	0.2	0.4
3-2	44%	181	109	3.1	0.3	0.4
3-3	48%	220	117	3.6	0.3	0.4
3-5	44%	207	105	3.7	0.4	0.4
3	46%	203	112	3.5	0.3	0.4
4-2	38%	162	94	2.8	0.2	0.4
4-3	45%	197	109	3.7	0.7	0.4
4-4	51%	224	123	4.7	1.3	0.4
4-5	46%	226	108	4.2	0.6	0.4
4	46%	204	112	3.9	0.8	0.4
5-1	45%	206	109	5.2	1.7	0.4
5-2	42%	192	99	3.9	0.5	0.5
5	43%	199	104	4.5	1.1	0.5
6-2	24%	108	53	1.9	0.2	0.3
6-3	30%	154	64	2.4	0.3	0.3
6	29%	150	63	2.4	0.3	0.3
All Nest/PFA	44%	202	107	3.9	0.7	0.4

Table 15. Existing Goshawk LOPFA Habitat Forest Structure and Habitat Components

Restoration Subunit-Unit	Ponderosa Pine SDI % of Max.	Ponderosa Pine TPA	Ponderosa Pine Basal Area	Tons CWD Total	Tons CWD >12"	Snags >18"
1-1	44%	208	103	3.7	0.5	0.3
1-2	36%	185	86	3.2	0.3	0.3
1-3	43%	212	102	3.8	0.5	0.3
1-4	43%	224	99	3.8	0.5	0.4
1-5	51%	248	118	4.5	0.7	0.5
1	46%	227	107	4.1	0.6	0.4
3-1	41%	175	99	2.8	0.2	0.4
3-2	39%	148	97	2.7	0.3	0.4
3-3	47%	209	114	3.8	0.5	0.3
3-4	53%	240	126	4.7	0.7	0.4
3-5	54%	264	127	4.8	0.7	0.4
3	47%	208	113	3.8	0.5	0.4
4-2	35%	142	86	2.5	0.2	0.3
4-3	38%	176	91	3.2	0.4	0.4
4-4	44%	198	107	3.5	0.4	0.3
4-5	44%	218	106	4.0	0.4	0.4
4	41%	187	100	3.3	0.4	0.4
5-1	31%	174	73	3.2	0.3	0.4
5-2	27%	119	67	3.0	0.4	0.4
5	28%	136	69	3.1	0.4	0.4
6-2	29%	166	63	2.3	0.3	0.2
6-3	33%	197	71	2.6	0.2	0.2
6-4	32%	198	67	3.1	0.3	0.4
6	32%	194	69	2.6	0.2	0.2
All LOPFA	41%	193	96	3.5	0.5	0.4

All goshawk habitat was assessed to determine the variety of tree size/age classes present in relation to the dominant size/age class. Those stands with one or two classes present have even-aged structure and those stands with three or more classes present have Uneven-aged structure. 1996 forest plan amendment for the Coconino Forest Plan direction for goshawk habitat outside of nest stands is to manage for uneven age stand conditions for live trees. Based upon this direction, the existing even-aged forest structure is not desired for goshawk forest habitat outside of nest stands.

Table 16 through table 19 illustrate the distribution of the dominate vegetation structural stages for all stands within each of goshawk habitats and age class strata. This is an indication of structural stage diversity throughout the goshawk habitat. Since the stand level structural stage is based on the tree size class with the highest square foot of basal area, it is a true description of age class diversity in even age stands while in uneven-age stands it does not give a complete portrayal. This is due to the fact that within uneven-age stands there are three or more age classes present and the dominate VSS class only tell us which one has the highest basal area.

The Coconino Forest Plan direction for goshawk habitat distribution outside of nest stands is:10% each grass/forb/shrub (VSS 1) and seedling-sapling (VSS 2), 20% each young forest (VSS 3), mid-aged forest (VSS 4), mature forest (VSS 5) and old forest (VSS 6).

The Even-aged stands (table 16 and table 18) are dominated by the young and mid-aged forest structural stages (over 80 percent within the LOPFA and almost 90 percent in the PFA) with very little representation of the other structural stages.

The existing Uneven-aged forest structure does not comprise a balance of VSS classes (table 17 and table 19). The young and mid-aged forest structural stages are surplus, and the grass/forb/shrub, seedling-sapling, mature and old forest stages are deficit relative to 1996 forest plan amendment for Coconino Forest Plan direction.

Table 16. Existing Forest Structure – Goshawk LOPFA Even-Aged Stands Percent of Area by Vegetative Structural Stages (VSS).

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")	2 – Seedling/ Sapling (1.0 - 4.9")	3 – Young Forest (5.0 - 11.9")	4 – Mid-age Forest (12.0 - 17.9")	5 – Mature Forest (18.0 - 23.9")	6 – Old Forest (24.0" +)
SU 1-1	0%	1%	38%	48%	2%	10%
SU 1-2	5%	0%	47%	44%	4%	0%
SU 1-3	1%	1%	49%	45%	1%	4%
SU 1-4	2%	0%	53%	43%	2%	0%
SU 1-5	1%	0%	45%	43%	9%	3%
RU 1	1%	0%	47%	44%	5%	3%
SU 3-1	2%	1%	31%	53%	13%	0%
SU 3-2	5%	0%	14%	58%	22%	2%
SU 3-3	3%	0%	39%	51%	7%	1%
SU 3-4	0%	3%	29%	58%	8%	2%
SU 3-5	2%	1%	34%	59%	4%	0%
RU 3	3%	0%	31%	55%	10%	1%
SU 4-2	4%	0%	27%	42%	25%	2%
SU 4-3	11%	0%	32%	50%	7%	1%
SU 4-4	4%	0%	33%	54%	8%	1%
SU 4-5	12%	0%	32%	49%	7%	0%
RU 4	7%	0%	32%	52%	8%	1%
SU 5-1	35%	0%	28%	28%	8%	1%
SU 5-2	19%	0%	16%	55%	7%	3%
RU 5	26%	0%	21%	44%	7%	2%
SU 6-2	5%	4%	84%	6%	1%	0%
SU 6-3	4%	2%	78%	11%	5%	1%
SU 6-4	2%	1%	87%	10%	0%	0%
RU 6	4%	2%	79%	10%	4%	1%
All	7%	0%	37%	47%	8%	1%

Table 17. Existing Forest Structure – Goshawk LOPFA Uneven-Aged Stands Percent of Area by Vegetative Structural Stages (VSS).

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")	2 – Seedling/ Sapling (1.0 - 4.9")	3 – Young Forest (5.0 - 11.9")	4 – Mid-age Forest (12.0 - 17.9")	5 – Mature Forest (18.0 - 23.9")	6 – Old Forest (24.0" +)
SU 1-1	0%	1%	33%	53%	10%	3%
SU 1-2	0%	4%	45%	41%	8%	2%
SU 1-3	0%	4%	38%	34%	15%	9%
SU 1-4	0%	0%	62%	29%	3%	6%
SU 1-5	0%	1%	28%	52%	14%	5%
RU 1	0%	2%	37%	43%	12%	6%
SU 3-1	0%	5%	42%	36%	12%	4%
SU 3-2	0%	0%	18%	39%	23%	21%
SU 3-3	0%	1%	39%	42%	10%	8%
SU 3-4	0%	0%	17%	47%	24%	12%
SU 3-5	0%	4%	37%	43%	5%	11%
RU 3	0%	2%	33%	41%	13%	11%
SU 4-2	0%	2%	33%	42%	22%	0%
SU 4-3	0%	1%	38%	31%	16%	13%
SU 4-4	0%	1%	34%	43%	14%	8%
SU 4-5	0%	0%	33%	50%	7%	10%
RU 4	0%	1%	36%	38%	15%	10%
SU 5-1	0%	6%	14%	40%	11%	28%
SU 5-2	0%	0%	12%	7%	24%	56%
RU 5	0%	1%	13%	14%	21%	51%
SU 6-2	0%	1%	55%	18%	10%	15%
SU 6-3	0%	5%	64%	18%	5%	7%
SU 6-4	0%	0%	77%	4%	3%	16%
RU 6	0%	4%	64%	16%	6%	10%
All	0%	2%	35%	32%	14%	17%

Table 18. Existing Forest Structure – Goshawk PFA/Nest* Even-aged Stands Percent of Area by Vegetative Structural Stages (VSS).

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")	2 – Seedling/ Sapling (1.0 - 4.9")	3 – Young Forest (5.0 - 11.9")	4 – Mid-age Forest (12.0 - 17.9")	5 – Mature Forest (18.0 - 23.9")	6 – Old Forest (24.0" +)
SU 1-1	-%	-%	-%	-%	-%	-%
SU 1-2	0%	0%	71%	29%	0%	0%
SU 1-3	0%	0%	30%	70%	0%	0%
SU 1-4	0%	0%	81%	19%	0%	0%
SU 1-5	0%	0%	25%	75%	0%	0%
RU 1	0%	0%	50%	50%	0%	0%
SU 3-1	2%	0%	34%	51%	13%	0%
SU 3-2	0%	0%	18%	62%	20%	0%
SU 3-3	13%	0%	34%	51%	3%	0%
SU 3-5	32%	0%	0%	68%	0%	0%
RU 3	11%	0%	27%	55%	8%	0%
SU 4-2	4%	0%	22%	36%	38%	0%
SU 4-3	1%	0%	27%	67%	4%	1%
SU 4-4	0%	0%	40%	50%	10%	0%
SU 4-5	0%	0%	34%	61%	5%	0%
RU 4	1%	0%	31%	58%	9%	1%
SU 5-1	8%	0%	40%	47%	0%	4%
SU 5-2	0%	0%	8%	68%	17%	7%
RU 5	4%	0%	24%	58%	9%	5%
SU 6-2	3%	0%	58%	0%	40%	0%
SU 6-3	8%	14%	40%	19%	14%	6%
RU 6	7%	12%	41%	18%	16%	5%
All	3%	1%	33%	54%	8%	1%

*Data analysis for nest areas was constrained by a limited data set and is represented with the PFA acres displayed.

Table 19. Existing Forest Structure – Goshawk PFA/Nest* Uneven-aged Stands Percent of Area by Vegetative Structural Stages (VSS).

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")	2 – Seedling/ Sapling (1.0 - 4.9")	3 – Young Forest (5.0 - 11.9")	4 – Mid-age Forest (12.0 - 17.9")	5 – Mature Forest (18.0 - 23.9")	6 – Old Forest (24.0" +)
SU 1-1	0%	0%	100%	0%	0%	0%
SU 1-2	0%	0%	38%	6%	27%	29%
SU 1-3	0%	0%	21%	71%	7%	0%
SU 1-4	0%	0%	0%	90%	0%	10%
SU 1-5	0%	0%	66%	13%	7%	14%
RU 1	0%	0%	41%	42%	9%	8%
SU 3-1	0%	0%	23%	55%	22%	0%
SU 3-2	0%	0%	11%	79%	10%	0%
SU 3-3	0%	0%	25%	44%	11%	20%
SU 3-5	0%	0%	60%	25%	15%	0%
RU 3	0%	0%	24%	55%	12%	9%
SU 4-2	0%	0%	40%	25%	22%	13%
SU 4-3	0%	2%	33%	49%	14%	2%
SU 4-4	0%	0%	18%	48%	25%	9%
SU 4-5	0%	0%	0%	34%	66%	0%
RU 4	0%	1%	28%	45%	19%	6%
SU 5-1	0%	0%	21%	71%	8%	0%
SU 5-2	0%	0%	11%	48%	27%	14%
RU 5	0%	0%	16%	58%	18%	7%
SU 6-2	0%	1%	6%	58%	11%	24%
SU 6-3	0%	2%	61%	4%	13%	20%
RU 6	0%	2%	56%	8%	13%	20%
All	0%	1%	35%	40%	14%	10%

*Data analysis for nest areas was constrained by a limited data set and is represented with the PFA acres displayed.

Forest Structure - Old Growth

The Coconino forest plan defines old growth as:

“A stand of timber that is past full maturity and well into old age. The last stage in forest succession. Old growth characteristics for ponderosa pine include: at least 1,400 overstory trees per 100 acres equal to or greater than 20 inches d.b.h. on sites greater than 54 (minor); at least 1,400 trees per 100 acres equal to or greater than 14 inches d.b.h. on sites less than 54 (minor); at least two-storied stands with approximately 60 GSL in the understory; at least 180 snags per 100 acre greater than or equal to 14 inches d.b.h. and 15 feet tall; and at least two trees per acre of down woody material 12 inches or greater in diameter and 15 feet long. See Wildlife Coefficients Report of old growth characteristics for other species” (CFP, page 258).

The Coconino forest plan old growth standard states (CFP, page 70-1):

Standards:

Until the forest plan is revised, allocate no less than 20 percent of each forested ecosystem management area to old-growth...

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.

Guidelines:

All analyses should be at multiple scales - one scale above and one scale below the ecosystem management areas. The amount of old-growth 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 analysis area...”

Kaibab Forest plan (USDA 2014, page 153) describes desired conditions for and defines old growth forest structure in ponderosa pine and pinyon-juniper communities with the following statement:

“Old growth in southwestern forested ecosystems is different than the traditional definition based on northwestern infrequent fire forests. Due to large differences among Southwest forest 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 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 1989, Helms 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 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.”

Four scales of analysis have been developed given the size of this project. For the Kaibab, the four scales of analysis is an additional analysis which is not required by the forest plan (USDA; 2014 See Appendix B of the Silviculture Specialist report for further clarification of consistency of Kaibab forest plan and old growth habitat.

The smallest scale is represented at the stand level with stands averaging less than 100 acres in size. The EMA is considered the restoration sub-unit. Sub-units range in size from 4,000 to 109,000 acres. The scale above the EMA is the restoration unit that ranges in size from 46,000 to 335,000 acres. The fourth scale for ponderosa pine type is the 507,839 acres of ponderosa pine within the 4FRI analysis area. For pinyon-juniper type, it is approximately 23,316 acres of pinyon-juniper within the 4FRI analysis area.

Allocations¹⁰ to old growth consist of landscape percentages meeting old growth conditions and not specific areas (CFP). The allocations for this project are independent of previous allocations that were part of other projects/analyses that overlap the 4FRI analysis area. This is due to changes in forest conditions since the previous analyses and updates to the MSO and goshawk habitat classifications.

A review of stand data and habitat classifications within the 4FRI analysis area indicates there are approximately 507,839 acres of ponderosa pine. Of this total, 192,819 acres meet or are moving toward old growth conditions. Old growth allocations are based on current conditions within the project area along with Coconino forest plan specific management direction. Currently, all restoration units meet or exceed the 20 percent minimum percentage Coconino requirement. Table 20 displays ponderosa pine old growth acres by restoration sub-unit/unit. The Kaibab Forest plan does not specify a percentage of required old growth habitats. To be consistent across forest boundaries this old growth on the Kaibab will be analyzed against the 20% allocated habitat.

For ponderosa pine, the old growth allocation acreage/percentage within the 4FRI analysis area includes: 100 percent of MSO protected habitat; 100 percent of MSO target/threshold; 40 percent of MSO restricted habitat that is Uneven-aged with low dwarf mistletoe infection; 80 percent of MSO restricted habitat that is even-aged, mid-aged to old with low dwarf mistletoe infection; 100 percent of goshawk nest stands; 40 percent of goshawk PFA and foraging areas that are Uneven-aged with low dwarf mistletoe infection; and, 80 percent of goshawk PFA and foraging areas that are even-aged, mid-aged to old with low dwarf mistletoe infection. Most sites currently do not fully meet the minimum criteria for ponderosa pine old growth conditions as listed in the Coconino forest plan. However, the habitat types noted above are closest to meeting old growth conditions.

¹⁰ Allocation is a term used exclusively in the Coconino Forest Plan. The Kaibab does not allocate old growth.

Table 20. 4FRI Analysis area ponderosa pine old growth acres and percent by restoration sub-unit/unit

Restoration Unit-Subunit	Ponderosa pine total acres	Ponderosa pine old growth acres	Old growth percent (%)
1-1	8,915	3,578	40%
1-2	6,517	2,034	31%
1-3	36,461	17,105	47%
1-4	17,285	6,323	37%
1-5	74,936	35,050	47%
1 (Total)	144,114	64,090	44%
3-1	18,805	6,216	33%
3-2	22,885	9,317	41%
3-3	44,426	15,624	35%
3-4	8,920	4,201	47%
3-5	34,190	11,305	33%
3 (Total)	129,226	46,663	36%
4-2	7,381	3,710	50%
4-3	55,312	20,144	36%
4-4	65,003	22,175	34%
4-5	6,581	2,030	31%
4 (Total)	134,277	48,059	36%
5-1	18,040	5,187	29%
5-2	40,994	18,529	45%
5 (Total)	59,034	23,716	40%
6-2	5,069	1,689	33%
6-3	32,635	8,210	25%
6-4	3,484	392	11%
6 (Total)	41,188	10,291	25%
Totals	507,839	192,819	38%

Areas currently allocated do not necessarily meet old growth standards by the Coconino forest plan definition but are managed to move toward those conditions to meet structural attributes over time. Table 21 displays the existing average structural attributes for the ponderosa pine old growth acres by restoration sub-unit and unit.

Table 21. Existing 4FRI Analysis area of Ponderosa Pine Old Growth Structural Attributes

Restoration Unit-Subunit	OG Acres	Avg. TPA 18"+	Avg. BA	Avg. Tons CWD ≥12"	Avg. Snags Per Acre ≥12"
1-1	3,578	13.2	117	0.4	1.4
1-2	2,034	11.0	101	0.3	1.1
1-3	17,105	13.5	128	0.6	2.0
1-4	6,323	11.6	117	0.3	1.7
1-5	35,050	14.9	146	0.6	2.8
1	64,090	13.9	134	0.5	2.3
3-1	6,216	12.9	121	0.3	1.6
3-2	9,317	14.7	113	0.3	1.5
3-3	15,624	13.8	132	0.4	2.0
3-4	4,201	15.8	148	0.7	2.8
3-5	11,305	15.2	147	0.8	2.6
3	46,663	14.4	132	0.5	2.1
4-2	3,710	13.0	103	0.2	1.2
4-3	20,144	11.9	107	0.3	1.4
4-4	22,175	13.2	119	0.3	1.4
4-5	2,030	14.1	136	0.4	2.1
4	48,059	12.7	113	0.3	1.4
5-1	5,187	11.7	99	0.5	1.4
5-2	18,529	11.9	84	0.5	1.3
5	23,715	11.8	87	0.5	1.3
6-2	1,689	8.5	84	0.2	0.6
6-3	8,210	9.1	92	0.2	0.6
6-4	392	9.3	109	0.3	1.0
6	10,291	9.0	91	0.2	0.6
Totals	192,819	13.0	118	0.4	1.8

To further address concerns about old growth distribution throughout the Coconino project area, we compiled old growth allocation summaries from separate vegetation analysis outside of the 4FRI analysis area. Table 22 displays ponderosa pine old growth acres by restoration unit/forest for all the ponderosa pine within the 4FRI analysis area on the Coconino NF as well as ponderosa pine for other areas within the project area that were analyzed in separate vegetation analysis (see Silviculture Area of Analysis discussion). Currently, the Coconino forest percentages meet or exceed the 20 percent minimum percentage requirement in all restoration units except RU 6.

The Kaibab NF does not allocate acres to old growth like the Coconino NF but instead relies on the structural components of Uneven-aged management to move the forest towards the desired conditions: “Old growth 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, snags, coarse woody debris, and structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality). “(KFP, page 18). However, we can quantify the pre-treatment acres that are near or progressing on a trajectory to contain sufficient representation of old growth components on a stand-level basis. There are 268,833 (189,408 4 FRI/79,425 other project) acres of ponderosa pine on the Kaibab NF. Of the 268,833 acres 83,186 acres (31%) (65,810 4 FRI/17,376 other project) can be said to be closest to the minimum old growth component criteria (KFP, page 18).

Table 22. Coconino NF Project area ponderosa pine old growth acres and percent by restoration unit/forest

	Ponderosa pine total acres	Ponderosa pine old growth acres	Old growth percent (%) of total acres
Restoration Unit	Coconino NF	Coconino NF	Coconino NF
	(4FRI/Other Projects) Total	(4FRI/Other Projects) Total	
1	(144,113/48,876) 192,989	(64,090/12,507) 76,597	40%
3	(58,327/29,176) 87,503	(21,486/10,894) 32,380	37%
4	(56,957/5,941) 62,898	(17,717/1,965) 19,682	31%
5	(59,034/45,022) 104,056	(23,716/8,441) 32,157	31%
6	This RU does not occur on Coconino NF	This RU does not occur on Coconino NF	This RU does not occur on Coconino NF
Total	(318,432/129,015) 447,447	(127,009/33,807) 160,816	36%

There are approximately 23,316 acres of pinyon-juniper within the 4FRI analysis area and approximately 6,218 acres of pinyon-juniper within other areas analyzed in separate vegetation analysis for a total of 29,534 acres (table 23). The old growth attributes for pinyon-juniper are shown in table 24. The old growth areas are those sites/acres that are closest to the minimum criteria for old growth conditions on the Coconino forest plan. The Coconino areas include approximately 888,758 acres that equates to 68 percent of the Coconino pinyon-juniper community acres.

The Kaibab NF does not allocate acres to old growth like the Coconino NF but instead relies on the structural components of Uneven-aged management to move the forest towards the desired conditions stated as; “Old growth occurs throughout the landscape, generally in small areas as individual components, or as clumps. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality)” (KFP, page 12).

Table 23. Project area pinyon-juniper old growth acres and percent by forest

	Pinyon-juniper total acres	Pinyon-juniper old growth acres	Pinyon-juniper old growth percent (%)
Restoration Unit	Coconino NF	Coconino NF	Coconino NF
	(4FRI/Other Projects) Total	(4FRI/Other Projects) Total	
1	(1,141/2,135) 3,276	(611/447) 1,058	32%
3	(832/0) 832	(356/0) 356	43%
4	(42/0) 42	(42/0) 42	100%
5	(8,771/0) 8,771	(7,302/0) 7,302	83%
6	This RU does not occur on Coconino NF	This RU does not occur on Coconino NF	This RU does not occur on Coconino NF
Total	(10,786/2,135) 12,921	(8,311/447) 8,758	68%

Table 24. Existing 4FRI analysis area Pinyon-Juniper acres of Old Growth Structural Attributes

Restoration Unit	OG Acres	Avg. TPA 12"+	Avg. BA	Avg. Tons CWD ≥12"	Avg. Snags Per Acre ≥12"
1	611	31	108	0.1	1.0
3	2,103	31	93	0.1	1.5
4	4,158	29	88	0.1	1.5
5	7,302	32	108	0.1	1.0
6	1,452	37	120	0.2	1.2
All:	15,626	31	102	0.1	1.2

Forest Health

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, and a long-term drought that included an extremely dry and warm period from 2001 through 2002, and bouts of defoliation 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 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 spouts was attributed to browsing by elk and deer as none of the sites studied were grazed currently by domestic cattle. Widespread mortality of mature aspen trees, chronic browsing by ungulates, and advanced conifer reproduction is expected to result in rapid vegetation change of many ecologically unique and important sites (Fairweather et. al. 2008). The annual Forest Health Protection aerial survey conducted in 2010 (USDA Forest Service 2011) indicated a continuation of the mortality trend within the project area.

Bark Beetles

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).

The annual aerial surveys on the Coconino and Kaibab in the summer of 2010 detected ponderosa pine mortality associated with bark beetles on approximately 6,500 acres within the project area. This mortality is most likely associated with the Ips beetle (USDA Forest Service 2011). This survey indicates a 10-fold increase in beetle mortality from the 2008 and 2009 surveys although

bark beetle activity in ponderosa pine is currently considered to be at endemic levels. Preliminary results of the 2011 survey indicate a minor reduction in ponderosa pine mortality from 2010.

During the morning of October 6, 2010, four tornados occurred approximately 10 miles to the west of Flagstaff traversing in south to north direction. There was an array of tree damage including windthrown trees, trees snapped off at various heights, and partially windthrown trees that are leaning at various degrees. Engraver beetles (*Ips* species), in particular, are most likely to colonize damaged and down ponderosa pine, have successful brood production, and threaten neighboring undamaged trees (USDA Forest Service 2011). There was little beetle related mortality observed within the tornado area in the summer of 2011. Preliminary surveys in the winter of 2012 indicate that adult beetles are overwintering in the storm damaged trees. If conditions are dry and warm in the spring of 2012, there is a heightened chance of beetle caused mortality in adjacent trees in the summer of 2012 and the potential to reach epidemic levels by the end of the summer (McMillin, personal communication, 2012).

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 shows 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).

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) and the draft *Ips* hazard model developed by McMillin et al. (2011) indicates that stands of ponderosa pine within the project area with a relative density below 30% of SDImax have a low hazard rating and stands between 30 and 40% of SDImax have a moderate hazard rating. Using these relative density thresholds, approximately 8 percent of the ponderosa pine analysis area has a low bark beetle hazard rating, while 21 percent of the area has a moderate rating and the remaining 71 percent has a high hazard of beetle attack (table 25).

Table 25. Existing Ponderosa Pine Beetle Hazard Rating (Percent of area in each RU)

Hazard Rating	RU 1	RU 3	RU 4	RU 5	RU 6	Analysis Area Acres (% of Total)
Low	3%	6%	8%	26%	0%	37,933 (7%)
Moderate	12%	11%	27%	46%	25%	106,131 (21%)
High	85%	83%	65%	28%	75%	363,775 (72%)

Dwarf Mistletoe

Dwarf mistletoes are the most widespread and damaging forest pathogens (disease-causing organisms) in the Southwest. 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 is common throughout the ponderosa pine analysis area. On both the stand and landscape level, the distribution of dwarf mistletoes is usually patchy, with more or less discrete infection centers surrounded by areas without the disease. Infection centers expand very slowly, so overall incidence changes little from year to year (USDA Forest Service 2011). Table 26 displays ponderosa pine dwarf mistletoe infection in terms of area by infection level and percent of ponderosa pine trees infected within each level. Approximately 66 percent of the area is not infected or has a low infection level, with less than 20% of the trees infected. Thirty four percent of the area is moderately infected (20% to 50% of the trees infected), or heavily infected (50-80% of the ponderosa pine infected). The average percent of trees infected ranges from 5 to 10 percent in none/low group and 33 to 41 percent in the moderate/high group. There are several stands that have an extreme infection rating where 80% or more of the trees are infected (table 26).

Table 26. Dwarf Mistletoe Infection Level

Infection Level		RU 1	RU 3	RU 4	RU 5	RU 6	Analysis area
None/Low	Percent of Area	53%	57%	74%	92%	82%	66%
None/Low	Average Percent Trees Infected	5%	6%	4%	10%	5%	6%
Moderate/High	Percent of Area	47%	43%	26%	8%	18%	34%
Moderate/High	Average Percent Trees Infected	38%	33%	38%	41%	42%	36%
Extreme	Percent of Area	<1%	<1%	<1%	0%	0%	<1%
Extreme	Average Percent Trees Infected	86%	86%	85%	-	-	86%

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.

Climate Change

Southwestern ecosystems have evolved under a long and complex history of climate variability and change. Taking into consideration the number of mega-droughts and other climate-related variation, through time, southwestern systems have some built-in resilience. This EIS focuses on restoring and maintaining resilience in forest and grassland ecosystems. Risks of increased wildfire, insects and disease outbreaks, and invasive species represent ongoing, broad-scale management challenges. These issues are not new. However, climate change has the potential to increase and exacerbate the impacts of these ecosystem risks.

Based on current projections, the primary regional-level effects of climate change most likely to occur in the Southwest that will have an effect on forest vegetation include warmer temperatures, decreasing precipitation, and increased extreme weather events. These changes could result in immediate vegetation disturbance due to wind or flooding, increased wildfire risks, increased outbreaks of insects, diseases, and spread of invasive species, increased drought related mortality and changes in plant species composition.

Carbon - 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 events, and subsequently, able to store more carbon in the form of large trees.

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 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.

Desired Conditions

Supporting Science

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. The Kaibab Forest Plan, which was

completed after the comment period for the DEIS, consist of desired conditions specific to vegetation communities that, for a great part, incorporated the concepts of GTR-310 (Reynolds et al, 2013). These desired conditions are consistent with the 4FRI project. See Appendix B for further clarification of consistency of forest plan desired conditions and this project.

The Desired Conditions for ponderosa pine forests incorporated information on the ecology of the overstory and understory vegetation comprising this type as well as information on its historic or natural range of variability in the composition, structure and pattern of vegetation.

Restoring southwestern ponderosa pine forests revolves around restructuring of forest interspacing and tree groups and reintroducing a regime of frequent, low-intensity fires like those that historically maintained forest structure and function (Friederici 2004, Reynolds 2013, Leiberg et al 1904). 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 et al 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 variability” (Friederici, 2004).

The natural range of variability (NRV) specific to the Four Forest Restoration Initiative on the Coconino NF and Kaibab NF project area comes from 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 the likes of 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 in 2013 published USDA Forest Service General Technical Report 310 that more fully explores and explains the historical reference conditions and management implications, and the current project relies heavily on this science.

Natural Range of Variability

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 variability (Reynolds et al 2013). The temporal and spatial variability in vegetation establishment, growth, and mortality, and the consequences of natural disturbances in a forest or woodland define the natural range of variability. Much of the range of variability 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 variability. In the southwestern United States, fire is a primary disturbance agent and fire regimes are central to understanding natural range of variability 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 ax, 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 27 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 variability. These metrics are not project area desired conditions but remain supporting science defining restoration.

Table 27. Ranges of reference conditions for ponderosa pine in the southwestern United States from studies detailed in RMRS-GTR-310 (Reynolds et al, 2013)

Reference Conditions	
Forest Attribute	Ponderosa Pine
Trees/ acre	11.7-124
Basal area (ft ² /acre)	22.1-89.3
Openness (%) ^a	52-90
Openness on sites with strong tree aggregation (%) ^a	70-90
Spatial patterns	Grouped or random
Number of trees /group	2-72
Size of groups (acres)	0.003-0.72
Number of groups /acre	6-7
Snags /acre	1-10
Logs /acre	2-20
^a Openness is the proportion of area not covered by tree crowns, estimated as the inverse of canopy cover.	

Species Composition

In this type, ponderosa pine is the dominant seral and climax tree species, but depending on locale may mix with Gambel oak, several juniper and pinyon species, quaking aspen, Douglas-fir, or

white pine (USDA 1997). Composition of the grass/forb/shrub understory is typically diverse in ponderosa pine forests, especially when canopy openings are present (Moir 1966, Naumburg and Dewald 1999, Laughlin et al. 2006, Abella et al. 2011). Presence of shrubs is variable depending on habitat type and locale (USDA 1997). While grasses and herbs occur in most ponderosa pine types (USDA 1997), the composition, abundance (cover), and productivity is variable depending on soil, aspect, elevation, latitude, moisture, and the presence or absence of tree cover (Moir 1966, Naumburg and Dewald 1999, Laughlin et al. 2006, Abella et al. 2011).

Tree Density and Distribution

Historical tree densities on reconstructed plots throughout the Southwest varied 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 BA (Moore et al. 2004). On the same Woolsey plots, SanchezMeador 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 al. 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). 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, Leiberger 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 variability 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 restoration on some portion of the landscape to conditions

reminiscent of pre-European settlement times would most likely provide for greater biodiversity, and greater ecosystem productivity, stability, sustainability, and services.

Desired Conditions – General

A variety of forest conditions (composition, structure and pattern) exists across the landscape, comparable to historic conditions. Forested landscapes are diverse with groups and patches of variable tree densities, including groups with dense, closed canopies (interlocking crowns); well-shaded soil beneath tree groups; dead, deformed and diseased trees; large logs and woody debris; and old, large oaks and aspen. Canopy openings within the forest are common and support a species diverse and productive grass/forb/shrub community. Openness ranges from very open within the savanna and grassland matrix to closed on the highly productive forest sites to achieve a heterogeneous condition across the forested landscape. Forest habitats contain a forest overstory dominated by ponderosa pine, mixed where appropriate with pinyon and juniper species, oaks, aspen, Douglas fir or white pine.

Overall, the project area comprise forest conditions that are resilient to disturbance (insects, disease, fire, climate change) and sustainable through at least several generations of trees. Forest habitats are generally vigorous, with endemic levels of native insect and disease occurrences. Dwarf mistletoe is an element of the forest landscape. There is a varied level of mistletoe across the landscape, comparable to historic conditions. Forest structure and density impedes spread and reduces impacts associated with infection.

The ponderosa pine forest is Uneven-aged and composed of a distribution of age classes that comprise a sustainable balance of structural stages. Old trees and old forest structure is common and sustained over time across the landscape. Managed, Uneven-aged stands range from 15% to 40% of maximum SDI. In areas outside of MSO protected and restricted target/threshold habitats, basal areas average less than 80 ft²/acre. Fully stocked, healthy forest conditions facilitate capacity to sequester carbon and minimize tree losses to wildfires, insects, and diseases. Wood products manufactured from biomass serve to sequester carbon and reduce use of fossil fuels. Forests within the project area provide a sustainable supply of diverse uses and values while contributing to the stabilization of carbon released into the atmosphere.

The Kaibab forest plan emphasizes restoration of ponderosa pine forests because these particular forests are highly departed from desired conditions and were identified as a priority need for change. Projects in ponderosa pine are aimed at restoring forest structure and process (e.g. natural disturbances such as low-severity fire, dwarf mistletoe, watershed function, and nutrient cycling). Additionally, project design features may seek to increase diversity that was historically present by promoting oak, aspen, openings (interspaces), and enhanced understory production. Treatments typically strive to mimic the structure and patterns of reference conditions using historical evidences and soil characteristics. However, treatments may consider other circumstances, desired conditions, and objectives, such as species-specific habitat needs. As a result, reconstructed reference conditions are general guides rather than rigid restoration prescriptions. See Appendix B for further clarification of consistency of forest plan desired conditions and the project desired conditions.

Coconino Desired Conditions – MSO Habitat

The Coconino forest plan provides the following management guidelines related to MSO habitat desired conditions (USDI, 1995).

Pine-Oak Restricted MSO Habitat

Ten percent of the pine-oak forest type (by area) provides for MSO nest/roost characteristics which include:

- Basal area > 150 ft², Gambel oak basal area >20 ft², twenty 18”+ trees per acre, and 45% of stand density in trees >12” diameter.
- All trees >24” diameter, substantive amounts of snags >18” diameter, down logs >12” midpoint diameter, and large hardwoods are retained following management treatments. Large oaks are present and vigorous. Oak regeneration is occurring.
- Uneven-aged stands with a diversity of structural stages present.

The remainder of the restricted habitat is managed toward these guidelines while providing a diversity of stand conditions across the landscape to ensure habitat for a diversity of prey species.

This project includes a Coconino forest plan amendment for Alternative C that allows for reducing density and improving habitat structure in line with the revised MSO recovery plan (USDI Fish and Wildlife Service 2012). Treatments within the target/threshold habitat would allow for a minimum of 110 ft² of basal area with a desired range of 110-150 ft².

Pine-Oak Protected MSO Habitat

Manage within the following limitations to minimize effects on the owl:

- Retain key forest species such as oak.
- Retain key habitat components such as snags and large down logs.
- Harvest conifers less than 9 inches in diameter only within those protected activity centers treated to mitigate fire risk.

An analysis of the PACs within the project area determined that 18 PACs have conditions that warrant mechanical treatment to enhance and retain key MSO habitat elements. This project (Alternative B-D) includes a Coconino forest plan amendment which allows for improving habitat structure in addition to managing for fire risk abatement. Treatments (Alternative B-D) within these 18 PACs would range from < 9 inches DBH to 16 inches DBH, depending on individual stand conditions. Alternative E with no plan amendments would thin PACs < 9 inches DBH.

MSO Habitat - Desired Forest Density and Habitat Components

Table 28 lists the desired MSO habitat forest density, snags and coarse woody debris related to the Coconino forest plan standards and guidelines, project purpose and need, site specific ecological limitations and reference conditions.

Table 28. MSO Habitat Desired Forest Density and Habitat Components

			Avg. Percent of Total SDI by Size Class						
Habitat	Basal Area	% Max SDI ¹	12.0 - 17.9"	18.0 - 23.9"	24.0" +	Avg. TPA 18"+	Avg. Gambel Oak BA Percent of Total BA	Tons CWD >12"	Snags >18"
Protected²	NA	≤55%	NA	NA	NA	NA	NA	≥1	≥2.0
Restricted Target/ Threshold	150-170 (Alt. C 110-150)	≤55%	15%	15%	15%	≥20	20%	≥1	≥2.0
Restricted Other	70-90	25-40%	15%	15%	15%	≥20	20%	≥1	2.0

¹The percent for protected and target/threshold is based on the desire to avoid unsustainable conditions as presented in

²Within protected habitat, there are no specific Forest Plan desired conditions relative to basal area, SDI, size class distribution, TPA >18" or Gambel oak basal area. The % Max SDI listed for this habitat represents a sustainable condition.

Kaibab Desired Conditions – MSO Habitat

The desired condition for MSO on the Kaibab National Forest is the MSO Recovery Plan adopted in 2012 (USDI, FWS, 2012) (KFP, page 128) summarized in Table C3 of the plan (figure 7).

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.

²BA's in m²/ha (ft²/acre), and include all trees >1 inch dbh (i.e., any species). We emphasize that values shown are **minimums**, not targets.

³Trees > 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.

⁴Pine-oak forest type: ≥10% of the stand BA or 4.6 m²/ha (20 ft²/ac) of BA consist of Gambel oak ≥ 13 cm (5 in) drc.

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

Figure 7. MSO Guidelines From 2012 Recovery Plan

Desired Conditions – Goshawk Habitat - Coconino

The Coconino forest plan describes the following desired conditions for goshawk forest habitat.

Ponderosa Pine Goshawk Nest Areas

Mature to old structural stages having a canopy cover between 50-70%. Tree pattern is non-uniform and clumpy.

Ponderosa Pine Goshawk Post-Fledging Family Area (PFA) Habitat

Provide for a healthy, sustainable forest environment for the post-fledgling family needs of goshawks which includes:

- Balanced Uneven-aged condition (stand area basis) with 50% canopy cover within the tree groups >12" diameter. Basal area averages from 70-80 ft².
- Two snags per acre >18" diameter, 3 downed logs per acre 12" diameter and 8' long, and 5-7 tons of woody debris >3" diameter.

Ponderosa Pine Landscapes Outside Goshawk PFA (LOPFA) Habitat

Provide for a healthy, sustainable forest environment for the habitat needs of goshawk prey species which includes:

- Balanced Uneven-aged condition (stand area basis) with 40% canopy cover within the tree groups >12" diameter. Tree density is dependent on site quality. Basal area averages from 50-60 ft².
- Two snags per acre >18" diameter, 3 downed logs per acre 12" diameter and 8' long, and 5-7 tons of woody debris >3" diameter.

Goshawk Habitat - Desired Forest Structure, Density and Habitat Components

The desired goshawk habitat forest structure, density, snags and coarse woody debris related to the Coconino forest plan standards and guidelines, project purpose and need, site specific ecological limitations and reference conditions are listed in table 29, table 30, and table 31.

Table 29. Average Desired Condition - Stand Structure Ponderosa Pine Goshawk PFA Habitat

				Group Basis (Mean)				Per Acre Basis (Mean)	
VSS Class	DBH Class	% of Area	Mean DBH	SDI	TPA	BA/Ac	Canopy Cover	TPA	BA/Ac
1	0.0 – 0.9"	10%	0.1"	0	203	0	NA	20.3	0
2	1.0 – 4.9"	10%	3"	28	193	9	NA	19.3	1
3	5.0 – 11.9"	20%	8.5"	105	136	54	NA	27.3	11
4	12.0 – 17.9"	7%	15"	137	72	88	60%	4.8	6
4	12.0 – 17.9"	13%	15"	130	68	83	50%	9.0	11
5	18.0 – 23.9"	20%	21"	127	39	93	50%	7.7	19
6	24.0" +	20%	27"	135	27	109	50%	5.5	22
								93.9	69
								Dq* =	13.1
								SDI* =	114

* Includes trees ≥ 1" DBH

Note on per acre basis and assumptions:

Reserve trees and interspace are included in these figures. Trees are closely grouped, allowing for open interspace between tree groups.

Percent SDI maximum values = SDI/450 x 100. SDI, TPA and BA are inferred from the Coconino forest plan.

Table 30. Average Desired Condition - Stand Structure Ponderosa Pine Goshawk LOPFA Habitat

				Group Basis (Mean)				Per Acre Basis (Mean)	
VSS Class	DBH Class	% of Area	Mean DBH	SDI	TPA	BA/Ac	Canopy Cover	TPA	BA/Ac
1	0.0 – 0.9"	10%	0.1"	0	203	0	NA	20.3	0
2	1.0 – 4.9"	10%	3"	28	193	9	NA	19.3	1
3	5.0 – 11.9"	20%	8.5"	105	136	54	NA	27.3	11
4	12.0 – 17.9"	20%	15"	89	46	57	40%	9.3	11
5	18.0 – 23.9"	20%	21"	100	30	73	40%	6.1	15
6	24.0" +	20%	27"	104	21	84	40%	4.2	17
								86.5	54
								Dq* =	12.3
								SDI* =	92

* Includes trees ≥ 1" DBH only.

Note on per acre basis and assumptions:

Reserve trees and interspace are included in these figures. Trees are closely grouped, allowing for open interspace between tree groups.

Percent SDI maximum values = SDI/450 x 100. SDI, TPA and BA are inferred from the Coconino forest plan.

Table 31. Characterizes the desired range of forest density and habitat components.

Habitat	% Max SDI	Basal Area	Total Tons CWD	>12" Tons CWD	Snags >18"
PFA	25-40%	70-80	5-7	≥1	2.0
LOPFA	15-35%	50-70	5-7	≥1	2.0

Desired Conditions – Goshawk Habitat - Kaibab

The Kaibab forest plan describes the following desired conditions for goshawk forest habitat. Forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest (e.g., goshawk post-fledging family areas, Mexican spotted owl nesting/roosting habitat, drainages, and steep north-facing slopes). Goshawk nest areas are multi-aged forests dominated by large trees with interlocking crowns and are generally denser than the

surrounding forest. A minimum of six goshawk nest areas (known and replacement) should be located per territory. Nest and replacement nest areas should generally be located in drainages, at the base of slopes, and on northerly (NW to NE) aspects. Nest areas should generally be 25 to 30 acres in size. Goshawk PFAs (post-fledging family areas) of approximately 420 acres in size should be designated surrounding the nest sites. Potentially disturbing project-related activities should be minimized in occupied goshawk nest areas during nesting season of March 1 through September 30.

Desired Conditions – Old Growth - Coconino

The Coconino forest plan provides the following guidance for ponderosa pine and pinyon/juniper old growth.

Allocate no less than 20 percent of each forested ecosystem management area to old growth as depicted by the following minimum structural attributes:

Minimum desired structural attributes for ponderosa pine old growth forested sites:

- 20 TPA 18" DBH and 180 Years Old.
- 1 Snag/acre 14" DBH and 25' in height.
- 2 down dead tree pieces 12" and 15' in length.
- Basal area 90 square feet.
- Canopy cover 50%.

Minimum desired structural attributes for pinyon-juniper old growth forested sites:

- 30 TPA 12" DRC and 200 Years Old.
- 1 Snag/acre 10" DRC and 10' in height.
- 2 down dead tree pieces 10" and 10' in length.
- Basal area 24 square feet.
- Canopy cover 35%.

On the Coconino, where the forested sites do not meet these conditions, allocate sites that represent the closest to meeting these conditions and manage those sites towards the above desired structural attributes.

Desired Conditions – Old Growth - Kaibab

This description derives from the nature of Uneven-aged management. Uneven-aged management is the application of a combination of actions needed to simultaneously maintain continuous high forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes to provide a sustained yield of forest products. Cutting is usually regulated by specifying the number or proportion of trees of particular sizes to retain within each area, thereby maintaining a planned distribution of size classes. Cutting methods that develop and maintain Uneven-aged stands are single tree selection and group selection. (KNF, page 159). See Appendix B of the Silviculture Specialist report for further clarification of consistency of forest plan desired conditions and the project.

Silviculture Specialist Report

4FRI Coconino/Kaibab EIS - Vegetation Effects Analysis

Spatial and Temporal Context for Project Level Effects Analysis

For the silviculture analysis, the spatial context being considered focuses on 588,716-acres analysis area where most of the mechanical and prescribed fire treatments occur. The spatial context for effects related to springs, channels and roads uses the larger 988,764-acre project area. The baseline year used for this analysis is the year 2010 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 2020), “short-term” effects refers to effects over the 10-year period from the time the final activity was accomplished (year 2030). Beyond 20-years we will be considering effects as “long-term” (year 2050). All Alternatives are compared across forest boundaries (Coconino-Kaibab combined). Both forests follow the MSO guidelines and FWS has already informed 4FRI that the proposed treatments are consistent with both the 1995 and 2012 MSO Recovery Plan. In terms of the analysis concerning goshawk, both forests are analyzed, discussed, and displayed using the guidelines from the Coconino NF (as amended). The Kaibab forest plan does not use the same terminology as the Coconino in terms of goshawk management; however, the plan does not preclude this current analysis from using VSS, old growth, and canopy cover to describe forest structure and components. For ease of comparison, analysis, and understanding, we discuss the alternatives in terms of the Coconino Forest Plan requirements, fully understanding that they are not the same requirements as the Kaibab, but that they are consistent within the context of the project.

Alternative A – No Action

Alternative A is the no action alternative as required by 40 CFR 1502.14(d). There would be no changes in current management and the forest plans would continue to be implemented. Alternative A is the point of reference for assessing action alternatives B-E.

Direct and Indirect Effects – Alternative A

Mexican Spotted Owl Habitat

Table 32 displays the MSO habitat forest structure and habitat components projected out to the years 2020 and 2050. Density in terms of basal area and SDI continues to increase and remains higher than desired in all habitats. By 2050, the distribution of size classes exceeds desired in the 12-18” and the 18-24” size classes and remains below desired in the 24” + size class. Average trees per acre 18” and larger are above 20 in all habitats except restricted other in RU 5. Average Gambel oak basal area is static between 2020 and 2050 and remains below desired in the restricted other habitat. All habitats show an increase in CWD >12” and snags >18” between 2020 and 2050. All habitats show an increase in snags >18” between 2020 and 2050.

Table 32. Alternative A - 2020 and 2050 Spotted Owl Habitat Forest Structure and Habitat Components

							Avg. Percent of Total SDI by Size Class																				
RU	Basal Area			% Max SDI			12.0-17.9"			18.0-23.9"			24.0" +			Avg. TPA 18" +			Avg. Gambel Oak BA Percent of Total BA			Tons CWD >12"			Snags >18"		
RU	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
Protected																											
1	154	163	180	78%	80%	81%	31%	31%	28%	13%	16%	22%	8%	8%	11%	14.6	17.6	27.3	14%	14%	15%	0.7	1.0	2.3	0.6	0.7	1.6
3	170	178	193	82%	84%	84%	31%	31%	27%	15%	17%	23%	9%	9%	13%	18.5	21.4	30.5	12%	12%	12%	1.2	1.5	3.0	0.7	0.9	2.0
4	100	109	131	49%	51%	56%	33%	35%	38%	9%	14%	23%	5%	5%	8%	8.6	10.8	19.8	8%	8%	9%	0.4	0.7	1.6	0.4	0.4	1.3
5	132	143	165	64%	67%	71%	34%	34%	27%	14%	16%	24%	8%	8%	13%	13.2	16.2	27.3	10%	10%	12%	1.1	1.4	2.8	0.6	0.6	1.8
Protected Total	155	164	181	78%	80%	81%	31%	31%	28%	14%	16%	22%	8%	8%	11%	15.0	18.0	27.6	13%	13%	15%	0.8	1.1	2.4	0.6	0.7	1.7
Threshold																											
1	204	209	226	101%	101%	102%	25%	24%	26%	24%	26%	28%	3%	3%	6%	28.0	30.8	35.4	29%	28%	26%	2.0	2.2	3.0	0.5	0.5	1.2
3	185	192	209	99%	99%	100%	26%	25%	19%	19%	21%	26%	8%	8%	11%	23.7	26.5	35.8	33%	33%	32%	0.6	1.0	2.6	0.7	1.0	2.1
Threshold Total	193	199	217	100%	100%	101%	25%	24%	22%	21%	24%	27%	6%	6%	9%	25.6	28.4	35.6	31%	31%	29%	1.2	1.6	2.8	0.6	0.8	1.7
Target																											
1	156	165	184	81%	83%	84%	30%	29%	28%	12%	14%	19%	7%	8%	9%	13.6	16.4	24.3	20%	20%	22%	1.5	1.7	2.7	0.5	0.6	1.4
3	148	158	181	79%	81%	85%	26%	26%	25%	13%	15%	17%	7%	8%	11%	13.4	15.8	22.1	24%	23%	24%	0.8	1.1	2.0	0.5	0.6	1.4
Target Total	152	162	183	80%	82%	84%	28%	28%	27%	13%	14%	19%	7%	8%	10%	13.5	16.1	23.4	22%	22%	23%	1.2	1.5	2.4	0.5	0.6	1.4
Restricted Other																											
1	138	148	170	68%	71%	75%	30%	31%	30%	12%	14%	20%	7%	7%	10%	11.6	14.1	22.7	15%	15%	17%	0.3	0.6	1.4	0.4	0.4	1.1
3	137	148	170	70%	73%	77%	29%	30%	26%	13%	15%	21%	7%	7%	10%	11.6	14.2	23.1	21%	21%	23%	0.5	0.7	1.5	0.4	0.5	1.2

4	129	141	165	67%	71%	75%	28%	27%	24%	13%	15%	20%	8%	9%	11%	11.6	14.1	21.9	24%	24%	26%	0.4	0.6	1.4	0.5	0.6	1.3
5	102	116	147	51%	56%	65%	24%	26%	28%	10%	10%	15%	9%	9%	10%	8.0	9.4	15.8	15%	17%	20%	0.2	0.3	0.8	0.4	0.3	0.7
Restricted Total	137	147	169	69%	72%	76%	29%	30%	28%	13%	14%	20%	7%	7%	10%	11.5	14.1	22.8	19%	19%	21%	0.4	0.6	1.5	0.4	0.5	1.1
Target Total	152	162	183	80%	82%	84%	28%	28%	27%	13%	14%	19%	7%	8%	10%	13.5	16.1	23.4	22%	22%	23%	1.2	1.5	2.4	0.5	0.6	1.4

Goshawk Habitat

Table 33 and table 34 display the goshawk structure and habitat components projected out to the years 2020 and 2050. Density in terms of SDI and basal area continues to increase and remains higher than desired in all habitats. All habitats show an increase in total CWD, CWD >12" and snags >18" between 2020 and 2050 resulting in conditions at or close to desired.

Table 33. Alternative A – 2020 and 2050 Goshawk Nest/PFA Habitat Forest Structure and Habitat Components

Restoration Subunit-Unit	Ponderosa Pine SDI % of Max			Ponderosa Pine TPA			Ponderosa Pine BA			Tons CWD Total			Tons CWD >12"			Snags >18"	
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020
1-1	29%	32%	39%	151	151	133	67	77	103	2.8	3.1	4.4	0.1	0.2	0.5	0.3	0.2
1-2	40%	42%	46%	202	192	151	94	102	121	3.6	4.2	6.3	0.5	0.6	1.1	0.4	0.4
1-3	54%	56%	58%	226	212	168	133	141	156	4.4	5.5	8.7	0.4	0.6	1.4	0.4	0.4
1-4	57%	60%	61%	313	290	219	134	143	159	8.6	9.2	11.7	4.9	4.7	4.6	0.3	0.4
1-5	55%	56%	55%	247	226	164	131	138	147	4.8	6.1	10.3	0.5	0.7	1.9	0.6	0.6
1	52%	54%	55%	239	223	171	124	132	147	5.0	6.0	9.2	1.1	1.2	1.9	0.4	0.5
3-1	44%	46%	49%	177	168	136	107	115	133	3.3	4.1	6.5	0.2	0.4	1.0	0.4	0.5
3-2	44%	47%	50%	181	171	138	109	117	134	3.1	3.8	6.3	0.3	0.4	1.1	0.4	0.5
3-3	48%	50%	53%	220	206	163	117	125	142	3.6	4.4	7.2	0.3	0.4	1.2	0.4	0.5
3-5	44%	46%	49%	207	195	156	105	113	131	3.7	4.6	7.5	0.4	0.5	1.3	0.4	0.4
3	46%	48%	51%	203	190	152	112	120	138	3.5	4.2	6.9	0.3	0.4	1.1	0.4	0.5

Restoration Subunit- Unit	Ponderosa Pine SDI % of Max			Ponderosa Pine TPA			Ponderosa Pine BA			Tons CWD Total			Tons CWD >12"			Snags >18'	
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020
4-2	38%	40%	45%	162	152	128	94	102	123	2.8	3.2	5.2	0.2	0.3	0.9	0.4	0.6
4-3	45%	47%	51%	197	186	149	109	118	137	3.7	4.3	6.8	0.7	0.8	1.4	0.4	0.5
4-4	51%	53%	55%	224	209	163	123	131	148	4.7	5.4	8.2	1.3	1.4	1.9	0.4	0.5
4-5	46%	48%	49%	226	210	156	108	117	130	4.2	4.9	7.8	0.6	0.7	1.5	0.4	0.4
4	46%	48%	52%	204	192	152	112	121	139	3.9	4.6	7.2	0.8	0.9	1.5	0.4	0.5
5-1	45%	47%	50%	206	194	151	109	117	133	5.2	6.0	8.8	1.7	1.8	2.3	0.4	0.4
5-2	42%	44%	45%	192	181	137	99	107	121	3.9	4.7	7.5	0.5	0.7	1.6	0.5	0.6
5	43%	45%	47%	199	187	143	104	112	126	4.5	5.3	8.1	1.1	1.2	1.9	0.5	0.5
6-2	24%	26%	31%	108	107	90	53	61	79	1.9	2.4	3.8	0.2	0.3	0.5	0.3	0.3
6-3	30%	32%	36%	154	148	120	64	72	90	2.4	2.9	4.3	0.3	0.4	0.6	0.3	0.3
6	29%	32%	36%	150	145	117	63	71	89	2.4	2.8	4.3	0.3	0.3	0.6	0.3	0.3
All PFA/dPFA	44%	47%	50%	202	190	150	107	115	132	3.9	4.6	7.1	0.7	0.8	1.4	0.4	0.4

Table 34: Alternative A – 2020 and 2050 Goshawk LOPFA Habitat Forest Structure and Habitat Components

Restoration Subunit-Unit	Ponderosa Pine SDI % of Max			Ponderosa Pine TPA			Ponderosa Pine BA			Tons CWD Total			Tons CWD >12"			Snags >18"	
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020
1-1	44%	46%	50%	208	196	161	103	112	132	3.7	4.4	6.5	0.5	0.6	1.0	0.3	0.3
1-2	36%	39%	43%	185	177	140	86	95	115	3.2	3.8	5.8	0.3	0.4	1.0	0.3	0.3
1-3	43%	46%	49%	212	199	159	102	110	128	3.8	4.5	6.8	0.5	0.6	1.2	0.3	0.4
1-4	43%	45%	48%	224	209	161	99	108	125	3.8	4.5	6.9	0.5	0.6	1.2	0.4	0.3
1-5	51%	52%	53%	248	228	167	118	126	137	4.5	5.6	9.0	0.7	0.9	1.8	0.5	0.6
1	46%	48%	50%	227	212	162	107	115	131	4.1	4.9	7.7	0.6	0.7	1.4	0.4	0.4
3-1	41%	44%	48%	175	167	136	99	108	128	2.8	3.5	5.7	0.2	0.4	0.9	0.4	0.4
3-2	39%	42%	46%	148	142	117	97	107	127	2.7	3.3	5.4	0.3	0.4	1.0	0.4	0.4
3-3	47%	49%	52%	209	195	153	114	122	139	3.8	4.7	7.5	0.5	0.6	1.3	0.3	0.4
3-4	53%	54%	55%	240	221	166	126	133	146	4.7	5.9	9.6	0.7	1.0	1.9	0.4	0.6
3-5	54%	56%	56%	264	243	181	127	134	146	4.8	5.9	9.6	0.7	0.9	1.7	0.4	0.4
3	47%	49%	51%	208	195	151	113	121	137	3.8	4.6	7.5	0.5	0.6	1.3	0.4	0.4
4-2	35%	38%	44%	142	140	119	86	95	119	2.5	3.0	4.6	0.2	0.3	0.7	0.3	0.3
4-3	38%	40%	44%	176	168	134	91	100	119	3.2	3.8	6.1	0.4	0.5	1.1	0.4	0.4
4-4	44%	47%	50%	198	186	145	107	117	135	3.5	4.2	6.8	0.4	0.6	1.2	0.3	0.4
4-5	44%	47%	50%	218	204	158	106	114	131	4.0	4.9	7.9	0.4	0.6	1.3	0.4	0.4
4	41%	44%	47%	187	177	140	100	109	127	3.3	4.0	6.4	0.4	0.6	1.1	0.4	0.4
5-1	31%	34%	38%	174	167	130	73	81	98	3.2	3.9	6.3	0.3	0.5	1.0	0.4	0.4
5-2	27%	30%	34%	119	118	96	67	75	93	3.0	3.5	5.4	0.4	0.5	1.0	0.4	0.5
5	28%	31%	35%	136	133	106	69	76	94	3.1	3.6	5.6	0.4	0.5	1.0	0.4	0.5
6-2	29%	32%	38%	166	161	133	63	72	94	2.3	2.7	3.9	0.3	0.3	0.5	0.2	0.2
6-3	33%	36%	41%	197	185	144	71	81	101	2.6	3.0	4.7	0.2	0.3	0.5	0.2	0.2

6-4	32%	33%	35%	198	183	135	67	74	85	3.1	3.8	6.0	0.3	0.5	0.9	0.4	0.4
6	32%	35%	40%	194	182	142	69	79	99	2.6	3.0	4.7	0.2	0.3	0.5	0.2	0.2
All LOPFA	41%	43%	46%	193	182	142	96	105	122	3.5	4.2	6.6	0.5	0.6	1.2	0.4	0.4

Table 35 through table 38 display the VSS distribution for Even-age and Uneven-age stands, for all forests (CFP and KFP) by goshawk habitat projected out to the years 2020 and 2050.

In 2020 the LOPFA even-aged stands (table 35) are dominated by the young and mid-aged forest structural stages with a combined overall distribution of 84 percent, more than twice the desired. The young forest stage ranges from a low of 12 percent in SU 3-2 to a high of 89 percent in SU 6-2. The mid-age forest stage ranges from a low of 0 percent in SU 6-2 to a high of 59 percent in SUs 1-2 and 3-1, 60 percent in 3-2. Overall distribution of VSS 1 is close to desired conditions at 7 percent while VSS 2 is deficit by 10 percent, VSS 5 is deficit by 13 percent, and VSS 6 is deficit by 18 percent.

As stand development continues, the distribution shifts toward the later stages by 2050. The mid-aged and mature forest structural stages are dominating with a combined overall distribution 79 percent. The mid-age forest stage ranges from a low of 19 percent in SU 6-4 to a high of 63 percent in SU 3-5. The mature forest stage ranges from a low of 0 percent in SU 6-2 to a high of 52 percent in SU 5-2. In 2050, there are no VSS 1 stands. The overall distribution VSS 2 is close to desired at 7 percent while, VSS 3 is deficit by 12 percent and VSS 6 is deficit by 15 percent.

Table 35. Alternative A - 2020 and 2050 VSS Distribution for Goshawk LOPFA Even-Aged Stands Percent of Area by Vegetative Structural Stages.

SU/RU Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 1-1	0%	0%	0%	0%	40%	15%	48%	42%	2%	33%	10%	10%
SU 1-2	5%	0%	0%	5%	32%	0%	59%	48%	4%	43%	0%	4%
SU 1-3	1%	0%	0%	1%	49%	12%	46%	54%	0%	28%	4%	5%

SU/RU Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 1-4	2%	0%	0%	2%	53%	8%	43%	51%	1%	38%	1%	1%
SU 1-5	1%	0%	0%	1%	45%	8%	43%	59%	9%	27%	3%	5%
RU 1	1%	0%	0%	1%	45%	9%	45%	54%	4%	31%	3%	5%
SU 3-1	2%	0%	0%	2%	25%	12%	59%	42%	13%	38%	0%	6%
SU 3-2	5%	0%	0%	5%	12%	4%	60%	33%	23%	48%	1%	10%
SU 3-3	3%	0%	0%	3%	37%	6%	53%	62%	8%	24%	1%	5%
SU 3-4	0%	0%	0%	0%	31%	9%	58%	55%	8%	29%	2%	7%
SU 3-5	2%	0%	0%	2%	35%	6%	59%	63%	2%	25%	2%	3%
RU 3	3%	0%	0%	3%	30%	6%	57%	54%	9%	31%	1%	6%
SU 4-2	4%	0%	0%	4%	21%	5%	49%	45%	26%	23%	0%	23%
SU 4-3	11%	0%	0%	11%	30%	5%	53%	42%	7%	38%	1%	4%
SU 4-4	4%	0%	0%	4%	30%	5%	58%	52%	8%	35%	1%	5%
SU 4-5	12%	0%	0%	12%	28%	4%	53%	50%	7%	33%	0%	1%
RU 4	7%	0%	0%	7%	29%	5%	55%	48%	8%	36%	0%	5%
SU 5-1	35%	0%	0%	35%	28%	4%	28%	26%	7%	29%	2%	6%
SU 5-2	19%	0%	0%	19%	16%	0%	55%	20%	7%	52%	3%	8%
RU 5	26%	0%	0%	26%	21%	2%	44%	23%	7%	42%	2%	7%

SU/RU Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 6-2	5%	0%	4%	5%	89%	35%	0%	59%	0%	0%	1%	1%
SU 6-3	4%	0%	1%	4%	81%	34%	9%	51%	0%	5%	5%	5%
SU 6-4	2%	0%	1%	2%	87%	76%	10%	19%	0%	3%	0%	0%
RU 6	4%	0%	1%	4%	82%	37%	8%	50%	0%	5%	5%	5%
All	7%	0%	0%	7%	35%	8%	49%	47%	7%	33%	2%	5%

In 2020 the LOPFA uneven-aged stands (table 36) are dominated by the young and mid-aged forest structural stages with a combined overall distribution of 70 percent. The young forest stage ranges from a low of 12 percent in SU 5-2 to a high of 70 percent in SU 6-3. The mid-age forest stage ranges from a low of 5 percent in SU 6-4 to a high of 66 percent in SU 4-5. Overall, there are no VSS 1 stands, distribution of VSS 2 is deficit by 9 percent, VSS 5 is deficit by 6 percent and VSS 6 is approaching desired at 16 percent.

As stand development continues, the distribution shifts toward the later stages by 2050. The mid-aged structural stage is dominating with a distribution of 42 percent, ranging from a low of 2 percent in SU 6-4 to a high of 72 percent in SU 6-3. The overall distribution of the mature and old forest stages are slightly above desired at 25 percent each. The VSS 5 range is 1 to 50 percent and the VSS 6 range is 6 to 79 percent. In 2050, there are no VSS 1 or VSS 2 stands. The overall distribution of VSS 3 is deficit by 12 percent.

Table 36. Alternative A - 2020 and 2050 VSS Distribution for Goshawk LOPFA Uneven-aged Stands Percent of Area by Vegetative Structural Stage

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9’')		2 – Seedling/ Sapling (1.0 - 4.9’)		3 – Young Forest (5.0 - 11.9’)		4 – Mid-age Forest (12.0 - 17.9’)		5 – Mature Forest (18.0 - 23.9’)		6 – Old Forest (24.0’ +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 1-1	0%	0%	1%	0%	33%	16%	53%	32%	10%	46%	3%	6%
SU 1-2	0%	0%	4%	2%	43%	10%	42%	54%	8%	25%	2%	8%
SU 1-3	0%	0%	4%	0%	38%	14%	34%	46%	7%	22%	17%	17%
SU 1-4	0%	0%	0%	0%	61%	5%	30%	64%	3%	25%	6%	6%
SU 1-5	0%	0%	0%	0%	29%	6%	52%	44%	12%	41%	6%	8%
RU 1	0%	0%	1%	0%	37%	9%	43%	47%	9%	33%	9%	10%
SU 3-1	0%	0%	0%	0%	46%	15%	37%	48%	15%	25%	2%	11%
SU 3-2	0%	0%	0%	0%	15%	4%	41%	21%	37%	43%	7%	32%
SU 3-3	0%	0%	0%	0%	31%	3%	51%	58%	13%	26%	5%	13%
SU 3-4	0%	0%	0%	0%	14%	2%	50%	36%	24%	50%	12%	12%
SU 3-5	0%	0%	0%	0%	41%	11%	43%	53%	5%	25%	11%	12%
RU 3	0%	0%	0%	0%	31%	7%	45%	45%	18%	31%	6%	17%
SU 4-2	0%	0%	0%	0%	28%	2%	50%	44%	23%	33%	0%	21%
SU 4-3	0%	0%	0%	0%	37%	5%	33%	39%	20%	35%	10%	21%

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 4-4	0%	0%	0%	0%	33%	9%	45%	40%	18%	34%	4%	16%
SU 4-5	0%	0%	0%	0%	18%	2%	65%	58%	7%	23%	10%	17%
RU 4	0%	0%	0%	0%	34%	7%	41%	41%	19%	34%	7%	18%
SU 5-1	0%	0%	0%	0%	21%	6%	40%	33%	11%	25%	28%	37%
SU 5-2	0%	0%	0%	0%	12%	0%	7%	13%	24%	8%	56%	79%
RU 5	0%	0%	0%	0%	14%	1%	14%	17%	21%	11%	51%	71%
SU 6-2	0%	0%	0%	0%	59%	6%	17%	57%	0%	13%	23%	24%
SU 6-3	0%	0%	4%	0%	70%	11%	22%	72%	0%	7%	4%	11%
SU 6-4	0%	0%	0%	0%	78%	56%	5%	27%	0%	1%	17%	17%
RU 6	0%	0%	3%	0%	69%	15%	20%	64%	0%	7%	9%	14%
All	0%	0%	1%	0%	36%	8%	34%	42%	14%	25%	15%	25%

The PFA even-aged stands (table 37) show a similar trend as the LOPFA even-aged stands. In 2020, they are dominated by the young and mid-aged forest structural stages with a combined overall distribution of 88 percent, more than twice the desired. The young forest stage ranges from a low of 0 percent in SU 3-5 to a high of 81 percent in SU 1-4. The mid-age forest stage ranges from a low of 0 percent in SU 6-2 to a high of 75 percent in SU 1-5. Overall distribution of VSS 1 is deficit by 7 percent, VSS 2 is deficit by 9 percent, VSS 5 is deficit by 13 percent and VSS 6 is deficit by 19 percent.

As stand development continues, the distribution shifts toward the later stages by 2050. The mid-aged and mature forest structural stages are dominating with a combined overall distribution of 84 percent. The mid-age forest stage ranges from a low of 7 percent in SU 6-2 to a high of 92 percent in SU 1-4.

The mature forest stage ranges from a low of 0 percent in SUs 6-2 and 6-3 to a high of 53 percent in SU 5-2. In 2050, there are no VSS 1 stands. The overall distribution of VSS 2 is deficit by 7 percent, VSS 3 is deficit by 16 percent and VSS 6 is deficit by 14 percent.

Table 37 Alternative A - 2020 and 2050 VSS Distribution for Goshawk PFA Even-aged Stands Percent of Area by Vegetative Structural Stage

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 1-1	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%
SU 1-2	0%	0%	0%	0%	71%	0%	29%	71%	0%	29%	0%	0%
SU 1-3	0%	0%	0%	0%	30%	0%	70%	76%	0%	24%	0%	0%
SU 1-4	0%	0%	0%	0%	81%	0%	19%	92%	0%	8%	0%	0%
SU 1-5	0%	0%	0%	0%	25%	9%	75%	54%	0%	37%	0%	0%
RU 1	0%	0%	0%	0%	50%	3%	50%	72%	0%	25%	0%	0%
SU 3-1	2%	0%	0%	2%	34%	0%	51%	85%	13%	13%	0%	0%
SU 3-2	0%	0%	0%	0%	18%	0%	62%	49%	20%	51%	0%	0%
SU 3-3	13%	0%	0%	13%	34%	0%	51%	63%	3%	22%	0%	3%
SU 3-4	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%
SU 3-5	32%	0%	0%	32%	0%	0%	68%	57%	0%	12%	0%	0%
RU 3	11%	0%	0%	11%	27%	0%	55%	63%	8%	25%	0%	1%
SU 4-2	4%	0%	0%	4%	29%	8%	36%	50%	30%	11%	0%	27%
SU 4-3	1%	0%	0%	1%	27%	3%	67%	59%	4%	32%	1%	4%

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 4-4	0%	0%	0%	0%	40%	2%	51%	70%	10%	24%	0%	5%
SU 4-5	0%	0%	0%	0%	34%	10%	61%	29%	5%	62%	0%	0%
RU 4	1%	0%	0%	1%	32%	4%	59%	59%	8%	30%	0%	6%
SU 5-1	8%	0%	0%	8%	40%	2%	47%	68%	5%	16%	0%	5%
SU 5-2	0%	0%	0%	0%	15%	0%	62%	24%	22%	53%	1%	23%
RU 5	4%	0%	0%	4%	27%	1%	55%	46%	13%	35%	1%	14%
SU 6-2	3%	0%	0%	3%	58%	51%	0%	7%	0%	0%	40%	40%
SU 6-3	8%	0%	14%	8%	55%	30%	11%	47%	0%	0%	13%	16%
SU 6-4	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%
RU 6	7%	0%	12%	7%	55%	32%	10%	43%	0%	0%	15%	18%
All	3%	0%	1%	3%	34%	4%	54%	59%	7%	27%	1%	6%

The PFA uneven-aged stands (table 38) show a similar trend as the LOPFA uneven-aged stands. In 2020 they are dominated by the young and mid-aged forest structural stages with a combined overall distribution of 81 percent. The young forest stage ranges from a low of 0 percent in SUs 1-4 and 4-5 to a high of 100 percent in SU 1-1. The mid-age forest stage ranges from a low of 0 percent in SU 1-1 to a high of 82 percent in SU 6-2. Overall, there are no VSS 1 and VSS 2 stands, VSS 5 is approaching desired at 15 percent and VSS 6 is deficit by 16 percent.

As stand development continues, the distribution shifts toward the later stages by 2050. The mid-aged structural stage is dominating with a distribution 52 percent, ranging from a low of 0 percent in SU 1-4 to a high of 100 percent in SU 1-1. The overall distributions of mature forest are slightly above desired

at 23 and 19 percent for and old forest. The VSS 5 range is 0 to 90 percent and the VSS 6 range is 0 to 66 percent. In 2050, there are no VSS 1 or VSS 2 stands. The overall distribution of VSS 3 is deficit by 15 percent.

Table 38 Alternative A - Distribution for Goshawk PFA Uneven-Aged Stands Percent Area by VSS

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 1-1	0%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
SU 1-2	0%	0%	0%	0%	38%	0%	6%	38%	27%	32%	29%	29%
SU 1-3	0%	0%	0%	0%	21%	0%	71%	74%	7%	18%	0%	7%
SU 1-4	0%	0%	0%	0%	0%	0%	90%	0%	0%	90%	10%	10%
SU 1-5	0%	0%	0%	0%	66%	0%	13%	73%	13%	6%	8%	21%
RU 1	0%	0%	0%	0%	41%	0%	42%	67%	11%	19%	6%	14%
SU 3-1	0%	0%	0%	0%	23%	5%	55%	19%	22%	77%	0%	0%
SU 3-2	0%	0%	0%	0%	11%	0%	79%	29%	10%	65%	0%	6%
SU 3-3	0%	0%	0%	0%	25%	1%	45%	60%	28%	9%	2%	31%
SU 3-4	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%
SU 3-5	0%	0%	0%	0%	60%	0%	25%	81%	15%	4%	0%	15%
RU 3	0%	0%	0%	0%	24%	1%	55%	48%	20%	34%	1%	18%
SU 4-2	0%	0%	0%	0%	40%	11%	25%	29%	35%	39%	0%	21%
SU 4-3	0%	0%	0%	0%	34%	5%	51%	49%	14%	30%	2%	15%

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 4-4	0%	0%	0%	0%	18%	3%	52%	37%	29%	33%	0%	26%
SU 4-5	0%	0%	0%	0%	0%	0%	34%	34%	66%	0%	0%	66%
RU 4	0%	0%	0%	0%	29%	5%	47%	42%	23%	32%	1%	20%
SU 5-1	0%	0%	0%	0%	21%	0%	71%	34%	8%	58%	0%	8%
SU 5-2	0%	0%	0%	0%	11%	0%	48%	57%	38%	3%	2%	40%
RU 5	0%	0%	0%	0%	16%	0%	58%	47%	25%	27%	1%	26%
SU 6-2	0%	0%	1%	0%	6%	1%	82%	69%	0%	20%	11%	11%
SU 6-3	0%	0%	1%	0%	64%	18%	24%	58%	0%	1%	11%	24%
SU 6-4	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%
RU 6	0%	0%	1%	0%	60%	16%	28%	59%	0%	2%	11%	23%
All	0%	0%	0%	0%	36%	5%	45%	52%	15%	23%	4%	19%

Old Growth

Table 39 displays the old growth structural attributes of the ponderosa pine old growth acres across the project analysis area projected out to the years 2020 and 2050 under the no action alternative.

In 2020, the average conditions are at or above the minimum criteria with the following exceptions:

- Trees per acre larger than 18” and 180 years old. This condition is deficit in all SUs ranging from a low of 10 TPA in SU 6-2 to a high of 18.8 TPA in SU 3-4 with an overall average for all acres of 16 TPA. The age of these trees is estimated be in the range of 100 to 140 years old with a few relic trees meeting the 180 year old criteria.
- Coarse woody debris greater than 12”. This condition is estimated to be deficit with less than the equivalent of 2 pieces per acre throughout RU 4 and 6, and various SUs.
- Snags per acre. This condition is estimated to be deficit with less than 1 snag per acre in SUs 6-2 and 6-3 and for RU 6 overall.

Over time, old growth conditions improve in terms of meeting the minimum criteria (CFP). In 2050, all RUs meet or exceed the criteria for TPA larger than 18” with the exception of RU 6. The age of these trees is estimated to be in the range of 130 to 170 years old. Coarse woody debris greater than 12” remains deficit in RU 6. It is estimated that all the other criteria will be met throughout the allocated old growth acres.

Table 39. Alternative A – 2020 and 2050 Ponderosa Pine OG Structural Attributes by Restoration Unit

Restoration Subunit /Unit	OG Acres	Avg. TPA 18"+			Avg. BA			Avg. Tons CWD ≥12"			Avg. Snags Per Acre ≥12"		
		2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
1-1	3,578	13.2	16.0	25.2	117	129	158	0.4	0.5	1.0	1.4	1.8	3.3
1-2	2,034	11.0	13.8	23.6	101	112	142	0.3	0.4	0.9	1.1	1.6	3.1
1-3	17,105	13.5	16.3	25.8	128	139	164	0.6	0.7	1.5	2.0	2.6	4.7
1-4	6,323	11.6	14.5	24.3	117	129	157	0.3	0.5	1.1	1.7	2.2	4.2
1-5	35,050	14.9	18.0	27.6	146	156	176	0.6	0.9	1.9	2.8	3.6	6.3
1	64,090	13.9	16.8	26.4	134	144	168	0.5	0.8	1.6	2.3	2.9	5.3
3-1	6,216	12.9	16.1	26.9	121	132	159	0.3	0.4	1.0	1.6	2.2	3.9
3-2	9,317	14.7	18.1	28.1	113	124	151	0.3	0.4	1.0	1.5	2.0	3.4
3-3	15,624	13.8	16.9	27.2	132	142	166	0.4	0.6	1.3	2.0	2.8	4.8
3-4	4,201	15.8	18.8	28.5	148	158	178	0.7	0.9	2.0	2.8	3.7	6.4
3-5	11,305	15.2	18.3	28.7	147	157	178	0.8	1.0	1.9	2.6	3.5	6.1
3	46,663	14.4	17.5	27.8	132	142	166	0.5	0.6	1.4	2.1	2.8	4.9
4-2	3,710	13.0	15.9	25.3	103	114	143	0.2	0.3	0.7	1.2	1.6	2.7
4-3	20,144	11.9	15.0	25.3	107	118	146	0.3	0.4	0.9	1.4	1.9	3.5
4-4	22,175	13.2	16.8	28.6	119	131	159	0.3	0.4	0.9	1.4	2.1	3.7
4-5	2,030	14.1	17.9	30.7	136	147	173	0.4	0.6	1.3	2.1	2.9	5.0
4	48,059	12.7	16.0	27.0	113	125	153	0.3	0.4	0.9	1.4	2.0	3.6
5-1	5,187	11.7	14.4	23.3	99	111	140	0.5	0.6	1.1	1.4	1.8	3.4
5-2	18,529	11.9	14.1	20.9	84	94	121	0.5	0.6	1.1	1.3	1.5	2.9
5	23,716	11.8	14.2	21.4	87	98	124	0.5	0.6	1.1	1.3	1.5	3.0
6-2	1,689	8.5	10.0	15.7	84	98	134	0.2	0.3	0.5	0.6	0.7	1.7
6-3	8,210	9.1	10.7	16.9	92	106	144	0.2	0.3	0.5	0.6	0.7	1.8
6-4	392	9.3	10.7	15.7	109	122	154	0.3	0.4	0.8	1.0	1.2	2.7
6	10,291	9.0	10.6	16.6	91	105	143	0.2	0.3	0.5	0.6	0.7	1.8
All	192,819	13.0	16.0	25.5	118	129	156	0.4	0.6	1.2	1.8	2.3	4.2

Table 40 displays the old growth structural attributes of the pinyon-juniper old growth acres projected out to the years 2020 and 2050 under Alternative A. In 2020, the average conditions are at or above the minimum criteria with the exception of tree age and CWD. The age of the 12" and larger trees is estimated to be approximately 90 to 120 years old with a few relic trees approaching the 200-year-old criteria. The CWD is slightly below the equivalent of 2 pieces per acre. By 2050, the average conditions on the old growth acres meet or exceed the minimum criteria with the exception of tree age.

Table 40. Alternative A – 2020 and 2050 Pinyon-Juniper Old Growth Structural Attributes by Restoration Unit

Restoration Unit	OG Acres	Avg. TPA 12"+			Avg. BA			Avg. Tons CWD ≥12"			Avg. Snags Per Acre ≥12"		
		2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
1	611	31	40	60	108	123	160	0.1	0.2	0.6	1.0	1.4	3.0
3	2,104	31	40	52	93	104	136	0.1	0.2	0.6	1.5	1.5	2.7
4	4,158	29	38	47	88	99	129	0.1	0.2	0.5	1.5	1.4	2.5
5	7,302	32	41	61	108	124	160	0.1	0.2	0.6	1.0	1.5	3.1
6	1,452	37	41	54	120	132	160	0.2	0.3	0.7	1.2	1.3	2.7
All	15,626	31	40	55	102	115	149	0.1	0.2	0.6	1.2	1.5	2.9

Openness

Table 10 lists the existing openness classification for ponderosa pine within the analysis area at the time of analysis (year=2010). In the absence of restoration treatments, existing openness is expected to continue on the same trajectory with at least 75 percent of the ponderosa pine classified as moderately closed to closed by 2020. As the forest develops over time and existing openings gradually fill in, some of the areas will move from an open to moderately closed condition and some of the areas will move from a moderately closed to closed condition lacking the presence of significant fire.

Forest Structure and Diversity - Mosaic of interspaces and tree groups of varying sizes and shapes

Under alternative A, no treatments would be implemented to create a mosaic of interspaces and tree groups as designed within the restoration context. Existing interspace would continue to be encroached upon by expanding tree crowns and ingrowth. Forest densities would continue to increase. Understory vegetation response would be suppressed. Fire risks would continue to increase. Crown fire risk (passive and active) will remain high. Any large scale tree mortality occurring has the potential to enhance interspace and create tree groups.

Forest Structure - All age and size classes represented

The MSO habitat forest structure analysis above indicates adequate representation in the 12-17.9" size class, stocking trending toward adequate in the 18-23.9" size class and inadequate representation in 24"+ size class (table 32). There would be no implementation of group selection within the restricted other habitat. These areas would trend toward a decreased representation of the seedling/sapling age class and low successional stage diversity.

The goshawk habitat structural stage analysis above indicates overall VSS distribution in all goshawk habitats will trend toward the mid-aged and mature structural stages with an overall underrepresentation throughout stages VSS 1, 2, 3 and VSS 6 in the even-aged stands (table 35 through table 38).

Natural Range of Variability (Alternative A)(Appendix C)

Appendix C graphically represents Natural Range of Variability Comparison by Treatment Type by forest attributes: Minimum, maximum and the weighted average for Alternative A. While Alternative A is the ‘no action’ alternative, it serves as a comparison for Alternatives B-E. Therefore the tables represent the same basis (acres) as are found in Alternative C. It can be seen that under Alternative A the “PP Trees per Acre”, PP Basal Area”, “All Trees per Acre >5”, and “All Basal Area” continue to increase from the historic range, and in most cases the averages exceed the historic range by 2020 and 2050. This Alternative represents an increase in tree density, slowing of tree growths, and increased risks from fire, insects, and diseases.

Old Forest Structure Sustained Over Time Across the Landscape

The MSO habitat forest structure analysis above indicates stocking trending toward adequate in the 18”-23.9” size class and inadequate representation in 24”+ size class (table 32).

The goshawk habitat structural stage analysis above indicates the mature and old forest structural stages to be underrepresented in even-aged stands and to be trending toward desired in Uneven-aged stands (table 35 through table 38).

The old growth analysis above indicates old growth structural attributes will continue to develop across the landscape under the no action alternative (table 39).

The sustainability of the large/old tree component across the landscape may be impaired by density related mortality and forest health issues as discussed in following section.

Forest Health

Density related mortality –

Over the next 10 years, stand densities within all MSO habitat would increase to levels ranging from an average of 51-100% of maximum stand density index (table 32). These density levels are at the threshold of, or well within, the zone of density related mortality and extremely high density (Table 7). Modeled stand development from 2020 to 2050 indicates growth stagnation and an increase in mortality in much of the protected and target/threshold habitat.

In goshawk habitat, table 33 shows 2020 ponderosa pine density levels range from an average of 32-60% of maximum density within nest/PFA habitat and Table 34 shows 30-55% in LOPFA habitat. These density levels are within the moderate to extremely high density zones (table 7). Overall averages show both habitats within the high density zone. In 2050, the nest/PFA habitat in SUs 1-3, 1-4, 1-5 and 4-4 and the LOPFA habitat in SUs 3-4 and 3-5 have reached extremely high density. Overall averages indicate both habitats to be on the upper end of the high density zone and approaching the threshold for the onset of density related mortality.

Bark beetle related mortality –

Table 41 lists the beetle hazard rating for the years 2020 and 2050 by RU and for the ponderosa pine analysis area. The overall hazard in 2020 is high across 84% of the analysis area. This increases to 92% in 2050. Stands with a hazard rating of high would be expected to have low resistance to successful bark beetle attack and be susceptible to large scale mortality. In the current climate change scenarios alternative A appears to be unsustainable because of the increased bark beetle hazard it poses.

Table 41. Alternative A – 2020 and 2050 Beetle Hazard Rating (Percent of Areas)

Hazard Rating	RU 1	RU 3	RU 4	RU 5	RU 6	% of Total
2010						
Low	3%	6%	8%	26%	0%	7%
Moderate	12%	11%	27%	46%	25%	21%
High	85%	83%	65%	28%	75%	72%
2020						
Low	3%	4%	7%	1%	0%	4%
Moderate	3%	8%	18%	37%	9%	13%
High	94%	88%	75%	62%	91%	83%
2050						
Low	0%	1%	2%	0%	0%	1%
Moderate	3%	5%	7%	26%	0%	7%
High	97%	94%	91%	74%	100%	92%

Dwarf mistletoe infection –

Table 42 lists the dwarf mistletoe infection level and average percent of trees infected for the years 2020 and 2050 by RU and for the ponderosa pine analysis area. For 2020, approximately 59 percent of the area is not infected or has a low infection level and 40 percent has a moderate to high infection level. The average percent of trees infected ranges from 5 to 11 percent in none/low group and 34 to 59 percent in the moderate/high group. The percentages for 2050 show an increase in the percent of area within the moderate/high infection level group and also an overall increase the average percent of trees infected. This is an indication that mistletoe infection is intensifying and spreading over time.

Table 42. Alternative A – 2020 and 2050 Dwarf Mistletoe Infection Level

Infection Level		RU 1	RU 3	RU 4	RU 5	RU 6	Analysis area
2010							
None/Low	Percent of Area	53%	57%	74%	92%	82%	66%
None/Low	Average Percent Trees Infected	5%	6%	4%	10%	5%	6%
Moderate/High	Percent of Area	47%	43%	26%	8%	18%	34%
Moderate/High	Average Percent Trees Infected	38%	33%	38%	41%	42%	36%
Extreme	Percent of Area	<1%	<1%	<1%	0%	0%	<1%

Infection Level		RU 1	RU 3	RU 4	RU 5	RU 6	Analysis area
Extreme	Average Percent Trees Infected	86%	86%	85%			86%
2020							
None/Low	Percent of Area	46%	46%	71%	79%	81%	59%
None/Low	Average Percent Trees Infected	6%	6%	6%	11%	7%	7%
Moderate/High	Percent of Area	53%	54%	29%	21%	19%	41%
Moderate/High	Average Percent Trees Infected	47%	40%	50%	35%	59%	45%
Extreme	Percent of Area	1%	<1%	<1%	0%	0%	<1%
Extreme	Average Percent Trees Infected	88%	91%	90%			89%
2050							
None/Low	Percent of Area	42%	45%	68%	68%	81%	56%
None/Low	Average Percent Trees Infected	6%	7%	7%	11%	7%	7%
Moderate/High	Percent of Area	56%	55%	32%	32%	15%	43%
Moderate/High	Average Percent Trees Infected	49%	44%	52%	33%	59%	47%
Extreme	Percent of Area	2%	<1%	<1%	0%	4%	1%
Extreme	Average Percent Trees Infected	87%	91%	89%		81%	85%

Climate Change

The dense forest conditions resulting from the no action alternative are at a high risk to density related stresses and bark beetle mortality and have limited resilience to survive and recover from potential large epidemic scale impacts. Under drier and warmer weather conditions, the potential impacts of these risks to ecosystem increase.

Carbon stocks under the no action alternative remain high. Individual tree growth is low to the point of stagnation. As tree density increases, many areas would experience higher mortality (release of carbon) than growth (carbon storage). This trend would result in areas becoming a carbon source to the atmosphere.

Vegetation Diversity and Composition

Grasslands –

Ponderosa pine tree canopy would continue to increase, shading out understory herbaceous vegetation and further reducing forage production and species diversity. Historic grasslands, savannas and forest openings would not be restored and pine encroachment will continue to further reduce historic acres.

Oak and Aspen –

Ponderosa pine tree canopy would continue to increase, shading out Gambel oak and aspen mid and understory trees. Oak and aspen growth and vigor would continue to be stagnated due to competition with pine resulting in lowered resistance to insects and disease and eventual mortality. Oak and aspen regeneration ability would continue to be impaired. Extirpation of aspen is likely across much of the analysis area but 2050.

Pine Sage –

Ponderosa pine tree canopy would continue to increase, shading out understory sage further reducing the sage component within the pine sage mosaic.

Other Direct and Indirect Effects:

Residual Tree Damage

Some damage to residual trees would be expected in alternative A with the continued felling, tractor yarding and piling operations associated with planned and future harvesting operations. Damage would be minimized through contract administration 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).

Tractor Yarding and Fuel Treatment

CFP:

Total Average Annual Firewood Harvest in Thousands of Cords¹

By the fifth decade, the projected supply, including accessible timber sale slash, meets only 72 percent of the projected demand.

Firewood Type	Decade 1	Decade 3	Decade 5
Green firewood - piñon/juniper, aspen, & oak	14.8	16.7	18.5
Dead & Down Material	18.3	22.0	7.3
Timber sale slash	25.2	33.1	35.3
Total Firewood	58.3	71.8	61.1
Total Demand	58.4	77.5	85.1

KFP:

On lands classified as suitable for timber production, mechanical tree removal and prescribed fire are needed to effectively make progress toward the desired conditions and are intended to retain characteristics of desired conditions for at least 20 years. In terms of prescriptions, this means that the post-treatment conditions may need to be on the more open end of the desired range to accommodate the growth that is anticipated in the interval between treatments. Within a given project boundary, some acres may be left untreated if they are already approaching desired conditions, or to provide for specific habitat needs as long as it would not affect desirable fire behavior at the mid-scale.

The objectives in this plan would mechanically thin 11,000 to 19,000 acres in ponderosa pine and 1,200 to 2,400 acres annually in the frequent fire mixed conifer type. This restoration work in ponderosa pine and frequent fire mixed conifer PNVTs is anticipated to be implemented using a combination of prescriptions to meet desired conditions including free thinning all sizes to a target basal area, group selection cuts with matrix thinning to a target basal area, individual tree selection, thin from below, and even-aged regeneration methods. Implementation of the proposed mechanical thinning treatments across the Kaibab NF would result in a significant supply of wood that could support a wood harvesting and utilization industry and help pay for treatments. The amount of wood that is estimated to be available for sale from the suitable land within the plan area for the first decade of plan implementation is called the allowable sale quantity (ASQ). The ASQ is better described as the “average allowable sale quantity” because it may be exceeded in a given year as long as the 10-year average is not exceeded. For this plan, the ASQ is 107,815 CCF (hundred cubic feet).

Once the desired conditions are met, the amount of wood harvest that can be sustained from lands being managed for timber production under a specified management intensity consistent with

multiple-use objectives is the long-term sustained yield (LTSY). The LTSY calculated for the proposed plan is 74,737 CCF.

Fireline placement would use existing features with naturally low fuels, skid trails, roads etc. as much as possible. Actual fireline construction would remove herbaceous material to bare mineral soil up to a 6 foot width.

Timber and Wood Products

A Coconino FP goal is to manage the timber resource to provide a sustained-yield of forest products (CFP plan page 23). A Kaibab FP goal is to manage suitable timberland to provide a sustained level of timber outputs to support local dependent industries (Kai Plan page 18).

Road Maintenance, Decommissioning, Reconstruction, Opening, and Temp Road Construction

CFP:

Normal roads operations will continue as per Appendix J (CFP)

KFP:

Grade roads and clean culverts on 100 miles of open National Forest System roads annually.

- Maintain ownership boundaries.
- Acquire legal access, as opportunities arise.
- Decommission roads that are no longer needed.
- Obliterate or naturalize 20 miles of non-system roads (unauthorized, decommissioned, etc.) within 10 years of plan approval.
- Implement decisions made under the 2005 Travel Management Rule.

Aspen Fencing and Barriers

CFP:

Manage the approximately 12,100 acres identified as the pine-aspen capability area for aspen, on a regulated, sustained-yield basis to maintain aspen as a component of the Forest. Feature a rotation to enhance firewood production and wildlife habitat. Use firewood sales to achieve regeneration by sprouting.

Aspen/conifer lands to be managed for aspen include all stands having a minimum of 25 percent of the total stems (greater than 5 inches d.b.h.) or 25 percent of the GSL in aspen, and which are suitable for aspen regeneration. Stands having less than 25 percent of total stems (greater than 5 inches d.b.h.) and GSL in aspen will be evaluated through the environmental analysis process

to determine management objectives and direction.

KFP:

Fence 200 acres of aspen within 10 years of plan approval. On Williams Ranger District, the aspen is generally found in small separate patches for a total acreage of approximately 2,000 acres, and on the Tusayan Ranger District is known only as three small clones totaling about 1 acre.

Restoration of Riparian Habitat, Ephemeral Streams and Springs

CFP:

Riparian Habitat is considered a significant issue. Accomplish eighty percent of the riparian recovery by 2030. The remaining 20 percent will be significantly improved, but will not have all of the characteristics of a fully recovered riparian area, such as 3 age classes of woody vegetation.

KFP:

Restore native vegetation and natural water flow patterns on at least 6 acres of wetlands within 5 years of plan approval. Protect and/or restore at least 10 individual springs within 5 years of plan approval.

2014 Kaibab National Forest: Forest Plan Consistency: Alternative A

Based on the direct effects of Alternative A, the project vegetation conditions would continue to move away from the desired conditions outlined in the revised Kaibab forest plan. Alternative A would not violate any Kaibab forest plan standards or guidelines.

Alternative B - Proposed Action

See Chapter 2 FEIS for a complete list of activities and a description of the treatments that are proposed for Alternative B.

The proposed action would implement approximately 583,330 treatment acres of restoration activities (within the 988,764 acre project area) (Figure 8).

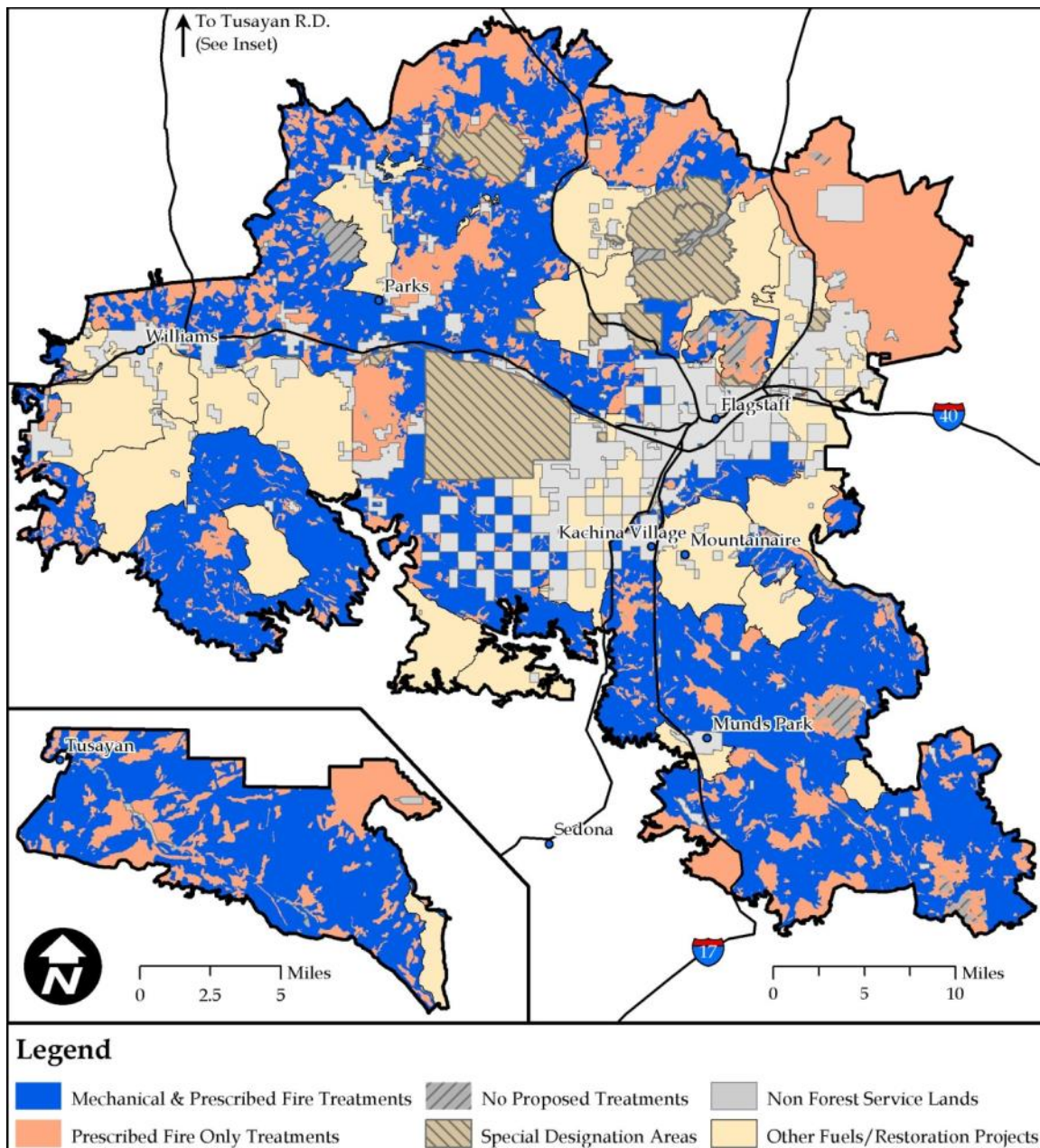


Figure 8. Alternative B general locations of mechanical and prescribed fire treatments

Restoration activities would:

- Mechanically cut trees and burn approximately 384,966 acres. This includes ponderosa pine restoration treatments within 300,463 acres of northern goshawk habitat and 84,503 acres of Mexican spotted owl habitat, 1,227 acres of aspen restoration, 535 acres of pinyon-juniper wildland urban interface treatments.
- Prescribe burn-only approximately 198,364 acres. Burn only treatments would occur within 119,620 acres of ponderosa pine and 223 of acres of aspen with the remaining 78,522 acres occurring in the PJ, oak woodland, grassland and non-vegetated cover types operationally to facilitate burning the ponderosa pine and aspen. Within the ponderosa pine 96,882 acres are within northern goshawk habitat and 22,738 acres are within Mexican spotted owl habitat.

Table 43 summarizes the vegetation treatments for Alternative B by cover type in each restoration unit.

Table 43. Alternative B mechanical treatment and prescribed fire acres by restoration unit (RU)

Treatment	Cover Type	RU 1	RU 3	RU 4	RU 5	RU 6	Grand Total
Mechanical Treatment with Prescribed Fire	Ponderosa Pine	119,567	113,048	109,371	11,244	29,974	383,204
	Aspen	182	201	451	392		1,227
	Pinyon-Juniper					535	535
	All	119,749	113,249	109,822	11,636	30,509	384,966
Prescribed Fire Only	Ponderosa Pine	20,298	15,531	24,794	47,783	11,215	119,620
	Aspen	167		46	10		223
	Pinyon-Juniper	1,422	5,884	7,283	8,845	1,684	25,117
	Oak Woodland	275	1,633	926	386	30	3,250
	Grassland	8,226	12,515	22,661	4,928	93	48,423
	Non-Vegetated	120	134	129	1,301	48	1,732
	All	30,507	35,696	55,839	63,252	13,069	198,364
Mechanical Treatment and Prescribed Fire Totals		150,256	148,946	165,661	74,889	43,578	583,330

Figure 9 shows mechanical and prescribed fire treatments in goshawk and MSO habitat for Alternative B.

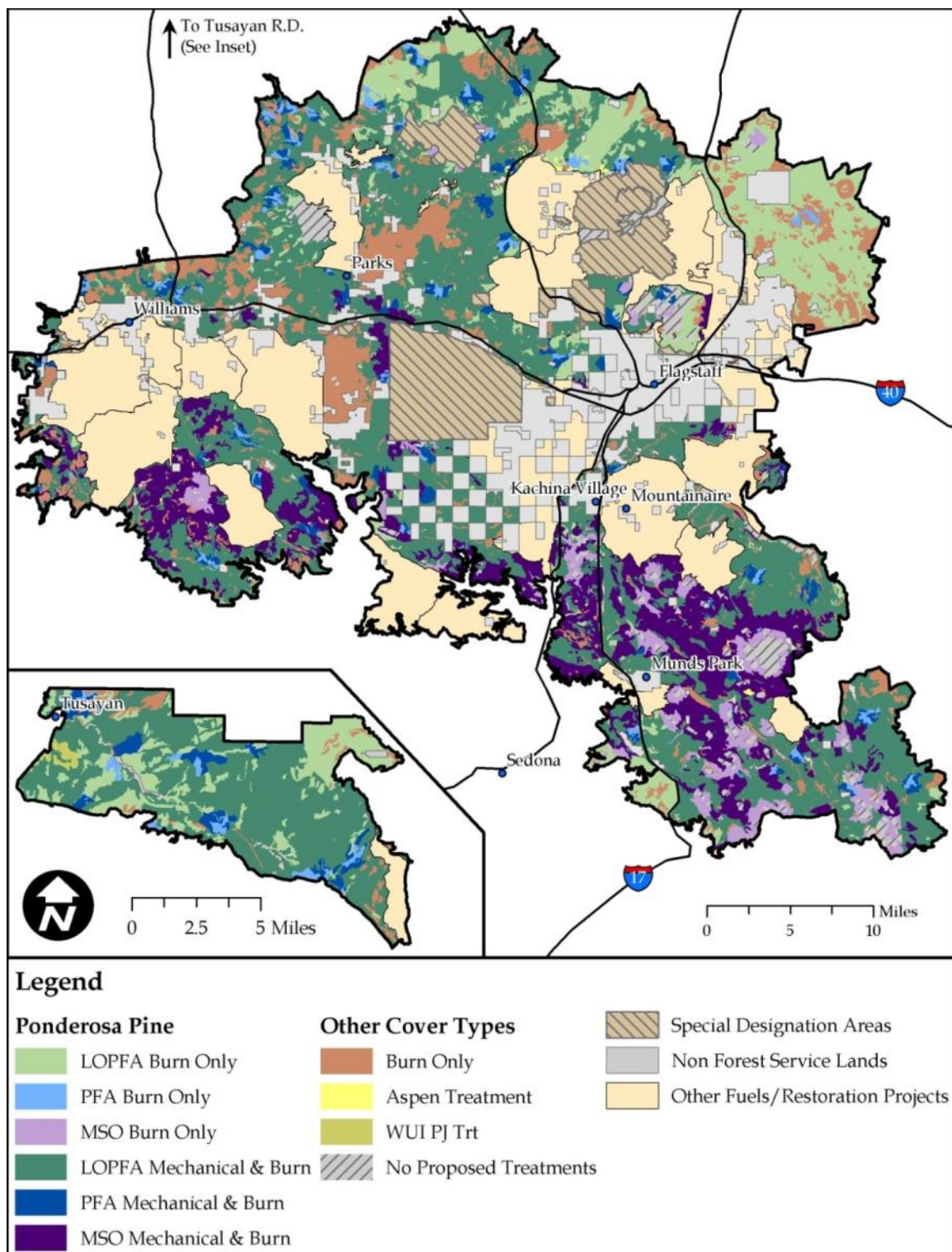


Figure 9. Alternative B mechanical and prescribed fire treatments in goshawk and MSO habitat

Table 44 summarizes alternative B acres of treatment type within goshawk habitat. See chapter 2 for a description of treatment objectives.

Table 44. Alternative B summary of Acres proposed for treatments in ponderosa pine goshawk habitat

Treatment Type	Landscapes Outside of PFA (Acres)	Post-Fledgling Family Area (PFA) (Acres)	Dispersal Post-Fledgling Family Area (dPFA) (Acres)	Total Acres by Treatment Type
Uneven-aged (UEA)	145,511	9,671	4,446	159,629
Intermediate Thinning (IT)	53,520	3,606	1,022	58,148
Stand Improvement (SI)	20,167	592	76	20,835
Savanna	45,405	0	0	45,405
Grassland	11,185	0	0	11,185
Pine-Sage	4,674	392	196	5,261
Prescribed Fire Only	86,869	8,713	1,299	96,882
Total mechanical treatment acres	280,462	14,261	5,740	300,463
Total prescribed fire analysis areas	367,331	22,975	7,039	397,345

Table 45 summarizes alternative B acres of treatment type within MSO habitat. See chapter 2 for a description of treatment objectives.

Table 45. Alternative B summary of acres of treatments in ponderosa pine MSO habitat

Treatment Type*	Protected (Acres)	Restricted (Acres)	Target and Threshold (Acres)	Total Acres by Treatment Type
Prescribed Fire Only	20,083	2,354	217 (Target), 84 (Threshold)	22,738
MSO Restricted	0	64,065	0	64,065
MSO Target	0	0	6,497	6,497
MSO Threshold	0	0	1,894	1,894
PAC -Mechanical	10,284	0	0	10,284
Total	30,367	66,419	6,715 (Target) 1,977 (Threshold)	105,478

Direct and Indirect Effects – Alternative B

Mexican Spotted Owl Habitat

Table 46 displays the MSO habitat forest structure and habitat components projected out to the years 2020 and 2050.

- Year 2020 summary: Basal area density is within the desired range in all habitats. SDI is in the extremely high density zone within the target/threshold and protected habitats (with the exception of RU 4) and on the high end of the desired range within restricted other habitat. This is largely due to the limited mechanical treatment in the protected habitat and the high oak stocking in the restricted habitat. The distribution of size classes is at or exceeds desired minimum in the 12-18” and the 18-24” size classes in all habitats. Stocking in the 24” + size class exceeds desired minimum in the restricted other habitat and is below desired minimum in the target/threshold habitat. Average trees per acre 18”

and larger are very close to desired minimum in the target/threshold habitat and well below desired minimum in restricted other. Overall average Gambel oak basal area is above the desired minimum in all habitats but is limited in RU5 restricted other. All habitats are approaching desired minimum CWD >12" and are below desired minimum in snags >18".

- Year 2050 summary: Basal area is above the desired minimum for target/threshold habitat and above the desired range for restricted other. The SDI density remains in the extremely high zone within the target/threshold and protected habitats and is higher than the desired range in restricted other. The distribution of size classes is at or exceeds desired minimum in the 12-18" and the 18-24" size classes in all habitats. Stocking in the 24" + size class also exceeds desired minimum in the restricted other habitat and remains below desired minimum in the target/threshold habitat. Average trees per acre 18" and larger exceed desired minimum in the target/threshold habitat and remain below desired minimum in restricted other. Overall average Gambel oak basal area is above the desired minimum in all habitats. All habitats show an increase in CWD >12" between 2020 and 2050. Snags >18" also show an increase in target/threshold and protected habitat while remaining static in restricted other.

Table 46. Alternative B - 2020 and 2050 Spotted Owl Habitat Forest Structure and Habitat Components

							Avg. Percent of Total SDI by Size Class																				
RU	Basal Area			% Max SDI			12.0-17.9"			18.0-23.9"			24.0" +			Avg. TPA 18" +			Avg. Gambel Oak BA Percent of Total BA			Tons CWD >12"			Snags >18"		
RU	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
Protected																											
1	154	154	175	78%	72%	75%	31%	32%	28%	13%	17%	24%	8%	9%	13%	15	18	28	14%	15%	15%	0.7	0.7	2.1	0.6	0.7	1.7
3	170	169	190	82%	79%	83%	31%	31%	26%	15%	18%	24%	9%	10%	13%	18	21	31	12%	13%	13%	1.2	1.0	2.5	0.7	0.9	1.9
4	100	106	128	49%	50%	55%	33%	35%	38%	9%	14%	24%	5%	5%	8%	9	11	20	8%	8%	9%	0.4	0.5	1.5	0.4	0.4	1.3
5	132	138	163	64%	64%	70%	34%	34%	27%	14%	17%	24%	8%	8%	13%	13	16	27	10%	11%	13%	1.1	0.9	2.4	0.6	0.6	1.8
Protected Total	155	155	176	78%	72%	76%	31%	32%	28%	14%	17%	24%	8%	9%	13%	15	18	28	13%	14%	15%	0.8	0.8	2.1	0.6	0.7	1.7
Threshold*																											
1	204	171	202	101%	85%	93%	25%	27%	23%	24%	32%	33%	3%	4%	8%	28	32	39	29%	35%	31%	2.0	1.4	2.1	0.5	0.4	1.1
3	185	171	200	99%	90%	96%	26%	22%	17%	19%	24%	27%	8%	10%	13%	24	27	36	33%	37%	36%	0.6	0.7	2.1	0.7	0.9	2.2
Threshold Total	193	171	201	100%	87%	95%	25%	24%	19%	21%	28%	30%	6%	7%	11%	26	29	37	31%	36%	34%	1.2	1.0	2.1	0.6	0.7	1.7
Target																											
1	156	138	169	81%	70%	78%	30%	30%	24%	12%	17%	23%	7%	10%	11%	14	17	26	20%	25%	26%	1.5	1.1	2.1	0.5	0.5	1.4
3	148	141	173	79%	73%	81%	26%	27%	23%	13%	17%	19%	7%	9%	12%	13	16	23	24%	27%	27%	0.8	0.7	1.6	0.5	0.6	1.3
Target Total	152	139	171	80%	71%	79%	28%	29%	24%	13%	17%	21%	7%	9%	12%	14	16	25	22%	26%	26%	1.2	0.9	1.9	0.5	0.5	1.4
Restricted Other																											
1	138	74	106	68%	34%	46%	30%	25%	21%	12%	21%	20%	7%	14%	19%	12	11	17	15%	22%	23%	0.3	0.7	1.5	0.4	0.8	0.8
3	137	80	114	70%	38%	50%	29%	25%	20%	13%	21%	21%	7%	12%	17%	12	11	17	21%	27%	28%	0.5	0.8	1.7	0.4	1.0	0.9
4	129	80	115	67%	39%	52%	28%	23%	18%	13%	21%	19%	8%	14%	18%	12	11	16	24%	29%	30%	0.4	0.7	1.6	0.5	1.0	1.0
5	102	64	98	51%	30%	42%	24%	24%	24%	10%	15%	16%	9%	14%	16%	8	8	13	15%	19%	22%	0.2	0.4	1.0	0.4	0.6	0.5
Restricted Total	137	78	111	69%	37%	49%	29%	25%	20%	13%	21%	20%	7%	13%	18%	12	11	17	19%	25%	26%	0.4	0.8	1.6	0.4	0.9	0.9

*Treatments within threshold habitat will not reduce forest density/structure or habitat components below threshold conditions.

Goshawk Habitat

Table 47 and table 48 displays the overall goshawk habitat structure attributes(Nest/PFA and LOPFA, respectively) projected out to the years 2020 and 2050. Average conditions include trees, interspaces, and canopy gaps as represented by the stand data. These average habitat conditions are a function of openness and tree group density across the different scales (restoration sub-unit, restoration unit, ponderosa pine extent).

- Year 2020 summary: At the habitat and RU scale all habitats are within the desired density range with the exception of RU 6 PFA. The pre-treatment RU 6 PFAs have low stocking (below the DC of 70 ft²), typical of RU 6 site conditions with patches of dense VSS 3. The treatments focus on thinning the dense patches and maintaining canopy cover in the mid-aged, mature and old (VSS 4, 5 and 6), further reducing overall density. Tons of coarse woody debris and snags per acre are below desired throughout all goshawk habitat.
- Year 2050 summary: At the habitat and RU scale all habitats remain within the desired SDI range. Basal area is at or above the desired of 70 ft². Tons of coarse woody debris exceeds the minimum desired with the exception of RU 6 PFA and LOPFA. Snags remain below desired levels.

Table 47. Alternative B - Goshawk Nest/PFA Habitat Forest Structure and Habitat Components

Restoration Subunit-Unit	Ponderosa Pine SDI % of Max			Ponderosa Pine TPA			Ponderosa Pine BA			Tons CWD Total			Tons CWD >12"			Snags >18"		
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
1-1	29%	21%	29%	151	97	89	67	55	79	2.8	2.2	4.6	0.1	0.3	1.0	0.3	0.8	0.4
1-2	40%	28%	33%	202	99	86	94	72	94	3.6	2.9	5.9	0.5	0.6	1.5	0.4	1.1	0.8
1-3	54%	25%	32%	226	80	72	133	69	93	4.4	3.6	6.1	0.4	0.9	1.8	0.4	1.0	0.9
1-4	57%	29%	36%	313	108	94	134	75	100	8.6	6.1	8.4	4.9	3.2	3.6	0.3	0.8	0.9
1-5	55%	29%	33%	247	74	64	131	79	97	4.8	3.7	7.4	0.5	0.8	2.2	0.6	1.4	1.6
1	52%	27%	33%	239	85	75	124	73	95	5.0	3.9	6.8	1.1	1.1	2.1	0.4	1.1	1.1
3-1	44%	27%	32%	177	81	72	107	71	91	3.3	2.6	5.5	0.2	0.5	1.5	0.4	1.2	1.0
3-2	44%	29%	35%	181	90	80	109	78	99	3.1	2.5	5.8	0.3	0.5	1.7	0.4	1.2	1.1
3-3	48%	27%	33%	220	89	79	117	72	95	3.6	2.9	5.7	0.3	0.6	1.5	0.4	1.0	0.9
3-5	44%	29%	35%	207	104	91	105	77	99	3.7	3.0	6.7	0.4	0.6	1.9	0.4	1.1	0.9
3	46%	28%	34%	203	90	80	112	74	96	3.5	2.8	5.8	0.3	0.6	1.6	0.4	1.1	1.0
4-2	38%	26%	32%	162	87	79	94	69	91	2.8	2.2	4.8	0.2	0.4	1.3	0.4	1.1	0.8
4-3	45%	29%	35%	197	96	84	109	77	100	3.7	2.9	6.1	0.7	0.8	1.8	0.4	1.1	0.9
4-4	51%	29%	35%	224	92	81	123	78	100	4.7	3.8	6.6	1.3	1.4	2.2	0.4	1.0	1.0
4-5	46%	31%	36%	226	98	82	108	82	101	4.2	3.1	6.7	0.6	0.6	1.8	0.4	1.0	1.4
4	46%	29%	35%	204	94	82	112	77	99	3.9	3.1	6.2	0.8	0.9	1.9	0.4	1.1	0.9
5-1	45%	29%	34%	206	92	79	109	77	98	5.2	4.0	7.3	1.7	1.4	2.5	0.4	1.2	1.0
5-2	42%	27%	32%	192	72	64	99	75	93	3.9	2.9	6.4	0.5	0.7	2.1	0.5	1.5	1.4

Restoration Subunit-Unit	Ponderosa Pine SDI % of Max			Ponderosa Pine TPA			Ponderosa Pine BA			Tons CWD Total			Tons CWD >12"			Snags >18"		
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
5	43%	28%	33%	199	81	71	104	76	96	4.5	3.4	6.8	1.1	1.0	2.3	0.5	1.4	1.2
6-2	24%	19%	23%	108	56	50	53	48	66	1.9	1.9	4.4	0.2	0.3	1.0	0.3	1.0	0.5
6-3	30%	21%	27%	154	78	71	64	51	71	2.4	1.9	4.4	0.3	0.4	1.0	0.3	0.9	0.5
6	29%	21%	26%	150	76	69	63	51	70	2.4	1.9	4.4	0.3	0.3	1.0	0.3	0.9	0.5
All PFA/dPFA	44%	27%	33%	202	88	78	107	72	94	3.9	3.0	6.0	0.7	0.8	1.8	0.4	1.1	0.9

Table 48. Alternative B - Goshawk LOPFA Habitat Forest Structure and Habitat Components

Restoration Subunit-Unit	Ponderosa Pine SDI % of Max			Ponderosa Pine TPA			Ponderosa Pine BA			Tons CWD Total			Tons CWD >12"			Snags >18"		
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
1-1	44%	22%	28%	208	75	69	103	59	80	3.7	2.7	4.9	0.5	0.7	1.4	0.3	0.9	0.6
1-2	36%	17%	22%	185	52	47	86	46	62	3.2	2.2	4.1	0.3	0.5	1.2	0.3	0.8	0.8
1-3	43%	19%	24%	212	59	55	102	49	68	3.8	2.7	4.5	0.5	0.7	1.3	0.3	0.8	0.7
1-4	43%	21%	26%	224	68	61	99	54	73	3.8	2.7	4.8	0.5	0.6	1.3	0.4	0.8	0.8
1-5	51%	24%	28%	248	65	58	118	62	80	4.5	3.4	6.0	0.7	0.9	1.9	0.5	1.1	1.3
1	46%	21%	26%	227	64	58	107	56	75	4.1	3.0	5.2	0.6	0.8	1.6	0.4	0.9	1.0
3-1	41%	20%	25%	175	63	58	99	52	72	2.8	2.3	4.3	0.2	0.5	1.2	0.4	0.9	0.8
3-2	39%	20%	25%	148	55	50	97	55	73	2.7	2.1	4.0	0.3	0.6	1.3	0.4	1.0	0.9
3-3	47%	20%	26%	209	60	55	114	53	73	3.8	3.0	5.0	0.5	0.8	1.5	0.3	0.9	0.9
3-4	53%	25%	30%	240	69	62	126	67	87	4.7	3.6	6.4	0.7	1.0	2.1	0.4	1.3	1.2
3-5	54%	27%	32%	264	85	74	127	71	91	4.8	3.9	7.1	0.7	0.9	2.0	0.4	1.1	1.1
3	47%	22%	27%	208	67	60	113	59	78	3.8	3.0	5.3	0.5	0.8	1.6	0.4	1.0	0.9
4-2	35%	17%	22%	142	52	48	86	45	64	2.5	1.9	3.5	0.2	0.5	1.0	0.3	0.8	0.6
4-3	38%	21%	27%	176	71	62	91	57	77	3.2	2.5	5.0	0.4	0.6	1.4	0.4	1.0	0.8
4-4	44%	21%	27%	198	66	59	107	56	76	3.5	2.7	4.8	0.4	0.7	1.4	0.3	0.9	0.9
4-5	44%	23%	29%	218	79	71	106	62	83	4.0	3.2	5.8	0.4	0.7	1.6	0.4	0.9	0.8
4	41%	21%	27%	187	68	61	100	56	76	3.3	2.6	4.9	0.4	0.6	1.4	0.4	0.9	0.8
5-1	31%	21%	26%	174	69	61	73	55	73	3.2	2.6	5.4	0.3	0.5	1.4	0.4	1.1	0.9
5-2	27%	22%	26%	119	64	56	67	61	78	3.0	2.2	5.2	0.4	0.5	1.6	0.4	1.4	0.9
5	28%	22%	26%	136	65	57	69	59	76	3.1	2.3	5.2	0.4	0.5	1.5	0.4	1.3	0.9
6-2	29%	19%	24%	166	64	59	63	46	67	2.3	1.8	3.8	0.3	0.3	0.9	0.2	0.7	0.4
6-3	33%	22%	28%	197	80	72	71	52	74	2.6	1.9	4.3	0.2	0.3	0.8	0.2	0.6	0.4
6-4	32%	22%	27%	198	81	68	67	57	74	3.1	3.7	7.2	0.3	0.5	1.5	0.4	1.2	0.8
6	32%	21%	27%	194	78	70	69	52	73	2.6	2.1	4.5	0.2	0.3	0.9	0.2	0.7	0.5
All LOPFA	41%	21%	27%	193	67	60	96	57	76	3.5	2.7	5.0	0.5	0.6	1.4	0.4	1.0	0.9

Table 49 through table 52 display the VSS distribution for even age and uneven age stands by goshawk habitat projected out to the years 2020 and 2050.

In 2020, overall distribution within the LOPFA even-aged stands (table 49) shows VSS 1 slightly above desired at 13 percent, no VSS 2, VSS 3 right at desired with 21 percent, VSS 4 almost twice desired at 37 percent, VSS 5 slightly above desired with 26 percent and VSS 6 deficit by 17 percent. There is a more balanced overall distribution compared to the no action alternative with improvement toward the desired representation in the grass/forb/shrub, young, mid-aged and mature forest stages.

As stand development progresses, the distribution shifts toward the later stages by 2050. The mid-aged, mature and old forest structural stages account for a combined overall distribution of 85 percent. This is very similar to the combined distribution of these stages in alternative A with the difference being alternative A results in a higher percentage of VSS 4 while alternative B results in a higher percentage of VSS 6. In 2050, there are no VSS 1 stands and the overall distribution shows VSS 2 close to desired at 13 percent, VSS 3 deficit by 17 percent, VSS 4 and VSS 5 above desired at 30 and 34 percent respectively and VSS 6 right at desired with 21 percent.

Table 49. Alternative B - 2020 and 2050 VSS Distribution for Goshawk LOPFA Even-Aged Stands Percent of Area by Vegetative Structural Stages

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 1-1	7%	0%	0%	7%	22%	0%	50%	41%	13%	37%	9%	16%
SU 1-2	7%	0%	0%	7%	0%	0%	50%	30%	42%	19%	0%	44%
SU 1-3	6%	0%	0%	6%	12%	0%	55%	39%	23%	31%	4%	24%
SU 1-4	9%	0%	0%	9%	15%	0%	59%	46%	17%	30%	1%	16%
SU 1-5	7%	0%	0%	7%	16%	0%	50%	32%	25%	38%	3%	23%
RU 1	7%	0%	0%	7%	14%	0%	52%	36%	24%	33%	3%	24%
SU 3-1	10%	0%	0%	10%	21%	11%	22%	18%	41%	35%	6%	25%
SU 3-2	12%	0%	0%	12%	9%	4%	18%	9%	53%	32%	9%	43%
SU 3-3	10%	0%	0%	10%	15%	2%	33%	30%	40%	34%	2%	24%
SU 3-4	8%	0%	0%	8%	13%	0%	36%	21%	41%	48%	2%	24%
SU 3-5	7%	0%	0%	7%	21%	0%	45%	35%	25%	47%	2%	11%
RU 3	9%	0%	0%	9%	16%	3%	33%	26%	38%	38%	4%	24%
SU 4-2	9%	0%	0%	9%	20%	5%	6%	17%	42%	25%	23%	44%
SU 4-3	16%	0%	0%	16%	22%	3%	36%	28%	24%	35%	2%	18%

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 4-4	11%	0%	0%	11%	13%	3%	39%	23%	35%	37%	2%	27%
SU 4-5	18%	0%	0%	18%	15%	0%	41%	27%	26%	38%	0%	17%
RU 4	13%	0%	0%	13%	17%	3%	37%	25%	30%	36%	3%	23%
SU 5-1	38%	0%	0%	38%	25%	0%	24%	27%	11%	23%	1%	12%
SU 5-2	20%	0%	0%	20%	13%	0%	55%	19%	9%	51%	3%	10%
RU 5	28%	0%	0%	28%	19%	0%	42%	22%	10%	39%	2%	11%
SU 6-2	8%	0%	0%	8%	86%	18%	0%	69%	0%	0%	6%	6%
SU 6-3	8%	0%	0%	8%	77%	16%	7%	62%	0%	7%	8%	8%
SU 6-4	3%	0%	0%	3%	87%	0%	9%	87%	0%	9%	1%	1%
RU 6	8%	0%	0%	8%	78%	15%	7%	64%	0%	7%	7%	7%
All	12%	0%	0%	12%	23%	3%	37%	30%	26%	34%	3%	21%

In 2020, overall distribution within the LOPFA Uneven-aged stands (table 50) shows VSS 1 slightly below desired at 7 percent, no VSS 2, VSS 3 and VSS 4 right at desired with 19 and 20 percent respectively, VSS 5 15 percent above desired and VSS 6 right at desired with 19 percent. This is a more balanced overall distribution compared to the no action alternative with improvement toward desired representation in the grass/forb/shrub, and young, mid-aged and old forest stages.

As stand development progresses, the distribution shifts toward the later stages by 2050. The mid-aged, mature and old forest structural stages account for a combined overall distribution of 92 percent. This is very similar to the combined distribution of these stages in alternative A with the difference being alternative A results in a higher percentage of VSS 4 while alternative B results in a higher percentage of VSS 6. In 2050, there are no VSS 1 stands and the overall distribution shows VSS 2 below desired at 6 percent, VSS 3 deficit by 18 percent, VSS 4 and VSS 5 right at desired with 18 and 20 percent respectively and VSS 6 well above desired with 55 percent.

Table 50. Alternative B - 2020 and 2050 VSS Distribution for Goshawk LOPFA Uneven-Aged Stands Percent of Area by Vegetative Structural Stage

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 1-1	13%	0%	0%	13%	22%	0%	13%	14%	46%	12%	6%	61%
SU 1-2	8%	0%	0%	8%	10%	0%	33%	8%	30%	27%	20%	57%
SU 1-3	10%	0%	0%	10%	11%	0%	7%	4%	37%	10%	35%	76%
SU 1-4	7%	0%	0%	7%	7%	0%	39%	19%	26%	28%	20%	46%
SU 1-5	7%	0%	0%	7%	8%	0%	30%	10%	46%	41%	9%	43%
RU 1	8%	0%	0%	8%	10%	0%	24%	10%	40%	27%	18%	55%
SU 3-1	14%	0%	0%	9%	19%	5%	15%	15%	47%	11%	6%	60%
SU 3-2	7%	0%	0%	7%	6%	0%	18%	5%	48%	16%	21%	71%
SU 3-3	6%	0%	0%	6%	14%	0%	19%	10%	51%	19%	9%	65%
SU 3-4	8%	0%	0%	8%	1%	0%	18%	1%	60%	42%	13%	49%
SU 3-5	7%	0%	0%	7%	14%	0%	42%	19%	24%	40%	13%	34%
RU 3	8%	0%	0%	7%	12%	1%	23%	11%	45%	23%	12%	58%
SU 4-2	10%	0%	0%	9%	14%	2%	11%	2%	56%	8%	9%	79%
SU 4-3	5%	0%	0%	5%	26%	0%	25%	27%	30%	21%	14%	47%
SU 4-4	9%	0%	0%	9%	13%	0%	19%	14%	46%	16%	12%	61%
SU 4-5	7%	0%	0%	7%	2%	0%	22%	11%	59%	43%	10%	38%
RU 4	7%	0%	0%	7%	18%	0%	22%	18%	40%	19%	13%	55%
SU 5-1	4%	0%	0%	4%	15%	0%	23%	20%	31%	29%	28%	48%
SU 5-2	1%	0%	0%	1%	11%	0%	7%	12%	25%	7%	56%	81%
RU 5	1%	0%	0%	1%	12%	0%	10%	13%	26%	11%	51%	75%
SU 6-2	4%	0%	0%	4%	47%	2%	15%	44%	0%	15%	33%	35%
SU 6-3	9%	0%	1%	9%	38%	7%	22%	50%	1%	12%	29%	22%
SU 6-4	0%	0%	0%	0%	75%	0%	4%	78%	0%	1%	20%	21%
RU 6	7%	0%	1%	7%	44%	5%	19%	52%	1%	12%	28%	24%
All	7%	0%	0%	6%	17%	1%	20%	19%	33%	19%	23%	55%

In 2020, overall distribution within the PFA even-aged stands (table 51) shows VSS 1 slightly below desired at 9 percent, no VSS 2, VSS 3 close to desired with 22 percent, VSS 4 more than twice desired at 46 percent, VSS 5 below desired with 14 percent and VSS 6 deficit by 12 percent. There is a more balanced overall distribution compared to the no action alternative with improvement toward the desired representation in the grass/forb/shrub, young, mature and old forest stages.

As stand development progresses, the distribution shifts toward the later stages by 2050. The mid-aged, mature and old forest structural stages account for a combined overall distribution of 89 percent. This is very similar to the combined distribution of these stages in alternative A with the difference being alternative A results in a higher percentage of VSS 4 while alternative B results in a higher percentage of VSS 5. In 2050, there are no VSS 1 stands and the overall distribution shows VSS 2 close to desired at 9 percent, VSS 3 deficit by 18 percent, VSS 4 and VSS 5 above desired at 41 and 39 percent respectively and VSS 6 below desired with 9 percent.

Table 51. Alternative B - 2020 and 2050 VSS Distribution for Goshawk PFA Even-aged Stands Percent of Area by Vegetative Structural Stage

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 1-1	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%
SU 1-2	5%	0%	0%	5%	37%	0%	58%	68%	0%	27%	0%	0%
SU 1-3	8%	0%	0%	8%	30%	0%	27%	30%	35%	62%	0%	0%
SU 1-4	8%	0%	0%	8%	24%	0%	21%	75%	0%	17%	47%	0%
SU 1-5	4%	0%	0%	4%	9%	0%	43%	37%	43%	58%	0%	0%
RU 1	6%	0%	0%	6%	23%	0%	36%	52%	21%	41%	13%	0%
SU 3-1	12%	0%	0%	12%	16%	0%	60%	33%	13%	42%	0%	13%
SU 3-2	32%	0%	0%	9%	14%	0%	41%	33%	13%	41%	0%	17%
SU 3-3	7%	0%	0%	19%	29%	0%	47%	33%	17%	45%	0%	3%
SU 3-4	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%
SU 3-5	32%	0%	0%	32%	0%	0%	57%	49%	12%	20%	0%	0%
RU 3	17%	0%	0%	17%	20%	0%	48%	35%	15%	41%	0%	7%
SU 4-2	12%	0%	0%	12%	10%	7%	41%	20%	36%	32%	0%	30%
SU 4-3	7%	0%	0%	7%	22%	3%	58%	43%	8%	42%	4%	4%
SU 4-4	8%	0%	0%	8%	20%	1%	39%	44%	17%	37%	16%	10%
SU 4-5	3%	0%	0%	3%	34%	0%	55%	34%	8%	58%	0%	4%
RU 4	8%	0%	0%	8%	21%	3%	50%	41%	14%	41%	8%	8%
SU 5-1	12%	0%	0%	12%	38%	0%	46%	58%	4%	26%	0%	4%
SU 5-2	3%	0%	0%	3%	0%	0%	76%	13%	20%	62%	1%	21%
RU 5	8%	0%	0%	8%	19%	0%	61%	36%	12%	44%	1%	13%
SU 6-2	3%	0%	0%	3%	58%	0%	0%	58%	0%	0%	40%	40%
SU 6-3	11%	0%	0%	11%	45%	4%	4%	45%	2%	0%	37%	40%
SU 6-4	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%
RU 6	11%	0%	0%	11%	46%	4%	4%	46%	2%	0%	37%	40%
All	9%	0%	0%	9%	22%	2%	47%	41%	14%	39%	7%	9%

In 2020, overall distribution within the PFA Uneven-aged stands (table 52) shows VSS 1 slightly below desired at 8 percent, no VSS 2, VSS 3 slightly below desired with 18 percent, VSS 4 21 percent above desired, VSS 5 4 percent above desired and VSS 6 below desired with 10 percent. This is a more balanced overall distribution compared to the no action alternative with improvement toward desired representation in the grass/forb/shrub, and young, mid-aged and old forest stages.

As stand development progresses, the distribution shifts toward the later stages by 2050. The mid-aged, mature and old forest structural stages account for a combined overall distribution of 92 percent. This is very similar to the combined distribution of these stages in alternative A with the difference being alternative A results in a higher percentage of VSS 4 while alternative B results in a higher percentage of VSS 5 and 6. In 2050, there are no VSS 1 stands and the overall distribution shows VSS 2 close to desired at 8 percent, no VSS 3 stands, VSS 4 and VSS 5 above desired with 29 and 39 percent respectively and VSS 6 slightly above desired with 24 percent.

Table 52. Alternative B - 2020 and 2050 VSS Distribution for Goshawk PFA Uneven-aged Stands Percent of Area by Vegetative Structural Stage

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 1-1	9%	0%	0%	9%	39%	0%	52%	91%	0%	0%	0%	0%
SU 1-2	6%	0%	0%	6%	0%	0%	38%	32%	27%	17%	29%	44%
SU 1-3	10%	0%	0%	10%	6%	0%	30%	19%	52%	64%	1%	7%
SU 1-4	9%	0%	0%	9%	0%	0%	82%	0%	0%	82%	10%	10%
SU 1-5	2%	0%	0%	2%	16%	0%	53%	26%	20%	52%	8%	20%
RU 1	7%	0%	0%	7%	10%	0%	42%	26%	33%	52%	7%	15%
SU 3-1	3%	0%	0%	3%	5%	0%	73%	5%	19%	73%	0%	19%
SU 3-2	5%	0%	0%	5%	9%	0%	76%	9%	10%	76%	0%	10%
SU 3-3	10%	0%	0%	10%	12%	0%	36%	20%	39%	41%	3%	28%
SU 3-4	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%
SU 3-5	10%	0%	0%	10%	4%	0%	67%	51%	18%	23%	0%	15%
RU 3	8%	0%	0%	8%	9%	0%	57%	19%	24%	54%	1%	19%
SU 4-2	10%	0%	0%	10%	22%	0%	38%	36%	14%	24%	16%	30%
SU 4-3	11%	0%	0%	9%	14%	2%	49%	30%	21%	44%	5%	15%
SU 4-4	9%	0%	0%	9%	4%	1%	54%	11%	25%	50%	8%	30%

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
SU 4-5	1%	0%	0%	1%	0%	0%	0%	0%	99%	34%	0%	65%
RU 4	10%	0%	0%	9%	12%	1%	49%	24%	22%	43%	7%	23%
SU 5-1	6%	0%	0%	6%	13%	0%	73%	18%	8%	68%	0%	8%
SU 5-2	3%	0%	0%	3%	4%	0%	24%	10%	66%	48%	2%	38%
RU 5	5%	0%	0%	5%	8%	0%	46%	14%	40%	57%	1%	25%
SU 6-2	1%	0%	0%	1%	5%	0%	20%	5%	0%	20%	74%	74%
SU 6-3	8%	0%	0%	8%	47%	0%	10%	57%	11%	1%	24%	34%
SU 6-4	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%	-%
RU 6	8%	0%	0%	8%	44%	0%	11%	53%	10%	2%	27%	37%
All	6%	0%	0%	7%	18%	0%	41%	29%	24%	39%	10%	24%

Old Growth

Table 53 displays the old growth structural attributes of the ponderosa pine old growth acres projected out to the years 2020 and 2050 under alternative B combine for Coconino NF and Kaibab NF by RU.

In 2020, the average conditions are at or above the minimum criteria with the following exceptions:

- Trees per acre larger than 18" and 180 years old. This condition is deficit in all SUs ranging from a low of 8.9 TPA in SU 6-2 to a high of 16.6 TPA in SU 3-4 with an overall average for all acres of 13.6 TPA. The age of these trees is estimated be in the range of 100 to 140 years old with a few relic trees meeting the 180 year old criteria.
- Basal area ≥ 90 . This condition is below desired in RUs 3, 4, 5 and 6. Overall average for all acres is 82.
- Coarse woody debris greater than 12". This condition is estimated to be deficit with less than the equivalent of 2 pieces per acre throughout RU 5 and 6, and various SUs.

Over time, old growth conditions improve in terms of meeting the minimum criteria. In 2050, all RUs are very close to or exceed the criteria for TPA larger than 18" with the exception of RU 6. The age of these trees is estimated be in the range of 130 to 170 years old. It is estimated that all the other criteria will be met throughout the allocated old growth acres.

Table 53. Alternative B – 2020 and 2050 Ponderosa Pine OG Structural Attributes by Restoration Unit

Restoration Subunit/Unit	OG Acres	Avg. TPA 18"+			Avg. BA			Avg. Tons CWD ≥12"			Avg. Snags Per Acre ≥12"		
		2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
1-1	3,578	13.2	13.3	19.0	117	76	105	0.4	0.6	1.3	1.4	3.9	1.6
1-2	2,034	11.0	11.1	16.6	101	63	89	0.3	0.6	1.2	1.1	3.7	1.4
1-3	17,105	13.5	14.2	20.7	128	88	116	0.6	0.8	1.5	2.0	3.7	2.5
1-4	6,323	11.6	12.7	19.7	117	89	116	0.3	0.5	1.3	1.7	3.7	2.8
1-5	35,050	14.9	16.5	24.3	146	118	143	0.6	0.8	1.8	2.8	4.6	4.4
1	64,090	13.9	15.0	22.1	134	101	128	0.5	0.7	1.6	2.3	4.2	3.4
3-1	6,216	12.9	12.9	18.8	121	72	101	0.3	0.6	1.3	1.6	4.0	1.5
3-2	9,317	14.7	14.5	19.4	113	70	97	0.3	0.6	1.3	1.5	3.5	1.5
3-3	15,624	13.8	14.0	19.8	132	80	110	0.4	0.7	1.5	2.0	4.3	2.0
3-4	4,201	15.8	16.6	23.6	148	112	138	0.7	0.9	1.9	2.8	4.8	4.0
3-5	11,305	15.2	15.6	22.6	147	92	122	0.8	1.0	2.1	2.6	5.7	2.8
3	46,663	14.4	14.5	20.5	132	82	111	0.5	0.8	1.6	2.1	4.5	2.2
4-2	3,710	13.0	12.3	17.0	103	62	87	0.2	0.5	1.1	1.2	3.5	1.2
4-3	20,144	11.9	12.4	19.3	107	70	97	0.3	0.6	1.4	1.4	4.8	1.8
4-4	22,175	13.2	13.2	19.4	119	66	95	0.3	0.6	1.3	1.4	3.7	1.2
4-5	2,030	14.1	14.4	22.9	136	78	111	0.4	0.8	1.6	2.1	5.0	1.6
4	48,059	12.7	12.8	19.3	113	68	96	0.3	0.6	1.3	1.4	4.2	1.5
5-1	5,187	11.7	12.6	19.8	99	75	102	0.5	0.6	1.6	1.4	5.5	2.1
5-2	18,530	11.9	12.9	19.6	84	75	97	0.5	0.5	1.6	1.3	5.8	2.3
5	23,716	11.8	12.8	19.6	87	75	98	0.5	0.5	1.6	1.3	5.8	2.3
6-2	1,689	8.5	8.9	14.2	84	63	94	0.2	0.3	0.9	0.6	3.9	1.0
6-3	8,210	9.1	9.4	15.0	92	69	104	0.2	0.3	0.9	0.6	3.6	0.9
6-4	392	9.3	9.5	15.4	109	78	108	0.3	0.4	1.5	1.0	6.6	2.0
6	10,291	9.0	9.3	14.9	91	69	102	0.2	0.3	0.9	0.6	3.8	1.0
All	192,819	13.0	13.6	20.1	118	82	110	0.4	0.7	1.5	1.8	4.4	2.3

Table 54 displays the old growth structural attributes of the pinyon-juniper allocated old growth acres projected out to the years 2020 and 2050 under alternative B. Alternative B proposes burning in the PJ cover type to facilitate burns in the adjacent ponderosa pine cover type. It is assumed that minimal acres would carry a fire in the PJ cover type under prescribed fire conditions. That assumption is difficult to simulate, so the post treatment conditions listed in the table indicate a worst case scenario in terms of fire effects to the PJ acres.

In 2020, the average conditions are at or above the minimum criteria with the exception of TPA >12" and tree age. The age of the 12" and larger trees is estimated to be approximately 90 to 120 years old with a few relic trees approaching the 200 year old criteria. By 2050, the average conditions on the old growth acres meet or exceed the minimum criteria with the exception of tree age.

Table 54. Alternative B – 2020 and 2050 Pinyon-Juniper Allocated Old Growth Structural Attributes by Restoration Unit

Restoration Unit	OG Acres	Avg. TPA 12"+			Avg. BA			Avg. Tons CWD ≥12"			Avg. Snags Per Acre ≥12"		
		2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
1	611	31	24	37	108	64	93	0.1	0.5	1.9	1.0	14.9	1.3
3	2,104	31	25	33	93	60	83	0.1	0.5	2.2	1.5	15.1	1.6
4	4,158	29	24	30	88	57	78	0.1	0.5	2.2	1.5	15.1	1.6
5	7,302	32	24	38	108	64	93	0.1	0.5	2.0	1.0	15.3	1.4
6	1,452	37	24	33	120	69	99	0.2	0.5	1.9	1.2	9.5	1.3
All	15,626	31	24	34	102	62	88	0.1	0.5	2.1	1.2	14.7	1.5

Openness

The variety of treatment types and desired conditions under alternative B would result in a wide range of openness post treatment. The following lists the openness that is projected to result by implementing the treatment types proposed:

- **Very Open**
 - Grassland Restoration, Savanna. Exceptions: areas that are already in a less dense condition.
- **Open**
 - Pine-Sage, WUI55, IT40, SI40, UEA40. Exceptions: areas that are already in a less dense condition.
- **Moderately Closed**
 - Burn Only within LOPFA, PFA and MSO Restricted Other Habitats; MSO Restricted Other, IT25, SI25 and UEA25. Exceptions: areas that are already in a less dense condition.
- **Closed**
 - Burn Only within Goshawk Nest, MSO PAC/Protected and Target/Threshold; PAC, Target/Threshold, IT10, SI10 and UEA10. Exceptions: areas that are already in a less dense condition.

Table 55 lists the post treatment openness within the ponderosa pine cover type for alternative B by restoration unit and sub unit. Overall ranges indicate a fairly diverse condition with openness leaning to the closed side of the range. Two percent of the ponderosa pine would be very open, 41 percent open, 47 percent moderately closed and 11 percent closed. The unknowns are those areas with no treatment proposed under this alternative.

Table 55. Alternative B – Post Treatment Openness Classification for Ponderosa Pine

Restoration Sub-unit / Unit	Very Open	Open	Moderately Closed	Closed
1-1	3%	61%	30%	6%
1-2	35%	47%	16%	3%
1-3	17%	45%	24%	14%
1-4	14%	51%	21%	14%
1-5	6%	31%	34%	29%
1	11%	40%	29%	21%
3-1	9%	49%	39%	3%
3-2	20%	52%	22%	5%
3-3	17%	44%	27%	11%
3-4	3%	33%	32%	32%
3-5	6%	29%	43%	21%
3	13%	41%	33%	13%
4-2	31%	59%	7%	3%
4-3	20%	49%	20%	11%
4-4	20%	58%	16%	6%
4-5	15%	40%	27%	18%
4	20%	54%	18%	8%
5-1	26%	32%	35%	7%
5-2	8%	69%	20%	3%
5	14%	58%	24%	4%
6-2	1%	77%	16%	5%
6-3	2%	39%	54%	6%
6-4	1%	5%	29%	66%
6	2%	41%	47%	11%
All Ponderosa Pine	13%	46%	28%	13%

* These are areas that will not be treated with mechanical and/or prescribed fire treatments. For Alternative B this includes PAC core areas and the Proposed Garland Prairie RNA.

Forest Structure and Diversity - Mosaic of interspaces and tree groups of varying sizes and shapes

While all treatments with the exception of Grassland Restoration are designed to reestablish forest openings and attain a mosaic of interspaces and tree groups of varying sizes and shapes, the intensity of the treatment affects the relative tendency toward this condition. The lower intensity treatments within MSO PAC, Target/Threshold and goshawk nest habitat will result in irregular tree spacing and subtle expansion of existing forest openings. The higher intensity treatments such as UEA 40, IT 40 and SI 40 will be removing more trees and extends greater flexibility in size and shape of interspaces and tree groups generated.

Natural Range of Variability (Alternative B) (Appendix D)

Appendix D graphically represents Natural Range of Variability Comparison by Treatment Type by forest attributes: Minimum, maximum and the weighted average. Forest Attributes are within the Natural range of Variability except for PACS, Goshawk nest areas and MSO Target Threshold Habitats. As the intensity of treatments increase the habitats are structured most closely to the historic range of variability. Mechanical treatments plus fire are more effective than fire alone. But fire is an essential element to achieve the best results to move towards desire conditions.

Table 56 lists alternative B acres by treatment intensity as an indication of the relative ability of the treatment to attain a mosaic of interspaces and tree groups and of the post treatment interspace/tree group condition. Forty one percent of the area treated is considered high, 25 percent is moderate, 24 percent is low and 10 percent is very low.

Table 56. Alternative B - summary of ponderosa pine treatment acres by their relative ability to attain a mosaic of interspaces and tree groups

Treatment Intensity	Treatment Type	Acres	
High	Grassland Restoration	11,185	
	Savanna	45,405	
	Pine Sage	5,261	
	WUI 55	2,224	
	UEA 40	100,133	
	IT 40	38,712	
	SI 40	12,303	
Total High:		215,224	(42%)
Moderate	MSO Restricted Trt	64,065	
	UEA 25	39,190	
	IT 25	11,871	
	SI 25	6,618	
Total Moderate:		121,743	(24%)
Low	UEA 10	18,082	
	IT 10	7,565	
	SI 10	1,914	

Treatment Intensity	Treatment Type	Acres	
	LOPFA Prescribed Fire Only	86,869	
	PFA Prescribed Fire Only	3,172	
	Restricted Prescribed Fire Only	2,354	
Total Low:		119,956	(24%)
Very Low	MSO Target Trt	6,497	
	MSO Threshold Trt	1,894	
	PAC - Mechanical	10,284	
	PFA Nest Stand Prescribed Fire Only	6,840	
	Protected Prescribed Fire Only	20,083	
	Target Prescribed Fire Only	217	
	Threshold Prescribed Fire Only	84	
	No Proposed Treatments	5,016	
Total Very Low:		50,915	(10%)

Forest Structure - All age and size classes represented

The MSO habitat forest structure analysis for alternative B indicates the post treatment distribution of size classes has good representation in the 12-18” and the 18-24” size classes in all habitats. Stocking in the 24” + size class has good representation in the restricted other habitat and is underrepresented in the target/threshold habitat (). Implementation of group selection as part of the restricted other treatments would result in up to 15 percent of the area trending toward early successional stages, thereby increasing representation of the seedling/sapling age class.

The goshawk habitat structural stage analysis for alternative B indicates overall post treatment VSS distribution in the even-aged goshawk habitats will have good representation of the VSS 1, 3 and 4 age classes, and the VSS 5 age class in the LOPFA; under-representation of the VSS 6 age class and the VSS 5 age class in the PFA; no representation of the VSS 2 age class. The Uneven-aged goshawk habitats will have good representation in the LOPFA of VSS 3, 4, 5 and 6 and of VSS 4 and 5 in the PFA; VSS 1 is underrepresented in the LOPFA and VSS 1, 3 and 6 are underrepresented in the PFA; there is no representation of the VSS 2 age class in all habitats (table 49 through table 52).

Old Forest Structure Sustained Over Time Across the Landscape

The restoration treatments proposed under alternative B are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Old trees would not be targeted for cutting (reference the Old Tree Implementation Strategy in Appendix A).

The MSO habitat forest structure analysis for alternative B indicates the post treatment distribution of size classes has good representation in the 18-24” size classes in all habitats. Stocking in the 24” + size class has good representation in the restricted other habitat and is underrepresented in the target/threshold habitat (table 46).

The goshawk habitat structural stage analysis above indicates the mature and old forest structural stages to be underrepresented in the PFA habitat and LOPFA even-aged stands. Projections show a trend toward improved representation in all habitats (table 49 through Tble 52).

Treatments within areas currently allocated OG would maintain existing old growth structural attributes and are managed to move towards those conditions over time. The ponderosa pine old growth analysis above indicates old growth structural attributes would continue to develop and improve across the landscape (Table53).

With the implementation of restoration treatments under alternative B, the sustainability of the large/old tree component across the landscape would be improved as presented in the following forest health discussion.

Forest Health

Density related mortality

Stand density in 2020 in the MSO restricted other habitat (table 46) would have an overall average 37% of maximum density (range 30-39%) putting these stands at the low end of the high density zone as described in Table 7. The restricted other habitat consists of mixed species pine/oak stands. The pine component within this habitat is estimated to have density within the low to moderate zone. The majority of target/threshold and protected habitat would remain in zone 4 due to the oak stocking and dense forest desired conditions in these habitats. Any areas with mechanical treatments within these habitats would experience reduced density related mortality compared to the no action alternative.

In goshawk habitat, table 47 shows 2020 ponderosa pine density levels average 27% of maximum density within nest/PFA habitat and 21% in LOPFA habitat. These density levels are within the low to moderate density zones (table 7). In 2050, overall averages indicate both habitats to be within the moderate density zone with a few of the nest/PFA SUs being on the low end of high density and well below the threshold for the onset of density related mortality.

Bark beetle related mortality –

Table 57 lists the beetle hazard rating for the years 2020 and 2050 by RU and for the ponderosa pine analysis area. The overall hazard in 2020 is high across 22% of the analysis area. This increases to 52% in 2050. Stands with a hazard rating of low or moderate would be expected to be resistant to successful bark beetle attack and large scale mortality. In the current climate change scenario alternative B mitigate the beetle hazard.

Table 57. Alternative B - Estimated 2020 and 2050 Beetle Hazard Rating (Percent of Area)

Hazard Rating	RU 1	RU 3	RU 4	RU 5	RU 6	% of Total	Analysis area Acres
2010							
Low	3%	6%	8%	26%	0%	7%	37,933
Moderate	12%	11%	27%	46%	25%	21%	106,132
High	85%	83%	65%	28%	75%	72%	363,775
2020							
Low	34%	40%	61%	46%	38%	45%	226,030

Hazard Rating	RU 1	RU 3	RU 4	RU 5	RU 6	% of Total	Analysis area Acres
Moderate	32%	30%	29%	48%	43%	33%	169,152
High	34%	30%	10%	6%	19%	22%	112,657
2050							
Low	9%	11%	17%	27%	2%	13%	66,254
Moderate	25%	27%	46%	50%	30%	34%	175,058
High	66%	62%	37%	24%	68%	52%	266,527

Dwarf mistletoe infection –

Table 58 lists the dwarf mistletoe infection level and average percent of trees infected for the years 2020 and 2050 by RU and for the ponderosa pine analysis area. For 2020, approximately 60 percent of the area is not infected or has a low infection level and 40 percent has a moderate to high infection level. The overall average percent of trees infected is 6 percent in the none/low group and 36 percent in the moderate/high group. This reflects an improvement from the no action alternative with two percent more area in the none/low group and 4 percent less area in the moderate/high group. Overall percent of trees infected is one percent less in none/low and 6 percent less in moderate/high. The percentages for 2050 indicate mistletoe infection is intensifying and spreading at a slower rate than alternative A.

Table 58. Alternative B Estimated Post Treatment and Long Term Dwarf Mistletoe Infection Level

Infection Level		RU 1	RU 3	RU 4	RU 5	RU 6	Analysis area %
2010							
None/Low	Percent of Area	53%	57%	73%	92%	82%	66%
None/Low	Average Percent Trees Infected	5%	6%	4%	10%	5%	6%
Moderate/High	Percent of Area	47%	43%	26%	8%	18%	34%
Moderate/High	Average Percent Trees Infected	38%	33%	38%	41%	42%	36%
Extreme	Percent of Area	1%	0%	0%	0%	0%	0%
Extreme	Average Percent Trees Infected	86%	86%	85%			86%
2020							
None/Low	Percent of Area	47%	47%	71%	79%	82%	60%
None/Low	Average Percent Trees Infected	5%	5%	5%	11%	6%	6%
Moderate/High	Percent of Area	52%	53%	29%	21%	18%	40%
Moderate/High	Average Percent Trees Infected	40%	34%	42%	31%	56%	39%
Extreme	Percent of Area	1%	0%	0%	0%	0%	0%
Extreme	Average Percent Trees Infected	88%	100 %				88%
2050							

Infection Level		RU 1	RU 3	RU 4	RU 5	RU 6	Analysis area %
None/Low	Percent of Area	45%	45%	69%	69%	82%	57%
None/Low	Average Percent Trees Infected	6%	6%	7%	11%	7%	7%
Moderate/High	Percent of Area	55%	55%	31%	31%	18%	43%
Moderate/High	Average Percent Trees Infected	47%	41%	49%	31%	62%	44%
Extreme	Percent of Area	1%	0%	0%	0%	0%	0%
Extreme	Average Percent Trees Infected	88%	100 %				89%

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 alternative B.

Within forest carbon stocks would be reduced under alternative B. 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 within the estimated 366,159,029 cubic feet of biomass removed by mechanical thinning would be sequestered for a time in the form of building materials.

Vegetation Diversity and Composition – Maintain and Promote

Grasslands

Alternative B would restore historic grasslands, savannas and forest openings by removing ponderosa pine tree canopy that is shading out understory herbaceous vegetation and reducing forage production and species diversity as follows:

- 11,185 acres of grassland restoration treatments on mollisol soils;
- 45,405 acres of savanna treatments on mollic integrate soils;
- 307,938 acres of ponderosa pine restoration treatments in PFA, LOPFA and MSO restricted other habitats enhancing small grassland inclusions within the greater forested area.

Oak

Treatments proposed in alternative B are designed to conserve oak and improve conditions that favor oak growth and establishment wherever it exists by reducing pine-oak competition. This would result in improved vigor of existing oak and establishment of a variety of oak size and age classes across the landscape. These conditions would be most prevalent within the 64,065 acres of MSO restricted other habitat treatments. Table 46 shows the overall post treatment oak basal area would be 5 percent higher in this habitat compared to the no action alternative (table 32).

Aspen

The treatments within 1,450 acres of aspen stands under alternative B are designed to maintain and/or regenerate aspen by reducing pine-aspen competition. These treatments would result in establishment of vigorous aspen regeneration free of competition from overtopping ponderosa pine.

Pine-Sage

The 5,261 acres of pine-sage thinning treatments are designed to remove post settlement pine that is currently overtopping and shading out the sage and to manage fire to enhance sage extent. These treatments would result in enhancement of the sage component within the pine sage mosaic.

Other Direct and Indirect Effects:

Residual Tree Damage

Some damage to residual trees would be expected in alternative B with the felling, tractor yarding and piling operations associated with mechanical treatments in ponderosa pine on approximately 384,966 (table 43) acres of p pine. Damage would be minimized through contract administration 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).

Tractor Yarding and Fuel Treatment

All merchantable harvested material would be whole-tree tractor yarded from the mechanical treatment units. Fuel treatments proposed for Alternative B includes pile burning, broadcast burns and fireline construction. Some damage to the residual trees would be expected with the felling, tractor yarding and piling operations within approximately 583,330 acres (table 43) of ponderosa pine mechanical treatments. Damage would be minimized through contract administration and proper harvest methods. All piling and/or low-severity burning treatments on approximately 507,208 (P pine) acres would reduce understory stocking and reduce inter-tree competition as well as stimulate understory vegetation (shrubs, forbs, grasses). Fireline placement would use existing features with naturally low fuels, skid trails, roads etc. as much as possible. Actual fireline construction would remove herbaceous material to bare mineral soil up to a 6 foot width.

Timber and Wood Products

A Coconino FP goal is to manage the timber resource to provide a sustained-yield of forest products (CFP plan page 23). A Kaibab FP goal is to manage suitable timberland to provide a sustained level of timber outputs to support local dependent industries (KFP page 18). Timber harvest of 243,302,331 cubic feet of biomass from the Coconino and 122,856,697 cubic feet of biomass from the Kaibab is a direct beneficial effect of Alternative B.

Road Maintenance, Decommissioning, Reconstruction, Opening, and Temp Road Construction

Road maintenance within the existing road prism would have no effect on the health and growth of the leave trees within the treatment units. Road decommissioning of 904 miles of existing system and unauthorized roads would allow ingrowth of forest vegetation once the road is decommissioned (approximately 2,712 acres). Constructing 245 miles of temporary roads will remove trees and forest vegetation within the road right of ways (approximately 735 acres). Opening 272 miles of decommissioned roads may remove trees and forest vegetation that has become established within the road right of way since the road was last maintained (approximately 816 acres). Reconstructing 10 miles of road will remove trees and forest vegetation within the area being reconstructed (approximately 30 acres). Road reconstruction consists of road improvement activities and road realignments activities. Road realignment of 10 miles of road would remove approximately 30 acres of trees and forest vegetation within the area being reconstructed. 30 miles of road improvement is expected to occur on small discreet areas and is expected to remove about 100 acres of forest vegetation. The above listed effects cover the maximum range of management actions. Possible management actions includes: Reestablish former drainage patterns, stabilizing slopes, and restore vegetation; Block the entrance to a road or installing water bars; Remove culverts, reestablish drainages, remove unstable fills, pull back road shoulders, and scatter slash on the roadbed; Completely eliminate the roadbed by restoring natural contours and slopes; and Other methods designed to meet the specific conditions associated with the unneeded road.

Aspen Fencing and Barriers

Up to 82 miles of protective barriers would be established around aspen clone patches within the ponderosa pine forest. Barriers would consist of fencing and/or felling trees (jack-strawing). Fencing would occur after mechanical and burning treatments and would have no effect to the vegetation. Jack-strawing may occur during the mechanical operation and would utilize trees that have been targeted for removal to meet treatment objectives. Leaving felled material on the ground would forego the opportunity to use that material for wood products.

Restoration of Springs and Ephemeral Channels

Springs and ephemeral channels are inclusions within the mechanical and burn analysis areas. Any tree removal that occurs as part of the restoration of these areas would be part of the design for those mechanical treatments that occur around these areas and the effects to the forest vegetation would be similar to the overall treatment. Up to 4 miles of protective fencing would be established around restored springs. Fencing would have no effect to the vegetation. Bank re-contouring and stabilization would occur along 39 miles of ephemeral channels. This activity would disturb existing forest vegetation. Up to 5 miles of willow, re-establishment would occur where evidence indicates historic willow presence. This would create vegetation diversity and allow natural willow expansion into adjacent areas of suitable habitat. The above listed effects cover the maximum range of management actions. Possible management actions for springs include: Remove tree canopy to pre-settlement condition within 2-5 chains of the spring; Apply for water right if none exists; remove noxious weeds; Prescribe burn; Identify stressor and

provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.); And/or other methods designed to meet the desired conditions.

2014 Kaibab National Forest: Forest Plan Consistency: Alternative B

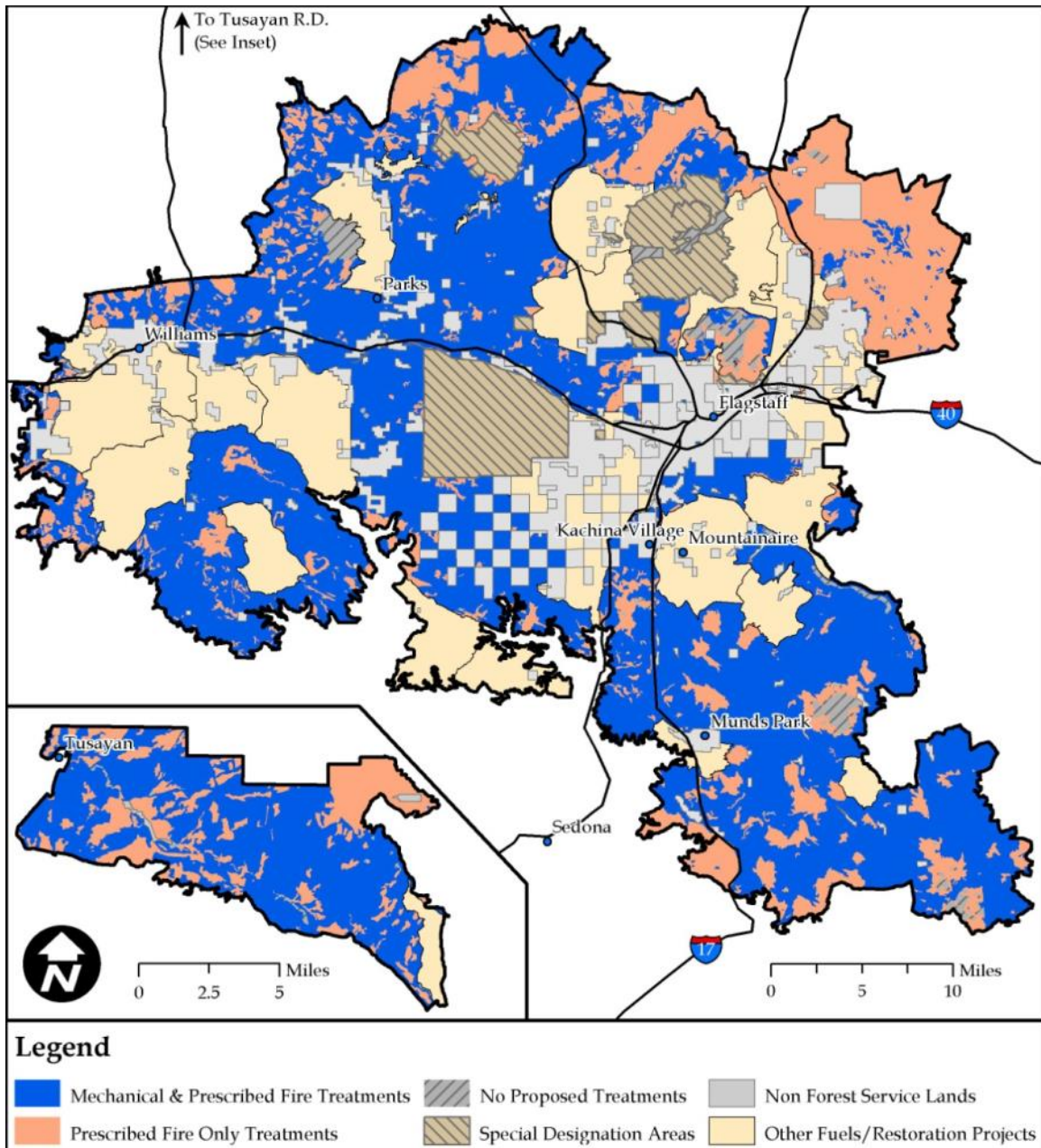
Alternative B incorporate key components of the Old Tree Protection Strategy into the alternative's implementation plan (Appendix A). The Forest Service worked collaboratively with stakeholders to develop implementation plan.

This alternative follows all plan standards and guidelines. Refer to Appendix B for further consistency on specific forest plan Standards, Guidelines and desired conditions. All aspects with this alternative are consistent with the Kaibab forest plan.

Alternative C (Preferred Alternative)

See Chapter 2 FEIS for a list of activities and a description of the treatments that are proposed for Alternative C.

Alternative C would implement approximately 586,110 acres of restoration activities (within the 988,764 acre project area) (figure 10).



Restoration activities would:

- Mechanically cut trees and burn approximately 431,049 acres. This includes ponderosa pine restoration treatments within 299,634 acres of northern goshawk habitat and 78,643 acres of Mexican spotted owl habitat, 1,227 acres of aspen restoration, 535 acres of

Figure 10. Alternative C mechanical and prescribed fire treatments

pinyon-juniper wildland urban interface treatments and 48,195 acres of grassland mechanical treatments.

- Prescribe burn-only approximately 155,061 acres. Burn only treatments would occur within 124,267 acres of ponderosa pine and 242 of acres of aspen with the remaining 30,552 acres occurring in the PJ, oak woodland, grassland and non-vegetated cover types operationally to facilitate burning the ponderosa pine and aspen. Within the ponderosa pine, 96,878 acres are within northern goshawk habitat and 30,204 acres are within Mexican spotted owl habitat.
- The post-treatment tree density (trees per acre, TPA), after mechanical treatments and prescribed fires, across the 431,049 acres, is projected to be no less than 65 TPA (mean).
- In the post-treatment landscape, across the 431,049 acres, it is projected that more than 16% of stands will have no less than 81 TPA (mean).
- The post-treatment landscape, across the 431,049 acres, is projected to be dominated by small trees, with more than 51.8% of the trees smaller than 15.7" DBH.

It is clear that the forest structure described in various literature (Reynolds et al 2013, Williams & Baker 2012, Williams & Baker 2013, William & Baker 2015, Woolsey 1911, Pearson 1950, Covington and Moore 1994, Swetnam and Baisan 1996, Covington et al. 1997, Fulé et al. 2003, Fulé et al. 1997, Leiberg et al, 1904) are all describing very similar forest structures as described as the Natural Range of Variability in this project. While the individual metrics used in the literature to describe the desired stand structure vary, it is clear that almost the entire project stand densities fall within the Natural Range of Variability described in the relevant literature (Box 1).

Box 1

Literature Indicated Forest Structure	4FRI Projected Post-Treatment Structure
Defined small trees as > 10cm up to 40 cm (3.9" up to 15.7" DBH).	Within Alternative C 4FRI proposes mechanical treatment on 431,049 acres.
Defines high density forests with approximately 141-145 trees/ha (57-59 trees per acre), and 17.3% of the forest exceeded 200 trees per hectare (81 trees per acre), and 4.2% of the area exceeding 300 trees per acre (122 trees per acre).	Post-treatment structure is: VSS 2 (4.0-4.9") = 18.24 TPA (0-604) (28.1%) VSS 3 (5.0-11.9") = 24.39 TPA (0-639) (37.5%) VSS 4 (12.0-17.9") = 12.7 TPA (0-84) (19.5%) VSS 5 (18-23.9") = 6.89 TPA (0-53) (10.6%) VSS 6 (24"+) = 2.83 TPA (0-18) (4.3%) Total Trees Per Acre = 65.05
58 TPA over 4" DBH 16-18% of forest areas >81 TPA 52-81% of trees under 16: DBH A range of TPA of 9-300 ? TPA (W&B 2014 (rebuttal) had a stated structure of 300 Trees per Hectare (or 81 trees per acre) at 4.2% of the area	Project projections for post-treatment density figures are: 65.05 TPA across the treatment stands (4.0"+ DBH) 29.3% of stands are > 81TPA 90.3% of the stands have >52% of the trees <16" DBH. The range of TPA is approximately 0-639 TPA

Table 59 summarizes the vegetation treatments for Alternative C by cover type in each restoration unit. Compared to the proposed action, alternative C proposes 2,113 more acres of mechanical with prescribed fire treatments in the ponderosa pine cover type and 48,195 more acres in the grassland cover type. Alternative C differences from the proposed action for the prescribed fire only treatment includes 4,647 more acres in ponderosa pine, 19 more acres in aspen, 6 more acres in PJ, 41 less acres in oak woodland and 47,935 less acres in the grassland cover type.

Table 59. Alternative C mechanical treatment and prescribed fire acres by restoration unit (RU)

Treatment	Cover Type	RU 1	RU 3	RU 4	RU 5	RU 6	Grand Total
Mechanical Treatment with Prescribed Fire	Ponderosa Pine	119,069	111,433	109,371	11,244	29,974	381,091
	Aspen	182	201	451	392		1,227
	Pinyon-Juniper					535	535
	Grassland	8,134	12,772	22,661	4,536	93	48,195
	All	127,386	124,406	132,484	16,172	30,601	431,049
Prescribed Fire Only	Ponderosa Pine	24,303	16,053	24,906	47,790	11,215	124,267
	Aspen	186		46	10		242
	Pinyon-Juniper	1,428	5,884	7,283	8,845	1,684	25,123
	Oak Woodland	287	1,580	926	386	30	3,209
	Grassland	91	6		392		488
	Non-Vegetated	120	134	129	1,301	48	1,732
	All	26,413	23,656	33,290	58,724	12,977	155,061
Mechanical Treatment and Prescribed Fire Totals		153,799	148,062	165,774	74,896	43,578	586,110

Figure 11 shows the mechanical and prescribed fire treatments in goshawk and MSO habitat for Alternative C.

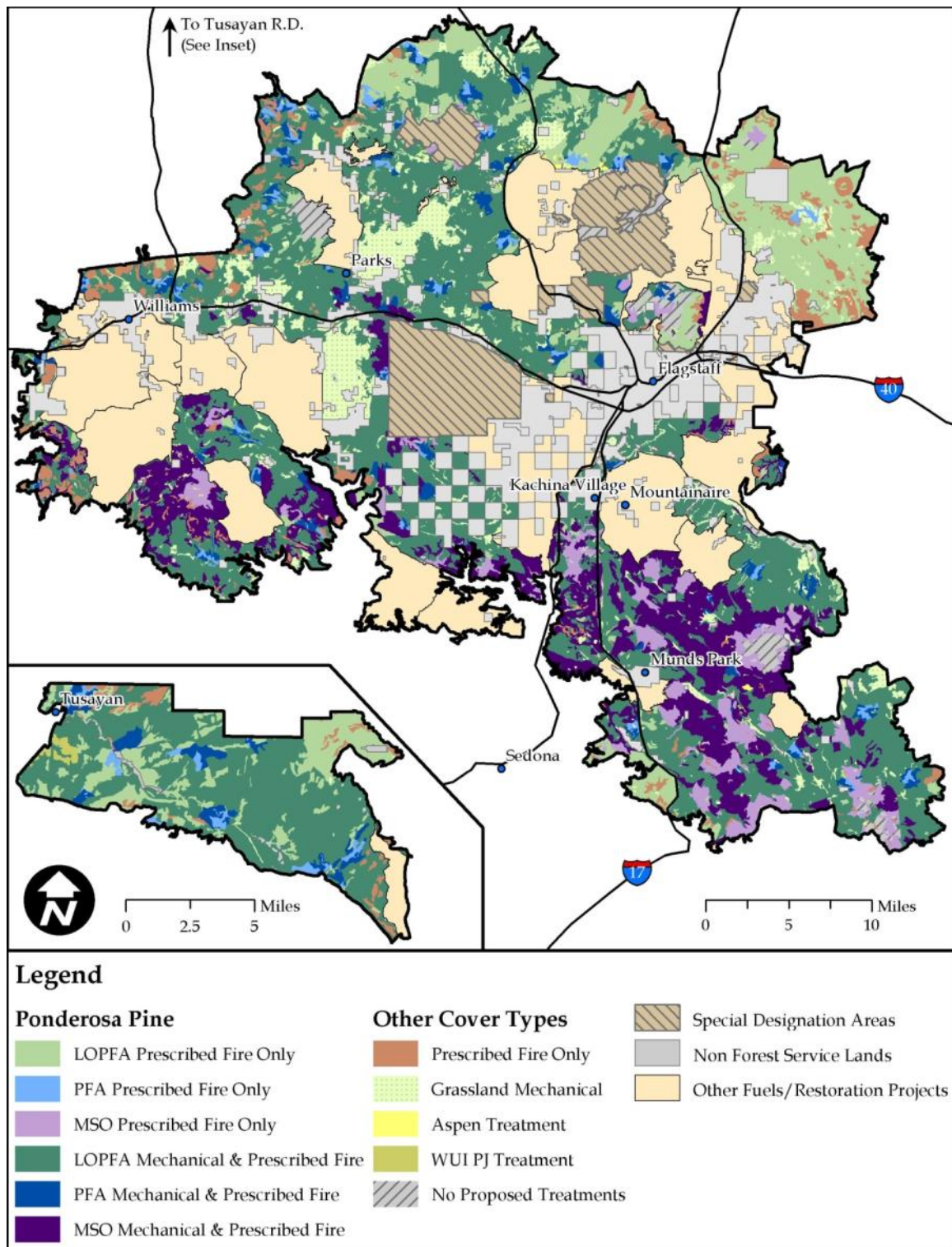


Figure 11. Alternative C mechanical and prescribed fire treatments in goshawk and MSO habitat

Table 60 summarizes alternative C acres of treatment type within goshawk habitat. See chapter 2 for a description of treatment objectives. Compared to the proposed action, alternative C proposes a total of 4 acres less burn only treatment within the LOPFA and PFA habitats, 481 acres less UEA, 96 acres less IT, 34 acres less SI, 263 acres less Savanna, 45 acres more grassland thinning and 4,837 acres of modified UEA (AZGFD design).

Table 60. Alternative C summary of Acres Proposed for treatments in ponderosa pine goshawk habitat

Vegetation Treatment Type	Landscapes Outside of PFA (Acres)	Post-Fledgling Family Area (PFA) (Acres)	Dispersal Post-Fledgling Family Area (dPFA) (Acres)	Total Acres by Treatment Type
Uneven-aged (UEA)	145,122	9,579	4,446	159,148
Intermediate Thinning (IT)	53,423	3,606	1,022	58,052
Stand Improvement (SI)	20,133	592	76	20,801
Savanna	45,142	0	0	45,142
Grassland restoration within ponderosa pine	11,230	0	0	11,230
Pine-Sage	4,674	392	196	5,261
Prescribed Fire Only	86,869	8,709	1,299	96,878
Total mechanical treatment acres	279,724	14,169	5,740	299,634
Total prescribed fire analysis areas	366,594	22,878	7,039	396,511

Table 61 summarizes alternative C acres of treatment type within MSO habitat. See chapter 2 for a description of treatment objectives. Compared to the proposed action, alternative C proposes a total of 7,466 acres more burn only treatment in protected and restricted other habitats, 1,280 acres less mechanical/burn treatment in the restricted other habitat, a diameter limit of up to 18” in select PAC thinning treatments and higher intensity thinning in the target/threshold habitat which follows the draft MSO recovery plan minimum conditions (USDI Fish and Wildlife Service 2011).

Table 61. Alternative C summary acres of treatments in ponderosa pine MSO habitat

Treatment Type*	Protected Habitat (Acres)	Restricted Habitat (Acres)	Target/Threshold Habitat (Acres)	Total Treatment Acres
Prescribed Fire Only	24,735	2,354	217 (Target) 84 (Threshold)	30,204
MSO Restricted	0	62,785	0	63,191
MSO Target	0	0	6,495	6,516
MSO Threshold	0	0	1,892	1,894
PAC Mechanical	10,284	0	0	10,741
Total	35,019	65,139	6,713 (Target), 1,976 (Threshold)	108,847

Direct and Indirect Effects – Alternative C

Mexican Spotted Owl Habitat

Table 62 displays the MSO habitat forest structure and habitat components projected out to the years 2020 and 2050.

- Year 2020 summary: Basal area density is within the desired range in all habitats. SDI is higher than desired within the target/threshold, protected habitat (with the exception of RU 4), and on the high end of the desired range within restricted other habitat. This is largely due to the limited mechanical treatment in the protected habitat and the high oak stocking in the restricted habitat. The distribution of size classes is at or exceeds minimum desired in the 12-18" and the 18-24" size classes in all habitats. Stocking in the 24" + size class exceeds minimum desired in the restricted other habitat and is below minimum desired in the target/threshold habitat. Average trees per acre 18" and larger is within 2 TPA of minimum desired in the target/threshold habitat and well below minimum desired in restricted other. Overall average Gambel oak basal area is above minimum desired in all habitats except RU5 restricted other where it is a limited component within that landscape. All habitats are approaching minimum desired CWD >12" and are below minimum desired in snags >18".
- Year 2050 summary: Basal area is above the desired range for target/threshold habitat. The average overall basal area in restricted other is 112 ft² which is the low end of the desired range for MSO nesting/roosting habitat (threshold). SDI density exceeds the desired range in all habitats. The distribution of size classes is at or exceeds minimum desired in the 12-18" and the 18-24" size classes in all habitats. Stocking in the 24" + size class also exceeds minimum desired in the restricted other habitat and remains below minimum desired in the target/threshold habitat. Average trees per acre 18" and larger exceed minimum desired in the target/threshold habitat and remain below minimum desired in restricted other. Overall average Gambel oak basal area is above minimum desired in all habitats except RU5 restricted other. All habitats show an increase in CWD >12" between 2020 and 2050. Snags >18" also show an increase in target/threshold and protected habitat while remaining static in restricted other.

Table 62. Alternative C - 2020 and 2050 Spotted Owl Habitat Forest Structure and Habitat Components

							Avg. Percent of Total SDI by Size Class															Tons CWD >12"			Snags >18"		
RU	Basal Area			% Max SDI			12.0-17.9"			18.0-23.9"			24.0" +			Avg. TPA 18" +			Avg. Gambel Oak BA Percent of Total BA								
RU	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
Protected																											
1	154	151	173	78%	70%	74%	31%	32%	27%	13%	18%	25%	8%	9%	13%	14.6	17.8	28.2	14%	15%	16%	0.7	0.7	2.0	0.6	0.7	1.7
3	170	167	189	82%	78%	82%	31%	31%	26%	15%	19%	25%	9%	10%	14%	18.5	21.5	31.6	12%	13%	13%	1.2	1.0	2.5	0.7	0.9	1.9
4	100	105	128	49%	49%	55%	33%	35%	38%	9%	14%	24%	5%	5%	8%	8.6	10.9	19.9	8%	8%	9%	0.4	0.4	1.4	0.4	0.4	1.3
5	132	138	163	64%	64%	70%	34%	34%	27%	14%	17%	24%	8%	8%	13%	13.2	16.3	27.5	10%	11%	13%	1.1	0.9	2.4	0.6	0.6	1.8
Protected Total	155	152	174	78%	71%	75%	31%	32%	27%	14%	18%	25%	8%	9%	13%	15.0	18.2	28.5	13%	14%	15%	0.8	0.7	2.1	0.6	0.7	1.7
Threshold																											
1	204	161	195	101%	81%	90%	25%	20%	21%	24%	32%	30%	3%	4%	9%	28.0	30.0	34.2	29%	37%	33%	2.0	1.5	2.0	0.5	0.5	1.0
3	185	165	196	99%	87%	95%	26%	19%	17%	19%	24%	24%	8%	10%	14%	23.7	25.6	32.4	33%	39%	37%	0.6	0.8	2.0	0.7	0.9	1.8
Threshold Total	193	163	195	100%	84%	93%	25%	20%	19%	21%	28%	26%	6%	7%	12%	25.6	27.6	33.2	31%	38%	35%	1.2	1.1	2.0	0.6	0.7	1.5
Target																											
1	156	125	161	81%	65%	76%	30%	24%	22%	12%	17%	19%	7%	11%	13%	13.6	15.7	21.9	20%	27%	29%	1.5	1.3	2.0	0.5	0.5	1.2
3	148	133	169	79%	70%	80%	26%	23%	21%	13%	17%	17%	7%	10%	13%	13.4	15.4	20.9	24%	28%	29%	0.8	0.8	1.6	0.5	0.5	1.2
Target Total	152	129	164	80%	67%	78%	28%	24%	22%	13%	17%	18%	7%	10%	13%	13.5	15.6	21.5	22%	28%	29%	1.2	1.1	1.8	0.5	0.5	1.2
Restricted Other																											
1	138	74	107	68%	35%	46%	30%	25%	21%	12%	21%	20%	7%	14%	19%	11.6	11.3	16.7	15%	22%	23%	0.3	0.7	1.5	0.4	0.8	0.8
3	137	82	116	70%	39%	51%	29%	25%	20%	13%	21%	21%	7%	12%	17%	11.6	11.6	17.5	21%	26%	27%	0.5	0.8	1.7	0.4	1.0	1.0
4	129	80	115	67%	39%	52%	28%	23%	18%	13%	21%	19%	8%	14%	18%	11.6	11.4	16.4	24%	29%	30%	0.4	0.7	1.6	0.5	1.0	1.0
5	102	64	98	51%	30%	42%	24%	24%	24%	10%	15%	16%	9%	14%	16%	8.0	8.0	12.6	15%	19%	22%	0.2	0.4	1.0	0.4	0.6	0.5
Restricted Total	137	79	112	69%	37%	49%	29%	25%	21%	13%	21%	20%	7%	13%	18%	11.5	11.5	17.1	19%	25%	26%	0.4	0.8	1.6	0.4	0.9	0.9

Goshawk Habitat

An analysis of the goshawk structure attributes for alternative C showed very minor differences in LOPFA habitat SUs 3-2, 3-5, and 4-3 compared to alternative B (Table 47). All numbers and percentages are the same for alternative C as alternative B for the remaining SUs and at the RU and habitat scales. Therefore, the summary (prior to table 47) of post treatment and 2050 habitat conditions for alternative B is the same for alternative C.

An analysis of the VSS distribution within goshawk habitat for alternative C showed minor differences compared to alternative B (table 49 through table 52). These differences are listed in table 63 at the RU and habitat scale. All percentages are the same for alternative C as alternative B for all other stages and years in each of the RUs and habitats. Therefore, the narrative summaries (prior to table 49 through table 52) describing post treatment and 2050 VSS distribution by habitat for alternative B are essentially the same for alternative C with the same trends.

Table 63. Alternative C - 2020 and 2050 VSS Distribution Differences Compared to Alternative B Percent of Area by Vegetative Structural Stages

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
LOPFA Even-Age												
RU 3							34% (+1)		37% (-1)			
All							38% (+1)					
LOPFA Uneven-Age												
RU 1						1% (+1)					17% (-1)	54% (-1)
RU 3							24% (+1)	12% (+1)	44% (-1)	24% (+1)		56% (-2)
RU 4					19% (+1)		21% (-1)	19% (+1)	41% (+1)	18% (-1)	12% (-1)	
RU 6			0% (-1)								29% (+1)	
All												54% (-1)
PFA Uneven-Age												
RU 3					22% (+2)		47% (-1)					

Area	1 – Grass/Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
RU 4							52% (+2)				6% (- 2)	
All					23% (+1)		47% (+1)				7% (- 1)	

Old Growth

Table 64 displays the old growth structural attributes of the ponderosa pine old growth acres projected out to the years 2020 and 2050 under alternative C.

In 2020, the average conditions are at or above the minimum criteria (CFP) with the following exceptions:

- **Trees per acre larger than 18" and 180 years old.** This condition is deficit in all SUs ranging from a low of 8.9 TPA in SU 6-2 to a high of 16.5TPA in SU3-4 with an overall average for all acres of 13.6 TPA. The age of these trees is estimated be in the range of 100 to 140 years old with a few relic trees meeting the 180 year old criteria.
- **Basal area ≥ 90 .** This condition is below desired in RUs 3, 4, 5 and 6. Overall average for all acres is 82.
- **Coarse woody debris greater than 12".** This condition is estimated to be deficit with less than the equivalent of 2 pieces per acre throughout RU 5 and 6, and various SUs.

Over time, old growth conditions improve in terms of meeting the minimum criteria. In 2050, all RUs are very close to or exceed the criteria for TPA larger than 18" with the exception of RU 6. The age of these trees is estimated be in the range of 130 to 170 years old. It is estimated that all the other criteria will be met throughout the old growth acres.

Table 64. Alternative C –OG Structural Attributes by Restoration Unit

Restoration Subunit/Unit	OG Acres	Avg. TPA 18"+			Avg. BA			Avg. Tons CWD ≥12"			Avg. Snags Per Acre ≥12"		
		2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
1-1	3,578	13.2	13.2	18.9	117	75	105	0.4	0.6	1.3	1.4	3.9	1.5
1-2	2,034	11.0	11.1	16.6	101	63	89	0.3	0.6	1.2	1.1	3.7	1.4
1-3	17,105	13.5	14.2	20.4	128	86	115	0.6	0.8	1.5	2.0	3.6	2.4
1-4	6,323	11.6	12.7	19.7	117	89	116	0.3	0.5	1.3	1.7	3.7	2.8
1-5	35,050	14.9	16.4	24.1	146	116	142	0.6	0.8	1.8	2.8	4.6	4.3
1	64,090	13.9	14.9	21.9	134	99	127	0.5	0.7	1.6	2.3	4.2	3.3
3-1	6,216	12.9	12.8	18.7	121	71	101	0.3	0.6	1.3	1.6	4.0	1.5
3-2	9,317	14.7	14.6	19.4	113	71	98	0.3	0.6	1.3	1.5	3.5	1.5
3-3	15,624	13.8	14.1	20.0	132	81	111	0.4	0.7	1.5	2.0	4.2	2.0
3-4	4,201	15.8	16.5	23.4	148	111	138	0.7	0.9	1.9	2.8	4.8	3.9
3-5	11,305	15.2	15.5	22.7	147	93	123	0.8	1.0	2.1	2.6	5.8	2.8
3	46,663	14.4	14.5	20.6	132	83	112	0.5	0.8	1.6	2.1	4.5	2.2
4-2	3,710	13.0	12.3	17.0	103	62	87	0.2	0.5	1.1	1.2	3.5	1.2
4-3	20,144	11.9	12.4	19.4	107	71	98	0.3	0.6	1.4	1.4	4.8	1.8
4-4	22,175	13.2	13.3	19.6	119	67	96	0.3	0.6	1.3	1.4	3.7	1.3
4-5	2,030	14.1	14.4	22.9	136	78	111	0.4	0.8	1.6	2.1	5.0	1.6
4	48,059	12.7	12.9	19.4	113	68	97	0.3	0.6	1.3	1.4	4.2	1.5
5-1	5,187	11.7	12.6	19.8	99	75	102	0.5	0.6	1.6	1.4	5.5	2.1
5-2	18,530	11.9	12.9	19.6	84	75	97	0.5	0.5	1.6	1.3	5.8	2.3
5	23,716	11.8	12.8	19.6	87	75	98	0.5	0.5	1.6	1.3	5.8	2.3
6-2	1,689	8.5	8.9	14.2	84	63	94	0.2	0.3	0.9	0.6	3.9	1.0
6-3	8,210	9.1	9.4	15.0	92	69	104	0.2	0.3	0.9	0.6	3.6	0.9
6-4	392	9.3	9.5	15.4	109	78	108	0.3	0.4	1.5	1.0	6.6	2.0
6	10,291	9.0	9.3	14.9	91	69	102	0.2	0.3	0.9	0.6	3.8	1.0
All	192,819	13.0	13.6	20.1	118	82	110	0.4	0.6	1.5	1.8	4.5	2.3

Alternative C proposes the same treatments in the pinyon-juniper cover type as alternative B. See Table 54 and the associated effects discussion for pinyon-juniper old growth.

Openness

The variety of treatment types and desired conditions under alternative C would result in a wide range of openness post treatment. The list of resulting openness by treatment type displayed for alternative B is the same for alternative C. Under alternative C, the closed classification also includes the modified UEA treatment (AZGFD design).

Table 65 lists the post treatment openness within the ponderosa pine cover type for alternative C by restoration unit and sub unit. Overall ranges indicate a diverse condition with openness leaning to the closed side of the range. Thirteen percent of the ponderosa pine would be very open, 45 percent open, 28 percent moderately closed and 14 percent closed.

Table 65. Alternative C – Post Treatment Openness Classification for Ponderosa Pine

Restoration Unit-Subunit	Very Open	Open	Moderately Closed	Closed
1-1	3%	61%	30%	6%
1-2	35%	47%	16%	3%
1-3	16%	44%	25%	15%
1-4	14%	51%	21%	14%
1-5	6%	31%	34%	29%
1	11%	40%	29%	21%
3-1	9%	49%	39%	3%
3-2	21%	51%	21%	7%
3-3	17%	42%	27%	14%
3-4	3%	33%	32%	32%
3-5	6%	27%	44%	23%
3	13%	40%	32%	15%
4-2	31%	59%	7%	3%
4-3	20%	48%	21%	12%
4-4	20%	56%	16%	8%
4-5	15%	40%	27%	18%
4	20%	52%	18%	10%
5-1	26%	32%	35%	7%
5-2	8%	69%	20%	3%
5	14%	58%	24%	4%
6-2	1%	77%	16%	5%
6-3	2%	39%	54%	6%
6-4	1%	5%	29%	66%
6	2%	41%	47%	11%
All Ponderosa Pine	13%	45%	28%	14%

Special Case Canopy Cover – Alternatives C and E

Canopy Cover at the Stand Level

In response to comments and feedback on the DEIS , on approximately 38,256 acres (22,772 acres on the Coconino and 15,484 acres on the Kaibab NF) of UEA 40, UEA 25, and non-WUI stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean BA greater than 70 of the VSS 4 size class and a mean TPA less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. After further public comments an additional 7,835 acres of IT10 and UEA 10 treatments were included for this section, for a total of 46,091 acres. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-WUI stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the planned prescription intensity range, managing for larger group sizes, and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, will achieve 40 percent canopy cover at the stand scale.

Maintaining high canopy cover percentages across the stand will necessitate maintaining high stocking basal area, high trees per acre, and high SDI. Currently the 38,256 acres encompasses 1,096 stands averaging 143.4 BA, 508.6 TPA, and 281.5 SDI (62.5% of max SDI: SDIMax = 450). This will result in continuous canopy cover over most of the stand which will increase the risk of density related mortality and crown fire risk above most other restoration treatments.

On the stands treated in table 66 prescriptions would be implemented to the lower intensity level were possible while trying to maintain stand structure at the upper ends of the NRV, with an intent to maintain 40% canopy cover. It is not proposed to change treatment types but to instead to maintain the planned treatments but to limit the treatment intensity such that the silviculturist favor the less intense range of the treatment planned and analyzed.

Management on 3,303 Acres of Proposed Savanna Treatments

In response to comments from the public there continues to be a conversation on large trees, issue 2. In response to comments and feedback, Alternative E best meets the concern because no savanna treatments are proposed. The implementation plan, as it relates to alternative E has been updated to clarify that most VSS 4, VSS 5 and VSS 6 would not be cut on about 3,300 acres. The 3,303 acres containing a significant number of trees in the VSS 4-6 classes, currently assigned to savanna treatments within Alternative C, will be removed from Alternative C and assigned to their analyzed Alternative E treatments. Alternative E does not include the amendments for the specific definitions for interspaces and groups, therefore while the IT40 and UEA40 are desired they may not be necessarily attainable (See project record for details). These stands, while moving towards savanna, will not attain the savanna desired conditions.

Forest Structure and Diversity - Mosaic of interspaces and tree groups of varying sizes and shapes

Table 66 lists alternative C acres by treatment intensity as an indication of the relative ability of the treatment to attain a mosaic of interspaces and tree groups and of the post treatment interspace/tree group condition. Forty one percent of the area treated is considered high, 24 percent is moderate, 25 percent is low and 10 percent is very low.

The design feature that applies to 46,091 acres to manage for larger group sizes, measuring canopy cover at the stand level, and retaining larger trees is expected to aid in a variety of group sizes across the landscape.

Table 66. Alternative C summary of ponderosa pine treatment acres by their relative ability to attain a mosaic of interspaces and tree groups

Treatment Intensity	Treatment Type	Acres	
High	Grassland Restoration	11,230	
	Savanna	45,142	
	Pine Sage	5,261	
	WUI 55	2,224	
	UEA 40	95,730	
	IT 40	38,616	
	SI 40	12,269	
Total High:		210,472	(41%)
Moderate	MSO Restricted Trt	62,785	
	UEA 25	38,492	
	IT 25	11,871	
	SI 25	6,618	
Total Moderate:		119,766	(24%)
Low	UEA AZGFD Design	4,837	
	UEA 10	17,865	
	IT 10	7,565	
	SI 10	1,914	
	LOPFA Prescribed Fire Only	86,869	
	PFA Prescribed Fire Only	3,172	
	Restricted Prescribed Fire Only	2,354	
Total Low:		124,577	(25%)
Very Low	MSO Target Trt	6,495	
	MSO Threshold Trt	1,892	
	PAC - Mechanical	10,284	
	PFA Nest Stand Prescribed Fire Only	6,836	
	Protected Prescribed Fire Only	24,735	
	Target Prescribed Fire Only	217	
	Threshold Prescribed Fire Only	84	
	No Proposed Treatments	2,482	
Total Very Low:		53,025	(10%)

Forest Structure - All age and size classes represented

The MSO habitat forest structure analysis for Alternative C indicates the post treatment distribution of size classes has good representation in the 12-18" and the 18-24" size classes in all habitats. Stocking in the 24" + size class has good representation in the restricted other habitat and is underrepresented in the target/threshold habitat (table 62). Implementation of group

selection as part of the restricted other treatments would result in up to 15 percent of the area trending toward early successional stages, thereby increasing representation of the seedling/sapling age class.

The goshawk habitat structural stage analysis for Alternative C indicates overall post treatment VSS distribution in the even-aged goshawk habitats will have good representation of the VSS 1, 3 and 4 age classes, and the VSS 5 age class in the LOPFA; under-representation of the VSS 6 age class and the VSS 5 age class in the PFA; no representation of the VSS 2 age class. The Uneven-aged goshawk habitats will have good representation in the LOPFA of VSS 3, 4, 5 and 6 and of VSS 4 and 5 in the PFA; VSS 1 is underrepresented in the LOPFA and VSS 1, 3 and 6 are underrepresented in the PFA; there is no representation of the VSS 2 age class in all habitats (table 49 through table 52 and table 63).

Natural Range of Variability (Alternative C) (Appendix E)

Appendix E graphically represents Natural Range of Variability Comparison by Treatment Type by forest attributes: Minimum, maximum and the weighted average. Forest Attributes are within the Natural range of Variability except for PACS, Goshawk nest areas and MSO Target Threshold Habitats. Pine basal areas remain within historic ranges, but all basal areas increase as other non-pine components increase in size (i.e., Gambel oak) except for Arizona Game and Fish designs which trend away from historic range of variations. As the intensity of treatments increase the habitats are structured most closely to the lower end of the historic range of variability. An exception to this will be the approximately 46,091 acres that will be managed towards the higher end of the natural range of variability in goshawk habitat and larger group sizes as a result of response to comments.

Old Forest Structure Sustained Over Time Across the Landscape

The restoration treatments proposed under alternative C are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Old trees would not be targeted for cutting. Reference the Old Tree Implementation Strategy in Appendix A of this report.

The MSO habitat forest structure analysis for alternative C indicates the post treatment distribution of size classes has good representation in the 18-24" size classes in all habitats. Stocking in the 24" + size class has good representation in the restricted other habitat and is underrepresented in the target/threshold habitat (table 62).

The goshawk habitat structural stage analysis above indicates the mature and old forest structural stages to be underrepresented in the PFA habitat and LOPFA even-aged stands. Projections show a trend toward improved representation in all habitats (table 49 through table 52 and table 63).

Treatments within OG will maintain existing old growth structural attributes and are managed to move towards those conditions over time. The old growth analysis above indicates old growth structural attributes will continue to develop and improve across the landscape (table 64).

With the implementation of restoration treatments under alternative C, the sustainability of the large/old tree component across the landscape will be improved as presented in the following forest health discussion.

Forest Health

Density related mortality –

Stand density in 2020 in the MSO restricted other habitat (Table 62) would have an overall average 37% of maximum density (range 30-39) putting these stands at the low end of the high density zone as described in Table 7. The restricted other habitat consists of mixed species pine/oak stands. The pine component within this habitat is estimated to have density within the low to moderate zone. The majority of target/threshold and protected habitat would remain in zone 4 due to the oak stocking and dense forest desired conditions in these habitats. Any areas with mechanical treatments within these habitats would experience reduced density related mortality compared to the no action alternative.

In goshawk habitat, table 47 (as a representation of both alternative B and C conditions) shows 2020 ponderosa pine density levels average 27% of maximum density within nest/PFA habitat and 21% in LOPFA habitat. These density levels are within the low to moderate density zones (table 7). In 2050, overall averages indicate both habitats to be within the moderate density zone with a few of the nest/PFA SUs being on the low end of high density and well below the threshold for the onset of density related mortality.

Bark beetle related mortality –

Table 67 lists the beetle hazard rating for the years 2020 and 2050 by RU and for the ponderosa pine analysis area. The overall hazard in 2020 is high across 22% of the analysis area. This increases to 53% in 2050. Stands with a hazard rating of low or moderate would be expected to be resistant to successful bark beetle attack and large scale mortality. In the current climate change scenario, alternative C mitigates the beetle hazard and combined with prescribed fire, reduces beetle hazard to the greatest extent for the longest period.

Table 67. Alternative C Estimated Post Treatment and Long Term Beetle Hazard Rating (Percent of Area)

Hazard Rating	RU 1	RU 3	RU 4	RU 5	RU 6	% of Total	Analysis area Acres
2010							
Low	3%	6%	8%	26%	0%	7%	37,933
Moderate	12%	11%	27%	46%	25%	21%	106,132
High	85%	83%	65%	28%	75%	72%	363,775
2020							
Low	34%	39%	59%	46%	38%	44%	221,861
Moderate	32%	31%	30%	48%	43%	34%	173,112
High	33%	30%	10%	6%	19%	22%	112,866
2050							
Low	8%	11%	17%	27%	2%	13%	66,036
Moderate	25%	26%	45%	50%	30%	34%	172,991
High	66%	62%	38%	24%	68%	53%	268,812

Dwarf mistletoe infection –

Table 68 lists the dwarf mistletoe infection level and average percent of trees infected for the years 2020 and 2050 by RU and for the ponderosa pine analysis area. For 2020, approximately 60 percent of the area is not infected or has a low infection level and 40 percent has a moderate to high infection level. The overall average percent of trees infected is 6 percent in the none/low group and 39 percent in the moderate/high group. This reflects an improvement from the no action alternative with one percent more area in the none/low group and one percent less area in the moderate/high group. Overall percent of trees infected is one percent less in none/low and 8 percent less in moderate/high. The percentages for 2050 indicate mistletoe infection is intensifying and spreading at a slower rate than alternative A.

Table 68. Alternative C Estimated Post Treatment and Long Term Dwarf Mistletoe Infection Level

Infection Level		RU 1	RU 3	RU 4	RU 5	RU 6	Treatment area
2010							
None/Low	Percent of Area	53%	57%	73%	92%	82%	66%
None/Low	Average Percent Trees Infected	5%	6%	4%	10%	5%	6%
Moderate/High	Percent of Area	47%	43%	26%	8%	18%	34%
Moderate/High	Average Percent Trees Infected	38%	33%	38%	41%	42%	36%
Extreme	Percent of Area	1%	0%	0%	0%	0%	0%
Extreme	Average Percent Trees Infected	86%	86%	85%			86%
2020							
None/Low	Percent of Area	46%	46%	71%	79%	82%	60%
None/Low	Average Percent Trees Infected	5%	5%	5%	11%	6%	6%
Moderate/High	Percent of Area	53%	54%	29%	21%	18%	40%
Moderate/High	Average Percent Trees Infected	40%	34%	42%	31%	56%	39%
Extreme	Percent of Area	1%	0%	0%	0%	0%	<1%
Extreme	Average Percent Trees Infected	87%	100%				88%
2050							
None/Low	Percent of Area	45%	45%	69%	69%	81%	57%
None/Low	Average Percent Trees Infected	6%	6%	6%	11%	7%	7%
Moderate/High	Percent of Area	55%	55%	31%	31%	19%	43%
Moderate/High	Average Percent Trees Infected	47%	41%	49%	31%	60%	44%
Extreme	Percent of Area	1%	0%	0%	0%	0%	<1%
Extreme	Average Percent Trees Infected	87%	100%				87%

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 alternative C.

Within forest carbon stocks would be reduced under alternative C. 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 within the estimated 367,737,165 cubic feet of biomass removed by mechanical thinning would be sequestered for a time in the form of building materials.

Vegetation Diversity and Composition

Grasslands

Alternative C would restore historic grasslands, savannas and forest openings by removing ponderosa pine tree canopy that is shading out understory herbaceous vegetation and reducing forage production and species diversity as follows:

- 48,195 acres of grassland mechanical treatments within grassland cover type;
- 11,230 acres of grassland restoration treatments on mollisol soils;
- 45,142 acres of savanna treatments on mollic integrate soils;
- 286,543 acres of ponderosa pine restoration treatments in PFA, LOPFA and MSO restricted other habitats enhancing small grassland inclusions within the greater forested area.

Oak

Treatments proposed in alternative C are designed to conserve oak and improve conditions that favor oak growth and establishment wherever it exists by reducing pine-oak competition. This would result in improved vigor of existing oak and establishment of a variety of oak size and age classes across the landscape. These conditions would be most prevalent within the 63,191 acres of MSO restricted other habitat treatments. Table 62 shows the overall post treatment oak basal area would be 5 percent higher in this habitat compared to the no action alternative.

Aspen

The treatments within 1,469 acres of aspen stands under alternative C are designed to maintain and/or regenerate aspen by reducing pine-aspen competition. These treatments would result in establishment of vigorous aspen regeneration free of competition from overtopping ponderosa pine.

Pine-Sage

The 5,261 acres of pine-sage thinning treatments are designed to remove post settlement pine that currently is overtopping and shading out the sage and to manage fire to enhance sage extent. These treatments would result in enhancement of the sage component within the pine sage mosaic.

Other Direct and Indirect Effects:

Residual Tree Damage

Some damage to residual trees would be expected in alternatives C with the felling, tractor yarding and piling operations associated with mechanical treatments in ponderosa pine on 431,049 acres (table 59). Alternative E would result in the most potential damage. Damage would be minimized through contract administration 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).

Tractor Yarding and Fuel Treatment

All merchantable harvested material would be whole-tree tractor yarded from the mechanical treatment units. Fuel treatments proposed for Alternative C includes pile burning, broadcast burns and fireline construction. Some damage to the residual trees would be expected with the felling, tractor yarding and piling operations within 381,976 acres of ponderosa pine mechanical treatments. Damage would be minimized through contract administration and proper harvest methods. All piling and/or low-severity burning treatments on 586,110 acres (ponderosa pine) acres would reduce understory stocking and reduce inter-tree competition as well as stimulate understory vegetation (shrubs, forbs, grasses). Fireline placement would use existing features with naturally low fuels, skid trails, roads etc. as much as possible. Actual fireline construction would remove herbaceous material to bare mineral soil up to a 6 foot width.

Timber and Wood Products

A Coconino FP goal is to manage the timber resource to provide a sustained-yield of forest products (CFP page 23). A Kaibab FP goal is to manage suitable timberland to provide a sustained level of timber outputs to support local dependent industries (Kai Plan pg 18). Timber harvest of 245,343,350 cubic feet of biomass from the Coconino and 122,393,816 cubic feet of biomass from the Kaibab is a direct beneficial effect of Alternative C.

Road Maintenance, Decommissioning, Reconstruction, Opening, and Temp Road Construction

Road maintenance within the existing road prism would have no effect on the health and growth of the leave trees within the treatment units. Road decommissioning of 904 miles of existing system and unauthorized roads would allow ingrowth of forest vegetation once the road is decommissioned (approximately 2,712 acres). Constructing 245 miles of temporary roads will remove trees and forest vegetation within the road right of ways (approximately 735 acres). Opening 272 miles of decommissioned roads may remove trees and forest vegetation that has become established within the road right of way since the road was last maintained (approximately 816 acres). Road reconstruction consists of road improvement activities and road realignments activities. Road realignment of 10 miles of road would remove approximately 30 acres of trees and forest vegetation within the area being reconstructed. 30 miles of road improvement is expected to occur on small discreet areas and is expected to remove about 100 acres of forest vegetation. The above listed effects cover the maximum range of management actions. Possible management actions includes: Reestablish former drainage patterns, stabilizing slopes, and restore vegetation; Block the entrance to a road or installing water bars; Remove culverts, reestablish drainages, remove unstable fills, pull back road shoulders, and scatter slash

on the roadbed; Completely eliminate the roadbed by restoring natural contours and slopes; and Other methods designed to meet the specific conditions associated with the unneeded road.

Aspen Fencing and Barriers

Up to 82 miles protective barriers would be established around aspen clone patches within the ponderosa pine forest. Barriers would consist of fencing and/or felling trees (jack-strawing). Fencing would occur after mechanical and burning treatments and would have no effect to the vegetation. Jack-strawing may occur during the mechanical operation and would utilize trees that have been targeted for removal to meet treatment objectives. Leaving felled material on the ground would forego the opportunity to use that material for wood products.

Restoration of Springs and Ephemeral Channels

Springs and ephemeral channels are inclusions within the mechanical and burn analysis areas. Any tree removal that occurs as part of the restoration of these areas would be part of the design for those mechanical treatments that occur around these areas and the effects to the forest vegetation would be similar to the overall treatment. Up to 4 miles of protective fencing would be established around restored springs. Fencing would have no effect to the vegetation. Bank re-contouring and stabilization would occur along 39 miles of ephemeral channels. This activity would disturb existing forest vegetation. Up to 5 miles of willow re-establishment would occur where evidence indicates historic willow presence. This would create vegetation diversity and allow natural willow expansion into adjacent areas of suitable habitat. The above listed effects cover the maximum range of management actions. Possible management actions for springs include: Remove tree canopy to pre-settlement condition within 2-5 chains of the spring; Apply for water right if none exists; remove noxious weeds; Prescribe burn; Identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.); And/or other methods designed to meet the desired conditions.

2014 Kaibab National Forest: Forest Plan Consistency: Alternative C

Alternative C incorporates key components of the Old Tree Protection Strategy into the alternative's implementation plan (Appendix A). The Forest Service worked collaboratively with stakeholders to develop implementation plan. Although there is no canopy cover guidance in the current Kaibab Forest Plan, there is guidance for canopy cover management in the Implementation Plan in the FEIS (Appendix D), including approximately 40,067 acres that will have canopy cover measured at the stand level. This is consistent with the guidance for ponderosa pine within the Forest Plan.

This alternative follows all plan standards and guidelines. Refer to Appendix B for further consistency on specific forest plan Standards, Guidelines and desired conditions. All aspects with this alternative are consistent with the Kaibab forest plan.

Alternative D

See Chapter 2 FEIS for a complete list of activities and a description of the treatments that are proposed for Alternative D.

Alternative D would implement approximately 563,407 acres of restoration activities (within the 988,764 acre EIS area) (figure 12).

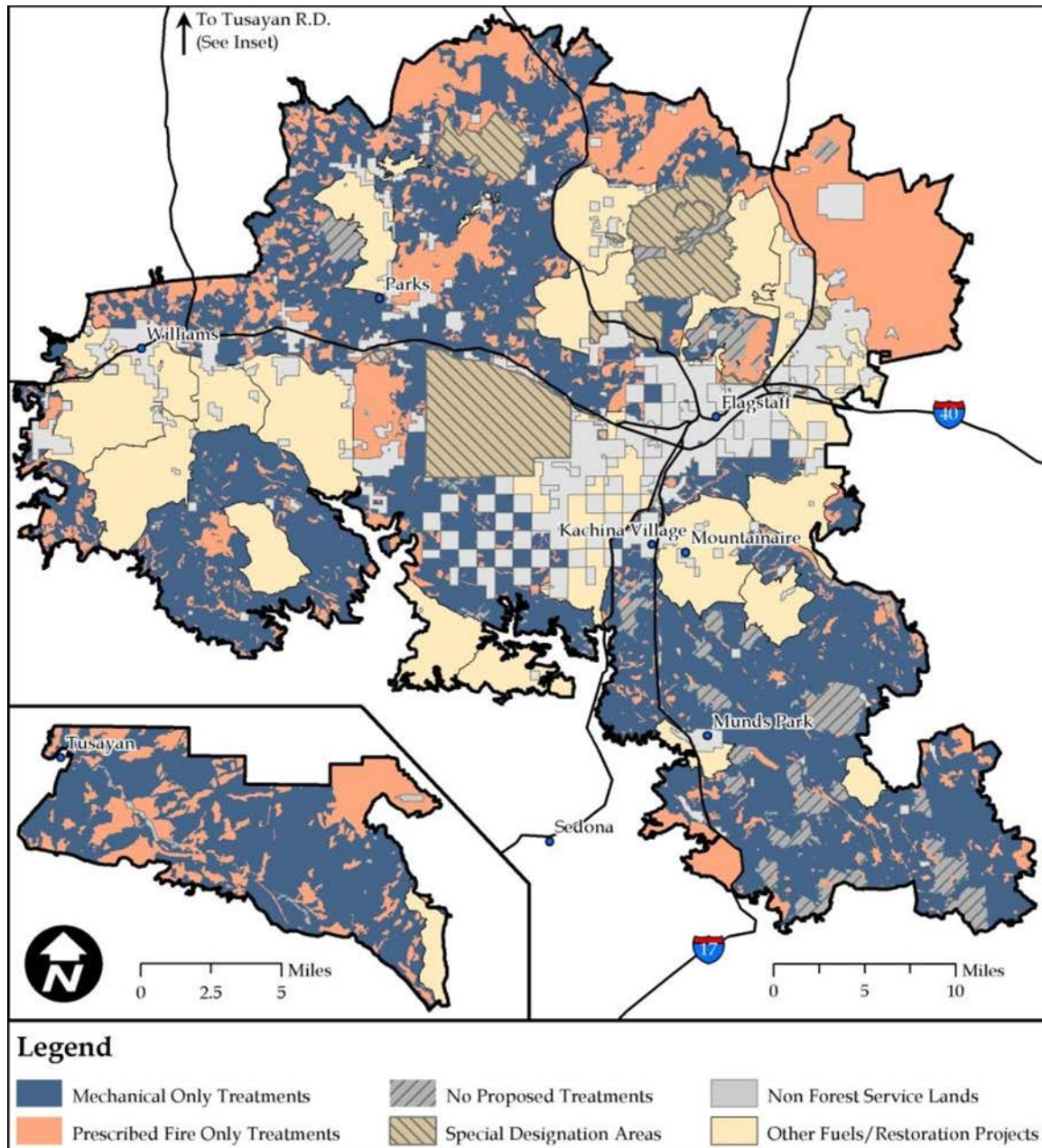


Figure 12. Alternative D mechanical and prescribed fire treatments

Restoration activities would:

- Mechanically cut trees and dispose of slash on approximately 384,966 acres. This includes ponderosa pine restoration treatments within 300,463 acres of northern goshawk habitat and 82,741 acres of Mexican spotted owl habitat, 1,227 acres of aspen restoration and 535 acres of pinyon-juniper wildland urban interface treatments.
- Prescribe burn-only approximately 178,441 acres. Burn only treatments would occur within 100,373 acres of ponderosa pine and 22 acres of aspen with the remaining 78,047 acres occurring in the PJ, oak woodland, grassland and non-vegetated cover types operationally to facilitate burning the ponderosa pine and aspen. Within the ponderosa pine, 96,882 acres are within northern goshawk habitat and 3,491 acres are within Mexican spotted owl habitat. No treatments on 24,263 acres.

Table 69 summarizes the vegetation treatments for Alternative D by cover type in each restoration unit. Compared to the proposed action, alternative D proposes the same 388,204 acres of mechanical treatments with mechanical slash treatment rather than prescribed fire. Alternative D differences from the proposed action for prescribed fire only includes 19,247 less acres in ponderosa pine, 201 less acres in aspen, 826 less acres in PJ, 71 less acres in oak woodland and 132 less acres in the grassland cover type.

Table 69. Alternative D mechanical treatment and prescribed fire acres by restoration unit (RU)

Treatment	Cover Type	RU 1	RU 3	RU 4	RU 5	RU 6	Grand Total
Mechanical Treatment Only	Ponderosa Pine	119,567	113,048	109,371	11,244	29,974	383,204
	Aspen	182	201	451	392		1,227
	Pinyon-Juniper					535	535
	All	119,749	113,249	109,822	11,636	30,509	384,966
Prescribed Fire Only	Ponderosa Pine	5,702	12,174	24,351	46,931	11,215	100,373
	Aspen	7		15			22
	Pinyon-Juniper	1,154	5,884	7,283	8,845	1,684	24,850
	Oak Woodland	204	1,633	926	386	30	3,179
	Grassland	8,100	12,510	22,661	4,928	93	48,291
	Non-Vegetated	114	134	129	1,301	48	1,727
	All	15,282	32,334	55,366	62,391	13,069	178,441
Mechanical Treatment and Prescribed Fire Totals		135,031	145,583	165,188	74,027	43,578	563,407

Figure 13 shows the areas for mechanical and prescribed fire treatments in goshawk and MSO habitat for Alternative D.

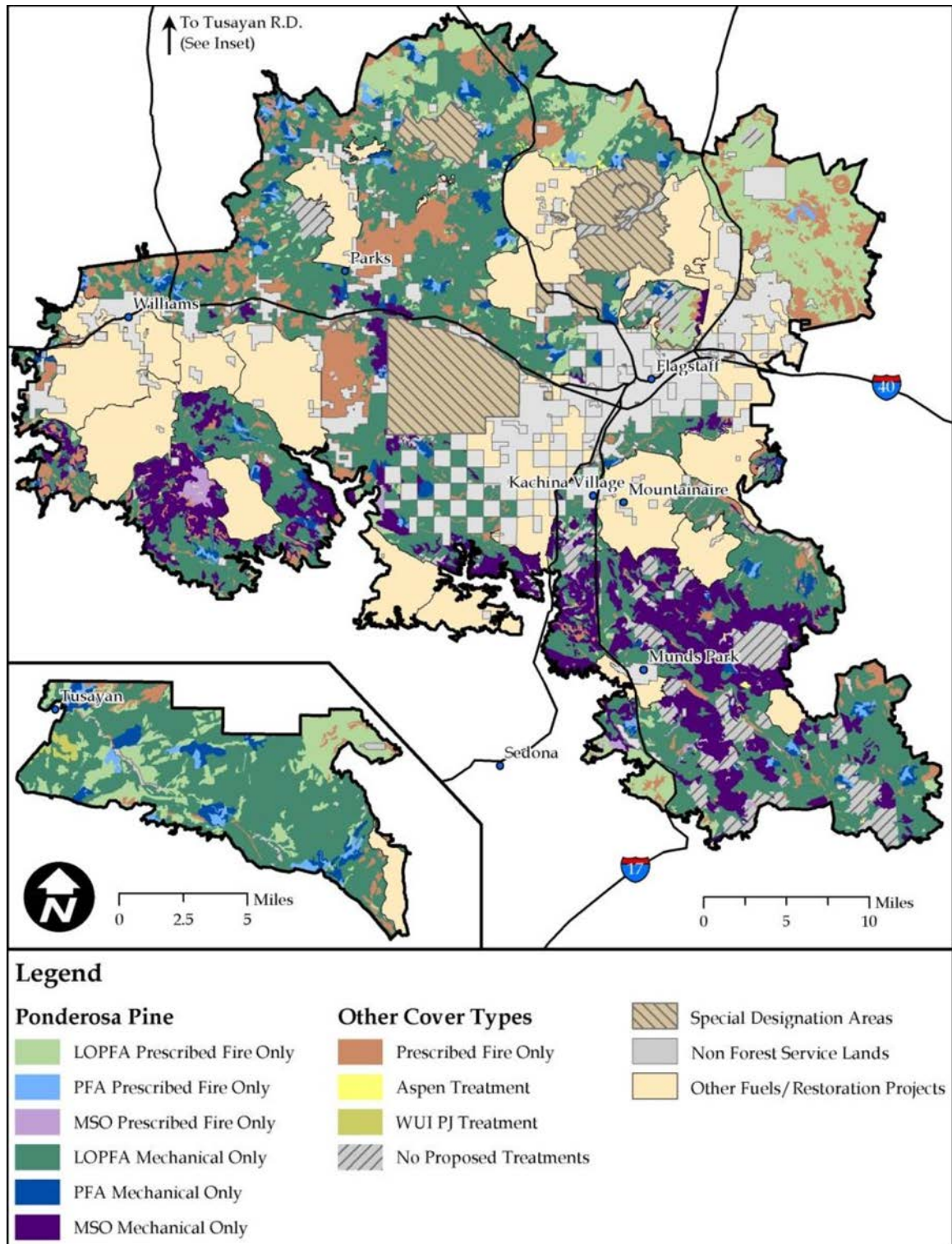


Figure 13. Alternative D mechanical and prescribed fire treatments in goshawk and MSO habitat

Table 70 summarizes alternative D acres of treatment type within goshawk habitat. See chapter 2 for a description of treatment objectives. Mechanical and burn only treatment acres within goshawk habitat proposed under alternative D would be the same as alternative B. There would be no prescribed fire within the mechanically treated areas. Alternative D proposes to dispose of slash through various other methods including chipping, shredding, mastication, and removal of biomass off-site.

Table 70. Alternative D summary of acres proposed for treatments in ponderosa pine goshawk habitat

Vegetation Treatment Type	Landscapes Outside of PFA (Acres)	Post-Fledgling Family Area (PFA) (Acres)	Dispersal Post-Fledgling Family Area (dPFA) (Acres)	Total Acres by Treatment Type
Uneven-aged (UEA)*	145,511	9,671	4,446	159,629
Intermediate Thinning (IT)	53,520	3,606	1,022	58,148
Stand Improvement (SI)	20,167	592	76	20,835
Savanna	45,405	0	0	45,405
Grassland Restoration	11,185	0	0	11,185
Pine-Sage	4,674	392	196	5,261
Prescribed Fire Only	86,869	8,713	1,299	96,882
Total Mechanical Treatment Acres	280,462	14,261	5,740	300,463
Total Prescribed Fire Analysis areas	86,869	8,713	1,299	96,882

Table 71 summarizes alternative D acres of treatment type within MSO habitat. See chapter 2 for a description of treatment objectives. Mechanical treatment acres within MSO habitat proposed under alternative D would be the same as alternative B. There would be no prescribed fire within the mechanically treated areas. Alternative D proposes to dispose of slash through various other methods including chipping, shredding, mastication, and removal of biomass off-site. Compared to the proposed action, alternative D also proposes a total of 19,247 acres less burn only treatment in the MSO protected habitat.

Table 71. Alternative D summary of treatments in ponderosa pine MSO habitat

Treatment Type*	Protected Habitat	Restricted Habitat	Target and Threshold Habitat (Acres)	Total Treatment Acres
	(Acres)	(Acres)		
Prescribed Fire Only	836	2,354	217 Target 84 Threshold	3,491
MSO Restricted	0	64,065	0	64,065
MSO Target	0	0	6,497	6,497
MSO Threshold	0	0	1,894	1,894
PAC - Mechanical	10,284	0	0	10,284
Total	11,120	66,419	6,715 Target/1,977 Threshold	86,231

Direct and Indirect Effects – Alternative D

Mexican Spotted Owl Habitat

Table 72 displays the MSO habitat forest structure and habitat components projected out to the years 2020 and 2050.

- Year 2020 summary: Basal area density is approaching the high end of the desired range within the restricted other habitat and is within desired for the other habitats. SDI is higher than desired in all habitats with the exception of restricted other RU 5 and protected RU 4. This is largely due to the limited mechanical and fire treatments in the protected habitat and the high oak stocking and lack of post mechanical treatment burning in the restricted habitat. The distribution of size classes is at or exceeds minimum desired in the 12-18” and the 18-24” size classes in all habitats. Stocking in the 24” + size class exceeds the desired minimum in the restricted other habitat and is below desired minimum in the target/threshold habitat. Average trees per acre 18” and larger are very close to desired minimum in the target/threshold habitat and well below desired minimum in restricted other. Overall average Gambel oak basal area is above desired minimum in all habitats except RU5 restricted other where it is a limited component within that landscape. All habitats are approaching desired minimum CWD >12” and are below desired minimum in snags >18”.
- Year 2050 summary: Basal area and SDI density exceeds desired in all habitats. The distribution of size classes is at or exceeds desired minimum in the 12-18” and the 18-24” size classes in all habitats. Stocking in the 24” + size class also exceeds desired minimum in the restricted other habitat and remains below desired minimum in the target/threshold habitat. Average trees per acre 18” and larger exceed desired minimum in the target/threshold habitat and remain below desired minimum in restricted other. Overall average Gambel oak basal area is above desired minimum in all habitats but remains limited in RU5 restricted other. All habitats show an increase in CWD >12” and Snags >18” between 2020 and 2050.

Table 72. Alternative D - 2020 and 2050 Spotted Owl Habitat Forest Structure and Habitat Components

							Avg. Percent of Total SDI by Size Class																				
RU	Basal Area			% Max SDI			12.0-17.9"			18.0-23.9"			24.0" +			Avg. TPA 18" +			Avg. Gambel Oak BA Percent of Total BA			Tons CWD >12"			Snags >18"		
RU	201 0	202 0	205 0	201 0	202 0	205 0	201 0	202 0	205 0	201 0	202 0	205 0	201 0	202 0	205 0	201 0	202 0	205 0	201 0	202 0	205 0	201 0	202 0	205 0	201 0	202 0	205 0
Protected																											
1	154	158	177	78%	74%	77%	31%	32%	28%	13%	17%	24%	8%	9%	12%	14.6	17.7	27.8	14%	14%	15%	0.7	1.0	2.3	0.6	0.7	1.7
3	170	173	192	82%	82%	84%	31%	31%	26%	15%	18%	24%	9%	10%	13%	18.5	21.4	31.2	12%	12%	12%	1.2	1.5	2.9	0.7	0.9	1.9
4	100	109	131	49%	51%	56%	33%	35%	38%	9%	14%	23%	5%	5%	8%	8.6	10.8	19.8	8%	8%	9%	0.4	0.7	1.6	0.4	0.4	1.3
5	132	143	165	64%	67%	71%	34%	34%	27%	14%	16%	24%	8%	8%	13%	13.2	16.2	27.3	10%	10%	12%	1.1	1.4	2.8	0.6	0.6	1.8
Protected Total	155	159	178	78%	75%	77%	31%	32%	28%	14%	17%	24%	8%	9%	12%	15.0	18.1	28.1	13%	14%	14%	0.8	1.1	2.3	0.6	0.7	1.7
Threshold																											
1	204	173	203	101%	85%	93%	25%	27%	23%	24%	32%	33%	3%	4%	8%	28.0	31.6	39.3	29%	34%	31%	2.0	2.2	2.8	0.5	0.4	1.1
3	185	173	200	99%	90%	96%	26%	22%	16%	19%	24%	27%	8%	9%	13%	23.7	26.7	35.7	33%	36%	35%	0.6	1.1	2.4	0.7	0.9	2.2
Threshold Total	193	173	201	100%	88%	95%	25%	24%	19%	21%	27%	30%	6%	7%	11%	25.6	28.8	37.3	31%	35%	33%	1.2	1.6	2.6	0.6	0.7	1.7
Target																											
1	156	141	171	81%	71%	79%	30%	30%	25%	12%	17%	23%	7%	9%	11%	13.6	16.8	25.9	20%	24%	25%	1.5	1.8	2.6	0.5	0.5	1.5
3	148	143	174	79%	74%	82%	26%	27%	23%	13%	17%	19%	7%	9%	12%	13.4	16.0	23.0	24%	26%	26%	0.8	1.1	1.9	0.5	0.6	1.4
Target Total	152	142	172	80%	72%	80%	28%	29%	24%	13%	17%	21%	7%	9%	11%	13.5	16.5	24.7	22%	25%	26%	1.2	1.5	2.3	0.5	0.5	1.4
Restricted Other																											
1	138	86	123	68%	43%	56%	30%	23%	20%	12%	19%	18%	7%	12%	16%	11.6	11.8	16.6	15%	23%	25%	0.3	1.1	1.5	0.4	0.4	0.8
3	137	94	130	70%	48%	60%	29%	23%	19%	13%	19%	18%	7%	11%	15%	11.6	12.0	17.3	21%	28%	29%	0.5	1.1	1.6	0.4	0.5	0.9
4	129	96	130	67%	50%	61%	28%	21%	18%	13%	19%	17%	8%	12%	16%	11.6	11.9	16.4	24%	31%	32%	0.4	1.0	1.5	0.5	0.5	1.0
5	102	76	114	51%	38%	52%	24%	22%	23%	10%	13%	14%	9%	12%	13%	8.0	8.2	12.4	15%	21%	24%	0.2	0.6	0.9	0.4	0.3	0.6
Restricted Total	137	91	127	69%	46%	58%	29%	23%	20%	13%	19%	18%	7%	11%	15%	11.5	11.8	17.0	19%	26%	28%	0.4	1.1	1.5	0.4	0.5	0.9

Goshawk Habitat

Table 73 and table 74 display the goshawk habitat structure attributes projected out to the years 2020 and 2050. Average conditions include trees, interspaces, and canopy gaps as represented by the stand data. These average habitat conditions are a function of openness and tree group density across the different scales (restoration sub-unit, restoration unit, ponderosa pine extent).

- Year 2020 summary: At the habitat and RU scale all habitats are within the desired density range with the exception of RU 6 PFA (due to these stands being dominated by young forest structural stage). With the exception of RU6 and LOPFA RU 5, tons of coarse woody debris are at or above desired due to the lack of prescribed fire reducing this attribute. Snags per acre are below desired at all scales.
- Year 2050 summary: At the habitat and RU scale all habitats remain within the desired SDI range. Basal area is at or above the desired with the exception of RU 6 PFA and corresponding canopy cover remains above the desired threshold. Total tons of coarse woody debris exceeds the minimum desired with the exception of RU 6 PFA and LOPFA. Snags have increased yet remain below desired levels.

Table 73. Alternative D - Average Goshawk Nest/PFA Habitat Structural Attributes

Restoration Subunit-Unit	Ponderosa Pine SDI % of Max			Ponderosa Pine TPA			Ponderosa Pine BA			Tons CWD Total			Tons CWD >12"			Snags >18"		
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
1-1	29%	25%	34%	151	129	118	67	61	88	2.8	3.0	4.7	0.1	0.3	0.8	0.3	0.7	0.3
1-2	40%	30%	36%	202	119	104	94	77	99	3.6	4.0	6.4	0.5	0.7	1.4	0.4	0.9	0.8
1-3	54%	28%	36%	226	100	90	133	75	100	4.4	7.2	8.4	0.4	1.2	1.8	0.4	0.6	0.8
1-4	57%	32%	40%	313	131	113	134	81	107	8.6	10.3	11.4	4.9	5.0	4.8	0.3	0.5	0.8
1-5	55%	31%	36%	247	85	74	131	84	101	4.8	6.9	9.4	0.5	1.0	2.1	0.6	1.0	1.6
1	52%	30%	36%	239	103	91	124	78	101	5.0	6.9	8.8	1.1	1.6	2.2	0.4	0.8	1.1
3-1	44%	29%	35%	177	94	83	107	75	96	3.3	4.7	6.6	0.2	0.7	1.4	0.4	0.7	1.0
3-2	44%	32%	37%	181	105	92	109	83	104	3.1	4.2	6.5	0.3	0.7	1.5	0.4	0.9	1.0
3-3	48%	30%	37%	220	109	97	117	78	102	3.6	5.6	7.1	0.3	0.8	1.4	0.4	0.6	0.9
3-5	44%	32%	39%	207	127	113	105	82	106	3.7	4.4	7.4	0.4	0.7	1.7	0.4	0.9	0.9
3	46%	31%	37%	203	108	96	112	79	102	3.5	5.0	6.9	0.3	0.8	1.5	0.4	0.7	0.9
4-2	38%	28%	35%	162	105	94	94	73	97	2.8	3.7	5.4	0.2	0.6	1.2	0.4	0.8	0.7
4-3	45%	31%	38%	197	113	99	109	82	105	3.7	4.8	7.0	0.7	1.0	1.8	0.4	0.8	0.9
4-4	51%	32%	38%	224	112	98	123	83	106	4.7	6.7	8.4	1.3	2.1	2.5	0.4	0.7	1.0
4-5	46%	35%	39%	226	122	100	108	89	108	4.2	5.2	7.7	0.6	0.8	1.6	0.4	0.6	1.4
4	46%	31%	38%	204	112	98	112	82	105	3.9	5.3	7.3	0.8	1.3	2.0	0.4	0.7	0.9
5-1	45%	31%	37%	206	108	93	109	81	103	5.2	6.0	8.7	1.7	2.0	2.8	0.4	1.0	1.0
5-2	42%	29%	34%	192	83	73	99	78	97	3.9	4.4	7.3	0.5	0.8	2.0	0.5	1.3	1.4
5	43%	30%	35%	199	95	82	104	79	100	4.5	5.2	7.9	1.1	1.4	2.4	0.5	1.1	1.2
6-2	24%	21%	26%	108	72	64	53	51	70	1.9	2.4	4.3	0.2	0.3	0.9	0.3	0.7	0.5

6-3	30%	25%	30%	154	110	96	64	56	76	2.4	3.1	4.6	0.3	0.4	0.8	0.3	0.5	0.5
6	29%	24%	30%	150	107	94	63	56	75	2.4	3.0	4.6	0.3	0.4	0.8	0.3	0.5	0.5
All PFA/dPFA	44%	30%	36%	202	108	95	107	77	99	3.9	5.2	7.1	0.7	1.1	1.8	0.4	0.7	0.9

Table 74. Alternative D - Average Goshawk LOPFA Habitat Structural Attributes

Restoration Subunit-Unit	Ponderosa Pine SDI % of Max			Ponderosa Pine TPA			Ponderosa Pine BA			Tons CWD Total			Tons CWD >12"			Snags >18"		
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
1-1	44%	25%	32%	208	99	89	103	64	86	3.7	5.4	6.5	0.5	1.0	1.3	0.3	0.5	0.6
1-2	36%	20%	25%	185	70	62	86	50	67	3.2	4.8	5.7	0.3	0.8	1.1	0.3	0.4	0.8
1-3	43%	22%	27%	212	80	72	102	54	74	3.8	6.0	6.6	0.5	1.1	1.3	0.3	0.4	0.7
1-4	43%	24%	30%	224	92	81	99	60	80	3.8	5.6	6.5	0.5	1.0	1.3	0.4	0.4	0.8
1-5	51%	27%	32%	248	85	73	118	68	86	4.5	7.0	8.3	0.7	1.4	1.9	0.5	0.6	1.3
1	46%	25%	30%	227	85	75	107	61	80	4.1	6.2	7.2	0.6	1.1	1.5	0.4	0.5	1.0
3-1	41%	22%	28%	175	81	72	99	57	78	2.8	4.7	5.6	0.2	0.8	1.1	0.4	0.5	0.7
3-2	39%	22%	27%	148	69	61	97	59	78	2.7	4.5	5.4	0.3	0.8	1.2	0.4	0.4	0.9
3-3	47%	23%	29%	209	77	69	114	58	79	3.8	6.3	7.1	0.5	1.1	1.5	0.3	0.4	0.8
3-4	53%	28%	33%	240	86	76	126	72	92	4.7	7.3	8.8	0.7	1.4	2.0	0.4	0.8	1.2
3-5	54%	30%	35%	264	100	86	127	76	96	4.8	7.0	9.1	0.7	1.3	2.0	0.4	0.7	1.1
3	47%	25%	30%	208	83	73	113	63	84	3.8	6.0	7.1	0.5	1.1	1.5	0.4	0.5	0.9
4-2	35%	19%	25%	142	66	60	86	49	68	2.5	4.1	4.7	0.2	0.7	1.0	0.3	0.4	0.5
4-3	38%	23%	29%	176	86	75	91	61	81	3.2	4.4	6.0	0.4	0.8	1.4	0.4	0.7	0.8
4-4	44%	24%	30%	198	85	75	107	61	82	3.5	5.6	6.5	0.4	1.0	1.4	0.3	0.4	0.8
4-5	44%	26%	32%	218	99	86	106	66	88	4.0	5.9	7.5	0.4	1.0	1.5	0.4	0.6	0.8
4	41%	24%	29%	187	85	75	100	61	82	3.3	5.1	6.3	0.4	0.9	1.3	0.4	0.5	0.8
5-1	31%	22%	27%	174	81	71	73	58	75	3.2	3.7	6.0	0.3	0.6	1.4	0.4	0.9	0.9
5-2	27%	22%	27%	119	66	58	67	61	78	3.0	2.4	5.3	0.4	0.5	1.6	0.4	1.3	0.9
5	28%	22%	27%	136	71	62	69	60	77	3.1	2.8	5.5	0.4	0.5	1.5	0.4	1.2	0.9
6-2	29%	21%	27%	166	89	80	63	51	72	2.3	2.9	4.2	0.3	0.4	0.8	0.2	0.5	0.3
6-3	33%	26%	32%	197	116	100	71	59	81	2.6	3.4	4.7	0.2	0.4	0.7	0.2	0.3	0.4
6-4	32%	23%	27%	198	86	71	67	58	75	3.1	3.9	7.2	0.3	0.5	1.5	0.4	1.2	0.8
6	32%	25%	31%	194	110	95	69	58	79	2.6	3.4	4.9	0.2	0.4	0.8	0.2	0.4	0.5
All LOPFA	41%	24%	29%	193	85	74	96	61	81	3.5	5.0	6.4	0.5	0.9	1.4	0.4	0.6	0.8

Table 75 is a comparison of the VSS distribution between alternative D and alternative B at the RU and habitat scale. Those cells populated in the table indicate the alternative D percentage and the difference from alternative B. Cells without percentages filled in are the same as indicated in alternative B (Table 49 through Table 52).

Overall the VSS distribution trends under alternative D compared to alternative B indicate an increase in VSS 3, a decrease in VSS 4, a slight decrease in VSS 5 in 2020 followed by a slight increase in 2050 and an overall decrease in VSS 6. The mechanical treatments between these two alternatives is the same, so these differences can be attributed to the lack of prescribed fire mortality associated with alternative D, especially in the VSS 3 class. The denser conditions

(table 73 and table 74) also affect the VSS distribution trend by slowing stand development and growth. This results in maintaining more of the landscape in the young forest stage and impeding development of the mature and old forest stages.

Table 75. Alternative D - 2020 and 2050 VSS Distribution Differences Compared to Alternative B Percent of Area by Vegetative Structural Stage

Area	1 – Grass/ Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age ForestForest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
LOPFA Even Age												
RU 1					43% (+29)	9% (+9)	27% (+25)	35% (-1)	20% (-4)			16% (-8)
RU 3					25% (+9)	5% (+2)	31% (-2)		31% (-7)	40% (+2)		19% (-5)
RU 4					26% (+9)	5% (+2)	32% (-5)	26% (+1)	26% (-4)	39% (+3)		18% (-5)
RU 5					20% (+1)	2% (+2)	40% (-2)	20% (-2)				
RU 6					79% (+1)	27% (+12)	8% (+1)	54% (-10)		5% (-2)	6% (-1)	6% (-1)
All					32% (+11)	7% (+4)	30% (-7)	29% (-1)	22% (-4)	36% (+2)		16% (-5)
LOPFA Uneven Age												
RU 1			1% (+1)		20% (+10)	8% (+8)	22% (+2)		39% (-1)	26% (-1)	9% (-9)	48% (-7)
RU 3					17% (+5)	6% (+5)		12% (+1)	41% (-4)	21% (-2)	11% (-1)	53% (-5)
RU 4					26% (+8)	6% (+6)	18% (-4)	16% (-2)	38% (-2)		10% (-3)	52% (-3)
RU 5					13% (+1)		11% (+1)		24% (-2)			
RU 6			2% (+1)		64% (+20)	14% (+9)	13% (-6)	57% (+5)	0% (-1)	7% (-5)	14% (-14)	15% (-9)

Area	1 – Grass/ Forb/ Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age ForestForest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
All			1% (+1)		26% (+8)	7% (+6)	18% (-2)		31% (-2)	18% (-1)	18% (-5)	50% (-5)
PFA Even Age												
RU 1					48% (+25)	3% (+3)	32% (-4)	49% (-3)	14% (-7)		0% (-13)	
RU 3					26% (+6)	1% (+1)	46% (-2)	34% (-1)	12% (-3)			
RU 4					30% (+9)		51% (+1)	43% (+2)	10% (-4)	38% (-3)	1% (-7)	
RU 5					26% (+7)	1% (+1)	54% (-7)	34% (-2)				
RU 6					50% (+4)	25% (+21)	10% (+6)	25% (-21)			28% (-9)	
All					32% (+10)	4% (+2)		40% (-1)	11% (-3)	37% (-2)	2% (-6)	
PFA Uneven Age												
RU 1					24% (+14)		29% (-13)				6% (-1)	
RU 3					18% (+9)		48% (-9)	20% (+1)		53% (-1)		
RU 4					20% (+8)	5% (+4)	43% (-6)	22% (-2)		42% (-1)	5% (-2)	
RU 5					14% (+6)		44% (-2)		37% (-3)			
RU 6						26% (+26)	26% (+15)	27% (-26)			12% (-15)	
All					25% (+7)	7% (+7)	38% (-3)	23% (-6)	23% (-1)	38% (-1)	6% (-4)	

Old Growth

Table 76 displays the old growth structural attributes of the old growth acres projected out to the years 2020 and 2050 under alternative D.

In 2020, the average conditions are at or above the minimum criteria with the following exceptions:

- Trees per acre larger than 18" and 180 years old. This condition is deficit in all SUs ranging from a low of 9.2 TPA in SU 6-2 to a high of 16.9 TPA in SU 3-4 with an overall average for all acres of 13.9 TPA. The age of these trees is estimated be in the range of 100 to 140 years old with a few relic trees meeting the 180 year old criteria.
- Basal area ≥ 90 . This condition is below desired in RUs 4, 5 and 6. Overall average for all acres is 89.
- Coarse woody debris greater than 12". This condition is estimated to be deficit with less than the equivalent of 2 pieces per acre throughout 6.

Over time, old growth conditions improve in terms of meeting the minimum criteria. In 2050, all RUs are very close to or exceed the criteria for TPA larger than 18" with the exception of RU 6. The age of these trees is estimated be in the range of 130 to 170 years old. It is estimated that all the other criteria will be met throughout the old growth acres.

Table 76. Alternative D –OG Structural Attributes by Restoration Unit

Restoration Subunit/Unit	OG Acres	Avg. TPA 18"+			Avg. BA			Avg. Tons CWD $\geq 12"$			Avg. Snags Per Acre $\geq 12"$		
		2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
1-1	3,578	13.2	13.7	19.3	117	84	116	0.4	0.9	1.3	1.4	2.2	1.7
1-2	2,034	11.0	11.4	17.0	101	70	99	0.3	0.8	1.1	1.1	2.1	1.6
1-3	17,105	13.5	14.6	20.8	128	95	125	0.6	1.1	1.6	2.0	2.1	2.7
1-4	6,323	11.6	13.0	19.9	117	97	125	0.3	0.8	1.3	1.7	2.0	3.0
1-5	35,050	14.9	16.7	24.4	146	124	150	0.6	1.2	2.0	2.8	3.1	4.7
1	64,090	13.9	15.3	22.2	134	108	136	0.5	1.1	1.7	2.3	2.6	3.6
3-1	6,216	12.9	13.4	19.2	121	81	113	0.3	0.9	1.2	1.6	1.9	1.8
3-2	9,317	14.7	15.1	19.8	113	77	106	0.3	0.9	1.2	1.5	1.7	1.6
3-3	15,624	13.8	14.5	20.1	132	89	120	0.4	1.1	1.5	2.0	2.4	2.2
3-4	4,201	15.8	16.9	23.7	148	118	146	0.7	1.3	2.1	2.8	3.2	4.3
3-5	11,305	15.2	16.0	22.7	147	99	131	0.8	1.5	2.2	2.6	4.1	3.0
3	46,663	14.4	15.0	20.8	132	90	121	0.5	1.1	1.6	2.1	2.7	2.4
4-2	3,710	13.0	12.8	17.5	103	68	96	0.2	0.7	1.0	1.2	1.8	1.3
4-3	20,144	11.9	12.7	19.6	107	76	105	0.3	0.8	1.3	1.4	3.3	1.9
4-4	22,175	13.2	13.7	19.9	119	74	106	0.3	1.0	1.2	1.4	1.7	1.4
4-5	2,030	14.1	14.8	23.2	136	86	121	0.4	1.2	1.6	2.1	3.1	1.8
4	48,059	12.7	13.3	19.7	113	75	105	0.3	0.9	1.2	1.4	2.5	1.6
5-1	5,187	11.7	12.8	20.0	99	79	107	0.5	0.8	1.6	1.4	4.6	2.2
5-2	18,530	11.9	12.9	19.6	84	75	98	0.5	0.5	1.6	1.3	5.7	2.4

Restoration Subunit/Unit	OG Acres	Avg. TPA 18"+			Avg. BA			Avg. Tons CWD ≥12"			Avg. Snags Per Acre ≥12"		
		2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
5	23,716	11.8	12.9	19.7	87	76	100	0.5	0.6	1.6	1.3	5.5	2.3
6-2	1,689	8.5	9.2	14.2	84	71	106	0.2	0.4	0.8	0.6	2.6	1.1
6-3	8,210	9.1	9.8	15.0	92	81	118	0.2	0.4	0.7	0.6	1.7	1.2
6-4	392	9.3	9.6	15.4	109	80	111	0.3	0.4	1.4	1.0	6.2	2.0
6	10,291	9.0	9.7	14.9	91	79	116	0.2	0.4	0.7	0.6	2.1	1.2
All	192,819	13.0	13.9	20.3	118	89	118	0.4	0.9	1.5	1.8	2.9	2.5

Alternative D proposes the same treatments in the pinyon-juniper cover type as alternative B. See Table 54 and the associated effects discussion for pinyon-juniper old growth.

Openness

The variety of treatment types and desired conditions under alternative D would result in a wide range of openness post treatment. The list of resulting openness by treatment type displayed for alternative B is the same for alternative D.

Table 77 lists the post treatment openness within the ponderosa pine cover type for alternative D by restoration unit and sub unit. Overall ranges indicate a fairly diverse condition with openness leaning to the closed side of the range. Two percent of the ponderosa pine would be very open, 41 percent open, 47 percent moderately closed and 11 percent closed. The unknowns are those areas with no treatment proposed under this alternative.

Table 77. Alternative D – Post Treatment Openness Classification for Ponderosa Pine

Restoration Unit-Subunit	Very Open	Open	Moderately Closed	Closed
1-1	3%	61%	30%	6%
1-2	35%	47%	16%	3%
1-3	17%	45%	24%	14%
1-4	14%	51%	21%	14%
1-5	6%	31%	34%	29%
1	11%	40%	29%	21%
3-1	9%	49%	39%	3%
3-2	20%	52%	22%	5%
3-3	17%	44%	27%	11%
3-4	3%	33%	32%	32%
3-5	6%	29%	43%	21%
3	13%	41%	33%	13%
4-2	31%	59%	7%	3%
4-3	20%	49%	20%	11%
4-4	20%	58%	16%	6%
4-5	15%	40%	27%	18%
4	20%	54%	18%	8%
5-1	26%	32%	35%	7%
5-2	8%	69%	20%	3%
5	14%	58%	24%	4%
6-2	1%	77%	16%	5%
6-3	2%	39%	54%	6%
6	1%	5%	29%	66%
All Ponderosa Pine	13%	46%	28%	13%

Forest Structure and Diversity - Mosaic of interspaces and tree groups of varying sizes and shapes

Table 78 lists alternative D acres by treatment intensity as an indication of the relative ability of the treatment to attain a mosaic of interspaces and tree groups and of the post treatment interspace/tree group condition. Forty two percent of the area treated is considered high, 24 percent is moderate, 24 percent is low and 10 percent is very low.

Table 78. Alternative D summary of ponderosa pine treatment acres by their relative ability to attain a mosaic of interspaces and tree groups

Treatment Intensity	Treatment Type	Acres	
High	Grassland Restoration	11,185	
	Savanna	45,405	
	Pine Sage	5,261	
	WUI 55	2,224	
	UEA 40	100,133	
	IT 40	38,712	
	SI 40	12,303	
Total High:		215,224	(42%)
Moderate	MSO Restricted Trt	64,065	
	UEA 25	39,190	
	IT 25	11,871	
	SI 25	6,618	
Total Moderate:		121,743	(24%)
Low	UEA 10	18,082	
	IT 10	7,565	
	SI 10	1,914	
	LOPFA Prescribed Fire Only	86,869	
	PFA Prescribed Fire Only	3,172	
	Restricted Prescribed Fire Only	2,354	
Total Low:		119,956	(24%)
Very Low	MSO Target Trt	6,497	
	MSO Threshold Trt	1,894	
	PAC - Mechanical	10,284	
	PFA Nest Stand Prescribed Fire Only	6,840	
	Protected Prescribed Fire Only	836	
	Target Prescribed Fire Only	217	
	Threshold Prescribed Fire Only	84	
	No Proposed Treatments	24,263	
Total Very Low:		50,915	(10%)

Forest Structure - All age and size classes represented

The MSO habitat forest structure analysis for alternative D indicates the post treatment distribution of size classes has good representation in the 12-18” and the 18-24” size classes in all habitats. Stocking in the 24” + size class has good representation in the restricted other habitat and is underrepresented in the target/threshold habitat (table 72). Implementation of group selection as part of the restricted other treatments would result in up to 15 percent of the area trending toward early successional stages, thereby increasing representation of the seedling/sapling age class.

The goshawk habitat structural stage analysis for alternative D indicates overall post treatment VSS distribution in the even-aged goshawk habitats will have good representation of the VSS 1, 3 and 4 age classes, and the VSS 5 age class in the LOPFA; under-representation of the VSS 6 age class and the VSS 5 age class in the PFA; no representation of the VSS 2 age class. The Uneven-aged goshawk habitats will have good representation in the LOPFA of VSS 3, 4, 5 and 6 and of VSS 3, 4 and 5 in the PFA; VSS 1 is underrepresented in the LOPFA and VSS 1 and 6 are underrepresented in the PFA; there is no representation of the VSS 2 age class in all habitats (table 75 and table 49 through table 52).

Natural Range of Variability (Alternative D) (Appendix F)

Appendix F graphically represents Natural Range of Variability Comparison by Treatment Type by forest attributes: Minimum, maximum and the weighted average. Forest Attributes are within the Natural range of Variability except for PACS, Goshawk nest areas and MSO Target Threshold Habitats. Forest Attributes tend to remain at the high end of the Natural Range of Variability. Pine basal areas remain within historic ranges, but all basal areas increase as other non-pine components increase in size (i.e., Gambel oak). Treatments within PFAs, PAC’s, MSO Restricted, MSO Target, and MSO Threshold trend to the high end or exceed the historic ranges. “No Proposed Treatments” areas all exceed the historic ranges of variability. As the intensity of treatments increase, the habitats become structured most closely to the lower end of the Natural Range of Variability. Mechanical treatments plus fire are more effective than fire alone. However, fire is an essential element to achieve the best results to move towards desire conditions.

Old Forest Structure Sustained Over Time Across the Landscape

The restoration treatments proposed under alternative D are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Old trees would not be targeted for cutting (reference the Old Tree Implementation Strategy in Appendix A).

The MSO habitat forest structure analysis for alternative D indicates the post treatment distribution of size classes has good representation in the 18-24” size classes in all habitats. Stocking in the 24” + size class has good representation in the restricted other habitat and is underrepresented in the target/threshold habitat (table 72).

The goshawk habitat structural stage analysis above indicates the mature and old forest structural stages to be underrepresented in the PFA habitat and LOPFA even-aged stands. Projections show a trend toward improved representation in all habitats (table 75 and table 49 through table 52).

Treatments within areas currently allocated OG would maintain existing old growth structural attributes and are managed to move towards those conditions over time. The old growth analysis above indicates old growth structural attributes would continue to develop and improve across the landscape (table 76).

With the implementation of restoration treatments under alternative D, the sustainability of the large/old tree component across the landscape would be improved as presented in the following forest health discussion.

Forest Health

Density related mortality

Stand density in 2020 in the MSO restricted other habitat (table 72) would have an overall average 46% of maximum stand density index (range 38-50%) putting these stands in the middle of the high density zone as described in table 7. The restricted other habitat consists of mixed species pine/oak stands. The pine component within this habitat is estimated to have density within the low to moderate zone. The majority of target/threshold and protected habitat would remain in zone 4 due to the oak stocking and dense forest desired conditions in these habitats. Any areas with mechanical treatments within these habitats would experience reduced density related mortality compared to the no action alternative.

In goshawk habitat, table 73 and table 74 show 2020 ponderosa pine density levels average 30% of maximum density within nest/PFA habitat and 24% in LOPFA habitat. These density levels are within the low to moderate density zones (Table 7). In 2050, overall averages indicate the LOPFA habitats to be within the moderate density zone and the nest/PFA being on the low end of high density yet well below the threshold for the onset of density related mortality.

Bark beetle related mortality

Table 79 lists the beetle hazard rating for the years 2020 and 2050 by RU and for the ponderosa pine analysis area. The overall hazard in 2020 is high across 43% of the analysis area. This increases to 69% in 2050. Stands with a hazard rating of low or moderate would be expected to be resistant to successful bark beetle attack and large-scale mortality. In the current climate change scenario, alternative D mitigates beetle hazard.

Table 79. Alternative D - Estimated 2020 and 2050 Beetle Hazard Rating

Hazard Rating	RU 1	RU 3	RU 4	RU 5	RU 6	% of Total	Analysis area Acres
2010							
Low	3%	6%	8%	26%	0%	7%	37,933
Moderate	12%	11%	27%	46%	25%	21%	106,132
High	85%	83%	65%	28%	75%	72%	363,775
2020							
Low	16%	22%	40%	40%	23%	27%	138,286
Moderate	25%	25%	32%	48%	25%	29%	149,448
High	58%	54%	28%	12%	52%	43%	220,105

Hazard Rating	RU 1	RU 3	RU 4	RU 5	RU 6	% of Total	Analysis area Acres
2050							
Low	3%	7%	9%	26%	2%	8%	42,216
Moderate	14%	15%	32%	45%	20%	23%	117,239
High	83%	78%	59%	30%	78%	69%	348,384

Dwarf mistletoe infection

Table 80 lists the dwarf mistletoe infection level and average percent of trees infected for the years 2020 and 2050 by RU and for the ponderosa pine analysis area. For 2020, approximately 66 percent of the area is not infected or has a low infection level and 34 percent has a moderate to high infection level. The overall average percent of trees infected is 6 percent in the none/low group and 36 percent in the moderate/high group. The percentages for 2050 indicate mistletoe infection is intensifying and spreading at a slower rate than alternative A.

Table 80. Alternative D Estimated Post Treatment and Long Term Dwarf Mistletoe Infection Level

Infection Level		RU 1	RU 3	RU 4	RU 5	RU 6	Analysis area
2010							
None/Low	Percent of Area	53%	57%	73%	92%	82%	66%
None/Low	Average Percent Trees Infected	5%	6%	4%	10%	5%	6%
Moderate/High	Percent of Area	47%	43%	26%	8%	18%	34%
Moderate/High	Average Percent Trees Infected	38%	33%	38%	41%	42%	36%
Extreme	Percent of Area	1%	0%	0%	0%	0%	0%
Extreme	Average Percent Trees Infected	86%	86%	85%			86%
2020							
None/Low	Percent of Area	46%	46%	71%	79%	82%	60%
None/Low	Average Percent Trees Infected	5%	5%	6%	11%	6%	6%
Moderate/High	Percent of Area	53%	54%	29%	21%	18%	40%
Moderate/High	Average Percent Trees Infected	41%	35%	43%	31%	58%	40%
Extreme	Percent of Area	1%	0%	0%	0%	0%	<1%
Extreme	Average Percent Trees Infected	88%	100%				88%
2050							
None/Low	Percent of Area	42%	45%	67%	68%	81%	56%
None/Low	Average Percent Trees Infected	5%	6%	6%	10%	7%	7%
Moderate/High	Percent of Area	57%	55%	33%	32%	15%	44%

Infection Level		RU 1	RU 3	RU 4	RU 5	RU 6	Analysis area
Moderate/High	Average Percent Trees Infected	46%	41%	49%	31%	56%	44%
Extreme	Percent of Area	1%	0%	0%	0%	4%	<1%
Extreme	Average Percent Trees Infected	87%	100%			81%	84%

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 alternative D.

Within forest carbon stocks would be reduced under alternative D. 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 within the estimated 366,156,380 cubic feet of biomass removed by mechanical thinning would be sequestered for a time in the form of building materials.

Vegetation Diversity and Composition – Maintain and Promote

Grasslands

Alternative D would restore historic grasslands, savannas and forest openings by removing ponderosa pine tree canopy that is shading out understory herbaceous vegetation and reducing forage production and species diversity as follows:

- 11,185 acres of grassland restoration treatments on mollisol soils;
- 45,405 acres of savanna treatments on mollic integrate soils;
- 307,938 acres of ponderosa pine restoration treatments in PFA, LOPFA and MSO restricted other habitats enhancing small grassland inclusions within the greater forested area.

Oak

Treatments proposed in alternative D are designed to conserve oak and improve conditions that favor oak growth and establishment wherever it exists by reducing pine-oak competition. This would result in improved vigor of existing oak and establishment of a variety of oak size and age classes across the landscape. These conditions would be most prevalent within the 64,065 acres of MSO restricted other habitat treatments. Table 72 shows the overall post treatment oak basal area would be 7 percent higher in this habitat compared to the no action alternative.

Aspen

The treatments within 1,249 acres of aspen stands under alternative D are designed to maintain and/or regenerate aspen by reducing pine-aspen competition. These treatments would result in establishment of vigorous aspen regeneration free of competition from overtopping ponderosa pine.

Pine Sage

The 5,261 acres of pine-sage thinning treatments are designed to remove post settlement pine that is currently overtopping and shading out the sage and to manage fire to enhance sage extent. These treatments would result in enhancement of the sage component within the pine sage mosaic.

Other Direct and Indirect Effects:

Residual Tree Damage

Some damage to residual trees would be expected in alternatives D with the felling, tractor yarding and piling operations associated with mechanical treatments in ponderosa pine on 384,966 acres (Table 69). 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).

Tractor Yarding and Fuel Treatment

All merchantable harvested material would be whole-tree tractor yarded from the mechanical treatment units. Fuel treatments proposed for Alternative D includes pile burning, broadcast burns and fireline construction. Some damage to the residual trees would be expected with the felling, tractor yarding and slash disposal operations within 563,407 acres of ponderosa pine mechanical treatments. Damage would be minimized through contract administration and proper harvest methods. All low-intensity burning treatments on 100,508 (P Pine) acres would reduce understory stocking and reduce inter-tree competition as well as stimulate understory vegetation (shrubs, forbs, grasses). Fireline placement would use existing features with naturally low fuels, skid trails, roads etc. as much as possible. Actual fireline construction would remove herbaceous material to bare mineral soil to a 3-6 foot width.

Timber and Wood Products

A Coconino FP goal is to manage the timber resource to provide a sustained yield of forest products (CFP pg. 23). A Kaibab FP goal is to manage suitable timberland to provide a sustained level of timber outputs to support local dependent industries (KFP pg. 18). Timber harvest of 243,299,684 cubic feet of biomass from the Coconino and 122,856,697 cubic feet of biomass from the Kaibab is a direct beneficial effect of Alternative D.

Road Maintenance, Decommissioning, Reconstruction, Opening, and Temp Road Construction

Road maintenance within the existing road prism would have no effect on the health and growth of the leave trees within the treatment units. Road decommissioning of 904 miles of existing system and unauthorized roads would allow ingrowth of forest vegetation once the road is decommissioned (approximately 2,712 acres). Constructing 245 miles of temporary roads will remove trees and forest vegetation within the road right of ways (approximately 735 acres). Opening 272 miles of decommissioned roads may remove trees and forest vegetation that has become established within the road right of way since the road was last maintained (approximately 816 acres). Reconstructing 10 miles of road will remove trees and forest vegetation within the area being reconstructed (approximately 30 acres). Road reconstruction consists of road improvement activities and road realignments activities. Road realignment of 10 miles of road would remove approximately 30 acres of trees and forest vegetation within the area being reconstructed. 30 miles of road improvement is expected to occur on small discreet areas and is expected to remove about 100 acres of forest vegetation. The above listed effects cover the maximum range of management actions. Possible management actions includes: Reestablish former drainage patterns, stabilizing slopes, and restore vegetation; Block the entrance to a road or installing water bars; Remove culverts, reestablish drainages, remove unstable fills, pull back road shoulders, and scatter slash on the roadbed; Completely eliminate the roadbed by restoring natural contours and slopes; and Other methods designed to meet the specific conditions associated with the unneeded road.

Aspen Fencing and Barriers

Up to 82 miles protective barriers would be established around aspen clone patches within the ponderosa pine forest. Barriers would consist of fencing and/or felling trees (jack-strawing). Fencing would occur after mechanical and burning treatments and would have no effect to the vegetation. Jack-strawing may occur during the mechanical operation and would utilize trees that have been targeted for removal to meet treatment objectives. Leaving felled material on the ground would forego the opportunity to use that material for wood products.

Restoration of Springs and Ephemeral Channels

Springs and ephemeral channels are inclusions within the mechanical and burn analysis areas. Any tree removal that occurs as part of the restoration of these areas would be part of the design for those mechanical treatments that occur around these areas and the effects to the forest vegetation would be similar to the overall treatment. Up to 4 miles of protective fencing would be established around restored springs. Fencing would have no effect to the vegetation. Bank re-contouring and stabilization would occur along 39 miles of ephemeral channels. This activity would disturb existing forest vegetation. Up to 5 miles of willow re-establishment would occur where evidence indicates historic willow presence. This would create vegetation diversity and allow natural willow expansion into adjacent areas of suitable habitat. The above listed effects cover the maximum range of management actions. Possible management actions for springs include: Remove tree canopy to pre-settlement condition within 2-5 chains of the spring; Apply for water right if none exists; remove noxious weeds; Prescribe burn; Identify stressor and

provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.); And/or other methods designed to meet the desired conditions.

2014 Kaibab National Forest: Forest Plan Consistency: Alternative D

Alternative D incorporate key components of the Old Tree Protection Strategy into the alternative's implementation plan (Appendix A). The Forest Service worked collaboratively with stakeholders to develop implementation plan.

This alternative follows all plan standards and guidelines. Refer to Appendix F for further consistency on specific forest plan Standards, Guidelines and desired conditions. All aspects with this alternative are consistent with the Kaibab forest plan.

Alternative E

See Chapter 2 FEIS for a complete list of activities and a description of the treatments that are proposed for Alternative E.

Alternative E would implement approximately 581,020 acres of restoration activities (within the 588,917 analysis area) (Figure 14).

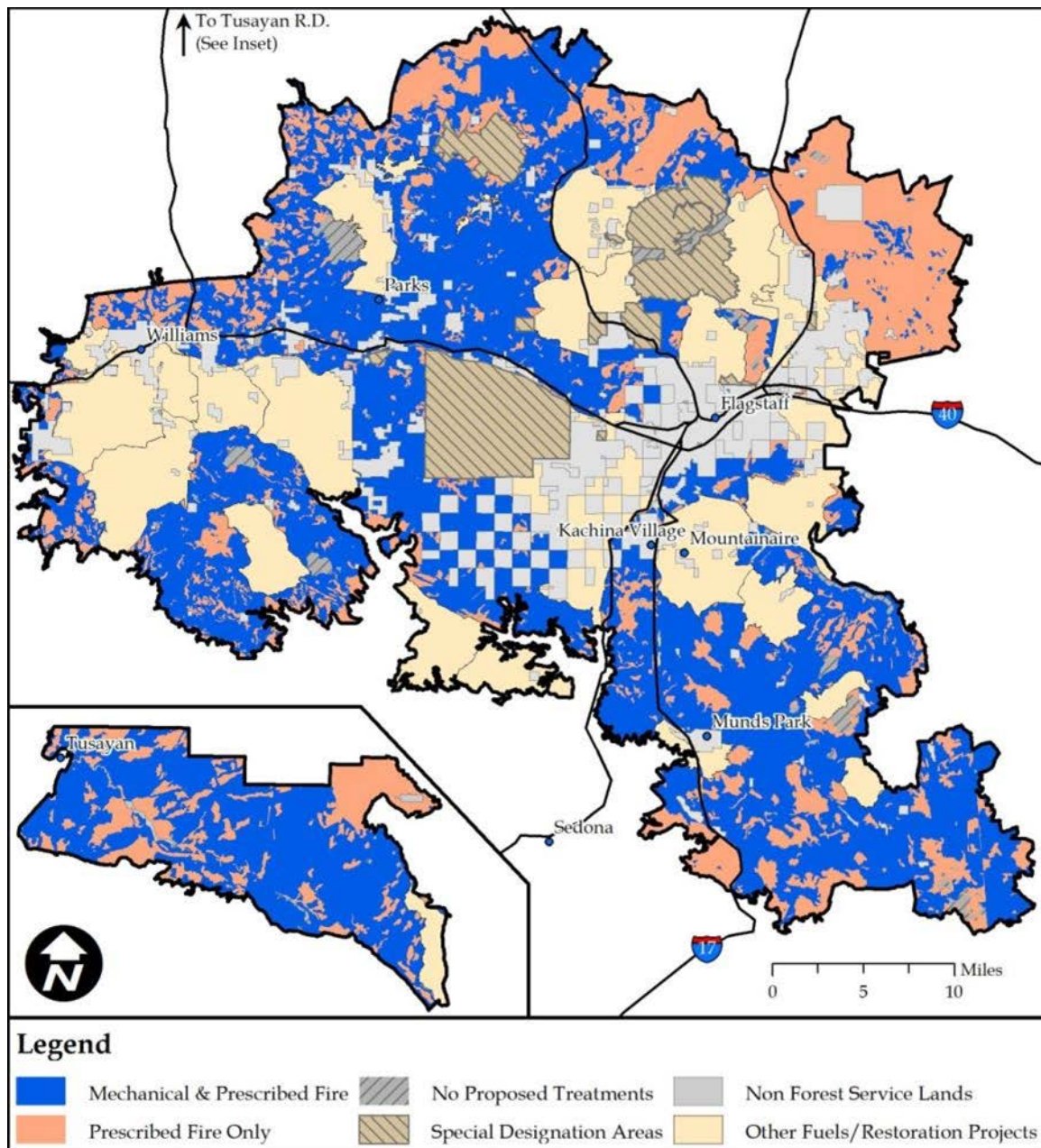


Figure 14. Alternative E mechanical and prescribed fire treatments

Restoration activities would:

- Mechanically cut trees and burn approximately 403,218 acres. This includes ponderosa pine restoration treatments within 184,988 acres of northern goshawk habitat and 81,457 acres of Mexican spotted owl habitat, 1,227 acres of aspen restoration, 535 acres of

pinyon-juniper wildland urban interface treatments, and 47,915 acres of grassland mechanical treatments.

- Prescribe burn-only approximately 177,801 acres. Burn only treatments would occur within 147,044 acres of ponderosa pine and 223 acres of aspen with the remaining 30,534 acres occurring in the PJ, oak woodland, grassland and non-vegetated cover types operationally to facilitate burning the ponderosa pine and aspen. Within the ponderosa pine, 59,708 acres are within northern goshawk habitat and 22,738 acres are within Mexican spotted owl habitat.
- Responds to Issue 3 (post-treatment landscape openness and canopy cover), and Issue 5 (range of alternatives and comparison between alternatives).
- It is similar to alternative C in that it adds acres of grassland treatments on the Kaibab NF and incorporates wildlife and watershed research on both forests.
- It proposes mechanically treating up to 9-inch d.b.h. in 18 MSO PACs and includes low-severity prescribed fire within 70 MSO PACs, excluding 54 core areas. Key components of the stakeholder-created Large Tree Retention Strategy are incorporated into the alternative's implementation plan.
- No forest plan amendments are proposed.

Table 81 summarizes the vegetation treatments for alternative E by cover type in each restoration unit. Compared to the proposed action, alternative E proposes 29,662 less acres of mechanical with prescribed fire treatments in the ponderosa pine cover type and 47,915 more acres in the grassland cover type. Alternative E differences from the proposed action for the prescribed fire only treatment includes 27,424 more acres in ponderosa pine, 53 less acres in oak woodland and 47,935 less acres in the grassland cover type.

Table 81. Alternative E mechanical treatment and prescribed fire acres by restoration unit (RU)

Treatment	Cover Type	RU 1	RU 3	RU 4	RU 5	RU 6	Grand Total
Mechanical Treatment with Prescribed Fire	Ponderosa Pine	111,386	103,291	98,404	10,487	29,974	353,542
	Aspen	182	201	451	392		1,227
	Pinyon-Juniper					535	535
	Grassland	8,134	12,491	22,661	4,536	93	47,915
	All	119,703	115,983	121,516	15,416	30,601	403,218
Prescribed Fire Only	Ponderosa Pine	27,982	23,548	35,761	48,539	11,215	147,044
	Aspen	167		46	10		223
	Pinyon-Juniper	1,422	5,884	7,283	8,845	1,684	25,117
	Oak Woodland	275	1,580	926	386	30	3,197
	Grassland	91	6		392		488
	Non-Vegetated	120	134	129	1,301	48	1,732
	All	30,056	31,151	44,145	59,473	12,977	177,801
Mechanical Treatment and Prescribed Fire Totals		149,758	147,134	165,661	74,889	43,578	581,020

Figure 15 shows the areas of mechanical and prescribed fire treatments in goshawk and MSO habitat for Alternative D.

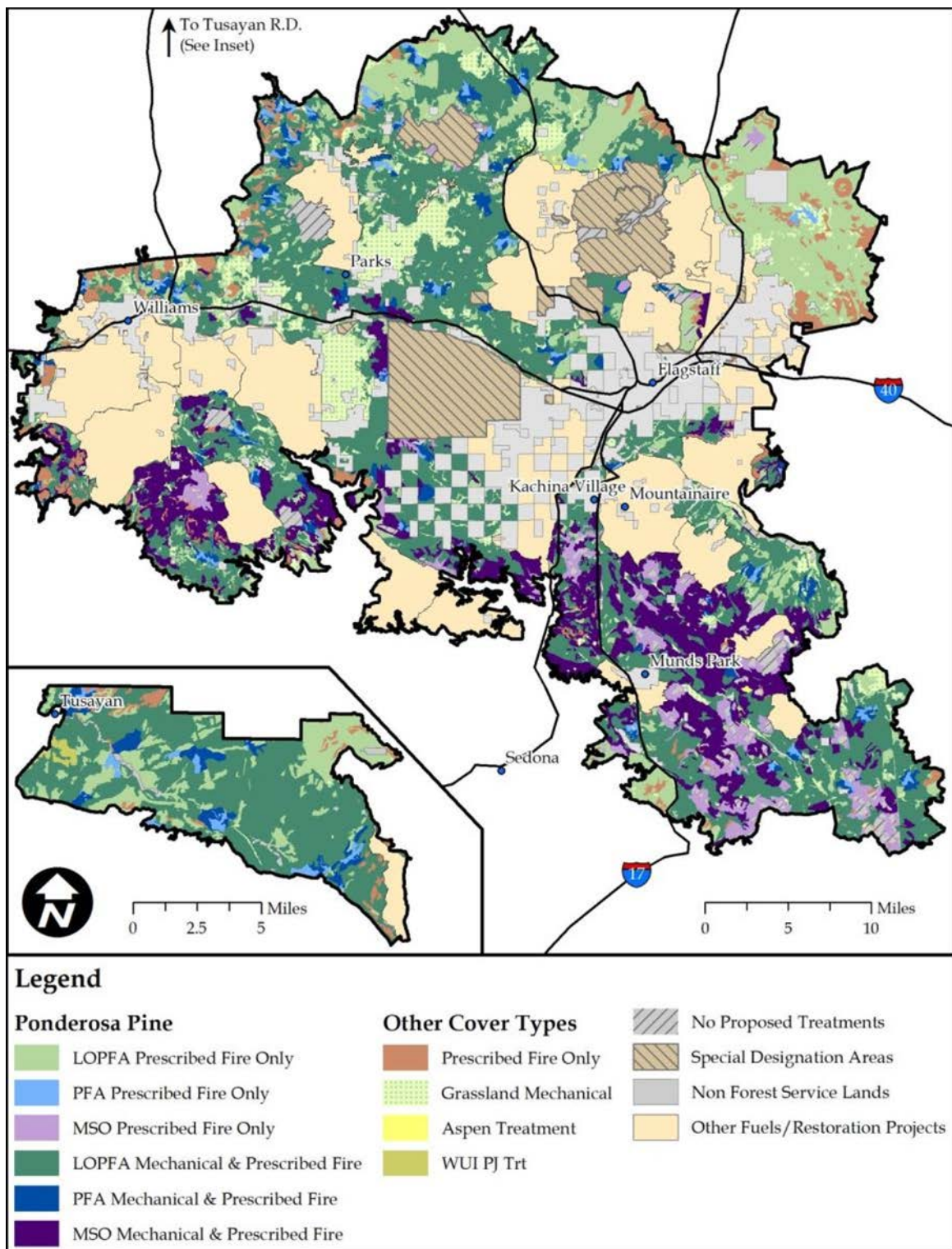


Figure 15. Alternative E mechanical and prescribed fire treatments in goshawk & MSO habitat

Table 82 summarizes Alternative E acres of treatment type within goshawk habitat (See chapter 2 for a description of treatment objectives). Compared to the proposed action, alternative E proposes a total of 27,424 acres more burn only treatment within the LOPFA and PFA habitats, 25,359 acres more UEA, 1,560 acres more IT, 1,292 acres more SI, 45,405 acres less Savanna, and 11,185 acres less grassland thinning.

Table 82. Alternative E summary of Acres Proposed for treatments in ponderosa pine goshawk habitat

Treatment Type	Landscapes outside of PFA (Acres)	Post-Fledgling Family Area (PFA) (Acres)	Dispersal Post-Fledgling Family Area (dPFA) (Acres)	Total Acres by Treatment Type
Uneven-aged (UEA)	170,962	9,579	4,446	184,988
Intermediate Thinning (IT)	55,080	3,606	1,022	59,708
Stand Improvement (SI)	21,459	592	76	22,127
Pine-Sage	4,674	392	196	5,261
Prescribed Fire Only	114,298	8,709	1,299	124,306
Total Mechanical Analysis areas	252,175	14,169	5,740	272,084
Total Prescribed Fire Analysis areas	366,473	22,878	7,039	396,390

Table 83 summarizes Alternative E acres of treatment type within MSO habitat. See chapter 2 for a description of treatment objectives. Compared to the proposed action, alternative E proposes a total of 1,283 acres more burn only treatment in protected and restricted other habitats, 1,843 acres less mechanical/burn treatment in the restricted other habitat, a diameter limit of up to 9” in select PAC thinning treatments and higher intensity thinning in the target/threshold habitat which follows the revised MSO recovery plan minimum conditions (USDI Fish and Wildlife Service 2012).

Table 83. Alternative E summary of treatment acres in ponderosa pine MSO habitat

Treatment Type*	Protected (Acres)	Restricted (Acres)	Target (Acres)	Threshold (Acres)	Total Acres by Treatment Type
Prescribed Fire Only	20,083	2,354	217	84	22,738
MSO Restricted	0	62,222	0	0	62,222
MSO Target	0	0	7,059	0	7,059
MSO Threshold	0	0	0	1,892	1,892
PAC - Mechanical	10,284	0	0	0	10,284
Total	30,367	65,139	7,276	1,976	104,195

Direct and Indirect Effects – Alternative E

Mexican Spotted Owl Habitat

Table 84 displays the MSO habitat forest structure and habitat components projected out to the years 2020 and 2050.

- Year 2020 summary: Basal area density is within the desired range in all habitats. SDI is higher than desired within the target/threshold and protected habitat (with the exception of RU 4) and on the high end of the desired range within restricted other habitat. This is largely due to the limited mechanical treatment in the protected habitat and the high oak stocking in the restricted habitat. The distribution of size classes is at or exceeds minimum desired in the 12-18” and the 18-24” size classes in all habitats. Stocking in the 24” + size class exceeds minimum desired in the restricted other habitat and is below minimum desired in the target/threshold habitat. Average trees per acre 18” and larger is within 4 TPA of minimum desired in the target/threshold habitat and well below minimum desired in restricted other. Overall average Gambel oak basal area is above minimum desired in all habitats except RU5 restricted other where it is a limited component within that landscape. All habitats are approaching minimum desired CWD >12” and are below minimum desired in snags >18”.
- Year 2050 summary: Basal area is above the desired range for target/threshold habitat. The average overall basal area in restricted other is 112 square feet which is the low end of the desired range for MSO nesting/roosting habitat (threshold). SDI density exceeds the desired range in all habitats. The distribution of size classes is at or exceeds minimum desired in the 12-18” and the 18-24” size classes in all habitats. Stocking in the 24” + size class also exceeds minimum desired in the restricted other habitat and remains below minimum desired in the target/threshold habitat. Average trees per acre 18” and larger exceed minimum desired in the target/threshold habitat and remain below minimum desired in restricted other. Overall average Gambel oak basal area is above minimum desired in all habitats except RU5 restricted other. All habitats show an increase in CWD >12” between 2020 and 2050. Snags >18” also show an increase in target/threshold and protected habitat while remaining static in restricted other.

Table 84. Alternative E - 2020 and 2050 Spotted Owl Habitat Forest Structure and Habitat Components

							Avg. Percent of Total SDI by Size Class																				
RU	Basal Area			% Max SDI			12.0-17.9"			18.0-23.9"			24.0" +			Avg. TPA 18" +			Avg. Gambel Oak BA Percent of Total BA			Tons CWD >12"			Snags >18"		
RU	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
Protected																											
1	154	159	179	78%	74%	77%	31%	33%	29%	13%	16%	23%	8%	9%	12%	14.6	17.7	27.7	14%	14%	15%	0.7	0.9	2.3	0.6	0.7	1.6
3	170	172	191	82%	81%	83%	31%	31%	28%	15%	18%	24%	9%	10%	13%	18.5	21.4	31.0	12%	13%	13%	1.2	1.1	2.7	0.7	0.9	2.0
4	100	106	128	49%	50%	55%	33%	35%	38%	9%	14%	24%	5%	5%	8%	8.6	10.9	19.8	8%	8%	9%	0.4	0.5	1.5	0.4	0.4	1.3
5	132	138	163	64%	64%	70%	34%	34%	27%	14%	17%	24%	8%	8%	13%	13.2	16.3	27.5	10%	11%	13%	1.1	0.9	2.4	0.6	0.6	1.8
Protected Total	155	159	179	78%	74%	78%	31%	32%	29%	14%	17%	23%	8%	9%	12%	15.0	18.1	28.0	13%	14%	15%	0.8	0.9	2.3	0.6	0.7	1.7
Threshold																											
1	204	171	202	101%	85%	93%	25%	27%	23%	24%	32%	33%	3%	4%	8%	28.0	31.6	38.6	29%	35%	31%	2.0	1.4	2.1	0.5	0.4	1.1
3	185	171	200	99%	90%	96%	26%	22%	17%	19%	24%	27%	8%	10%	13%	23.7	26.7	35.8	33%	37%	36%	0.6	0.7	2.1	0.7	0.9	2.2
Threshold Total	193	171	201	100%	87%	95%	25%	24%	19%	21%	28%	30%	6%	7%	11%	25.6	28.9	37.0	31%	36%	34%	1.2	1.0	2.1	0.6	0.7	1.7
Target																											
1	156	138	169	81%	70%	78%	30%	30%	24%	12%	17%	23%	7%	10%	11%	13.6	16.8	26.1	20%	25%	26%	1.5	1.1	2.1	0.5	0.5	1.4
3	146	140	173	78%	73%	82%	26%	26%	23%	14%	17%	19%	8%	9%	12%	13.5	15.7	22.6	25%	27%	27%	0.8	0.6	1.6	0.5	0.5	1.3
Target Total	151	139	171	80%	72%	80%	28%	28%	23%	13%	17%	21%	8%	9%	12%	13.6	16.3	24.5	22%	26%	27%	1.2	0.9	1.8	0.5	0.5	1.4
Restricted Other																											
1	138	74	107	68%	35%	46%	30%	25%	21%	12%	21%	20%	7%	14%	19%	11.6	11.3	16.7	15%	22%	23%	0.3	0.7	1.5	0.4	0.8	0.8
3	137	82	116	70%	39%	51%	29%	25%	20%	13%	21%	21%	7%	12%	17%	11.5	11.6	17.5	21%	26%	27%	0.5	0.8	1.7	0.4	1.0	1.0
4	129	80	115	67%	39%	52%	28%	23%	18%	13%	21%	19%	8%	14%	18%	11.6	11.4	16.4	24%	29%	30%	0.4	0.7	1.6	0.5	1.0	1.0
5	102	64	98	51%	30%	42%	24%	24%	24%	10%	15%	16%	9%	14%	16%	8.0	8.0	12.6	15%	19%	22%	0.2	0.4	1.0	0.4	0.6	0.5
Restricted Total	137	79	112	69%	37%	49%	29%	25%	21%	13%	21%	20%	7%	13%	18%	11.5	11.4	17.1	18%	24%	26%	0.4	0.8	1.6	0.4	0.9	0.9

Goshawk Habitat

An analysis of the goshawk structure attributes for alternative E showed minor differences in LOPFA habitat SUs 3-2, 3-5, and 4-3 compared to alternative B (Table 48). All numbers and percentages are the same for alternative E as alternative B for the remaining SUs and at the RU and habitat scales. Therefore, the summary (prior to Table 48) of post treatment and 2050 habitat conditions for alternative B is the same for alternative E.

An analysis of the VSS distribution within goshawk habitat for alternative E showed minor differences compared to alternative B (Table 49 through Table 52). These differences are listed in Table 63 at the RU and habitat scale. All percentages are the same for alternative E as alternative B for all other stages and years in each of the RUs and habitats. Therefore, the narrative summaries (prior to Table 49 through Table 52) describing post treatment and 2050 VSS distribution by habitat for alternative B are essentially the same for alternative E with the same trends.

Table 85 Alternative E - 2020 and 2050 VSS Distribution Differences Compared to Alternative B Percent of Area by Vegetative Structural Stage

Area	1 – Grass/Forb/Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
LOPFA Even Age												
RU 1	9% (+2)			9% (+2)	20% (+6)		53% (+1)	44% (+8)	16% (-8)	40% (+7)	2% (-1)	7% (-17)
RU 3	11% (+2)			11% (+2)	15% (-1)		40% (+7)	29% (+3)	33% (-5)	45% (+7)	1% (-3)	12% (-12)
RU 4	15% (+2)			15% (+2)	16% (-1)		43% (+6)	28% (+3)	26% (-4)	43% (+7)	0% (-3)	12% (-11)
RU 5							44% (+2)		8% (-2)	41% (+2)		9% (-2)
All	14% (+1)			14% (+1)			42% 0.05	33% (+3)	21% (-5)	40% (+6)	1% (-2)	10% (-11)
LOPFA Uneven Age												
RU 1	9% (+1)		1% (+1)	9% (+1)	12% (+2)	1% (+1)	23% (-1)		41% (+1)	29% (+2)	14% (-4)	52% (-3)
RU 3	9% (+1)			8% (+1)	16% (+4)		26% (+3)	14% (+3)	41% (-4)	26% (+3)	8% (-4)	50% (-8)
RU 4	9% (+2)			8% (+1)	20% (+2)		25% (+3)	19% (+1)	37% (-3)	23% (+4)	9% (-4)	50% (-5)
RU 5							9% (-1)					
All				7% (+1)	19% (+1)		21% (+1)		32% (-1)	21% (+2)	21% (-2)	51% (-4)
PFA Even Age												
RU 3					22% (+2)		47% (-1)	36% (+1)	14% (-1)			
RU 4							52% (+2)	40% (-1)			6% (-2)	
RU 5	7% (-1)			13% (+5)	18% (-1)		57% (-4)	33% (-3)	17% (+5)	41% (-3)		12% (-1)
All				10% (+1)	23% (+1)		47% (+1)				7% (-1)	
PFA Uneven Age												
RU 3							58% (+1)	20% (+1)		53% (-1)		

Area	1 – Grass/Forb/Shrub (0.0 - 0.9")		2 – Seedling/ Sapling (1.0 - 4.9")		3 – Young Forest (5.0 - 11.9")		4 – Mid-age Forest (12.0 - 17.9")		5 – Mature Forest (18.0 - 23.9")		6 – Old Forest (24.0" +)	
	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
RU 4								25% (+1)				22% (-1)
RU 6					45% (+1)			54% (+1)				
All								30% (+1)	23% (-1)			

Old Growth

Table 86 displays the old growth structural attributes of the ponderosa pine old growth acres projected out to the years 2020 and 2050 under alternative E.

In 2020, the average conditions are at or above the minimum criteria with the following exceptions:

- Trees per acre larger than 18" and 180 years old. This condition is deficit in all SUs ranging from a low of 8.9 TPA in SU 6-2 to a high of 16.6 TPA in SUs 1-5 and 3-4 with an overall average for all acres of 13.6 TPA. The age of these trees is estimated be in the range of 100 to 140 years old with a few relic trees meeting the 180 year old criteria.
- Basal area ≥ 90 . This condition is below desired in RUs 3, 4, 5 and 6. Overall average for all acres is 82.
- Coarse woody debris greater than 12". This condition is estimated to be deficit with less than the equivalent of 2 pieces per acre throughout RU 5 and 6, and various SUs.

Over time, old growth conditions improve in terms of meeting the minimum criteria. In 2050, all RUs are very close to or exceed the criteria for TPA larger than 18" with the exception of RU 6. The age of these trees is estimated be in the range of 130 to 170 years old. It is estimated that all the other criteria will be met throughout the old growth acres.

Table 86. Alternative E –OG Structural Attributes by Restoration Unit

Restoration Subunit/Unit	OG Acres	Avg. TPA 18"+			Avg. BA			Avg. Tons CWD $\geq 12"$			Avg. Snags Per Acre $\geq 12"$		
		2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050
1-1	3,578	13.2	13.3	19.1	117	76	106	0.4	0.6	1.3	1.4	3.9	1.6
1-2	2,034	11.0	12.9	20.4	101	76	104	0.3	0.6	1.5	1.1	5.7	1.8
1-3	17,105	13.5	14.6	21.5	128	93	121	0.6	0.8	1.7	2.0	4.0	2.8
1-4	6,323	11.6	13.2	20.8	117	94	122	0.3	0.6	1.4	1.7	4.1	2.9
1-5	35,050	14.9	16.5	24.3	146	120	146	0.6	0.9	1.9	2.8	4.5	4.6
1	64,090	13.9	15.2	22.6	134	105	132	0.5	0.8	1.7	2.3	4.3	3.6
3-1	6,216	12.9	13.2	19.5	121	74	105	0.3	0.6	1.4	1.6	4.3	1.6
3-2	9,317	14.7	15.4	21.2	113	78	106	0.3	0.6	1.4	1.5	4.2	1.8
3-3	15,624	13.8	14.3	20.9	132	88	118	0.4	0.7	1.6	2.0	4.8	2.5
3-4	4,201	15.8	16.6	23.6	148	112	139	0.7	0.9	1.9	2.8	4.8	4.0
3-5	11,305	15.2	15.8	23.1	147	94	124	0.8	1.0	2.1	2.6	5.8	2.8
3	46,663	14.4	14.9	21.5	132	87	117	0.5	0.8	1.7	2.1	4.9	2.4
4-2	3,710	13.0	13.9	19.6	103	70	97	0.2	0.5	1.3	1.2	4.6	1.6
4-3	20,144	11.9	12.9	20.4	107	74	102	0.3	0.6	1.4	1.4	5.1	1.9
4-4	22,175	13.2	13.7	20.6	119	70	100	0.3	0.7	1.3	1.4	4.2	1.4
4-5	2,030	14.1	14.4	23.0	136	79	112	0.4	0.9	1.6	2.1	5.0	1.6
4	48,059	12.7	13.4	20.5	113	72	101	0.3	0.6	1.4	1.4	4.7	1.6

5-1	5,187	11.7	12.8	20.4	99	78	105	0.5	0.6	1.6	1.4	5.8	2.2
5-2	18,530	11.9	12.9	19.6	84	75	97	0.5	0.5	1.6	1.3	5.8	2.3
5	23,716	11.8	12.9	19.8	87	75	99	0.5	0.5	1.6	1.3	5.8	2.3
6-2	1,689	8.5	8.9	14.2	84	63	94	0.2	0.3	0.9	0.6	3.9	1.0
6-3	8,210	9.1	9.4	15.0	92	69	104	0.2	0.3	0.9	0.6	3.6	0.9
6-4	392	9.3	9.5	15.4	109	78	108	0.3	0.4	1.5	1.0	6.6	2.0
6	10,291	9.0	9.3	14.9	91	69	102	0.2	0.3	0.9	0.6	3.8	1.0
All	192,819	13.0	13.9	20.8	118	86	114	0.4	0.7	1.6	1.8	4.7	2.4

Alternative E proposes the same treatments in the pinyon-juniper cover type as alternative B. See Table 54 and the associated effects discussion for pinyon-juniper old growth.

Special Case Canopy Cover – Alternatives C and E

In response to comments and feedback on the DEIS , on approximately 38,256 acres (22,772 acres on the Coconino and 15,484 acres on the Kaibab NF) of UEA 40, UEA 25, and non-WUI stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean BA greater than 70 of the VSS 4 size class and a mean TPA less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. After further public comments an additional 7,835 acres of IT10 and UEA 10 treatments were included for this section, for a total of 46,091 acres. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-WUI stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the planned prescription intensity range, managing for larger group sizes, and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and will achieve 40 percent canopy cover at the stand scale.

Maintaining high canopy cover percentages across the stand will necessitate maintaining high stocking basal area, high trees per acre, and high SDI. Currently the 38,256 acres encompasses 1,096 stands averaging 143.4 BA, 508.6 TPA, and 281.5 SDI (62.5% of max SDI: SDIMax = 450). This will result in continuous canopy cover over most of the stand which will increase the risk of density related mortality and crown fire risk above most other restoration treatments.

On the stands treated in Table 99 (page 243) prescriptions would be implemented to the lower intensity level were possible while trying to maintain stand structure at the upper ends of the NRV, with an intent to maintain 40% canopy cover. It is not proposed to change treatment types but to instead to maintain the planned treatments but to limit the treatment intensity such that the silviculturist favor the less intense range of the treatment planned and analyzed.

Management on 3,303 Acres of Proposed Savanna Treatments

In response to comments from the public there continues to be a conversation on large trees, issue 2. In response to comments and feedback, Alternative E best meets the concern because no savanna treatments are proposed. The implementation plan, as it relates to alternative E has been updated to clarify that most VSS 4, VSS 5 and VSS 6 would not be cut on about 3,300 acres. The

3,303 acres containing a significant number of trees in the VSS 4-6 classes, currently assigned to savanna treatments within Alternative C, will be removed from Alternative C and assigned to their analyzed Alternative E treatments. Alternative E does not include the amendments for the specific definitions for interspaces and groups, therefore while the IT40 and UEA40 are desired they may not be necessarily attainable (See project record for details). These stands, while moving towards savanna, will not attain the savanna desired conditions.

Management on 1,600 For Arizona Game and Fish Department

In response to comments 1,600 acres will be managed according to recommendations from Arizona Game and Fish Department and will have a defined range of groups for AZGF to study wildlife response.

Openness

The variety of treatment types and desired conditions under alternative E would result in reduction to the varying range of openness post treatment. The list of treat types and treated acres displayed for alternative C is the same for alternative E. However, without the forest plan amendments that specifically defines groups and interspaces, the openness will be more evenly spaced and favoring a less open structure (Table 87). Applying treatments in the absence of amendments will, spatially, have the look of a more traditional thinning that has a uniform distribution of tree spacing. Thinning in Uneven-aged silviculture systems entails removals across all diameter ranges without preference for creating groups, interspace, and regeneration openings, other than what is currently a part of the stand structure. The uniform structure of these treatments will mean potentially more active crown fire, shorter treatment life as crowns close quicker, potential for more extreme fire behavior that can lead to larger acreage losses because of larger areas of continuous canopy cover. Alternative E will have less forest edge for wildlife, lower understory vegetative response, and snowpack accumulation will be less with higher sublimation rates. If the treated stands have a current structure that has distinct groups, this stand structure will follow thru to the post-treatment stand and it will have the similar benefits as Alternative B-D.

The 4FRI project does not require forest plan amendments for the Kaibab NF Forest Plan (2014). The KFP will move the forest towards the desired conditions without amendments.

Table 87 lists the post treatment openness within the ponderosa pine cover type for alternative E by restoration unit and sub unit. Overall ranges indicate a diverse condition with openness trending to the closed side of the range. Three percent of the ponderosa pine would be very open, 54 percent open, 28 percent moderately closed and 14 percent closed.

Table 87. Alternative E – Post Treatment Openness Classification for Ponderosa Pine

Restoration Unit-Subunit	Very Open	Open	Moderately Closed	Closed
1-1	1%	63%	30%	6%
1-2	2%	74%	18%	5%
1-3	0%	59%	25%	16%
1-4	1%	63%	21%	15%

Restoration Unit-Subunit	Very Open	Open	Moderately Closed	Closed
1-5	0%	36%	34%	29%
1	1%	49%	29%	21%
3-1	1%	55%	39%	5%
3-2	2%	68%	23%	8%
3-3	1%	55%	27%	16%
3-4	0%	36%	32%	32%
3-5	1%	31%	44%	24%
3	1%	50%	33%	16%
4-2	2%	81%	11%	5%
4-3	6%	60%	22%	12%
4-4	2%	72%	17%	9%
4-5	8%	47%	27%	18%
4	4%	66%	19%	10%
5-1	21%	36%	35%	7%
5-2	7%	70%	20%	3%
5	12%	60%	24%	4%
6-2	1%	77%	16%	5%
6-3	2%	39%	54%	6%
6-4	1%	5%	29%	66%
6	2%	41%	47%	11%
All Ponderosa Pine	3%	54%	29%	14%

Forest Structure and Diversity - Mosaic of interspaces and tree groups of varying sizes and shapes

Table 88 lists alternative E acres by treatment intensity. Thirty-six percent of the area treated is considered high, 23 percent is moderate, 30 percent is low and 11 percent is very low. The lack of Forest Plan amendment that allows for interspaces indicates that these treatments will be more evenly spaced with little or no groups and interspaces on the Coconino NF. The 4FRI project does not require forest plan amendments for the Kaibab NF Forest Plan (2014). The KFP will move the forest towards the desired conditions without amendments.

Table 88. Alternative E summary of ponderosa pine treatment acres by their relative ability to attain a mosaic of interspaces and tree groups.

Treatment Intensity	Treatment Type	Acres	
High	Pine Sage	5,261	
	WUI 55	2,224	
	UEA 40	121,570	
	IT 40	40,272	
	SI 40	13,595	
Total High:		182,923	(36%)
Moderate	MSO Restricted Trt	62,222	
	UEA 25	38,492	
	IT 25	11,871	
	SI 25	6,618	
Total Moderate:		119,202	(23%)
Low	UEA AZGFD Design	4,837	
	UEA 10	17,865	
	IT 10	7,565	
	SI 10	1,914	
	LOPFA Prescribed Fire Only	114,298	
	PFA Prescribed Fire Only	3,172	
	Restricted Prescribed Fire Only	2,354	
Total Low:		152,005	(30%)
Very Low	MSO Target Trt	7,059	
	MSO Threshold Trt	1,892	
	PAC - Mechanical	10,284	
	PFA Nest Stand Prescribed Fire Only	6,836	
	Protected Prescribed Fire Only	20,083	
	Target Prescribed Fire Only	217	
	Threshold Prescribed Fire Only	84	
	No Proposed Treatments	7,254	
Total Very Low:		53,709	(11%)

Forest Structure - All age and size classes represented

The MSO habitat forest structure analysis for alternative E indicates the post treatment distribution of size classes has good representation in the 12-18" and the 18-24" size classes in all habitats. Stocking in the 24" + size class has good representation in the restricted other habitat and is underrepresented in the target/threshold habitat (Table 84). Implementation of group selection as part of the restricted other treatments would result in up to 15 percent of the area trending toward early successional stages, thereby increasing representation of the seedling/sapling age class.

The goshawk habitat structural stage analysis for alternative E indicates overall post treatment VSS distribution in the even-aged goshawk habitats will have good representation of the VSS 1, 3 and 4 age classes, and the VSS 5 age class in the LOPFA; under-representation of the VSS 6 age class and the VSS 5 age class in the PFA; no representation of the VSS 2 age class. The uneven-aged goshawk habitats will have good representation in the LOPFA of VSS 3, 4, 5 and 6 and of VSS 4 and 5 in the PFA; VSS 1 is underrepresented in the LOPFA and VSS 1, 3 and 6 are underrepresented in the PFA; there is no representation of the VSS 2 age class in all habitats (Table 49 through Table 52 and Table 63).

Natural Range of Variability (Alternative E) (Appendix G)

Appendix G graphically represents Natural Range of Variability Comparison by Treatment Type by forest attributes: Minimum, maximum and the weighted average. Forest Attributes are within the Natural range of Variability except for PACS, Goshawk nest areas and MSO Target Threshold Habitats. Pine basal areas remain within historic ranges but trend into the high end of the range as treatment intensities lessen. Treatments within PFAs, PAC's, MSO Restricted, MSO Target, and MSO Threshold trend to the high end or exceed the historic ranges as does the Arizona Game and Fish design. "No Proposed Treatments" areas all exceed the historic ranges of variability's. As the intensity of treatments increase the habitats are structured most closely to the lower end of the historic range of variability. Mechanical treatments plus fire are more effective than fire alone. But fire is an essential element to achieve the best results to move towards desire conditions.

Old Forest Structure Sustained Over Time Across the Landscape

The restoration treatments proposed under alternative E are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Old trees would not be targeted for cutting. Reference the Old Tree Implementation Strategy in Appendix A of this report.

The MSO habitat forest structure analysis for alternative E indicates the post treatment distribution of size classes has good representation in the 18-24" size classes in all habitats. Stocking in the 24" + size class has good representation in the restricted other habitat and is underrepresented in the target/threshold habitat (Table 84).

The goshawk habitat structural stage analysis above indicates the mature and old forest structural stages to be underrepresented in the PFA habitat and LOPFA even-aged stands. Projections show a trend toward improved representation in all habitats (Table 85).

Treatments within areas currently allocated OG will maintain existing old growth structural attributes and are managed to move towards those conditions over time. The old growth analysis above indicates old growth structural attributes will continue to develop and improve across the landscape (Table 86).

With the implementation of restoration treatments under alternative E, the sustainability of the large/old tree component across the landscape will be improved as presented in the following forest health discussion.

Forest Health

Density related mortality –

Stand density in 2020 in the MSO restricted other habitat (Table 84) would have an overall average 37% of maximum density (range 30-39) putting these stands at the low end of the high density zone as described in Table 7. The restricted other habitat consists of mixed species pine/oak stands. The pine component within this habitat is estimated to have density within the low to moderate zone. The majority of target/threshold and protected habitat would remain in zone 4 due to the oak stocking and dense forest desired conditions in these habitats. Any areas with mechanical treatments within these habitats would experience reduced density related mortality compared to the no action alternative.

In goshawk habitat, Table 48 (as a representation of both alternative C and E conditions) shows 2020 ponderosa pine density levels average 27% of maximum density within nest/PFA habitat and 21% in LOPFA habitat. These density levels are within the low to moderate density zones (Table 7). In 2050, overall averages indicate both habitats to be within the moderate density zone with a few of the nest/PFA SUs being on the low end of high density and well below the threshold for the onset of density related mortality.

Bark beetle related mortality –

Table 89 lists the beetle hazard rating for the years 2020 and 2050 by RU and for the ponderosa pine analysis area. The overall hazard in 2020 is high across 23% of the analysis area. This increases to 56% in 2050. Stands with a hazard rating of low or moderate would be expected to be resistant to successful bark beetle attack and large-scale mortality. In the current climate change scenario, alternative E mitigates the beetle hazard.

Table 89. Alternative E Estimated Post Treatment and Long Term Beetle Hazard Rating (Percent of Area)

Hazard Rating	RU 1	RU 3	RU 4	RU 5	RU 6	% of Total	Analysis area Acres
2010							
Low	3%	6%	8%	26%	0%	7%	37,933
Moderate	12%	11%	27%	46%	25%	21%	106,132
High	85%	83%	65%	28%	75%	72%	363,775
2020							
Low	30%	37%	57%	45%	38%	41%	209,783
Moderate	35%	31%	32%	49%	43%	36%	181,250
High	35%	31%	11%	6%	19%	23%	116,806
2050							
Low	1%	1%	3%	25%	2%	5%	23,099
Moderate	28%	34%	55%	51%	30%	40%	200,633
High	71%	65%	42%	24%	68%	56%	284,108

Dwarf mistletoe infection –

Table 90 lists the dwarf mistletoe infection level and average percent of trees infected for the years 2020 and 2050 by RU and for the ponderosa pine analysis area. For 2020, approximately 59 percent of the area is not infected or has a low infection level and 40 percent has a moderate to high infection level. The overall average percent of trees infected is 7 percent in the none/low group and 45 percent in the moderate/high group. There is no 2020 difference in dwarf mistletoe infection levels between alternative A and E. The percentages for 2050 indicate mistletoe infection is intensifying and spreading at a slower rate than alternative A.

Table 90. Alternative E Estimated Post Treatment and Long Term Dwarf Mistletoe Infection Level

Infection Level		RU 1	RU 3	RU 4	RU 5	RU 6	Analysis area
2010							
None/Low	Percent of Area	53%	57%	73%	92%	82%	66%
None/Low	Average Percent Trees Infected	5%	6%	4%	10%	5%	6%
Moderate/High	Percent of Area	47%	43%	26%	8%	18%	38%
Moderate/High	Average Percent Trees Infected	38%	33%	38%	41%	42%	36%
Extreme	Percent of Area	1%	0%	0%	0%	0%	0%
Extreme	Average Percent Trees Infected	86%	86%	85%			86%
2020							
None/Low	Percent of Area	46%	46%	71%	79%	81%	62%
None/Low	Average Percent Trees Infected	6%	6%	6%	11%	7%	7%
Moderate/High	Percent of Area	53%	54%	29%	21%	19%	38%
Moderate/High	Average Percent Trees Infected	47%	40%	50%	35%	59%	45%
Extreme	Percent of Area	1%	0%	0%	0%	0%	<1%
Extreme	Average Percent Trees Infected	88%	91%	90%			89%
2050							
None/Low	Percent of Area	42%	45%	67%	68%	81%	59%
None/Low	Average Percent Trees Infected	6%	7%	7%	11%	7%	7%
Moderate/High	Percent of Area	56%	55%	32%	32%	15%	41%
Moderate/High	Average Percent Trees Infected	49%	44%	52%	33%	59%	47%
Extreme	Percent of Area	1%	0%	0%	0%	4%	<1%
Extreme	Average Percent Trees Infected	87%	91%	89%		81%	85%

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 alternative E.

Within forest carbon stocks would be reduced under alternative E. 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 within the estimated 367,737,165 cubic feet of biomass removed by mechanical thinning would be sequestered for a time in the form of building materials.

Vegetation Diversity and Composition

Grasslands

Alternative E would restore historic grasslands that are not classified as timber suitable lands, savannas and forest openings by removing ponderosa pine tree canopy that is shading out understory herbaceous vegetation and reducing forage production and species diversity as follows:

- 47,915 acres of grassland mechanical treatments within grassland cover type;
- 334,306 acres of ponderosa pine restoration treatments in PFA, LOPFA and MSO restricted other habitats enhancing small grassland inclusions within the greater forested area. The lack of Forest Plan amendments that allows for interspaces indicates that these treatments will be more evenly spaced with little or no groups and interspaces on the Coconino NF. The 4FRI project does not require forest plan amendments for the Kaibab NF Forest Plan (2014). The KFP will move the forest towards the desired conditions without amendments.

Oak treatments proposed in alternative E are designed to conserve oak and improve conditions that favor oak growth and establishment wherever it exists by reducing pine-oak competition. This would result in improved vigor of existing oak and establishment of a variety of oak size and age classes across the landscape. These conditions would be most prevalent within the 62,222 acres of MSO restricted other habitat treatments. Table 84 shows the overall post treatment oak basal area would be 5 percent higher in this habitat compared to the no action alternative.

Aspen

The treatments within 1,450 acres of aspen stands under alternative E are designed to maintain and/or regenerate aspen by reducing pine-aspen competition. These treatments would result in establishment of vigorous aspen regeneration free of competition from overtopping ponderosa pine.

Pine Sage

The 5,261 acres of pine-sage thinning treatments are designed to remove post settlement pine that currently is overtopping and shading out the sage and to manage fire to enhance sage extent. These treatments would result in enhancement of the sage component within the pine sage mosaic.

Other Direct and Indirect Effects:

Residual Tree Damage

Some damage to residual trees would be expected in alternatives E with the felling, tractor yarding and piling operations associated with mechanical treatments in ponderosa pine on 403,218 acres (Table 81). Alternative E would result in the most potential damage because of the extensive harvesting using individual tree selection in overly dense stands. Damage would be minimized through contract administration 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).

Tractor Yarding and Fuel Treatment

All merchantable harvested material would be whole-tree tractor yarded from the mechanical treatment units. Fuel treatments proposed for Alternative E includes pile burning, broadcast burns and fireline construction. Some damage to the residual trees would be expected with the felling, tractor yarding and piling operations within 581,020 acres of ponderosa pine mechanical treatments. Damage would be minimized through contract administration and proper harvest methods. All piling and/or low-severity burning treatments on 563,407 (p pine) acres would reduce understory stocking and reduce inter-tree competition as well as stimulate understory vegetation (shrubs, forbs, grasses). Fireline placement would use existing features with naturally low fuels, skid trails, roads etc. as much as possible. Actual fireline construction would remove herbaceous material to bare mineral soil up to a 6 foot width.

Timber and Wood Products

A Coconino FP goal is to manage the timber resource to provide a sustained-yield of forest products (CFP plan pg. 23). A Kaibab FP goal is to manage suitable timberland to provide a sustained level of timber outputs to support local dependent industries (KFP pg. 18). Timber harvest of 245,343,350 cubic feet of biomass from the Coconino and 122,393,816 cubic feet of biomass from the Kaibab is a direct beneficial effect of Alternative E.

Road Maintenance, Decommissioning, Reconstruction, Opening, and Temp Road Construction

Road maintenance within the existing road prism would have no effect on the health and growth of the leave trees within the treatment units. Road decommissioning of 904 miles of existing system and unauthorized roads would allow ingrowth of forest vegetation once the road is decommissioned (approximately 2,712 acres). Constructing 245 miles of temporary roads will remove trees and forest vegetation within the road right of ways (approximately 735 acres). Opening 272 miles of decommissioned roads may remove trees and forest vegetation that has become established within the road right of way since the road was last maintained (approximately 816 acres). Road reconstruction consists of road improvement activities and road realignments activities. Road realignment of 10 miles of road would remove approximately 30 acres of trees and forest vegetation within the area being reconstructed. 30 miles of road improvement is expected to occur on small discreet areas and is expected to remove about 100 acres of forest vegetation. The above listed effects cover the maximum range of management actions. Possible management actions includes: Reestablish former drainage patterns, stabilizing slopes, and restore vegetation; Block the entrance to a road or installing water bars; Remove

culverts, reestablish drainages, remove unstable fills, pull back road shoulders, and scatter slash on the roadbed; Completely eliminate the roadbed by restoring natural contours and slopes; and Other methods designed to meet the specific conditions associated with the unneeded road.

Aspen Fencing and Barriers

Up to 82 miles protective barriers would be established around aspen clone patches within the ponderosa pine forest. Barriers would consist of fencing and/or felling trees (jack-strawing). Fencing would occur after mechanical and burning treatments and would have no effect to the vegetation. Jack-strawing may occur during the mechanical operation and would utilize trees that have been targeted for removal to meet treatment objectives. Leaving felled material on the ground would forego the opportunity to use that material for wood products.

Restoration of Springs and Ephemeral Channels

Springs and ephemeral channels are inclusions within the mechanical and burn analysis areas. Any tree removal that occurs as part of the restoration of these areas would be part of the design for those mechanical treatments that occur around these areas and the effects to the forest vegetation would be similar to the overall treatment. Up to 4 miles of protective fencing would be established around restored springs. Fencing would have no effect to the vegetation. Bank re-contouring and stabilization would occur along 39 miles of ephemeral channels. This activity would disturb existing forest vegetation. Up to 5 miles of willow re-establishment would occur where evidence indicates historic willow presence. This would create vegetation diversity and allow natural willow expansion into adjacent areas of suitable habitat. The above listed effects cover the maximum range of management actions. Possible management actions for springs include: Remove tree canopy to pre-settlement condition within 2-5 chains of the spring; Apply for water right if none exists; remove noxious weeds; Prescribe burn; Identify stressor and provide protection measure for the stressor (fence, jackstraw, remove/relocate road/trail etc.); And/or other methods designed to meet the desired conditions.

2014 Kaibab National Forest: Forest Plan Consistency: Alternative E

Alternative E incorporates key components of the Old Tree Protection Strategy into the alternative's implementation plan (Appendix A). The Forest Service worked collaboratively with stakeholders to develop implementation plan. Although there is no canopy cover guidance in the current Kaibab Forest Plan, there is guidance for canopy cover management in the Implementation Plan in the EIS (Appendix D), including approximately 46,091 acres that will have canopy cover measured at the stand level. This is consistent with the guidance for ponderosa pine within the Forest Plan.

Special Case Canopy Cover – Alternatives C and E

In response to comments and feedback on the DEIS , on approximately 38,256 acres (22,772 acres on the Coconino and 15,484 acres on the Kaibab NF) of UEA 40, UEA 25, and non-WUI stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean BA greater than 70 of the VSS 4 size class and a mean TPA less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. After further public comments an additional 7,835 acres of IT10 and UEA 10 treatments were included for this section, for a total of 46,091 acres. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-WUI

stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the planned prescription intensity range, managing for larger group sizes, and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and will achieve 40 percent canopy cover at the stand scale.

Maintaining high canopy cover percentages across the stand will necessitate maintaining high stocking basal area, high trees per acre, and high SDI. Currently the 38,256 acres encompasses 1,096 stands averaging 143.4 BA, 508.6 TPA, and 281.5 SDI (62.5% of max SDI: SDIMax = 450). This will result in continuous canopy cover over most of the stand which will increase the risk of density related mortality and crown fire risk above most other restoration treatments.

On the stands treated in Table 99 prescriptions would be implemented to the lower intensity level were possible while trying to maintain stand structure at the upper ends of the NRV, with an intent to maintain 40% canopy cover. It is not proposed to change treatment types but to instead to maintain the planned treatments but to limit the treatment intensity such that the silviculturist favor the less intense range of the treatment planned and analyzed.

Management on 3,303 Acres of Proposed Savanna Treatments

In response to comments from the public there continues to be a conversation on large trees, issue 2. In response to comments and feedback, Alternative E best meets the concern because no savanna treatments are proposed. The implementation plan, as it relates to alternative E has been updated to clarify that most VSS 4, VSS 5 and VSS 6 would not be cut on about 3,300 acres. The 3,303 acres containing a significant number of trees in the VSS 4-6 classes, currently assigned to savanna treatments within Alternative C, will be removed from Alternative C and assigned to their analyzed Alternative E treatments. Alternative E does not include the amendments for the specific definitions for interspaces and groups, therefore while the IT40 and UEA40 are desired they may not be necessarily attainable (See project record for details). These stands, while moving towards savanna, will not attain the savanna desired conditions.

Summary of Direct and Indirect Effects

Table 91 provides a summary of the alternatives and the potential effects of implementing each alternative considered in detail. Information in the table focuses on effects related to the purpose and need for the project specific to the vegetation resource and summarizes the detailed discussion of the effects above.

Table 91. Comparison of Effects by Alternative

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Vegetation Structure							
Age and Size Class		Uneven-aged. Distribution of age-classes that comprise a sustainable balance of structural stages.	Even-aged remain even-aged. Uneven-aged trending toward even-aged Dominant representation in the young and mid-aged structural stages Low representation in the grass/forb/shrub, seedling/sapling, mature and old structural stages.	Even-aged trending toward Uneven-aged. Uneven-aged maintained as Uneven-aged Dominant representation in the young and mid-aged structural stages. Improved representation in the grass/forb/shrub, seedling/sapling, mature and old structural stages. Trending toward a balance of structural stages.	Even-aged trending toward Uneven-aged. Uneven-aged maintained as Uneven-aged Dominant representation in the young and mid-aged structural stages. Improved representation in the grass/forb/shrub, seedling/sapling, mature and old structural stages. Trending toward a balance of structural stages.	Even-aged trending toward Uneven-aged. Uneven-aged maintained as Uneven-aged Dominant representation in the young and mid-aged structural stages. Improved representation in the grass/forb/shrub, seedling/sapling, mature and old structural stages. Trending toward a balance of structural stages.	Even-aged trending toward Uneven-aged. Uneven-aged maintained as Uneven-aged Dominant representation in the young and mid-aged structural stages. Improved representation in the grass/forb/shrub, seedling/sapling, mature and old structural stages. Trending toward a balance of structural stages.

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Spatial Arrangement	Continuous tree canopy with generally small interspace inclusions	Mosaic of interspaces and tree groups of varying sizes and shapes	Similar to existing. Trending toward reduction of interspace.	Treatment acres with relative ability to attain mosaic of interspaces and tree groups: Very Low – 47,157 Low – 120,363 Moderate – 122,963 High – 216,725	Treatment acres with relative ability to attain mosaic of interspaces and tree groups: Very Low – 52,007 Low – 126,074 Moderate – 121,050 High – 211,215	Treatment acres with relative ability to attain mosaic of interspaces and tree groups: Very Low – 27,182 Low – 120,363 Moderate – 122,963 High – 216,725	Treatment acres with little ability to attain mosaic of interspaces and tree groups: Very Low – 52,007 Low – 126,074 Moderate – 121,050 High – 211,215
Heterogeneity (Openness within ponderosa pine cover type)	Very Open and Open – 22 percent Moderately Closed – 29 percent Closed – 45 percent Unknown – 3 percent	Ranges from very open to closed. Desired openness determined by soils and site potential.	Similar to existing condition. Trending toward closed.	Very Open – 11 percent Open – 31 percent Moderately Closed – 42 percent Closed – 15 percent Unknown – 1 percent	Very Open – 11 percent Open – 30 percent Moderately Closed – 42 percent Closed – 17 percent Unknown – 0 percent	Very Open – 11 percent Open – 31 percent Moderately Closed – 42 percent Closed – 11 percent Unknown – 5 percent	Very Open – 11 percent Open – 30 percent Moderately Closed – 42 percent Closed – 17 percent Unknown – 0 percent

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Forest Health							
Stand Density	Percent of maximum SDI by Habitat: MSO Protected – 78 percent MSO Target/Threshold – 85 percent MSO Restricted – 69 percent NOGO Nest/PFA – 45 percent NOGO LOPFA – 40 percent	Density within ponderosa pine forests is below the zone where density related mortality is prevalent (<56 percent of maximum SDI). Managed, Uneven-aged forests range from 15-40 percent of maximum SDI.	Percent of maximum SDI by Habitat: MSO Protected – 80 percent MSO Target/Threshold – 86 percent MSO Restricted – 72 percent NOGO Nest/PFA – 47 percent NOGO LOPFA – 43 percent	Percent of maximum SDI by Habitat: MSO Protected – 72 percent MSO Target/Threshold – 75 percent MSO Restricted – 37 percent NOGO Nest/PFA – 27 percent NOGO LOPFA – 21 percent	Percent of maximum SDI by Habitat: MSO Protected – 71 percent MSO Target/Threshold – 71 percent MSO Restricted – 37 percent NOGO Nest/PFA – 27 percent NOGO LOPFA – 21 percent	Percent of maximum SDI by Habitat: MSO Protected – 74 percent MSO Target/Threshold – 76 percent MSO Restricted – 46 percent NOGO Nest/PFA – 30 percent NOGO LOPFA – 24 percent	Percent of maximum SDI by Habitat: MSO Protected – 71 percent MSO Target/Threshold – 71 percent MSO Restricted – 37 percent NOGO Nest/PFA – 27 percent NOGO LOPFA – 21 percent
Insect and Disease	Beetle Hazard Rating: Low – 8 percent Moderate – 21 percent High – 71 percent Dwarf mistletoe infection level: None/Low – 66 percent Moderate/High – 34 percent Extreme - <1 percent	Forest conditions are resilient to insect and disease. Insect and disease populations are at endemic levels.	Beetle Hazard Rating: Low – 4 percent Moderate – 13 percent High – 83 percent Dwarf mistletoe infection level: None/Low – 59 percent Moderate/High – 41 percent Extreme - <1 percent	Beetle Hazard Rating: Low – 38 percent Moderate – 36 percent High – 26 percent Dwarf mistletoe infection level: None/Low – 61 percent Moderate/High – 39 percent Extreme - <1 percent	Beetle Hazard Rating: Low – 38 percent Moderate – 36 percent High – 26 percent Dwarf mistletoe infection level: None/Low – 60 percent Moderate/High – 40 percent Extreme - <1 percent	Beetle Hazard Rating: Low – 28 percent Moderate – 26 percent High – 45 percent Dwarf mistletoe infection level: None/Low – 60 percent Moderate/High – 40 percent Extreme - <1 percent	Beetle Hazard Rating: Low – 28 percent Moderate – 26 percent High – 45 percent Dwarf mistletoe infection level: None/Low – 60 percent Moderate/High – 40 percent Extreme - <1 percent

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Vegetation Diversity and Composition							
Gambel oak	Acres of pine-oak MSO habitat: 112,546	Conserve oak and improve conditions that favor oak growth and establishment.	Treatment acres that would actively reduce pine-oak competition: 0 acres Treatment acres within pine-oak MSO habitat that would release large oak: 0 acres	Treatment acres that would actively reduce pine-oak competition: 65,024 acres. Treatment acres within pine-oak MSO habitat that would release large oak: 84,177	Treatment acres that would actively reduce pine-oak competition: 63,191 acres. Treatment acres within pine-oak MSO habitat that would release large oak: 82,344	Treatment acres that would actively reduce pine-oak competition: 65,024 Treatment acres within pine-oak MSO habitat that would release large oak: 84,177	Treatment acres that would actively reduce pine-oak competition: 63,191 acres. Treatment acres within pine-oak MSO habitat that would release large oak: 82,344
Aspen	Acres of aspen patches within ponderosa pine forest: 1,471	Maintain and/or regenerate aspen patches	Treatment acres within aspen patches: 0 acres	Treatment acres within aspen patches: 1,452 acres	Treatment acres within aspen patches: 1,471 acres	Treatment acres within aspen patches: 1,452 acres	Treatment acres within aspen patches: 1,471 acres

Indicator	Existing Condition	Desired Condition	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Grasslands	Acres of encroached grasslands: 48,196 acres Acres of historic grasslands (ponderosa pine cover type on mollisol soils): 14,665 acres Acres of savannas (ponderosa pine cover type on mollic integrate soils with open reference condition): 302,926 acres	Restore grasslands and savannas; Enhance historic grassland inclusions within greater forested area.	Treatment acres within encroached grasslands: 0 acres Treatment acres within historic grasslands: 0 acres Treatment acres within savannas: 0 acres Treatment acres within PFA, LOPFA and MSO restricted habitat that would enhance grassland inclusions: 0 acres	Treatment acres within encroached grasslands: 0 acres Treatment acres within historic grasslands: 11,185 acres Treatment acres within savannas: 45,469 acres Treatment acres within PFA, LOPFA and MSO restricted habitat that would enhance grassland inclusions: 310,917 acres	Treatment acres within encroached grasslands: 48,196 acres Treatment acres within historic grasslands: 11,230 acres Treatment acres within savannas: 45,469 acres Treatment acres within PFA, LOPFA and MSO restricted habitat that would enhance grassland inclusions: 308,199 acres	Treatment acres within encroached grasslands: 0 acres Treatment acres within historic grasslands: 11,185 acres Treatment acres within savannas: 45,469 acres Treatment acres within PFA, LOPFA and MSO restricted habitat that would enhance grassland inclusions: 305,657 acres	Treatment acres within encroached grasslands: 48,196 acres Treatment acres within historic grasslands: 11,230 acres Treatment acres within savannas: 45,469 acres Treatment acres within PFA, LOPFA and MSO restricted habitat that would enhance grassland inclusions: 308,199 acres
Pine-Sage	Acres with pine-sage potential vegetation type: 16,000	Maintain and enhance the sage understory and restore the historic overstory/understory pattern within the pine-sage mosaic.	Treatment acres the within pine-sage potential vegetation type: 0 acres	Treatment acres the within pine-sage potential vegetation type: 5,262 acres	Treatment acres the within pine-sage potential vegetation type: 5,262 acres.	Treatment acres the within pine-sage potential vegetation type: 5,262 acres.	Treatment acres the within pine-sage potential vegetation type: 5,262 acres.
Ponderosa Pine Acres Moving Toward Landscape-Scale Forest Resiliency and Function (ponderosa pine acres with improved vegetation structure, forest health and vegetation diversity and composition).			0 acres	501,208 acres	510,346 acres	487,233 acres	510,346 acres

Alternatives A through E - Effects of Not Amending the Coconino Forest Plan (Table 91)

The following is a description of how the forest plan amendments for the Coconino NF Forest Plan under this EIS would modify the forest plan standards and guidelines and what the effects to the vegetation resource would be if the amendment did not occur.

Alternatives A and E

- Alternative A is the “No Change” alternative and plan amendments are not necessary.
- Alternative E was added after the DEIS public comments and it has no forest plan amendments.
- If Amendment #1 were not applied: 1) Mechanical treatments above 9-inch d.b.h. would limit the removal of ladder and canopy fuels which would not reduce the fire risk in the 18 PACs (to the extent possible); 2) would not define a monitoring protocol; 3) would not redefine Target and Threshold Habitat; and 4) would not remove PAC treatment limits.
- If amendment #2 were not applied: 1) No desired percentage of interspaces would be added; 2) No language clarifying where canopy cover is and is not measured would be added; 3) Zero acres would be managed for up to 90 percent open with less than 3 to 5 reserve trees; and 4) No definition of interspace and stands would be added, 5) tree groups would be undefined, and 6) regeneration openings would not be defined.
- If amendment #3 were not applied: 1) The amendment deletes the standard that would require achieving a “no effect” determination and adds the words “or no adverse effect” to the remaining standard. In effect, management strives to achieve a “no effect” or “no adverse effect” determination.

Amendment #1 Coconino NF Alternative B

Mechanical Treatment Up to 16-inch d.b.h. in select PACs (6,906 acres)

- MSO PAC field reviews, data evaluation, and vegetation simulation modeling indicated 18 MSO PACs (approximately 3,378 acres) would move toward revised MSO Recovery Plan desired conditions from mechanically cutting trees up to 9-inch d.b.h. Treatments up to 9-inch d.b.h. are consistent with the current Coconino NF forest plan.
- If amendment 1 was not applied the following would not occur: An additional 6,906 acres within 18 PACs would have nesting and roosting habitat benefits from cutting trees up to 16-inch d.b.h. Mechanical treatments above 9-inch d.b.h. would facilitate the removal of ladder and canopy fuels which would reduce the fire risk in the 18 PACs (to the extent possible). Increasing the range of the mechanical treatment thresholds up to 16-inch d.b.h. within 18 MSO PACs would provide for a higher degree of stand structure improvements to nesting and roosting habitat. The treatments (as allowed by the amendment) would address comments from the FWS and meet the intent of the Revised MSO Recovery Plan by improving nesting roosting habitat (USDIFWS 2012).

Amendment #1 Coconino NF Alternative C

Mechanical Treatment Up to 17.9-inch d.b.h. in Select PACs (6,942 acres)

- MSO PAC field reviews, data evaluation, and vegetation simulation modeling indicated 18 MSO PACs (approximately 3,378 acres or 10 percent of all PACs acres within the analysis area) would move toward recovery plan desired conditions from mechanically cutting trees up to 9-inch d.b.h. Treatments up to 9-inch d.b.h. are consistent with the forest plan. See the wildlife specialist report “Methodology” section for complete details on the habitat evaluation process.
- An additional 6,942 acres within 18 PACs would have nesting and roosting habitat benefits from cutting trees up to 17.9-inch d.b.h. Mechanical treatments above 9-inch d.b.h. would facilitate the removal of ladder and canopy fuels which would reduce the fire risk in the 18 PACs (to the extent possible). Increasing the range of the mechanical treatment thresholds up to 18-inch d.b.h. within 18 MSO PACs would provide for a higher degree of stand structure improvements to nesting and roosting habitat. The proposal addresses comments from the FWS and is in alignment with the revised MSO recovery plan (USDIFWS 2012).

Prescribed Fire Within 54 PAC Core Areas (About 5,400 acres)

- In order to improve habitat conditions outside of the 100-acre core area within 54 PACs, there is a need to use prescribed fire within select PAC core areas. Without the use of low-intensity prescribed fire within the core, each core area would need to have fire line constructed around it to prevent fire from entering the nest site during treatment in the surrounding PAC habitat. Depending on site and weather conditions, this could be anything from a 3-foot-wide hand line to a dozer line. The number of acres potentially affected from fire line activities within PACs would likely range from 0.80 (hand line) acre to 3.2 (dozer) acres. Most fire line would require post-treatment habitat rehabilitation.
 - Burning in MSO PACs is difficult as there is a need to address the high fuel loadings while maintaining many of the habitat elements that contribute to fuel loading. Burning has to be conducted in a very short timeframe to avoid the breeding season (i.e., the nonbreeding season – September 1 to February 28). Applying low intensity prescribed burning within the 100-acre core areas would eliminate the need for fire line construction and would potentially minimize impacts to protected habitat.

Manage 6,299 Acres of MSO Restricted Target and Threshold Habitat for a Minimum of 110 to 150 Basal Area

- The development of 6,299 acres of restricted target and threshold habitats would be managed toward meeting a 110 to 150 basal area for MSO nest and roost habitat as recommended in the revised MSO recovery plan (USDIFWS 2012).
 - It would allow more of the uncharacteristic in-growth of mid-aged and mid-sized trees that currently dominate the 4FRI landscape to be removed while retaining nesting and roosting habitat components. Thinning more of these trees would improve forest health, increasing the ability to retain large trees and increase large tree growth rates as described in the revised recovery plan (USDIFWS 2012). This would increase forest spatial heterogeneity, improve tree age

diversity, and benefit prey habitat. These changes would both increase and retain nesting and roosting structure and increase understory cover.

Amendment #1 Coconino NF Alternative D

- This amendment is the same as described for alternative B in that the amendment allows mechanical treatment up to 16-inch d.b.h. in 18 PACs MSO PACs. Although alternative D reduces the acres that would receive prescribed fire, the amendment would still be required to address mechanical treatment above 9-inch d.b.h., eliminating incremental treatments within PACs, and deferring monitoring to the project's FWS biological opinion.

Amendment #2 Coconino NF Alternatives B, C, D

Management of Canopy Cover and Ponderosa Pine with an Open Reference Condition within Goshawk Habitat (Coconino NF)

In the “Vegetation Management – Landscapes Outside Goshawk Post-fledgling Family Areas” and “Vegetation Management –Within Post-fledgling Family Areas” section of the forest plan, a site-specific, non-significant plan amendment would: (1) add the desired percentage of interspace within uneven-aged stands to facilitate restoration, (2) add the interspace distance between tree groups, (3) add language clarifying where canopy cover is and is not measured, (4) allow 28,952 acres to be managed for an open reference condition (which affects canopy cover guidelines for VSS 4 through VSS 6 groups and reserve trees), and (5) add a definition to the forest plan glossary for the terms interspaces, open reference condition, and stands.

- The forest plan directs projects to manage for uneven-aged stand conditions within goshawk habitat. The elimination of this amendment as cited in 1) above does not clarify the relationship between interspaces and natural openings and the group structure of a restored ponderosa pine forest. This lack of interspace leads to a reduced response by grasses and forbs (Naumburg et al, 2001 and Naumburg et al, 1999), reduces the opportunities to establish regeneration areas, does not mitigate fire risks, does not aid the hydrologic function of the site, reduces the accumulation of snow pack (Hedstrom et al 1998 and Storck et al 2002)) and maintains a high rate of snow ablation and loss of moisture to the forest floor (Poneroy et al, The forest plan directs projects to manage for uneven-aged stand conditions within goshawk habitat. Forested groups consist of an interspersed of six vegetation structural stages (VSS 1 to VSS 6). For the purposes of this amendment, the following definitions apply:
- **Stands** are defined as a contiguous area of trees sufficiently uniform in forest type, composition, structure, and age class distribution, growing on a site of sufficiently uniform conditions to be a distinguishable unit. Four classification characteristics are generally used to distinguish forest stands: biophysical site (soils, aspect, elevation, plant community association, climate, etc.), species composition, structure (density, and age (1-aged, 2-aged, uneven-aged)), and management emphasis (administrative requirements and local management emphasis that will shape structure over time). Based upon Agency guidelines, the minimum stand mapping size is 10 acres.
- **Interspaces** are defined as the open space between tree groups intended to be managed for grass/forb/shrub vegetation during the long term. Interspaces may include scattered single trees.

- **Open reference condition** is defined as forested ponderosa pine areas with typically, but not exclusively, mollic-integgrade soils to be managed as a relatively open forest with trees typically aggregated in small groups within a grass/forb/shrub matrix.

Amendment #3 Coconino NF Alternatives B, C, and D

Effect Determination for Cultural Resources (Coconino NF)

- Amendment 3 is a specific, one-time variance for the Coconino NF restoration project. Once the project is complete, current forest plan direction would apply to the project area. The language proposed does not apply to any other forest project. The amendment would be authorized per direction in the National Forest Management Act of 1976 (NFMA) and its implementing regulations found in 36 CFR 219 (1982).
- The amendment deletes the standard that addresses achieving a “no effect” determination and adds the words “or no adverse effect” to the remaining standard. Management strives to achieve a “no effect” or “no adverse effect” determination.
 - If the amendment did not occur, it could potentially result in areas not being treated in order to attain a “no effect” determination. Without treatment, these areas would not move toward desired conditions in terms of creating a mosaic of interspaces and tree groups of varying shapes and sizes, enhancing the representation of all age and size classes, sustaining old forest structure across the landscape, improving forest health and enriching vegetation diversity and composition.
 - If the amendment did not occur: 1) Treatments within MSO habitat would continue to meet the intent of the MSO recovery plan and the MSO habitat definition will not have an effect on the treatments themselves or their outcomes; 2) Managing for 10% threshold habitat within the KFP portion of the project area could result in habitat that is not capable of maintaining a population of MSOs and that could not be sustained through time being designated as threshold; 3) Mechanical treatments within the 2,090 acres of target/threshold habitat would follow the denser 150 ft² basal area guidance thereby reducing the ability to improve MSO nesting/roosting habitat in terms of sustainability, as indicated by high potential for density related mortality and high bark beetle hazard rating as well as reducing the ability to improve age class diversity and the liberation of overtopped oak; 4) Following existing Coconino Forest Plan language concerning MSO population and habitat monitoring or MSO habitat design will not have an effect on the treatments themselves or their outcomes.

Summary of Mosaic of Interspaces and Tree Groups of Varying Sizes and Shapes

Mosaic of Interspaces and Tree Groups of Varying Sizes and Shapes

While all treatments, with the exception of grassland restoration, were designed to restore forest openings and attain a mosaic of interspaces and tree groups of varying sizes and shapes, the intensity of the treatment affects the relative tendency toward this desired condition.

In Alternative A, the no change alternative, no treatments would be implemented to create a mosaic of interspaces and tree groups. Existing interspace would continue to be reduced by expanding tree crowns and increased tree densities. Understory vegetation response would be suppressed. Fire risks would not be reduced and would continue to increase. Any large scale tree mortality occurring has the potential to enhance interspace and create tree groups.

In Alternative B and D, 42 percent of the area treated would be considered high intensity treatments, 24 percent would be moderate intensity treatments, 24 and 25 percent would be low intensity treatments, and 10 percent would be very low intensity treatments. While the percentage distribution between intensity levels are similar the acres treated by each individual treatment with the intensity levels is different. Comparing Table 53 and Table 75 in the Silviculture report there is a difference between the acres for “Protected Prescribed Fire Only” (Alt B=20,083 and Alt D=836) and “No Proposed Treatments” (Alt B=5,016 and Alt D=24,263). All other treatment acres are the same and the post-treatment results are similar. The increased use of prescribe fire in Alt B is beneficial while the increased “no proposed treatments” in Alt D is non-beneficial and does not move the acres towards the desired conditions.

In Alternative C 41 percent of the area treated would be considered high intensity treatments, 24 percent would be moderate intensity treatments, 25 percent would be low intensity treatments, and 10 percent would be very low intensity treatments. These results are similar to Alternatives B & D. However, the distribution of the individual treatments within the Treatment Intensity levels differ considerably (Table 63, Silviculture Report). In response to public comments, Alternative C reduced acres in the High Intensity category (Alt B & D=215,224 and Alt C=210,472 acres) and instead treated them in the Moderate, Low, and Very Low Treatment Intensity categories (Moderate Alt B & D=121,743 and Alt C=119,766; Low Alt B & D= 119,956 and Alt C=124,577; Very Low Alt B & D=50,915 and Alt C=50,025). Alternative C also includes 4,875 acres of suggested treatment acres from the Arizona Game and Fish Department. Alternative C benefits from the increased use of prescribed fire and reduces the acres left with no treatments. This Alternative moves more acres into or towards the desired results than other alternatives.

In Alternative E, 36 percent of the area treated would be considered high intensity treatments, 23 percent would be moderate intensity treatments, 30 percent would be low intensity treatments, and 11 percent would be very low intensity treatments. This treatment shows the greatest differences among Alternatives B-D. Alternative E was developed between the DEIS and FEIS in response to public comments. Alternative E treats more acres (Table 88) (Alt E = 581,020 vs approximately Alt B, C, D=507,838). However, Alternative E does not use any forest plan amendments as found in Alternative B-D for the Coconino NF. The resulting effects of treatment outcomes is noticeable in the lack of groups and interspaces as outlined in the amendments. Without the establishment of groups and interspaces the effectiveness of treatments is reduced; understory vegetation response is reduced, risk of crown fire is increased, hydrologic function is not restored, snowfall sublimation is increased and snowbank accumulations are reduced, high bark beetle hazard rating is not mitigated. The treatments do not move the forest towards the restoration desired conditions.

Amendments are only proposed for the Coconino NF because the Kaibab NF has a new plan that encompasses the concept of restoration, and the 4FRI project is compliant with this plan without the need for additional amendments. The Kaibab NF Forest Plan will move the forest towards the desired conditions for the 4FRI project.

Summary of Openness

A key characteristic of historical ponderosa pine 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. Classifications of openness are as follows:

- **Very Open = 70-90% Interspace**
- **Open = 40-70% Interspace**
- **Moderately Closed = 25-40% Interspace**
- **Closed = <25% Interspace**

The concept of interspaces (openness), maybe more than anything else, helps to define the stand structure of the desired conditions. With the reduction in, or loss of, interspaces, we get the dense fire-prone stand structures we see today. Without the interspaces we do not reestablish and restore forest structure and pattern, forest health, and vegetation composition and diversity, we do not increase forest resiliency and sustainability, nor do we protect soil productivity or improve soil and watershed function.

To understand the change in interspaces it is necessary to define the current stand structure. Pre-treatment openness acres across the projects 507,839 acres (Table 10, Silviculture Report) are summarized as follows:

Restoration Unit-Subunit	Very Open	Open	Moderately Closed	Closed
All Ponderosa Pine (Alt A)	3%	22%	29%	46%

Alternative A (Post-treatment openness)

There would be no change in openness under Alternative A (Table above) and the ability to maintain openings and groups would be reduced. Interspaces lack definitive definitions under Alternative A and without significant interspaces, tree densities (basal area, trees per acre, stand density index, canopy closure) will all increase and continue to move away from the desired conditions for most areas. Fire risks and fuel loadings will continue to increase beyond acceptable values as densities and canopy closures increase. Density related mortality, insects, and diseases would be more prominent under this alternative.

Alternative B & D (Post-treatment openness)

Alternative B is a combination of mechanical treatments with prescribed fire and the use of prescribed fire only (Table 56 and 78, Silviculture Report). The differences between Alternatives B-D are the mix of treatments applied across the acres. Post-treatment openness for Alternatives B & D looks like:

Restoration Unit-Sub Unit	Very Open	Open	Moderately Closed	Closed
All Ponderosa Pine (Alt B & D)	13%	46%	28%	13%

Alternative B moves the forest from 25% very open/open to 59%, and moves moderately closed from 29% to 28% and moves closed from 45% to 13%. The relative shift in openness from a fairly closed stand structure (74% moderately closed to closed pre-treatment) to a more open stand structure (59% very open to open) is a designed result of adding interspaces, groups, and regeneration openings. While this appears to be a very open forest structure, 87% of the project is within the open to closed interspace category, with the majority of the forest in the open to moderately closed structure (25-70% interspace). Alternative B reflects the proposed amendment for the Coconino NF Forest Plan that allows mechanical treatment up to 16" DBH. Alternative D was developed to respond to Issue 1—prescribed fire emissions—by decreasing the acres on which prescribed fire would be utilized (Table 43 versus Table 69). Other attributes of alternative D, with the exception of the use of prescribed fire, are similar to alternative B. Alternative D leaves 24,263 acres untreated and Alternative B 5,016 acres are untreated.

Alternative C (Post-treatment openness)

Alternative C is a combination of mechanical treatments with prescribed fire and the use of prescribed fire only. The differences between Alternatives B-D are the mix of treatments applied across the acres. Post-treatment openness for Alternative C looks like:

Restoration Unit-Subunit	Very Open	Open	Moderately Closed	Closed
All Ponderosa Pine	13%	46%	28%	14%

In response to comments from the public Alternative C reflects additional design from the Arizona Game and Fish Department that maintains higher densities (Table 66, Silviculture Report). Alternative C has fewer acres in “No Proposed Treatments” and adds an has more acres treated with “protected prescribed fire only” treatments. Alternative C reflects the proposed amendment for the Coconino NF Forest Plan that allows mechanical treatment up to 18" DBH in 18 PACs and prescribed fire in 56 core areas. Alternative C also proposes an amendment that allows managing within restricted target and threshold habitat for a range of 110 to 150 BA. These amendments account for the distribution of openness.

Alternative E (Post-treatment openness)

Alternative E is a combination of mechanical treatments with prescribed fire and the use of prescribed fire only (Table 88, Silviculture Report). The differences between Alternative E and Alternatives B-D are the mix of treatments applied across the acres and the lack of any propose amendments to the Coconino NF Forest Plan and no proposed restoration treatments for grassland or savanna communities. Alternative E proposes to enhance historical grasslands, but not to restore grasslands that are currently classified as timber suitable lands. Post-treatment openness for Alternative E looks like:

Restoration Unit-Subunit	Very Open	Open	Moderately Closed	Closed
All Ponderosa Pine	3%	54%	29%	14%

The variety of treatment types and desired conditions under alternative E would result in a wide range of openness post treatment. The list of resulting treatment types for alternative B is the same for alternative E. However, without the Forest Plan amendment that allows for interspaces and grassland/savanna restoration treatments, the openness will result in less very open, more open, treatments will be more uniformly spaced trees, less distinct groups without interspaces, and lacking in regeneration openings, with no clear direction to create groups. The low occurrence of the very open structure (3%) when compared to Alternative C (13%) is the result of no amendment for interspace development. The groups and interspaces that will develop within Alternative E come from the current stand structure. The canopy will have more expanses of canopy closure because of the design of the thinning (no groups or interspaces to break them up), this will increase the probability of crown fire, and shorten the life of the treatment. Alternative E will either move the forest towards the desired conditions slowly or maintain current forest structure on the Coconino NF. The 4FRI project does not require forest plan amendments for the Kaibab NF Forest Plan (2014). The KFP will move the forest towards the desired conditions without amendments.

Cumulative Effects – All Alternatives

For the cumulative effects analysis, the spatial context being considered is the 988,764 acre project area. Cumulative effects are discussed in terms of vegetation and wildfire management activities that have occurred since 2001 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 2010 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 2020), “short-term” effects refers to effects over the 10-year period from the time the final activity was accomplished (year 2030). Beyond 20-years we will be considering effects as “long-term” (year 2050). All Alternatives are compared across forest boundaries (Coconino-Kaibab combined).

Vegetation Management Activities and Wildfire 2001 to 2014

Tables 92 & 93 lists approximate acres of the various vegetation management, fuels treatment and prescribed burning that have occurred within the project area from 2001 to 2013/4. Mechanical vegetation management activities have mainly consisted of tree thinning. This includes 50,940 acres with a fuels reduction emphasis, 14,950 acres with a ponderosa pine restoration emphasis and 750 acres with an emphasis on improving forest structure, health and growth. There has also been 12,560 acres of tree removal to restore ponderosa pine savannas and encroached grasslands, 2,650 acres of removal of dead, damaged or dwarf mistletoe infected trees to improve forest health, 100 acres of tree removal to restore aspen inclusions and 1,935 acres of habitat improvement treatments that reduced tree density within antelope travel corridors. Within the project area there has been 640 acres of tree and vegetation removal associated with powerline corridor management and protection.

Fuels treatments that have been accomplished in association with the above listed mechanical treatments included 3,910 acres of mechanical fuels treatments, 5,070 acres of machine piling and burning and 59,640 acres of broadcast burning. The primary focus of these treatments was to rearrange and reduce activities generated fuels.

Prescribed burns have been implemented on 47,970 acres to reduce natural fuels accumulations and reintroduce fire to fire adapted ecosystems.

Table 92. 2001 to 2013 – Approximate Acres of Vegetation Management Activities and Prescribed Fire within or Adjacent to Project Area

2001 - 2013 non-grassland vegetation treatments	Acres*	Acres	
		Thinning	Broadcast burn
APS Power line	2007	167	0
APS Hazard Tree Removal	2003	0	315
Arboretum WUI	2000	602	602
Bald Mesa WUI	2005	457	4,451
Bill Williams Cap	2009	10	1
Blue Ridge 69kV	2005	50	1,300
Camp Navajo Army Depot	2011	1,213	0
City	2005	8,667	12,400
City of Flagstaff Forest Treatment Activities	2011-2013	1,065	1,594
Clover High (385 acres all within the 'City' project)	2004	385	0
Dogtown	2004	6,029	6,029
Doney Park 69kV	2005	9	0

2001 - 2013 non-grassland vegetation treatments		Acres*	
Project	Year	Thinning	Broadcast burn
Eastside	2006	7,599	19,977
Elden	2006	193	0
Eldon	2002	200	200
Elk Park	2007	1,800	3,500
Flag Tank	2007	22	36
Frenchy	2003	9,319	9,319
Government Mountain/Coleman	2005	75	0
IMAX	2002	1,595	6,358
Kachina Village	2003	3,801	2,147
Kendrick	2005	2,835	2,835
Lake Mary	2005	1,845	1,400
Little Draw Aspen	2009	107	0
Mormon Lake	2005	1,820	1,820
Mormon Mountain (thinning around towers)	2007	11	0
Munds Park	2009	990	2,950
Pineaire	2004	602	645
Potato Hill	2003	637	0
Rocky Park	2001	5,651	7,800
Skunk Canyon	2005	0	831
Slate Mountain	2010	2,250	0
Twin	2005	1,400	1,400
Valley	2005	0	10,245
Williams Follow-up Mistletoe	2004	368	0
Williams High Risk	2001	756	756
Woody Ridge	2004	7,987	11,184
	Total =	70,517	110,095
**Footprint Acres = 117,618			
2001 - 2010 grassland* vegetation treatments		Acres	
Project	Year	Thinning	Broadcast burn
Anderson Mesa	2003	0	800
Apache Maid Grassland Restoration	2004	54,528	0
Dogtown	2004	480	480
Eastside	2006	220	220
Garland Prairie	2005	500	0
IDA Grassland	2008	1,800	1,800
Lake Mary	2005	1,845	3,245
Rocky Park	2001	200	200
Slate Mountain	2010	2,250	0
South Williams Prescribed Burn #51	2005	0	290
Twin	2005	1,400	1,400
	Total =	63,223	8,435
**Footprint Acres = 65,713			

Table 93. Estimated acres of vegetation management activities potentially affecting 4Fri proposed treatments for RU6

Restoration Unit 6		Acres	
Project Name	Year*	Thinning	Broadcast burn
Hull		876	876
X Fire	2009	140	0

Restoration Unit 6		Acres	
Project Name	Year*	Thinning	Broadcast burn
O'Connell	<2009	500	0
Moqui Antelope Habitat Improvement	2006	2,990	2,990
Long Jim	2005	913	1,175
Russell	2013	0	400
Scott	2001	721	9,434
Ten X	2004	1,780	700
Topeka	2004	1,100	1,100
Tusayan West	2001	549	850
Tusayan East	2002	2,600	2,600
Tusayan South	2000	1,970	1,970
Tusayan South/Boggy Tank	2000	0	2,948
Upper Basin Burn Project	2000	0	1,884
Grand Canyon NP prescribed fires (South Rim)	2001 - 2013	527	22,253
	Total	14,666	50,900
**Footprint acres = 50,500			

Wildfire

Wildfires from 2001 to 2014 effects (Table 94 and 95) (Fire Ecology Specialist Report) have burned on approximately 255,067 acres in or adjacent to the project area. Of these acres, it is estimated that the overall average burn 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.

Many of the wildfires that burned within the project in the last 10 years were managed primarily for resource objectives instead of primarily for suppression) (Fire Ecology Specialist Report), and produced primarily low severity. All of the projects have decreased the potential for active crown fire and crown fire initiation on acres thinned (14,666), and the potential for crown fire initiation, and high severity effects from surface fire on about 50,900 acres of prescribed fire, and about 52,422 acres of wildfire. Past mechanical and prescribed fire treatments decreased the potential for crown fire by breaking up the vertical and horizontal continuity of canopy fuels.

Table 94. Large wildfires in or near the southern portion of the project area from 2001 – 2014.

Fire Name	Year	Acres	Fire Name	Year	Acres
Leroux	2001	1,200	Cross	2009	7,718
Gov. Prairie	2001	751	Independence	2009	1,370
Five Mile	2002	376	July 4TH Complex	2009	3,084
Packrat	2002	2,800	Point	2009	1,295
Springer	2002	874	Raptor	2009	1,922
Tram	2002	197	Rattle Ridge	2009	403
Trick	2002	5,550	Real	2009	1,545
Fry	2003	179	Red	2009	2,203
Lizard	2003	5,270	Reservoir	2009	156
Mormon	2003	2,725	Taylor	2009	3,545
Jacket	2004	17,219	Tucker	2009	2,600
Morgan	2004	670	Twin	2009	908
Webber	2004	1,400	Wildhorse	2009	13,790

Fire Name	Year	Acres	Fire Name	Year	Acres
Wildsteer	2004	1,220	89 Mesa	2010	523
Bull Run	2005	885	Bravo	2010	3,254
Tater	2005	150	Eagle Rock	2010	3,474
Brins	2006	4,317	Hardy	2010	3,026
February	2006	150	Hobble	2010	2,395
Kennedy	2006	191	Juniper	2010	470
Knife	2006	560	Ranger	2010	2,200
La Barranca	2006	800	Schultz	2010	15,075
Pomeroy*	2006	260	Tag	2010	355
Sawmill	2006	300	Tuba	2010	363
Towel	2006	237	Weir	2010	1,600
Woody	2006	106	Beale	2011	5,096
Bargaman	2007	320	Beef	2011	358
Birdie	2007	5,016	Bolt	2011	1,790
Dutch*	2007	3,148	Engineer	2011	601
Radio*	2007	175	Fly	2011	896
Black	2008	225	International	2011	320
Late	2008	140	Kehl	2011	187
Lost Eden	2008	1,500	Lava	2011	220
Marteen*	2008	10,789	Rocky	2011	4,990
Oak*	2008	473	Sandrock	2011	4,600
Oh	2008	180	Scout	2011	775
Poor Farm	2008	140	Canyon	2012	8,716
Yeager	2008	470	Rabbit	2012	125
Bear	2009	350	Egypt	2013	501
Bow	2009	2,940	Mud	2013	308
Brady	2009	4,000	Wildhorse	2013	102
Cinder Hills	2009	256	Slide	2014	21,277
Total acres = 202,645					

Table 95. Wildfires in Restoration Unit 6.

Fire Name	Year	Acres
Antelope*	2003	244
Horse*	2003	153
Camp 36*	2004	3,052
Transfer*	2004	1,058
Mudersbach*	2005	7,260
North*	2005	1,315
West*	2006	1,925
Bar*	2006	193
Newt*	2008	770
Twenty-two*	2008	1,255
X	2008	2,030
Anderson*	2009	1,238
Indian	2009	619

Fire Name	Year	Acres
Miller	2009	3,160
Rae	2009	1,392
Ruby	2009	4,107
Scott	2010	458
Tank	2010	945
Wash	2010	197
Grand Canyon NP (south rim)	2011-2013	5,508
Armstrong	2011	2,500
Parallel	2011	4,346
Lower	2011	2,002
Skinner	2011	1,439
Woodbridge	2011	1,762
Grand	2012	450
Halfway	2013	250
Skinner	2013	1,463
Grand Canyon NP (south rim)	2001 - 2010	684
Grand Canyon NP (south rim)*	2001 – 2010	647
Total Acres = 52,422		

Timber Harvest

Past timber harvest practices influenced vegetation structure, pattern, and composition on about 90 percent 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 Flagstaff and Williams area. By 1940, the railroads had removed all the profitable lumber that could be easily accessed. In terms of vegetation structure, most of the largest and oldest tree sizes (VSS 5 and VSS 6) were removed from the project area (and across the Forests in general). Extensive regeneration with no large trees interspersed within the younger age classes became the norm. The pattern on the landscape no longer resembled the historic condition with historic tree groups and patch sizes ranging from 0.1 to 0.75 acre in size and with 2 to 72 or more trees (White 1985) (Reynolds 2013) (Figure 16).

Past timber sales within the project area such as the 49'er, El Paso (1991), and Moritz sales (1985), all 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. Today, at the landscape (project area) scale, pre-settlement trees are underrepresented.

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, at least 84 percent of goshawk non-PFA habitat vegetation structural stage 3 (young-aged forest) and 4 (mid-aged forest) is even-aged. Approximately 74 percent of the project area is classified as having moderately closed to closed tree canopies. Figure 16 displays the general location of past vegetation projects that occurred prior to 1996.

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

After the region-wide 1996 amendment, vegetation objectives included uneven-aged management (Figure 17) (Table 96 & 97). A review of the FACTS timber database indicates that treatments designed to promote uneven-aged management began being recorded in 1991 on the Kaibab NF and as early as 1987 on the Coconino 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. Both the Coconino NF and Kaibab NF use even-aged stand structure and nothing in the plans preclude the use of this silviculture system.

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. From 1996 to 2000, at least seven projects (Spring Valley WUI, Upper Basin, Marteen, Ten X and Red Horse Mudderbach, Elk Lee, Beacon, and Parks) totaling 30,000 acres on the Kaibab NF, were treated with objectives including reduced fire risk, savanna and meadow restoration, oak improvement, improved age class structure and diversity, and to maintain industry.

On the Coconino NF, at least 68,800 acres were planned for treatment for similar purposes (Fire Data FY96 to FY99, 2011). Large projects on the Coconino NF that addressed fire risk included Mint Spring (7,778 acres of mechanical and 12,000 acres of prescribed fire, 1998) and the A-1 project (14,500 acres with mechanical and broadcast prescribed fire, 2000).

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 2010. Projects implemented from 2010 to 2013 have resulted in minor to no changes (less than 1 percent change) to the current condition as most vegetation and prescribed fire analyses have recent decisions and have not been implemented.

From 2000 to 2013, most vegetation project objectives have included reducing fire risk to communities, improving wildlife habitat in sagebrush (Tusayan district, Kaibab NF) and grasslands, improving winter range wildlife habitat, improving forest health and diversity (moving toward a balance of age classes, reducing mistletoe infection, promoting growth in old, large ponderosa pine, promoting aspen, and restoring ponderosa pine savanna conditions).

On the Coconino NF, examples of projects designed primarily to address fire risk in the project area include Rocky Park Fuels Reduction (13,651 acres, 2001), Kachina Village (11,029 acres, 2003), and Mormon Lake Fuels Reduction (1,820 acres, 2005-2013). Examples of similar projects on the Kaibab NF include Williams High Risk Precommercial Thin (756 acres, 2001), Dogtown Fuels Reduction (8,209 acres, 2004), and Pineaire Fuels Reduction (650 acres, 2004).

Since 2000, at least 6,149 acres have been mechanically treated and prescribed burned on the Kaibab NF to improve wildlife habitat, and 2,485 acres have been treated to improve/restore grasslands. Wildlife habitat improvement projects included Potato Hill Habitat Improvement

Project (1,275 acres, 2003), Upper Basin Project (1,884 acres, 2000), and Moqui Antelope Habitat Improvement Project (2,990 acres, 2006). Grassland restoration projects included Garland Prairie (500 acres, 2005), Ida Grassland Restoration (1,800 acres, 2008), and Community Tank Grassland Restoration (185 acres, 2011). On the Coconino NF, almost 7,000 acres were treated (up to 2010) to directly improve wildlife habitat (habitat improvement was the treatment objective). Some of the larger projects (within the project area) on the Coconino NF designed to restore grasslands, woodlands, and wildlife habitats include Hart Prairie Fuels Reduction (9,815 acres, 2010), Elk Park Fuels Reduction (11,100 acres, 2007), and the Slate Mountain Pronghorn Project (2,250 acres, 2010). Projects adjacent to, but outside of, the project area include the Anderson Mesa Project.

Since 2000, over 13,829 acres of treatment on the Kaibab NF have focused on forest health and diversity objectives. Projects include Frenchy (9,319 acres of thinning that include savanna and meadow restoration and prescribed burning, 2003). On the Coconino, projects that addressed fire risk but also included restoration objectives such as meadow, riparian, and grassland restoration include Fort Valley (1,700 acres, 2000), Apache Maid Grass (54,528 acres, 2004), and Woody Ridge (8,599 acres, 2004).

However, even some of the more recent tree thinning projects (from 2000 to 2010) have focused thousands of acres of treatment on the removal of the smallest trees. Some of these treatments were limited in order to comply with the forest plans when treating in MSO protected and restricted habitats. This has produced results similar to treatments conducted in the 1980s – rapid regeneration and high tree density. Projects that focused on removing only the smallest trees (usually up to 9-inch d.b.h.) were primarily focused on reducing fire risk adjacent to public areas such as residential areas and campgrounds. Available data was reviewed and assumptions were made on some projects where data was incomplete.

From 2000 to 2010 on the Kaibab NF, about 3 percent of the analysis area (of the 588,917 acres proposed for treatment) was treated in a manner that resulted in prolific regeneration.

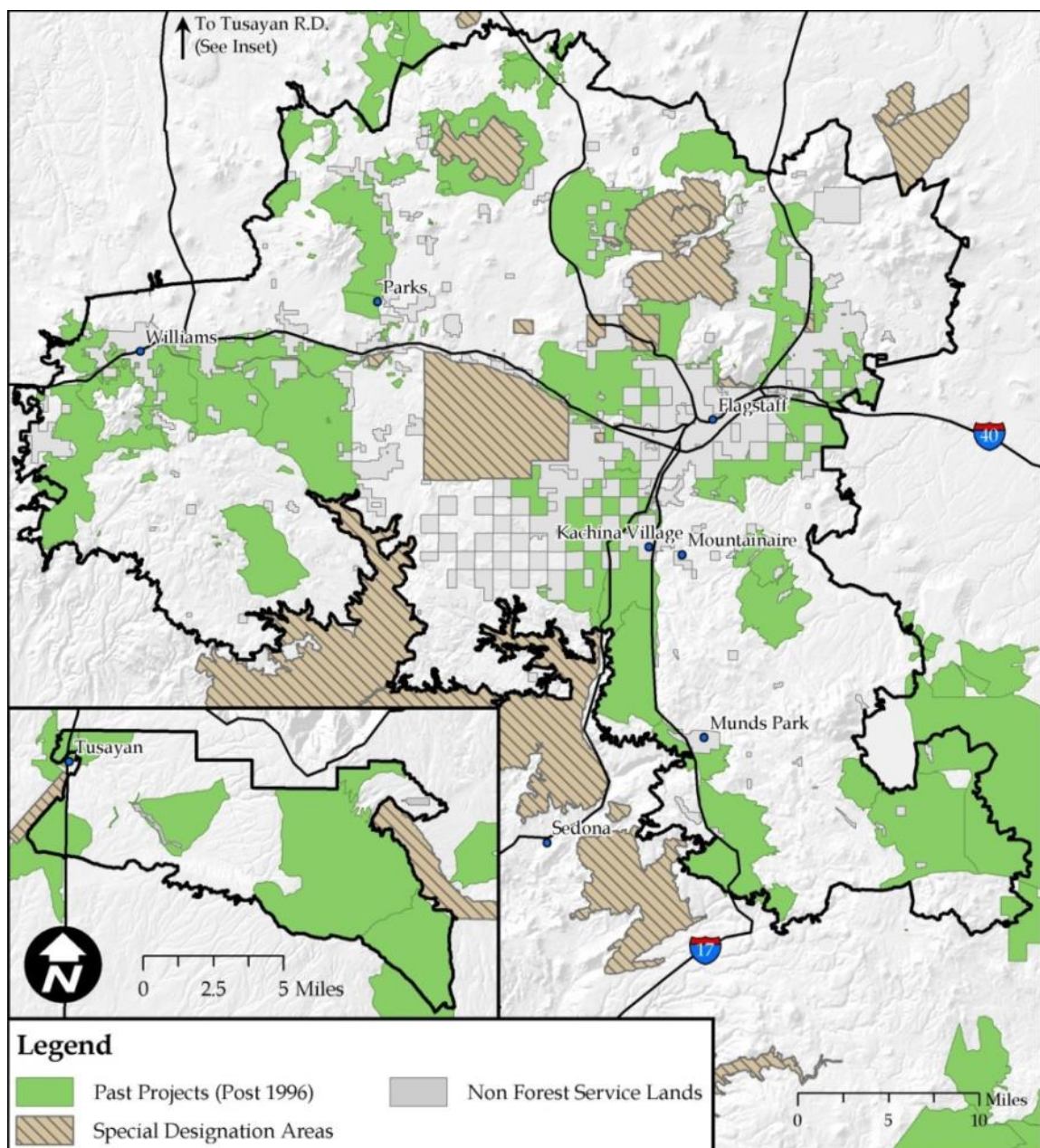


Figure 16. Pre-1996 vegetation and prescribed fire projects within the project area

Table 96. Summary of past projects that have influenced existing conditions (2000 to 2013)

Project Name	Year (NEPA Decision)	Treatment Type	Acres* Mechanical /Prescribed Fire	Forest/District	
				Coconino	Kaibab
Williams High Risk	2001	Mechanical treatment and pile burn	756/756		Williams
Potato Hill	2003	Mechanical treatment, lop and scatter	1,275/0		Williams
Frenchy	2003	Mechanical treatment and pile burn	9,319/9,319		Williams
Dogtown	2004	Mechanical treatment and pile burn	6,509/6,509		Williams
Clover High	2004	Mechanical treatment and pile burn	385/385		Williams
Pineaire	2004	thin and prescribe, pile burn	650/650		Williams
Williams Follow-up Mistletoe	2004	Mechanical treatment and pile burn	368/368		Williams
Government Mountain/ Coleman	2005	Mechanical	75/0		Williams
Garland Prairie	2005	Mechanical treatment and lop, pile burn	500/47		Williams
City	2005	Mechanical treatment and pile burn/ prescribed fire	8,667/12,400		Williams
Kendrick	2005	Mechanical treatment and prescribed fire	Unknown		Williams
Flag Tank	2007	Mechanical treatment and prescribed fire	22/36		Williams
IDA Grassland	2008	Mechanical treatment and prescribed fire	1,800/1,800		Williams
Bill Williams Cap	2009	Thin and prescribe burn	10/10		Williams
Community Tank	2011	Mechanical treatment and prescribed fire	185/185		Williams
Upper Basin	2000	Prescribed fire	0/1,884		Tusayan
Tusayan West	2001**	Mechanical treatment and prescribed fire	549/850		Tusayan

Project Name	Year (NEPA Decision)	Treatment Type	Acres* Mechanical /Prescribed Fire	Forest/District	
				Coconino	Kaibab
Tusayan South/Boggy Tank	2000–2002	Mechanical treatment and prescribed fire	2,948/2,948		Tusayan
Ten X	2004	Mechanical treatment and prescribed fire	1,780/700		Tusayan
Topeka	2004	Mechanical treatment and prescribed fire	1,100/1,100		Tusayan
Moqui Antelope	2006	Mechanical	2,990/2,990		Tusayan
Scott	2001	Mechanical, pile, and prescribed fire	721/9,434		Tusayan
X Fire	2009	Mechanical	140/0		Tusayan
O’Connell	< 2009	Mechanical	500/0		Tusayan
Arboretum WUI	2000	Mechanical treatment and prescribed fire	602/602	Flagstaff	
Eagle Rock Reforestation http://www.fs.fed.us/nepa/nepa_project_exp.php?project=39790	2013	Tree Planting	300 acres		Williams
Fort Valley	2000	Mechanical	1,700/0	Mogollon Rim/Flagstaff	
A-1 East, West	2000	Mechanical, pile, and prescribed fire	5,517/8,638	Flagstaff	
Rocky Park	2001	Mechanical treatment and prescribed fire	5,651/8,000	Flagstaff	
Lake Mary	2005	Mechanical treatment and prescribed fire	1,845/3,245	Flagstaff	
APS Hazard Tree	2003	Prescribed fire	0/315	Flagstaff	
APS Powerline	2007	Mechanical	167/0	Flagstaff	
Blue Ridge 69kV	2005	Mechanical treatment and prescribed fire	50/1,300	Mogollon Rim	
Doney Park 69kV	2007	Mechanical	9/0	Flagstaff	
Kachina Village	2003	Mechanical treatment and prescribed fire	3,801/2,147	Flagstaff	
Apache Maid Grass	2004	Mechanical	54,528/0	Mogollon Rim	
Woody Ridge	2004	Mechanical treatment and prescribed fire	7,987/11,184	Flagstaff	

Project Name	Year (NEPA Decision)	Treatment Type	Acres* Mechanical /Prescribed Fire	Forest/District	
				Coconino	Kaibab
Mormon Lake Basin Fuels Reduction ¹	2005-2013	Mechanical treatment and prescribed fire	1,820/1,820 (of 2,388)	Flagstaff	
Skunk Canyon	2005	Prescribed fire	0/831	Flagstaff	
Elden ¹	2002	Mechanical and prescribed fire	200/200	Flagstaff	
Eastside	2006-2008	Mechanical treatment and prescribed fire	7,819/20,197	Flagstaff	
East Clear Creek	2006	Mechanical treatment and prescribed fire	83/14,500	Mogollon Rim	
Elk Park	2007	Mechanical treatment and prescribed fire	1,800/3,500	Flagstaff	
Little Draw Aspen	2009	Mechanical	107/0	Flagstaff	
Mormon Mountain (thinning around towers)	2007-2008	Mechanical	11	Flagstaff	
Munds Park	2009	Mechanical treatment and prescribed fire	990/2,950	Flagstaff	
Slate Mountain	2010	Mechanical	2,250/0	Flagstaff	
Schultz Fire BAER	2010	Mechanical (snag removal)	150 snags removed/0	Flagstaff – Not included in acreage tally	
Acre Summary					
Total mechanical/vegetation treatment acres			138,486 (less than 1 percent change since 2010)		
Total prescribed fire acres			131,800 (less than 1 percent change since 2010 due to data refinement)		
Total “Other” acres			9 (9 acres added since 2010)		

*Some projects are still in the implementation phase. Acres included here only include acres that have been implemented.

**The decision for Tusayan West was 1998 and implementation was 2001.

1. Project information from the Flagstaff Watershed Protection Project (2013)

Table 97. Summary of past vegetation and prescribed fire project acres (2000 to 2013) adjacent to the project area

Project Name	Year (NEPA decision)	Treatment Type	Acres Mechanical/ Prescribed Fire	Forest/District	
				Coconino	Kaibab
Williams High Risk	2001	Mechanical treatment and pile burn	756/756	data not available	Williams
Potato Hill	2003	Mechanical, lop and scatter	1,275/0	data not available	Williams
Frenchy	2003	Mechanical treatment and prescribed fire	9,319/9,319	data not available	Williams
Dogtown	2004	Mechanical treatment and prescribed fire	6,509/6,509	data not available	Williams
Acre Summary					
Total mechanical/vegetation treatment acres			17,859 acres (no change since 2010)		
Total prescribed fire acres			16,584 acres (no change since 2010)		

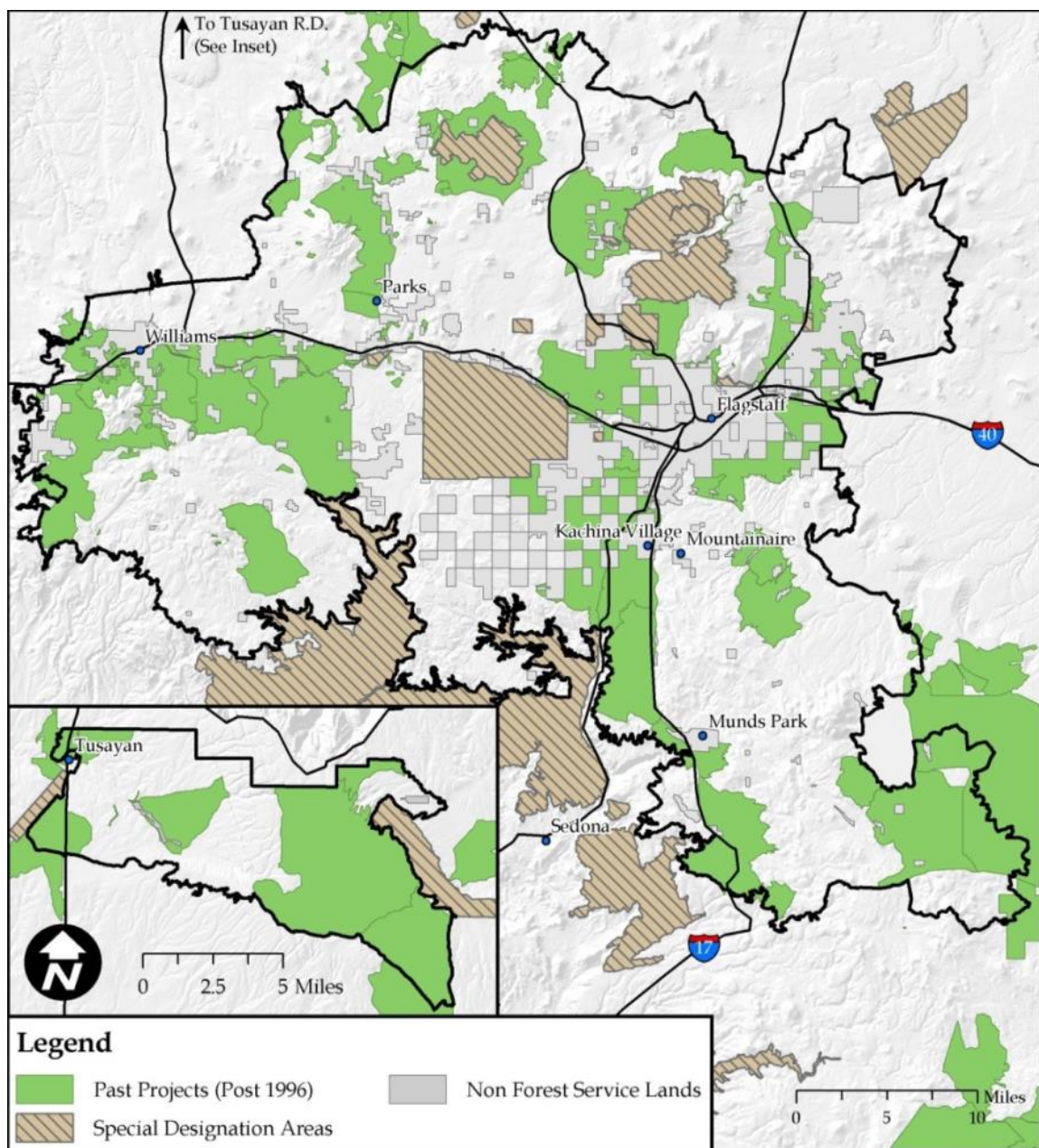


Figure 17. General locations of past projects (post-1996) within the project area

Natural Disturbances – Insect and Disease

The Coconino NF 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 acres, respectively. Ponderosa pine needleminer defoliated over 9,000 acres of ponderosa pine on the Coconino NF in 1999 (USDA Forest Service 2000) (Table 98).

On the southern portion of the Kaibab NF, western pine beetle activity was reported in late 1970s and early 1980s. The contemporary (2000s) bark beetle outbreak is probably more severe than past outbreaks. Ponderosa pine mortality approached 100 percent in some stands (Gitlin et al.

2006), but averaged only 3.4 percent in a limited number of plots distributed across Williams Ranger District (RD) and Tusayan RD (Negrón et al. 2009).

Southwestern dwarf mistletoe is dispersed throughout the project area where 2 to 31 percent of the commercial ponderosa pine type was infected in the 1980s on the northern half of the Coconino NF, and 25 to 38 percent of the commercial ponderosa pine type was infected on the Williams district (Hessburg and Beatty 1985).

Annual aerial surveys on the Coconino and Kaibab NFs in the summer of 2010 detected ponderosa pine mortality associated with bark beetles on approximately 6,500 acres within the project area. This mortality is most likely associated with the Ips beetle (USDAFS 2010.2011). This survey indicates a ten-fold increase in beetle mortality from the 2008 and 2009 surveys, although bark beetle activity in ponderosa pine is currently considered to be at endemic levels. Preliminary results of the 2011 survey indicate a minor reduction in ponderosa pine mortality from 2010. However, bark beetle activity in Arizona increased statewide from 6,400 acres with damage mapped in 2011 to 34,500 acres in 2012. Approximately 98% of bark beetle damage occurred in ponderosa pine forests with the majority of activity taking place on the Coconino and Kaibab National Forests (USDAFS 2012.2013). Much of this beetle-caused tree mortality was related to recent disturbance events such as fires and tornados. In pinyon-juniper woodlands, both localized and widespread mortality events have occurred over time on the Coconino and south Kaibab NFs. These events have typically been pinyon Ips outbreaks associated with periods of drought, such as occurred in the 1950s, and more recently in the mid-1990s and 2001 through 2003. From 2010 to 2014, pine sawfly defoliation occurred in the Bull Basin area on the Coconino and Kaibab NFs. Approximately 1 to 5 percent ponderosa pine mortality occurred (Personal communication Gonzalez, 2014).

Juniper mortality from wood borers and *Phloeosinus* beetles has occurred in areas of poor site quality within the project area during the recent drought (Mueller et al. 2005, USDA Forest Service 2002, 2003). Juniper mortality averaged 3.3 percent within an 80 kilometer radius of Flagstaff, with greater mortality on grassland versus non-grassland sites (Gitlin et al. 2006).

In aspen, mortality has been attributed to the severity of the 1999 frost damage, severe drought conditions, and western tent caterpillar defoliation in 2004 and 2005. Although dying trees sprouted, survival has been very low due to browsing by elk. Mortality has been greatest in the low-elevation range. In 2008, Faithweather et al. found that more than 50 percent of surveyed aspen sites below 7,500 feet elevation experienced 97 percent mortality (Fairweather et al 2006, 2008)

In summary, as agents of change, forest insects and diseases have a significant role in forest ecosystem dynamics. Forest insect and disease driven change alters forest ecological processes, forest structure, and composition. At one time or another, all of the vegetation types within the project area have incurred extensive damage by one or more agents (Table 98). The transitory agents causing the most extensive and severe damage have been pinyon Ips in pinyon pine, Ips bark beetle species in ponderosa pine, and multiple biotic and abiotic agents in aspen. Each of the vegetation types shows distinct periods of increased insect damage that can be associated with droughts. The most extensive and damaging persistent agent is southwestern dwarf mistletoe in ponderosa pine. More detailed information can be found in Lynch et al. 2008a and 2008b.

Table 98. Acres affected by insect and disease outbreaks by forest (within project area)

Time Period	Insect/Disease Type	Acres and/or Percent of Forest Affected	
		Coconino	Kaibab
1950s	Bark beetle (ponderosa pine) damage	200,000	NA
1950s	Wood borers and Phloeosinus beetle (juniper woodland) mortality	Unquantified – described as extensive	
1970s to 1980s	Western bark beetle (ponderosa pine)	NA	Unquantified
1980s	Southwestern dwarf mistletoe (ponderosa pine) infection	19,773 to 306,489 (2 to 31 percent)	247,169 to 375,696 (2 to 38 percent)
1999	Needleminer (ponderosa pine)	9,000	NA
2000s	Bark beetle (ponderosa pine) damage	72,000	NA
2000s	Bark beetle (ponderosa pine) mortality	100 percent mortality in select stands	29,660 (3 percent)
2002–2005	Wood borers and Phloeosinus beetle (juniper woodland) mortality	3 percent mortality within 50 mile radius around Flagstaff*	Extensive
2005–2008	1999 frost and 2004–2005 western tent caterpillar defoliation (aspen) mortality	97 percent mortality in greater than 50 percent of surveyed aspen sites below 7,500 feet (Fairweather et al. 2008).	
2010	Bark beetle (ponderosa pine) mortality	6,500	
2010–2014	Saw Fly (ponderosa pine defoliation)	Bull Basin Area - 2,000 acres with 1 to 5 percent mortality across both Forests	

*Accurate acreage number not feasible given the amount of non-FS lands included in the 50 mile radius.

Alternative A

Alternative A 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 (Table 100) (Figure 19) . Approximately 166,897 acres of current and ongoing vegetation treatments and 195,076 acres of prescribed fire projects would continue to be implemented within and adjacent to the project area. Approximately 43,041 acres of vegetation treatments and 58,714 acres of prescribed fire and maintenance burning would be implemented adjacent to the project area by the Forests in the foreseeable future (within 5 years). It is expected that when these actions are completed that these acres will be moving towards the desired conditions. Alternative A is the point of reference for assessing action alternatives B-E. 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 towards their desired conditions.

MSO

Table 32 displays the MSO habitat forest structure and habitat components projected out to the years 2020 and 2050. Density in terms of basal area and SDI continues to increase and remains higher than desired in all habitats. Refer to Table 100 for planned MSO treatment acres. The Kaibab is planning treatments in the PAC area their treatments remain below 20% of the area. The Coconino Flagstaff Watershed Protection Project plans to use 4FRI acres that were removed from 4FRI. Treatments include 1,825 acres of PAC treatments in Mormon Mtn, 1,221 PAC treatments in Dry Lake Hills, 424 acres of MSO core area treatment in Mormon Mtn, and 396 acres of MSO core area treatment in Dry Lake Hills, 103 acres of goshawk nest fuels reduction in Dry Lake Hills. Should these future plans be approved and implemented they will move the forest towards their desired conditions.

The prior thinning and burn and burn only treatments do not indicate that they were primarily to treat within MSO habitat and these habitats will remain overly dense and prone to slow growth, increased insect risks, and high risk for crown fires (Table 32).

During past treatments, burning, while allowed outside of core areas, personnel were reluctant to conduct prescribed fires without prior mechanical treatment. Planned treatments will aid forest structure but because of treatment constraints (similar to 4FRI) these stand densities will remain high as will crown fire risk. The Williams District is proposing to treat 31 acres in preparation of cable logging operations within MSO PACs that would cause a loss of most snags and trees (including snags greater than 18 inch d.b.h. and trees greater than 24 inch d.b.h.) across approximately 15 percent of the area with this proposed treatment within the PAC in order to provide cable corridors and safe logging operations. Approximately 15 percent, or 5 acres, of the PAC area treated with cable logging operations would have most trees removed. 4FRI is not proposing any cable logging operations. Most of the untreated area continues to move away from the desired conditions. Treatments within MSO Cores and PACs are high density stands with high canopy cover and they do not move towards nor are they on trajectories to desired conditions. They remain high risk stands for mortality, density related and bark beetle, and fire.

Goshawk

Goshawk habitat on the Coconino NF follows the MRNG guidelines in areas outside of MSO management areas. On the Kaibab NF goshawk vegetation management was developed using the MRNG as a template and are managed at the mid-scale by maintaining forest conditions in some areas that have 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest; these include goshawk post-fledging family areas, Mexican spotted owl nesting/roosting habitat, and north-facing slopes. Interspaces with native grass, forb, and shrub vegetation typically range from 10 to 50 percent of the area.

Since 1996 the Coconino and Kaibab National Forests have emphasized uneven-aged management. The mechanical treatments from Table 96 and 97 would have followed forest plan directions. If the prior 10 years treatments followed uneven-aged marking guidelines then those acres would be moving towards desired conditions for their forest plans, but not the desired conditions for this project.

The treatment acres planned within the next 5 years are small, but they will move the forest towards their desired conditions. Table 33 and Table 34 display the goshawk structure and habitat components projected out to the years 2020 and 2050. Density in terms of SDI and basal area continues to increase and remains higher than desired in all habitats. All habitats show an increase in total CWD, CWD >12" and snags >18" between 2020 and 2050 resulting in conditions at or

close to desired. Most of the untreated area continues to move away from the desired conditions. Planned forest treatments within this forest component will move the forests towards their desired conditions. Untreated acres will continue to move away from their desired conditions. The presence of prescribed or wildland fire may or may not move untreated acres towards their desired conditions.

Timber Harvest

Past timber harvest practices influenced vegetation structure, pattern, and composition on about 90 percent 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 stands are even-aged, dense, and lack age class diversity. Today, at least 84 percent of goshawk non-PFA habitat vegetation structural stage 3 (young-aged forest) and 4 (mid-aged forest) are even-aged. Approximately 74 percent of the project area is classified as having moderately closed to closed tree canopies. The large acres of even-aged stands will take considerable time to convert to an uneven-aged structure as acres are treated and new regenerations openings are created. Some stands will inevitably remain in an even-aged structure which is consistent with current forest plans. Historically wildfire would have maintained a diverse matrix of age class diversification and reintroduction of a NRV for fire 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 increase and risks of crown fire increase.

The Bill Williams Mountain Restoration project, while still awaiting decision, will treat 11,650 acres for fuels reductions, balance age classes, and reintroduce fire. This should move these areas towards their desired conditions. 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 Watts Vegetation Project planned to treat 3,000 acres with mechanical and prescribed fire, but is still in the scoping phase and no impacts can be assigned other than to say that reducing stand densities, reducing dwarf mistletoe, tornado salvage should maintain or move these acres closer to their desired conditions. If completed, prescribed fire following mechanical treatments to balance age classes provide the best chance to set these stands on a trajectory towards desired conditions.

The Turkey/Barney Pasture Forest Health Restoration planned to treat 17,838 acres with mechanical and prescribed fire. It was planned to reduce dwarf mistletoe, conduct a tornado salvage, and improve MSO habitat. However, the slide fire changed analyzed condition. Decision was planned for October 2014.

Forest products will continue to flow from treated acres.

Forest Structure and Diversity - Mosaic of interspaces and tree groups of varying sizes and shapes

In Alternative A, the no change alternative, few treatments would be implemented to create a mosaic of interspaces and tree groups. Existing interspace would continue to be reduced by expanding tree crowns and increased tree densities. Understory vegetation response would be suppressed. Fire risks would not be reduced and would continue to increase. Any large scale tree mortality occurring has the potential to enhance interspace and create tree groups. While the Kaibab and the Coconino have an emphasis to favor uneven-aged management, this silvicultural system does not assure interspaces and groups. The new Kaibab Forest Plan (2014) has a decidedly restoration silvicultural preference, it has yet to be implemented over large acreages, and in fact will rely on 4FRI for most of the restoration treatments (KFP page 20). The Coconino NF has latitude to create opening and groups but has 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 do not significantly move the forest towards the desired conditions at this time.

Forest Structure - All age and size classes represented

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 dominate and co-dominate 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.

The thinning treatments with restoration objectives were very similar to the goshawk habitat and MSO restricted other habitat treatments proposed under this EIS and have resulted in similar diversity in age and size class, and should move these stands towards desired conditions.

High and mixed severity 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 high and mixed severity wildfires.

Over time, old growth conditions improve in terms of meeting the minimum criteria (CFP). In 2050, all RUs meet or exceed the criteria for TPA larger than 18" with the exception of RU 6. The age of these trees is estimated to be in the range of 130 to 170 years old. Coarse woody debris greater than 12" remains deficit in RU 6. It is estimated that all the other criteria will be met throughout the allocated old growth acres. The sustainability of the large/old tree component across the landscape may be impaired by density related mortality and forest health issues.

Uneven-aged management has been emphasized since 1996 and those treated stands will move towards their, then stated, desired conditions. The desired condition at the times of treatment were not a restoration directed treatment, so while they will meet the desired condition of attaining an uneven-aged structure, or moving towards an uneven-aged stand structure, these are will not have the spatial distribution, openness, of a restoration derived prescription.

Old Forest Structure Sustained Over Time Across the Landscape

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 intensity 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 this structural stage desired condition 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. 4FRI plans for distinct interspaces of varying sizes with groups of varying sizes to aid in forest diversity (horizontal and vertical) while at the same time breaking up areas of continuous canopy cover to reduce risks to crown fire (canopy cover in the very open to open category). Past uneven-aged treatments will have trees more uniformly spaced with more of a closed canopy (moderately closed to closed).

Forest Health

Past thinning treatments resulted in forest density within the low to moderate density zones. 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. Within forest carbon stocks were reduced by the thinning. Some of the carbon removed has been sequestered for a time in the form of pallets and building materials. Mixed and high severity wildfires released large amounts of carbon into the atmosphere and resulted in a carbon source as dead material continues to decay. This is especially prevalent in burned areas where the conifer forests have not regenerated.

Over the next short-term, stand densities within all MSO habitat would increase to levels ranging from an average of 51-100% of maximum stand density index (Table 32). These density levels are at the threshold of, or well within, the zone of density related mortality and extremely high density (Table 7).

Vegetation Diversity and Composition – Maintain and Promote Grasslands

The savanna/grassland restoration treatments implemented restored historic grasslands, savannas and forest openings by removing ponderosa pine tree canopy that was shading out understory herbaceous vegetation. Thinning treatments with a restoration objective also restored historic forest openings.

Oak

Removing conifer competition with mid and understory oak as part of the thinning contributed to maintaining and improving oak growth and vigor. Mixed and high severity wildfire killed large oaks that were replaced by oak sprouts thereby changing oak structure from old to young. On untreated lands ponderosa pine tree canopy would continue to increase, shading out Gambel oak

and aspen mid and understory trees. Oak and aspen growth and vigor would continue to be stagnated due to competition with pine resulting in lowered resistance to insects and disease and eventual mortality. Oak and aspen regeneration ability would continue to be impaired.

Aspen

Aspen restoration treatments were very similar to the aspen treatments proposed under this EIS and have resulted in aspen regeneration and age class diversity. On untreated aspen stands growth and vigor will continue to be stagnated due to competition and succession pressures from conifer under/overstory. Aspen regeneration ability will continue to be impaired. Extirpation of aspen is likely across much of the analysis area by 2050.

Pine-Sage

Some of the fuels reduction thinning within pine sage on the Tusayan district removed overtopping young pines and improved conditions for understory sage. In untreated areas ponderosa pine tree canopy would continue to increase, shading out understory sage further reducing the sage component within the pine sage mosaic that moves these areas away from their desired condition.

Alternatives B - D

Mechanical treatments in Alternatives B-D are similarly modeled from a consistent set of assumptions (Table 3). The outputs from the model, across treatments and through time, have similar results (they are all derived from the same dataset). What varies are the acres treated and the amendments applied to the Coconino Forest Plan acres. Grassland and savanna treatments are found in Alternative B-D but not in E. Several special area treatments were identified through public comment and are shown separately.

With the approval of the new 2014 Kaibab Forest Plan proposed treatments going forward will either be restoration-type treatments (at least there will be an option for a restoration-type treatment) or the treatments will be completed for the Kaibab NF by the 4FRI project (Williams and Tusayan Ranger Districts), as outlined in the current forest plan (KFP page 20).

Alternative B restoration treatments would contribute approximately an additional 583,330 acres toward improving forest health and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions.

Alternative C restoration treatments would contribute an additional 586,110 acres toward improving forest health and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions.

Alternative D restoration treatments would contribute an additional 563,407 acres toward improving forest health and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions.

Alternatives B & D treatments are the same, except that Alternative D reduces prescribed fire acres to reduce emissions (Table 56 & 78).

Alternatives C & E treatments are similar, except that Alternative E does not use proposed Coconino Forest Plan amendments. The lack of amendments remove defined interspaces, groups, savanna, grassland, and the Arizona Game and Fish treatments (Tables 66 and 88). Prescribed

fires are increased in Alternative E over C. On the average, 45,000 acres of vegetation would be mechanically treated.

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. Approximately 40,000 acres of prescribed fire would be implemented annually across the analysis area. Two prescribed fires would be conducted on all acres proposed for treatment over the 10-year period. Prescribed fires may be conducted pre- or post-treatment. See Fire Specialist Report for details.

For the years 2001-2010 prescribed fire over 169,430 acres of broadcast burns reduce fuels, modified fire behavior, and lowered crown fire risks. The majority of these acres occurred prior to 2007 and will require reintroduction of a prescribed fire within the next 5 years in order to maintain the benefits of the prior burn. The proposed 586,110 of mechanical treatment with prescribed fire or prescribed fire only of the 4FRI project, combined with proposed, but yet unapproved 55,531 acres, prescribed fires and mechanical treatments for normal Coconino and Kaibab treatments, will reduce uncharacteristic fire behavior and crown fire potential on approximately 811,071 acres over the next 10 years. Realizing that of the 169,430 previously burned will require prescribed fire and will be included in the 586,430 proposed by this project, and that the 55,531 are current (at this writing) being proposed may or may not be approved. 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 uncharacteristic fire behavior in these treatment areas.

MSO

Alternative B, C, & D: Basal areas are currently above the desired minimum for protected, restricted, and target/threshold habitat. The SDI density remains in the extremely high zone within the target/threshold and protected habitats and is higher than the desired range in restricted other. Prior mechanical and prescribed fire treatments within MSO habitat, especially cores and PACs, were either not completed or completed to a low degree because of the chance of damage to the MSO habitat without prior mechanical preparations. For this reason, prior treatments have done little to reduce the high fire dangers associated with treating these habitats. With the 4FRI project mechanically treating MSO habitat prior to most burns (some PACs are scheduled for prescribed fire-only treatments) the risk of unintentional damage by fire is reduced somewhat. However, with 4FRI, Coconino, and Kaibab proposed treatments PACs and Cores will remain very dense with closed canopies and, therefore, remain very prone to wildfire, density related mortality, insects attacks, and crown fire damage even post-treatments. The new MSO Plan (2012) encourages treatments within the Critical Habitat, and states that these are not hands off areas. 4FRI treatments are designed to treat within MSO habitat to improve stand structure and resilience. Prior treatments and proposed treatments within MSO habitat will maintain or move these habitats towards their desired conditions over approximately 108,847 acres. Alternative B, C and D all propose treating up to 16" d.b.h (Alt B and D) or 17.9" d.b.h (Alt C) in PACs and some treatments within PAC Core areas (Table 145). Alternative C proposes reducing the target basal area in PACs from 150 to 110 to be in alignment with the 2012 MSO guidelines. The proposed treatments within PACs, if completed, would benefit the structural components of the

stands, but will still leave them at fairly high densities, SDI, beetle, and crown fire risks. The proposed treatments that leave high densities within MSO habitat, while not ideal in terms of forest health, will be somewhat offset by their juxtaposition of treated stands surrounding them and offering some protection from uncharacteristic fire, but not offering relief in terms of beetle, density related mortality, or unintended fire ignitions within the habitat boundary. The MSO habitats will remain high risk areas for damage (fire, insect/disease, density) post treatment simply due to the nature of the stand structures required by legislation, and treatment can offer only a limited amount of mitigation. But the 2012 MSO Recovery Plan goes farther in offering management options than the prior 1995 MSO Recovery Plan and this is considered a benefit.

Goshawk

Alternative B, C, & D: (Tables 47-52, 73-75) Currently Goshawk Nest/PFA stands SDI is averaging 44% (range 24-57%) of maximum and Goshawk LOPFA stands SDI are averaging 41% (range 27-54%). Indications are that prior treatments have reduced certain areas densities effectively while leaving others are much high densities that are now approaching the threshold for density related mortality issues (Table 7) but overall shows that Goshawk habitat is in far better condition, density wise, than MSO habitat which is currently averaging well over 70% of maximum (Table 62, Alt C). Prior treatments over 169,430 acres have reduced densities within both PFA and LOPFA areas. The emphasis during the 2001 to 2010 period being uneven-aged management. The 169,430 acres were moving towards the Forest Plans desired conditions at the time of treatment. Many of these past treatments would not need mechanical treatments for another 20 years under the past treatment regimes, however under the current 4FRI project many of these stands will be treated again to restore them to within their Natural Range of Variability. Project proposal calls for approximately 583,330 acres of treatments. Foreseeable treatments from the Coconino and Kaibab of 55,531 acres mean that approximately 638,861 acres will move towards improving forest health and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions.

Forest Structure and Diversity - Mosaic of interspaces and tree groups of varying sizes and shapes

Alternative B, C, & D: Treatments prior to 1996 were designed primarily for even-aged stands. 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 over 169,430 acres between 2001-2010 have reduced densities within both PFA and LOPFA areas but very little 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 Natural Range of Variation desired conditions. The 169,430 acres were moving towards the Forest Plans desired conditions at the time of treatment, however under the current 4FRI project many of these stands will be treated again to restore them to within their Natural Range of Variability as part of a restoration prescription.

Most all treatments on the Coconino and Kaibab NF, either even-aged or uneven-aged prescription, left the forest with denser stands when compared to the proposed restoration treatments in this project. Spatially, the prior treatments, for the most part 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 across the landscape to enhance structural diversity. Planned interspaces will average between 10 to 90% at the stand level, while canopy cover will be managed at the group level. The proposed restoration treatments are a departure from past management and have desired conditions for interspaces and groups that will move these stands towards a more Natural Range of Variability. The new 2014 Kaibab Forest Plan will approximate this project and, in fact, leverage the 4FRI project to achieve forest treatments (KFP page 20).

Canopy Cover & Openness

Alternative B, C, & D: A key characteristic of historical ponderosa pine forests were the grass-forb-shrub interspersed among tree groups; defined as interspace (Key Issue #1, page 14) (Reynolds 2013). Historically interspace typically comprised a larger portion of the landscape than is currently present (Reynolds 2013).

Current stand canopy cover, and its antithesis in openness, are rooted in past plans and prescriptions for even-aged and uneven-aged management. Canopy cover was managed at the stand level since stands are the basic unit of management. The past emphasis was not necessarily to create new openings within the stands (interspaces) but to enhance site productivity in terms of volumes. Current openness (Table 10) shows the majority of the analysis area is moderately closed (29%) to closed (45%) indicative of prior treatments prescriptions pre- and post-1996. Because of the current high degree of closed canopy stands, most will be treated under this proposal in order to reduce canopy cover.

Many prior treated stands will be treated within 4FRI to bring them within their Natural Range of Variability. Most of the prior treated stands are still too dense, canopies too closed, and risks too high (fire and insects) to qualify as a restoration treatment. The prior treatments will make it easier to set the stands on a trajectory for restoration.

Some foreseeable treatments on the proposed 55,531 acres may leave adequate openness, in terms of the Natural Range of Variability (i.e. 17,838 acres on Turkey/Barney Pasture Forest Health Restoration where dwarf mistletoe and tornado salvage are prime drivers) while others have different priorities and will not necessarily appreciably open the forest (i.e., Watts Vegetation Management Project would treat 3,000 acres of non-forest product objective to provide fuelwood and alleviate illegal fuelwood cutting). Foreseeable planned projects will not be of sufficient size to significantly affect the overall plans of the 4FRI project.

Special Silviculture Acres (Alternative C & E)¹¹

46,091 acres: In response to comments and feedback on the DEIS, on approximately 38,256 acres (22,772 acres on the Coconino and 15,484 acres on the Kaibab NF) of UEA 40, UEA 25, and non-WUI stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean BA greater than 70 of the VSS 4 size class and a mean TPA less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. After further public comments an additional 7,835 acres of IT10 and UEA 10 treatments were included for this section, for a total of 46,091 acres. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-

¹¹ See Implementation Plan, FEIS, and project record for full details

WUI stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the planned prescription intensity range, managing for larger group sizes, and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and will achieve 40 percent canopy cover at the stand scale.

The structure of these stands are such that they will move away from their desired conditions for BA, SDI, TPA, openness, fire risks, insect risks, crown fire risks. These areas will have the canopy cover managed for high percentage cover at the stand level, instead of at the group level for the rest of the analysis area. (See Implementation Plan, Appendix A).

3,303 acres: In response to comments from the public there continues to be a conversation on large trees, issue 2. In response to comments and feedback, Alternative E best meets the concern because no savanna treatments are proposed. The implementation plan, as it relates to alternative E has been updated to clarify that most VSS 4, VSS 5 and VSS 6 would not be cut on about 3,300 acres. The 3,303 acres containing a significant number of trees in the VSS 4-6 classes, currently assigned to savanna treatments within Alternative C, will be removed from Alternative C and assigned to their analyzed Alternative E treatments. Alternative E does not include the amendments for the specific definitions for interspaces and groups, therefore while the IT40 and UEA40 are desired they may not be necessarily attainable (See project record for details). These stands, while moving towards savanna, will not attain the savanna desired conditions.

Old Forest Structure Sustained Over Time Across the Landscape

Alternative B, C, & D:

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 (KFP page 153).

Treatments prior to 1996 removed most old and large trees and they are underrepresented in today's forest in many areas. Treatments after 1996 realized the importance of large and/or old ponderosa pine to the forest health. Treatments are designed to retain, enhance, and recruit younger and smaller trees into the older forest structural classes. These type of transitions take time and space. Proposed treatments on the Kaibab and the Coconino (with amendments) will retain and enhance large trees health. The Large Tree Implementation guide is designed to allow the trees to grow at their optimal pace and achieve maturity within the shortest time period. The shift from even-aged management to uneven-aged management across the analysis area will help create old forest structure and move the forest towards this desired condition.

Even-aged management is not conducive to developing large trees and old forest structural components. The change in emphasis after 1996 is better suited to developing old forest structural components. Post-1996 treatments had a uneven-aged emphasis but still retained high densities (basal areas, trees per acre, and SDI) as attested to by the current high SDI's. To develop larger trees quickly takes growing space not only for the tree and canopy, but also the rooting zone. The high stand densities of past treatments does not put these treated stands on a trajectory for old forest structure over time across the landscape.

Most prior treated stands in the analysis area will be treated by 4FRI. The more intense proposed treatments will develop mid-sized to large-sized trees more quickly than less intense treatments. The use of uneven-age management, and the treatment of the stands throughout the entire

diameter ranges present within a stand, will set these stands on a trajectory for old forest structure.

Special treatment areas where tree and canopy densities remain high to closed, respectively, will develop old forest structure more slowly and some may not progress to old forest structure entirely (i.e. PACs, Cores, some PFAs, Arizona Game and Fish, 46,091 acres, etc.).

Foreseeable treatments, while not specifically prescribed to develop old forest structure, can, by the very design of uneven-aged treatment areas, contribute to old forest structure. Some foreseeable treatments are designed specifically for wildlife, and ultimately may not move any of the treatment areas towards their restoration desired conditions.

The acres associated with foreseeable potential old forest structure is small (20,838 acres) and will contribute little, if implemented, to the overall 583,330 acres within the 4FRI analysis area.

The approximately 583,330 acres of proposed 4FRI treatments will enhance prior treatments acres and will move prior untreated acres towards a desired uneven-aged structure, reduce uncharacteristic fire behavior, and reduce insect and disease risks. Uneven-aged silviculture prescriptions implemented across the landscape will, over time, develop old forest structure components as part of their Natural Range of Variability.

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). Current stand densities across the analysis area average 44% of maximum SDI (Table 14) which puts the average stand in the High Density category (Table 7) and approaching the onset of density related mortality. Within MSO habitat the SDI averages 78% of maximum (Table 13) and is well within the extreme range and places these stands at high fire, beetle, and density related mortality risks.

Prior treatments have used prescriptions, both even-aged and uneven-aged, to reduce stand densities. Table 96 lists some of the treatments complete in the analysis area since 2000 and most all were designed to reduce densities on approximately 138,486 acres. Post 1996 treatments were effective in reducing density related mortality (see introduction on insect outbreaks since 1996). 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, few were designed as a restoration treatment. Therefore, these stands are not moving towards the restoration desired conditions of this project and could be treated again in order to aid in moving them closer to their desired conditions, or onto a trajectory to achieve the desired conditions.

Proposed treatments in the foreseeable future (Table 100) will be more closely allied with a restoration structure prescription. The Kaibab Forest Plan clearly spells out the intent to treat widely across the forest with a restoration desired condition (KFP page 20). While the foreseeable acreages are small right now and do not significantly modify the 4FRI proposed actions, they do show the intent of the forests as they go forward with the forest plans.

The combined 4FRI treatments of approximately 583,330 acres and the foreseeable treatments on 55,531 acres will move approximately 638,861 acres towards a desired condition of reduced stand densities with interspaces and groups in a heterogeneous landscape, and in the presence of prescribed fire, will move the forest towards their desired conditions through time.

Bark beetle related mortality –

Bark beetles are normal endemic residents in ponderosa pine 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). Table 98 shows a long history of epidemic bark beetle infestations within the analysis area 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 SDI's (Tables 13, 14, and 15) with closed canopies (Tables 16-19). Post 1996 treatments were effective in reducing density related mortality (see introduction on insect outbreaks since 1996). Even with the reduced stand densities some stands were susceptible to the drought period during the early 2000's. These stands would be considered moving towards the desired conditions at that time. Proposed treatments will further restructure stands towards a restoration desired condition and this should aid in further stresses.

Because bark beetles can fly,, treatments outside, and adjacent to, the analysis area have an important influence of beetle activity within the analysis area. Prior treatments and Foreseeable treatments outside of the analysis area (Tables 96, 97, and 100) can both benefit and/or be a danger to the stands within the analysis area. Activity fuels (those created from thinning's, road work, fuels treatments, etc.) if not properly and timely treated may act as attractants to bark beetles (primarily *Ips spp*). Areas treated outside of the analysis area can act as a refuge for bark beetles if not managed accordingly. In times of drought and climate change, dense stands become stressed and are susceptible to insect infestations. Controlling stand densities is one way to mitigate future infestations. Once bark beetle infestations become epidemic mitigation options become impractical. Project such as Turkey/Barney Pasture Forest Health Restoration (17,838 acres), Watts Vegetation Project (3,000 acres), and Bill Williams Mountain Restoration (11,600 acres) are prime examples of projects that will work synergistically with this project.

Dwarf mistletoe infection –

Stand treatments from 2000-2013 mechanically treated within the analysis area approximately 138,486 acres (Table 96) and 17,859 acres adjacent to the analysis area. 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 change to preference removal of infected trees (at or above a predetermined infection level). Treatment of stands outside the analysis area do not have as great a potential impact as do stands adjacent to the analysis area (Table 97). 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 are 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 infected stands 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 4FRI project will target DM infected stands for the more intense treatment levels, and this will lower the infection level. But with 40 percent of the area infected, it is difficult to mitigate this pathogen over the long period. Groups with their edges and interspaces and regeneration openings may slightly increase the spread of dwarf mistletoe along the interfaces. Regeneration within 66 feet of an infected edge are at most risk to infection as the trees mature. The best defense against dwarf mistletoe is to keep the stands in good health. 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 ration 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 considerable latent infections (those not visible at the time of treatment) will remain within the stands.

Vegetation Diversity and Composition

Oak

Prior to 1996 oak retention and improvement was not a major consideration. Post-1996 treatments realized the importance of oak in adding diversity to the forest and treatments were designed to conserve oak and improve conditions that favor oak growth and establishment wherever it exists by reducing pine-oak competition. Dense stands within cores and PACs tend to suppress vegetation diversity and suppress grass/forb responses, and these move away from desired conditions for diversity and stand health.

Foreseeable project such as the 11,600 acre Bill Williams Mountain Restoration project, while primarily a wildlife project, aims to improve the understory composition and productivity. The Turkey Butte-Barney Pasture Forest Health Restoration Project will restore approximately 17,838 acres by thinning and prescribed fire use and will encourage species diversity (including oak) and mitigation for DM. Thinning contributes to maintaining and improving oak growth and vigor. Mixed and high severity wildfire killed large oaks that were replaced by oak sprouts thereby changing oak structure from old to young. Oak/Juniper are favored where possible and not targeted for removal. Competing conifers suppressing larger oaks will be removed to reduce competition. Oak sprouting will be encouraged. Interspaces and treatments will give oaks the space and light needed for vigorous growth and sprouting. Treatments will increase oak/juniper percentages. These treatments will result in improved vigor of existing oak and establishment of a variety of oak size and age classes across the landscape. These conditions would be most prevalent within the 9,263 ponderosa pine restoration acres (Turkey Butte-Barney Pasture).

Projects adjacent to the analysis area, in terms of vegetation diversity and composition, do not immediately impact the analysis area; but lend themselves to the diversity of the forest at the landscape level and are a desirable feature to be considered.

The 4FRI treatments on approximately 583,330 will encourage species diversity with interspaces and groups and specifically encourage oak as an important component of the ponderosa pine community where it occurs.

Aspen

Current stand conditions within the analysis area of high tree densities is not conducive to establishment or expanding aspen enclaves. Aspen prefers full sunlight and site disturbance (primarily fire) in order to reoccupy a stand site. There is very little aspen within the analysis area with about 1,552 acres total.

Prior treatments pre- and post-1996, while prescribed to reduce stand densities and reduce uncharacteristic fire behavior, have not increased the occurrence of aspen appreciably. The Kaibab Forest Plan calls for fencing 200 acres of aspen within 10-years of plan approval (KFP page 29). 4 FRI proposes to treat approximately 1,469 acres and build 82 miles of fence to protect aspen.

While aspen primarily reproduce by asexual sprouting it does have the capability to produce viable seed. Therefore, treatments outside and adjacent to the analysis area are important to the production of aspen seed and potential establishment within the analysis area on suitable sites.

The treatments within the 1,469 acres of aspen stands are designed to maintain and/or regenerate aspen by reducing pine-aspen competition. These treatments would result in establishment of vigorous aspen regeneration free of competition from overtopping ponderosa pine. Ungulate browsing is the major concern for aspen sapling establishment. Mechanical treatment followed by fire has proven to be the best combination to ensure aspen sprouting (Kilpatrick et al 2003). This EIS plans up to 82 miles of fence to protect aspen regeneration. This will move aspen toward the desired condition.

Alternative E

In response to comments after the DEIS Alternative E was developed to model Alternative C without plan amendments to the Coconino Forest Plan. Alternative E would implement approximately 581,020 acres of restoration activities within the analysis area (588,917 acres) (Figure 14).

Alternative E treatments would contribute an additional 581,020 acres toward improving forest health and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions.

Restoration activities would include (Table 81):

- Mechanically cut trees and burn approximately 403,218 acres. This includes ponderosa pine restoration treatments within 184,988 acres of northern goshawk habitat and 81,457 acres of Mexican spotted owl habitat, 1,227 acres of aspen restoration, 535 acres of pinyon-juniper wildland urban interface treatments, and 47,915 acres of grassland mechanical treatments.
- Prescribe burn-only approximately 177,801 acres. Burn only treatments would occur within 147,044 acres of ponderosa pine and 223 acres of aspen with the remaining 30,534 acres occurring in the PJ, oak woodland, grassland and non-vegetated cover types operationally to facilitate burning the ponderosa pine and aspen. Within the ponderosa pine, 59,708 acres are within northern goshawk habitat and 22,738 acres are within Mexican spotted owl habitat.

- Responds to Issue 3 (post-treatment landscape openness and canopy cover), and Issue 5 (range of alternatives and comparison between alternatives).
- It is similar to alternative C in that it adds acres of grassland treatments on the Kaibab NF and incorporates wildlife and watershed research on both forests.
- It proposes mechanically treating up to 9-inch d.b.h. in 18 MSO PACs and includes low-severity prescribed fire within 70 MSO PACs, excluding 54 core areas. Key components of the stakeholder-created Large Tree Retention Strategy are incorporated into the alternative's implementation plan.
- No forest plan amendments are proposed (Table 145)
- The positive growth response of healthy young trees to density reduction is well known (Ffolliott et al 2000, Latham and Tappeiner 2002). Old growth and large trees have also shown a positive growth response to restoration density reduction as well (Kerhoulas et al 2013, Erickson and Waring 2014). The environmental consequences to old forest structure and large tree recruitment on these 46,091 acres is that VSS 4, 5 and 6's will not, for the most part, be released to grow into the next size class with any rapidity. Without restoration mechanical treatment, growth response of the VSS 4, and especially the VSS 5 & 6 will be reduced (Erickson and Waring 2014). In long-term consequences, old forest structure and large tree recruitment and retention will be challenged by climate change pressures where these stands, and VSS 4, 5 and 6's in particular, may suffer greater losses than if they had been treated. The reduction in growth will greatly delay, or forgo, these stands reaching desired conditions of

Without the amendments proposed for the Coconino NF under Alternative C, Alternative E will not be able to:

- Prescribe treatments that have restoration quality interspaces and groups of varying size and density across the landscape.
- Treat up to 17.9 inch d.b.h. in 18 and decreases the minimal basal area from 150 to 110 in the 18 PACs
- Use prescribed fire in 54 core areas
- Manage 6,299 acres of restricted target and threshold habitat for a minimum range of 110 to 150 basal area

The loss of the foregoing restrictions can be discussed in terms of effects of vegetation management outcomes.

MSO

Basal area is above the desired minimum for target/threshold habitat and above the desired range for restricted other. The SDI density remains in the extremely high zone within the target/threshold and protected habitats and is higher than the desired range in restricted other. The distribution of size classes is at or exceeds desired minimum in the 12-18" and the 18-24" size classes in all habitats. Stocking in the 24" + size class also exceeds desired minimum in the restricted other habitat and remains below desired minimum in the target/threshold habitat. Average trees per acre 18" and larger exceed desired minimum in the target/threshold habitat and

remain below desired minimum in restricted other. Tree densities within the PACs and Core remain high in terms of BA, SDI, TPA, and canopy cover. Stand density is to the point the trees are slow growing, water-nutrient-light-space deprived leading to increased stress, bark beetle risk remains high and increasing, and crown fire risk is high and increasing. These stands remain high risk stands for the foreseeable future. Treatments will remove some suppressed and codominant trees and fire will improve overall stand health, however, these stands remain at high risk for losses.

The greatest impacts to Alternative E MSO, within the CFN, is being restricted from treating up to 17.9 inches d.b.h within the 18 PACs and then having to carry a target basal area of 150. Without the amendments tree removals diameter caps will be as low as 9 inch d.b.h and below and instead of managing for a minimum of 110 basal area, the treatment would be required to target a basal area of 150. This severely limits the silvicultural options for reducing stand densities, beetle risk, and crown fire risks. Not being able to treat throughout the entire diameter ranges present, with an uneven-aged prescription, leaves the stands closer to an even-aged structure, or on a trajectory to even-aged structure, and away from the desired condition of uneven-aged structure with components of old growth. In this aspect the treatments within Alternative E will be very similar to the outcomes of Alternative C where densities, in terms of basal area and SDI, continue to increase and remain higher than desired, but within E as compared to C the densities will be even higher post-treatment and the risks greater. Without being able to treat throughout the diameter ranges puts these MSO areas at high risk post-treatment into the future.

Goshawk

Goshawk habitat on the Coconino NF follows the MRNG guidelines in areas outside of MSO management areas. Treatments on the CNF following the prescriptions developed for the 4FRI project will have a distinctively different outcome than Alternatives C-D. The amendments define, and allow for, interspaces and groups. Without this amendment treatments cannot achieve the openness associated with restoration. Interspaces (now gaps) will be smaller and less defined and confined to enhancing natural forest gaps. Groups will not be as discernible and unique. Grass and forb responses can be expected to be less than in Alternative C since there will be less canopy openness. Canopy openness will be measured at the stand level instead of the group level, and this will force a change in marking guides of the stand that will leave the stand at higher densities for basal area and SDI. Treatments will leave the spatial arrangement of trees in a much more uniform pattern with no interspaces, smaller gaps, and larger groups. Regeneration openings will not be identified and this will perpetuate the current condition of underrepresentation within VSS classes 1 and 2. In general, the stand structure will resemble the stands that have come before, and that the 4FRI project is designed to change.

On the Kaibab NF vegetation management was developed using the MRNG as a template and are managed at the mid-scale by maintaining forest conditions in some areas that have 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest; these include goshawk post-fledging family areas, Mexican spotted owl nesting/roosting habitat, and north-facing slopes. Interspaces with native grass, forb, and shrub vegetation typically range from 10 to 50 percent of the area. The treatment acres planned within the next 5 years are small, but they will move the forest towards their desired conditions. Table 33 and Table 34 display the goshawk structure and habitat components projected out to the years 2020 and 2050. Density in terms of SDI and basal area continues to increase and remains higher than desired in all habitats. All habitats show an increase in total CWD, CWD >12" and snags >18" between 2020 and 2050

resulting in conditions at or close to desired. Most of the untreated area continues to move away from the desired conditions. Planned forest treatments within this forest component will move the forests towards their desired conditions. Untreated acres will continue to move away from their desired conditions. The presence of prescribed or wildland fire may or may not move untreated acres towards their desired conditions.

Timber Harvest

Many stands today are even-aged, dense, and lack age class diversity. At least 84 percent of goshawk non-PFA habitat vegetation structural stage 3 (young-aged forest) and 4 (mid-aged forest) are even-aged. Approximately 74 percent of the project area is classified as having moderately closed to closed tree canopies. Currently planned forest treatments should move these stands towards a trajectory for their desired conditions. Untreated stands will continue to move away from their desired conditions and become more dense. Without amendments treatments on the CNF following the prescriptions developed for the 4FRI project will have a distinctively different outcome than Alternatives C-D. The amendments define, and allow for, interspaces and groups. Without this amendment treatments cannot achieve the openness associated with restoration. Interspaces (now gaps) will be smaller and less defined and confined to enhancing natural forest gaps. Groups will not be as discernible and unique. Treatments will leave the spatial arrangement of trees in a much more uniform pattern. Canopies, now measured at the stand level, will be more continuous and prone to crown fire. Regeneration openings will not be identified and this will perpetuate the current condition of underrepresentation within VSS classes 1 and 2. In general, the stand structure will resemble the stands that have come before, and that the 4FRI project is designed to change. Forest products will still be produced through this alternative.

Restoration has a distinct spatial signature within the ponderosa pine and pine-oak vegetative plant communities. The distinct interspaces varying from 10% up to 90% of stand area in restoration treatments will be missing in Alternative E. The inherent gaps and crown cover of the current forest will prevail in the silviculture prescription. Opportunities will exist to enlarge the already occurring natural opening to make pseudo-interspaces, but opportunities to create regeneration openings will be limited. Marking guidelines will dictate a more uniform distribution of leave trees, natural groups will be larger, and gaps smaller and fewer. The marking guides, instead of setting out interspaces and groups it will establish a leave/cut formula reminiscent of treatments post 1996 to current time, but they will not resemble restoration removals. The forest will continue to produce forest products and the forest will move towards the forest plans desired conditions, but will maintain or move away from 4FRI desired forest conditions.

Special Silviculture Acres – Alternatives C and E

In response to comments and feedback on the DEIS , on approximately 38,256 acres (22,772 acres on the Coconino and 15,484 acres on the Kaibab NF) of UEA 40, UEA 25, and non-WUI stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean BA greater than 70 of the VSS 4 size class and a mean TPA less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. After further public comments an additional 7,835 acres of IT10 and UEA 10 treatments were included for this section, for a total of 46,091 acres. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-WUI stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the planned prescription intensity range, managing for larger group sizes, and/or

retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and will achieve 40 percent canopy cover at the stand scale.

Maintaining high canopy cover percentages across the stand will necessitate maintaining high stocking basal area, high trees per acre, and high SDI. Currently the 38,256 acres encompasses 1,096 stands averaging 143.4 BA, 508.6 TPA, and 281.5 SDI (62.5% of max SDI: SDIMax = 450). This will result in continuous canopy cover over most of the stand which will increase the risk of density related mortality and crown fire risk above most other restoration treatments.

On the stands treated in Table 66 prescriptions would be implemented to the lower intensity level were possible while trying to maintain stand structure at the upper ends of the NRV, with an intent to maintain 40% canopy cover. It is not proposed to change treatment types but to instead to maintain the planned treatments but to limit the treatment intensity such that the silviculturist favor the less intense range of the treatment planned and analyzed.

Specific to alternative C and E, approximately 46,091 acres of VSS 4, 5 and 6 would have canopy cover measured at the stand level. Maintaining high canopy cover percentages across the stand would require treatments to maintain high stocking basal area, high trees per acre, and high SDI.

Currently the 38,256 acres encompasses 1,096 stands averaging 143.4 BA, 508.6 TPA, and 281.5 SDI (62.5% of max SDI: SDIMax = 450). The positive growth response of healthy young trees to density reduction is well known (Ffolliott et al 2000, Latham and Tappeiner 2002). Old growth and large trees have also shown a positive growth response to density reduction as well (Latham and Tappeiner 2002, Kerhoulas et al 2013, Erickson and Waring 2014). The environmental consequences to old forest structure and large tree recruitment on these 46,091 acres is that VSS 4, 5 and 6's will not, for the most part, be released to grow into the next size class with any rapidity. Without adequate mechanical treatment growth response of the VSS 4, and especially the VSS 5 & 6 will be significantly reduced. In long-term consequences, old forest structure and large tree recruitment and retention will be challenged by climate change pressures where these stands, and VSS 4, 5 and 6's in particular, may suffer losses. The reduction in growth will greatly delay, or forgo, these stands reaching desired conditions of uneven-aged stands with components of old growth structure in the shortest possible timeframe.

Management on 3,303 Acres of Proposed Savanna Treatments

In response to comments from the public there continues to be a conversation on large trees, issue 2. In response to comments and feedback, Alternative E best meets the concern because no savanna treatments are proposed. The implementation plan, as it relates to alternative E has been updated to clarify that most VSS 4, VSS 5 and VSS 6 would not be cut on about 3,300 acres. The 3,303 acres containing a significant number of trees in the VSS 4-6 classes, currently assigned to savanna treatments within Alternative C, will be removed from Alternative C and assigned to their analyzed Alternative E treatments. Alternative E does not include the amendments for the specific definitions for interspaces and groups, therefore while the IT40 and UEA40 are desired they may not be necessarily attainable (See project record for details). These stands, while moving towards savanna, will not attain the savanna desired conditions.

Forest Structure and Diversity - Mosaic of interspaces and tree groups of varying sizes and shapes

Many stands today are even-aged, dense, and lack horizontal and vertical diversity. It is difficult to convert even-aged to uneven-aged stands without being able to open up a stand to allow for adequate regeneration (openness, regeneration openings, interspaces). Keeping basal areas high, canopies closed, and gaps small, leads to an even-aged stand structure with little or no grass and forb understory and forest diversity is reduced. Where applicable, current stand structures, with their high densities, lead to the encouragement of shade-tolerant species (i.e., spruce, white fir, southwestern white pine, Douglas-fir) and leads to stand succession to cool site late seral species that are generally less fire tolerant than ponderosa pine. Without the amendments, treatments cannot establish groups, interspaces, and regeneration. Treatments will resemble thinning from below that further encourages an uneven-aged stand structure if you cannot create adequate openings for regeneration. Groups, interspaces, and regeneration openings are part of a restoration treatment. Without groups, interspaces, and regeneration openings the project cannot hit the desired conditions of a mosaic of interspaces and tree groups of varying sizes and shapes with any consistency.

Projects planned within the analysis area on the CNF and KNF, if completed, should help move those areas toward their desired conditions.

Forest Structure - All age and size classes represented

Without CFP amendments the opportunities to establish groups, interspaces, and regeneration openings is reduced or eliminated. The main objective of past thinning is to reduce canopy fuels and the potential for crown fire initiation. Generally, this type of treatment focuses on removal of trees in the subordinate crown positions and retaining those trees in the dominate and co-dominate crown positions and any pre-settlement trees. This type of treatment results in a moderately open to closed canopy, even-aged forest structure with very little age and size class diversity. Without CNF amendments this type of forest treatment may be perpetuated.

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.

High and mixed severity 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.

Natural Range of Variability (Alternative E) (Appendix G)

Appendix E graphically represents Natural Range of Variability Comparison by Treatment Type by forest attributes: Minimum, maximum and the weighted average. Forest Attributes are within the Natural range of Variability except for PACS, Goshawk nest areas and MSO Target Threshold Habitats. Pine basal areas remain within historic ranges, but all basal areas increase as other non-pine components increase in size (i.e., Gambel oak) except for Arizona Game and Fish designs which trend away from historic range of variations. As the intensity of treatments increase the habitats are structured most closely to the lower end of the historic range of variability. An exception to this will be the approximately 46,091 acres that will be managed towards the higher end of the natural range of variability in goshawk habitat and larger group sizes as a result of response to comments. Without amendments the project treatments will have difficulty achieving

and maintaining the desired NRV. Without interspaces and openness the spatial structure of the forest will be much more uniform tree distribution. While treatments can obtain similar basal areas, trees per acre, and SDI figures the spatial context within which the forest is structure is so different as to present a different type of forest, visually and ecologically.

Old Forest Structure Sustained Over Time Across the Landscape

The restoration treatments proposed under alternative E are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Old trees would not be targeted for cutting. Reference the Old Tree Implementation Strategy in Appendix A of this report. The lack of amendments for Alternative E do not have significant impact on the ability to retain old forest structure over time. However, within MSO areas that contain old trees it will be difficult to protect them from fire and increased competition from smaller and closely space trees. Stands that maintain high densities and canopy cover pose risks to old forest structure from fire, insects, and density related mortality. This does not move the forest towards the desired condition.

The MSO habitat forest structure analysis for alternative E indicates the post treatment distribution of size classes has good representation in the 18-24" size classes in all habitats. Stocking in the 24" + size class has good representation in the restricted other habitat and is underrepresented in the target/threshold habitat (Table 84). Maintaining this type of old forest structure is difficult over time on a landscape basis.

The goshawk habitat structural stage analysis indicates the mature and old forest structural stages to be underrepresented in the PFA habitat and LOPFA even-aged stands. Projections show a trend toward improved representation in all habitats (Table 85). Maintaining the even-aged stand structure will do little to establish replacement candidates or protect currently established old forest structure. Without amendments the progression towards mature and old forest structure will be slow and the forest may not attain this structure desired condition.

With the implementation of restoration treatments under alternative E, the sustainability of the large/old tree component across the landscape will be improved as presented in the following forest health discussion.

Openness

The variety of treatment types and desired conditions under alternative E would result in reduction to the varying range of openness post treatment. The list of treatment types and treated acres displayed for alternative C is the same for alternative E except for the implied interspaces and groups implied in the treatment nomenclature. However, without the forest plan amendments that specifically defines groups and interspaces, the openness will be more evenly spaced and favoring a less open structure (Table 87). Applying treatments in the absence of amendments will, spatially, have the look of a more traditional thinning that has a uniform distribution of tree spacing. Thinning in Uneven-aged silviculture systems entails removals across all diameter ranges without preference for creating groups, interspace, and regeneration openings, other than what is currently a part of the stand structure. The uniform structure of these treatments will mean potentially more active crown fire, shorter treatment life as crowns close quicker, potential for more extreme fire behavior that can lead to larger acreage losses because of larger areas of continuous canopy cover. Alternative E will have less forest edge for wildlife, lower understory vegetative response, and snowpack accumulation will be less with higher sublimation rates. If the

treated stands have a current structure that has distinct groups, this stand structure will follow thru to the post-treatment stand and it will have the similar benefits as Alternative B-D.

The 4FRI project does not require forest plan amendments for the Kaibab NF Forest Plan (2014). The KFP will move the forest towards the desired conditions without amendments.

Table 87 lists the post treatment openness within the ponderosa pine cover type for alternative E by restoration unit and sub unit. Overall ranges indicate a diverse condition with openness trending to the closed side of the range. Three percent of the ponderosa pine would be very open, 54 percent open, 28 percent moderately closed and 14 percent closed.

Forest Health

Density related mortality

Stand density is the dominant factor affecting the 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). Current stand densities across the analysis area average 44% of maximum SDI (Table 14) which puts the average stand in the High Density category (Table 7) and approaching the onset of density related mortality. Within MSO habitat the SDI averages 78% of maximum (Table 13) and is well within the extreme range and places these stands at high fire, beetle, and density related mortality risks. Past treatments within the analysis area and proposed treatments under review on both the Coconino and Kaibab NF will reduce high stand densities, reduce density related mortality and provide bark beetle risk mitigation. For Alternative E crown fire risk will be moderated slightly using non-restoration treatments.

Bark beetle related mortality

The overall bark beetle hazard in 2020 is high across 22% of the analysis area. This should remain steady or decrease slightly under Alternative E. Long-term prognosis is that bark beetle risk will increase substantially compared to Alternative C by 2050 (Table 89) Stands with a hazard rating of low or moderate would be expected to be resistant to successful bark beetle attack and large scale mortality and would be resilient to most non-epidemic outbreaks. In the current climate change scenario, Alternative C-D mitigates the beetle hazard and combined with prescribed fire, reduces beetle hazard to the greatest extent for the longest period.

Dwarf mistletoe infection

Dwarf mistletoe infection level and average percent of trees infected for the years 2020 and 2050 are listed in Table 68. For 2020, approximately 60 percent of the area is not infected or has a low infection level and 40 percent has a moderate to high infection level. The overall average percent of trees infected is 6 percent in the none/low group and 39 percent in the moderate/high group. This reflects an improvement from the no action alternative with one percent more area in the none/low group and one percent less area in the moderate/high group. Overall percent of trees infected is one percent less in none/low and 8 percent less in moderate/high. The percentages for 2050 indicate mistletoe infection is intensifying and spreading at a slower rate than alternative A. Treatments using a SI treatment could lessen the post-treatment DMR but 40 percent of the area

infected it is difficult to mitigate this pathogen over the long period. Groups with their edges and interspaces and regeneration openings may slightly increase the spread of dwarf mistletoe along the interfaces. Regeneration within 66 feet of an infected edge are at most risk to infection as the tree matures. The best defense against dwarf mistletoe is to keep the stands in good health. 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 ratio of 3 (Hoffman 2010). Treatments will move most stands towards desired conditions. Because of the spatial distribution of trees under Alternative E (as compared to C) dwarf mistletoe can be expected to spread faster under more intense treatments where spacing between trees is more open (as compared to Alternative C), however, in less intense treatments dwarf mistletoe can be expected to spread slower than in some Alternative C treatments. Within MSO habitats dwarf mistletoe can be expected to spread and intensify between trees and within trees at similar rates in all alternatives.

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 alternative E. 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 alternative E. 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 time in the form of building materials.

Vegetation Diversity and Composition

Grasslands

Past treatments have restored historic grasslands that are not classified as timber suitable lands, savannas and forest openings by removing ponderosa pine tree canopy that is shading out understory herbaceous vegetation and reducing forage production and species diversity. Past and foreseeable treatments are not as extensive as those proposed under the 4FRI project. Past treatments have moved grasslands towards their desired conditions.

Prior to 1996 oak was not a preferred species. Following the 1996 amendment oak was recognized as an integral component of the pine and pine-oak communities and was given management priority. Oak treatments proposed in alternative E are designed to conserve oak and improve conditions that favor oak growth and establishment wherever it exists by reducing pine-oak competition. Outcomes from treatments between Alternative C and E for oak will be similar, except in areas of high tree canopy cover where sunlight will not be adequate and openings not large enough to encourage growth and sprouting. High canopy cover is a detriment to oak health and grass and forbs. While there will be some improved vigor of existing oak and establishment of a variety of oak size and age classes across the landscape they will be less than in Alternative C. These conditions would be most prevalent within the 62,222 acres of MSO restricted other habitat treatments. Table 84 shows the overall post treatment oak basal area would be 5 percent higher in this habitat compared to the no action alternative.

Aspen

Prior treatments to maintain and/or regenerate aspen by reducing pine-aspen competition would result in establishment of vigorous aspen regeneration free of competition from overtopping ponderosa pine. Treatments to improve aspen regeneration for past and future projects will move aspen towards its desired condition. 4FRI will treatments of 1,450 acres of aspen stands under alternative E are designed to maintain and/or regenerate aspen by reducing pine-aspen competition. These treatments would result in establishment of vigorous aspen regeneration free of competition from overtopping ponderosa pine. Prior aspen treatments and proposed aspen treatments (forest and 4FRI proposals) will move aspen towards its desired condition.

Aspen Fencing and Barriers

Current Kaibab Forest Plans calls for 200 acres of aspen fence within 10 years and reduce conifer encroachment on 800 acres (KFP page 29). These and past treatments will help move aspen towards the desired conditions.

Coconino Forest Plans calls to protect regenerated areas and assign no grazing capacity until seedlings are established. Protect areas or a group of areas by excluding grazing through fencing, or other means where appropriate. If funding is not available for needed protection, do not harvest the area(s).

4FR proposes to install up to 82 miles protective barriers around aspen clone patches within the ponderosa pine forest. Barriers would consist of fencing and/or felling trees (jack-strawing). Fencing would occur after mechanical and burning treatments and would have no effect to the vegetation. Jack-strawing may occur during the mechanical operation and would utilize trees that have been targeted for removal to meet treatment objectives. Leaving felled material on the ground would forego the opportunity to use that material for wood products. All previous and proposed aspen treatments will move treated aspen towards their desired condition.

Pine Sage

Prior pine-sage treatments will move pine-sage towards its desired condition. The 5,261 acres of pine-sage thinning treatments for this project are designed to remove post settlement pine that currently is overtopping and shading out the sage and to manage fire to enhance sage extent. These treatments would result in enhancement of the sage component within the pine sage mosaic.

Other Direct and Indirect Effects:

Residual Tree Damage

Some damage to residual trees would be expected in alternatives E with the felling, tractor yarding and piling operations associated with mechanical treatments in ponderosa pine on 403,218 acres (Table 81). Damage rates should be similar to current silviculture practices. Alternative E would result in the most potential damage because of the extensive harvesting using individual tree selection in overly dense stands. Damage would be minimized through contract administration 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).

Timber and Wood Products

A Coconino FP goal is to manage the timber resource to provide a sustained-yield of forest products (CFP plan pg. 23). A Kaibab FP goal is to manage suitable timberland to provide a sustained level of timber outputs to support local dependent industries (KFP pg. 18). Timber harvest of 245,343,350 cubic feet of biomass from the Coconino and 122,393,816 cubic feet of biomass from the Kaibab is a direct beneficial effect of Alternative E. Timber and wood products will still be available under Alternative E.

Managing for High Canopy Cover on 46,091 acres

Environmental Consequences – Alternatives C and E

In response to comments and feedback on the DEIS , on approximately 38,256 acres (22,772 acres on the Coconino and 15,484 acres on the Kaibab NF) of UEA 40, UEA 25, and non-WUI stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean BA greater than 70 of the VSS 4 size class and a mean TPA less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. After further public comments an additional 7,835 acres of IT10 and UEA 10 treatments were included for this section, for a total of 46,091 acres. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-WUI stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the planned prescription intensity range, managing for larger group sizes, and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and will achieve 40 percent canopy cover at the stand scale.

Specific to alternative C and E, approximately 46,091 acres of VSS 4, 5 and 6 would have canopy cover measured at the stand level. Maintaining high canopy cover percentages across the stand would require treatments to maintain high stocking basal area, high trees per acre, and high SDI. Currently the 38,256 acres encompasses 1,096 stands averaging 143.4 BA, 508.6 TPA, and 281.5 SDI (62.5% of max SDI: SDIMax = 450). The positive growth response of healthy young trees to density reduction is well known (Ffolliott et al 2000, Latham and Tappeiner 2002). Old growth and large trees have also shown a positive growth response to density reduction as well (Latham and Tappeiner 2002, Kerhoulas et al 2013, Erickson and Waring 2014). The environmental consequences to old forest structure and large tree recruitment on these 46,091 acres is that VSS 4, 5 and 6's will not, for the most part, be released to grow into the next size class with any

rapidity. Without adequate mechanical treatment growth response of the VSS 4, and especially the VSS 5 & 6 will be significantly reduced. In long-term consequences, old forest structure and large tree recruitment and retention will be challenged by climate change pressures where these stands, and VSS 4, 5 and 6's, in particular, may suffer losses. The reduction in growth will greatly delay, or forgo, these stands reaching desired conditions of uneven-aged stands with components of old growth structure in the shortest possible timeframe.

Table 99. Goshawk treatments and acres to be measured at the stand level

Treatment Type	Acres	Treatment Type by Forest	Acres	Treatment Type by Forest	Acres
Total	38,256	CNF	22,772	KNF	15,673
dPFA - IT25	25	dPFA - IT40	287	dPFA - IT25	25
dPFA - IT40	287	dPFA - UEA25	209	dPFA - UEA25	361
dPFA - UEA25	570	dPFA - UEA40	234	dPFA - UEA40	266
dPFA - UEA40	500	IT25	872	IT25	366
IT25	1,238	IT40	8,053	IT40	2,346
IT40	10,400	PFA - IT25	9	PFA - IT40	192
PFA - IT25	9	PFA - IT40	608	PFA - UEA25	261
PFA - IT40	800	PFA - SI25	37	PFA - UEA40	378
PFA - SI25	37	PFA - UEA25	64	UEA25	3,149
PFA - UEA25	326	PFA - UEA40	218	UEA40	8,141
PFA - UEA40	595	SI25	22	Grand Total	15,484
SI25	22	UEA25	2,352		
UEA25	5,501	UEA40	9,805		
UEA40	17,946	Grand Total	22,772		
Grand Total	38,256				
Proposed Treatments	ACRES				
dPFA - IT10	55				
dPFA - UEA10	198				
IT10	1,697				
PFA - IT10	176				
PFA - UEA10	484				
UEA10	5,225				
TOTAL	7,835				

Current average stand conditions over the 46,091 acres are approximately:

Number of Stands = 1,069

Average Total Basal Area = 143

Average Basal Area VSS 4, 5 and 6 = 107

Average Trees per Acre = 511

Average SDI = 281 (62% of SDIMax: SDImax = 450)

Average SDI VSS 4, 5, and 6 = 177

Stand acres (range) = 4 to 344 acres

Average Stand acreage = 36 acres

Desired Conditions: Managing canopy cover at the stand level. Within group structure specific to mid-aged to old classes (VSS 4 to 6) includes some open understories, interlocking tree crowns, abundant large limbs, and shade.

Managing with an emphasis on retaining the majority of the stocking in VSS 4, 5, and 6 while maintaining high canopy cover will, by necessity lead to:

High stocking: estimated average basal area will be around 120, TPA 400, and SDI 55% post treatment.

Continuous canopy: placing management emphasis on retaining VSS 4,5 and 6 will lead to high canopy cover at the stand level. This will:

- Raise crown fire risk
- Increase bark beetle risk
- Reduce grass/forb response

Thin from below: To retain VSS 4, 5, and 6's the marking guide will be a thin from below or free thin treatment. This type of thinning will lead to:

- Increased QMD
- Age compression
- Cohort compression
- Remove young trees
- smaller regeneration openings
- High probability that this moves trajectory from uneven-aged stand towards even-aged stand (remove young trees in favor of older trees in order to manage from canopy)

Managing canopy cover is not one of our desired conditions at the stand level within the 4FRI matrix. And this type of forest structure is counter to restoration science. Therefore, on these 46,091 acres these stands do not move towards desired conditions in the short or long term.

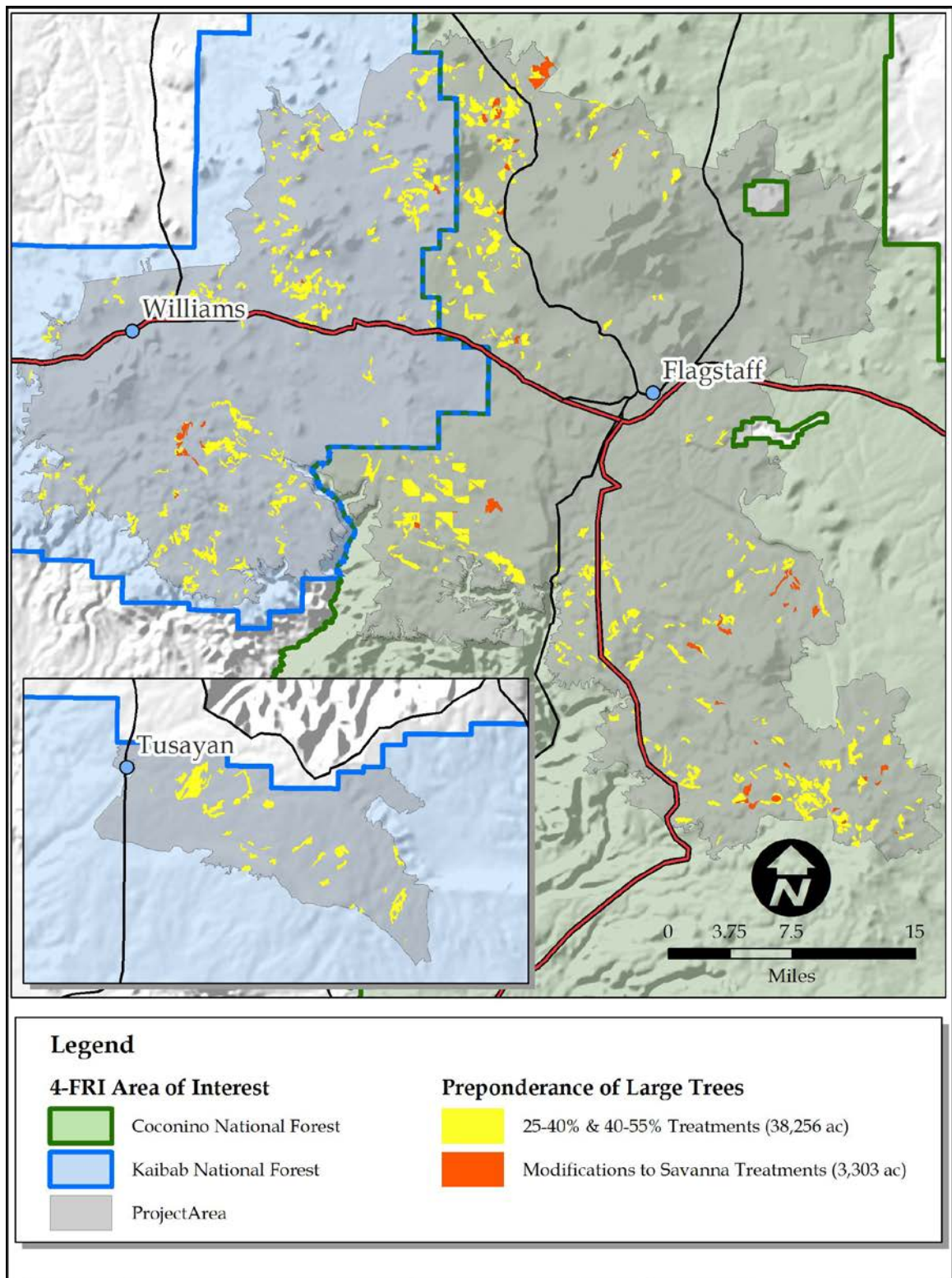


Figure 18. Managing for Higher Canopy Cover

Slide Fire (2014) (Appendix H)

The Slide fire started the afternoon of May 20, 2014, contained on June 5th, and controlled on June 10th after burning 21,227 acres. The Slide fire burned 7,870 acres of 4FRI project area. Appendix H provides an analysis of the impacts of this fire to the specific project area (7,870 acres). The burned area would be deferred for a minimum of five years. This would provide an opportunity for recovery of affected soils and vegetation prior to implementing any actions that may cause additional disturbance. The proposed treatments would not change; however, prior to implementation, and appropriate resource specialists would evaluate the area to ensure that treatments are still appropriate and would meet resource objectives and move the area towards their desired conditions.

Reasonably Foreseeable Projects With Insufficient Information for Analysis

The Four-Forest Restoration Initiative, Apache-Sitgreaves NFs and Tonto NF, as of March 2014, has no tangible information that would be meaningful for this cumulative effects analysis. No project boundary has been created, no decision has been made on the existing and desired condition of resources (no purpose and need for action); therefore, no specific activities have been proposed. For this reason, it was eliminated from the cumulative effects reasonably foreseeable category.

Foreseeable treatments plan on reducing stand densities using uneven-aged stand level silviculture systems, forest health treatments to reduce dwarf mistletoe, and treat some MSO habitat. These treatments, if completed, are not planned to include stand treatment designs identical to those planned for 4FRI and they lack the proposed plan amendments for the Coconino FP. These treatments, while improving stand structure and fire risks are over limited acres using less intense treatments. 4FRI will contain increased areas of interspace, more defined groups, increased stand diversity (horizontally and vertically within the groups), increased understory response, and greater landscape diversity of groups, gaps, and interspaces than currently planned in the foreseeable plans. The 4FRI plans to treat up to 588,917 acres with various treatments designed to reduce stand densities using an uneven-aged silviculture system, where applicable, that incorporates groups of various sizes, interspaces of various sizes, and regeneration openings of various sizes within the 10-year planned period (or until completed). The landscape level of 4FRI is a distinct advantage over fewer and smaller projects over the same period and will move significantly more acres to, or on a trajectory towards, the forests desired conditions.

Table 100. Reasonably foreseeable vegetation and ground-disturbing projects within and adjacent to project area

Project Name	Treatment Type	Metric	Forest/District		Project Objective Summary and Status
			Coconino	Kaibab	
Bill Williams Mountain Restoration	Mechanical, prescribed fire, roads	11,650 acres mechanical 15,200 acres prescribed fire 28 miles road decommission and 23 miles temporary road construction		Williams	Reintroduce fire, reduce stand densities and fire potential, move toward balanced age classes, improve understory composition and productivity, includes 31 acres of cable logging in MSO PACs that would cause a loss of most snags and trees (including snags greater than 18 inch d.b.h. and trees greater than 24 inch d.b.h.) across approximately 15 percent of the area with this proposed treatment within the PAC in order to provide cable corridors and safe logging operations. Approximately 15 percent, or 5 acres, of the PAC area treated with cable logging operations would have most trees removed within these corridors under Alternative 2 (SDEIS, page 6). removes timber suitability on 8,954 acres, thinning above 9 inch d.b.h. in MSO PACs, burning greater than 1 acre in the AZ Bugbane Botanic Area Status: analysis underway, DEIS was released in 2012, SDEIS was released in October of 2013, a decision is likely in 2014.
Watts Vegetation Project http://www.fs.fed.us/nepa/nepa_project_exp.php?project=41569	Mechanical and prescribed fire	3,000 acres		Tusayan	Scoping 01/2014 with decision expected 05/2014
Turkey/Barney Pasture Forest Health Restoration http://www.fs.fed.us/nepa/nepa_project_exp.php?project=37244	Mechanical and prescribed fire	Potentially 17,838 acres of mechanical and prescribed fire	Flagstaff		Reduce dwarf mistletoe, tornado salvage, improve MSO habitat Status: analysis underway, decision may occur in October 2014; however, 2014 Slide Fire resulted in changed conditions.

Project Name	Treatment Type	Metric	Forest/District		Project Objective Summary and Status
			Coconino	Kaibab	
Flagstaff Watershed Protection Project	Mechanical and Prescribed Fire	10,543 acres (7,569 acres Dry Lake Hills and 2,974 acres Mormon Mtn)	Flagstaff		4FRI treatments in Dry Lake Hills and Mormon Mtn removed – deferred to FWPP Treatments include 1,825 acres of PAC treatments in Mormon Mtn, 1,221 PAC treatments in DryLake Hills, 424 acres of MSO core area treatment in Mormon Mtn, and 396 acres of MSO core area treatment in Dry Lake Hills, 103 acres of goshawk nest fuels reduction in Dry Lake Hills, 59 acres of grassland restoration in Dry Lake Hills and 1.733 acres of no treatment due to previous NEPA or site condition Status: Scoping conducted in April, 2013, decision likely in 2014 with implementation in 2015

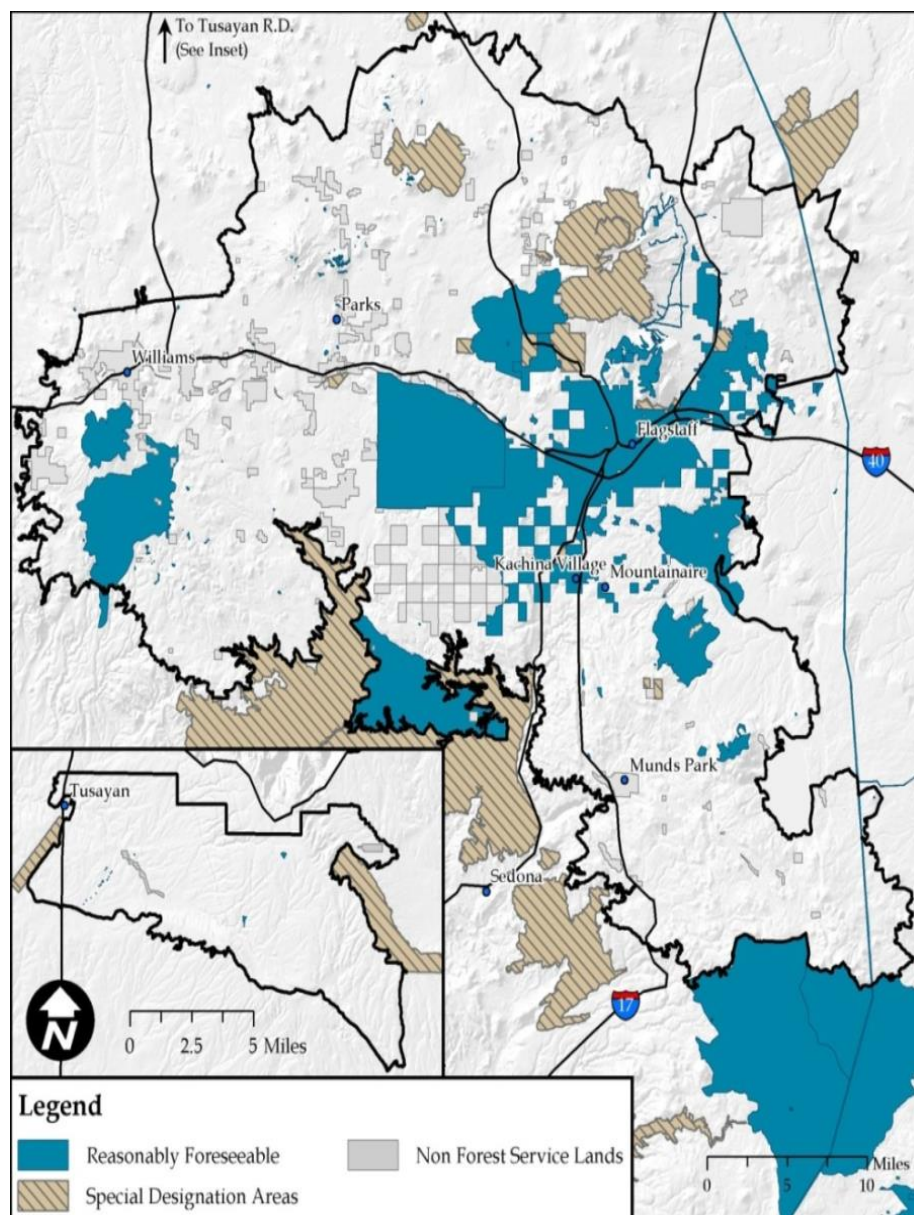


Figure 19. General locations of foreseeable projects within or adjacent to the project area

References

- Abella, S.R. 2008a. Managing Gambel oak in southwestern ponderosa pine forests: the status of our knowledge. Gen. Tech. Rep. RMRS-GTR-218. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 27 p.
- Abella, S.R., 2008b. Gambel oak growth forms: management opportunities for increasing ecosystem diversity. Res. Note RMRSRN-37. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 6 pp.
- Abella, S.R., Springer, J.D. 2008. Canopy-tree influences along a soil parent material gradient in *Pinus ponderosa*-*Quercus gambelii* forests, northern Arizona. *Journal of the Torrey Botanical Society*. 135:26-36.
- Abella, S.R.; Denton, C.W. 2009. Spatial variation in reference conditions: Historical tree density and pattern on a *Pinus ponderosa* landscape. *Canadian Journal of Forestry* 39:2391-2403.
- Abella, S.R.; Denton, C.W.; Brewer, D.G.; Robbie, W.A.; Steinke, R.W.; Covington, W.W. 2011. Using a terrestrial ecosystem survey to estimate the historical density of ponderosa pine trees. Research Note RMRS-RN-45. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO. 9 pp.
- Allen, S.R.; Savage, M.; Falk, D.A.; Suckling, K.F.; Swetnam, T.W.; Shulke, T.; Stacey, P.B.; Morgan, P.; Hoffman, M.T.; Klingel, J.T. 2002. Ecological restoration of southwestern ponderosa pine ecosystems: A broad perspective. *Ecological Applications* 12(5):1418-1433.
- Allen C.D. 2007. Interactions across spatial scales among forest dieback, fire, and erosion in northern New Mexico landscapes. *Ecosystems* 10: 797-808.
- Allen, C.D. tech. ed. 1996 Fire effects in southwestern forests: Proceedings of the second La Mesa Fire symposium. Los Alamos, NM. General Technical Report RM-GTR-286. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 216 pp
- Andrews S.R., Daniels J.P. 1960. A survey of dwarf mistletoes in Arizona and New Mexico. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Station Paper 49: 17 p.
- Arnold, J. F. 1950. Changes in ponderosa pine bunchgrass ranges in northern Arizona resulting from pine regeneration and grazing. *Journal of Forestry* 48: 118-126.
- BAER Team Report. Draft Slide Fire Burned Area Emergency Response Report, Coconino National Forest. June 2014. 211 p
- Bartos, D.L. 2001. Landscape dynamics of aspen and conifer forests. Pages 5-14 In: Shepperd, Wayne D., Binkley, Dan: Bartos, Dale L., Stohlgren, Thomas, and Eskew, Lane G., compilers. 2001. Sustaining Aspen in Western Landscapes: Symposium Proceedings; 13-15 June 2001, Grand Junction, CO. Proceedings RMRS-P_18. Fort Collins, CO, USDA Forest Service, Rocky Mountain Research Station. 460pp.
- Belsky, J., and D. M. Blumenthal. 1997. Effects of livestock grazing on stand dynamics and soils in upland forests of the Interior West. *Conservation Biology* 11(2): 315-327.
- Bernardos, D.A. et al, 2004. Selection of Gambel oak roosts by Southwestern myotis in ponderosa pine-dominated forest, Northern Arizona. *Journal of Wildlife Management* 68(3):595-601.
- Bonnet, V.H., A.W. Schoettle, W.D. Shepperd. 2005. Postfire environmental conditions influence the spatial pattern of regeneration for *Pinus ponderosa*. *Can. J. Fore. Res.* 35: 37-47.

- Breece, C.R., T.E. Kolb, B.G. Dickson, J.D. McMillin, K.M. Clancy. 2008. Prescribed fire effects on bark beetle activity and tree mortality in southwestern ponderosa pine forests. *Forest Ecology and Management* 255: 119-128.
- Brown, D.E., and C.H. Lowe. 1982. Biotic communities of the Southwest (scale 1:1,000,000). GTR-RM-78. USDA Forest Service, Fort Collins, Colorado. Reprinted and revised 1994 by University Utah Press, Salt Lake City. http://azconservation.org/downloads/biotic_communities_of_the_southwest_gis_data
- Brown, P.M., Kaye, M.W., Huckaby, L. Baisan, C. 2001. Fire history along environmental gradients in the Sacramento Mountains, New Mexico: Influences of local patterns and regional processes. *Ecoscience* 8:115-126.
- Brown, J.K., E. D. Reinhardt, K. A. Kramer. 2003. Coarse Woody Debris: Managing Benefits and Fire Hazard in the Recovering Forest. USDA Forest Service General Technical Report RMRS-FTR-105. 20pp.
- Burns, Russell M., and Barbara H. Honkala, tech. coords. 1990. *Silvics of North America: 1. Conifers; 2. Hardwoods*. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC. vol.2, 877 p. http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm
- Chambers, C.L. 2002. Final Report: status and habitat use of oaks. Arizona Game and Fish Heritage Grant I98012. 52pp.
- Chambers, C.L. and J.N. Mast. 2014. Snag Dynamics and Cavity Excavation after Bark Beetle Outbreaks in Southwestern Ponderosa Pine Forests. *Forest Science*. Society of American Foresters. 60(4): 713-723.
- Chojnacky, D.C., B.J. Bentz, and J.A. Logan. 2000. Mountain pine beetle attack in ponderosa pine: comparing methods for rating susceptibility. USDA Forest Service Research Paper, RMRS-RP-26, 10 pp.
- Clary, W.P. and A. R. Tiedemann. 1992. Ecology and values of Gambel oak woodlands. Pages 87-95 In: P.F. Ffolliott et al, eds. *Ecology and management of oak and associated woodlands: perspectives in the southwestern U.S. and northern Mexico*. USDA Forest Service GTR RM-218.
- Cochran, P.H., and J.W. Barrett. 1995. Growth and mortality of ponderosa pine poles thinned to various densities in the Blue Mountains of Oregon. Res. Paper PNW-RP-483. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.
- Cochran, P.H., and J.W. Barrett. 1999. Growth of ponderosa pine thinned to different stocking levels in central Oregon: 30-year results. Res. Pap. PNW-RP-508. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. http://www.fs.fed.us/pnw/pubs/rp_508.pdf
- Conklin, D.A.; Fairweather, M.L. 2010. Dwarf mistletoes and their management in the Southwest. USDA Forest Service, Southwestern Region, R3-FH-10-01. 23p. <http://www.fs.fed.us/r3/resources/health>
- Coop, J.D., Thomas J Givnish. 2007. Spatial and temporal patterns of recent forest encroachment in montane grasslands of the Valles Caldera, New Mexico, USA. *Journal of Biogeography* 34(5):914-927.
- Cooper, C.F. 1960. Changes in vegetation, structure, and growth of southwestern pine forests since white settlement. *Ecological Monographs* 30:129-164.

- Covington, W.W.; Moore, M.M. 1994a. Post settlement changes in natural fire regimes and forest structure: Ecological restoration of old-growth ponderosa pine forests. *Journal of Sustainable Forestry* 2(1/2):153-181.
- Covington W.W., Moore M.M. 1994b. Southwestern ponderosa pine structure: changes since Euro-American settlement. *Journal of Forestry* 92: 39-47.
- Covington, W. W., Fulé, P. Z., Moore, M. M., Hart, S. C., Kolb, T. E., Mast, J. N., Sackett, S. S., and M. R. Wagner. 1997. Restoring ecosystem health in ponderosa pine forests of the southwest. *Journal of Forestry*, 94 (4): 23-29.
- Covington, W.W., and S.S. Sackett. 1992. Soil mineral nitrogen changes following prescribed burning in ponderosa pine. *Forest Ecology and Management* 54:175-191.
- Crookston, N.L. and L.R. Stage. 1999. Percent Canopy Cover and Stand Structure Statistics from the Forest Vegetation Simulator. USDA Forest Service, RMRS-GRT-24. 16 p.
- Crookston, N. L. et al. 2002. Users guide to the most similar neighbor imputation program version 2. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. General Technical Report RMRS-GTR-96.
- Dahl, T.E. 1990. Wetland losses in the United States, 1780's. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 21pp.
- Dahms C. W., Geils B.W. (Technical editors). 1997. An assessment of forest ecosystem health in the Southwest. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-GTR-295. 97 p. Fort Collins CO.
- DeByle N.V. 1985. Wildlife and animal impacts. Pages 133-152, 115-123 In: DeByle, N.V., Winokur, R.P., eds. *Aspen: ecology and management in the western United States*. GTR RM-119. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.
- DeMars, C.J., and B.H. Roettgering. 1982. Western pine beetle. USDA Forest Service Forest Insect & Disease Leaflet 1. 8 p.
- Di Orio, A.P., R. Callas, R.J. Schaefer. 2005. Forty-eight year decline and fragmentation of aspen (*Populus tremuloides*) in the South Warner Mountains of California. *Forest Ecology & Management* 206:307-313.
- Dixon, Gary E. comp. 2002. Essential FVS: A user's guide to the Forest Vegetation Simulator. Internal Rep. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Forest Management Service Center. 240p. (Revised: November 24, 2010)
- Drake, W.M. 1910. A report on the Coconino National Forest. Unpublished report, Coconino National Forest, Flagstaff, AZ.
- Ehle, D.S.; Baker, W.L. 2003. Disturbance and stand dynamics in ponderosa pine forests in Rocky Mountain National Park, USA. *Ecological Monographs* 73:543-566.
- Erickson, C.C., Waring K.M. 2014. Old Pinus ponderosa growth responses to restoration treatments, climate and drought in a southwestern US landscape. *Applied Vegetation Science* (17) 97-108.
- Fairweather M.L., Barton K., Geils B., Manthei M. 2006. Aspen Dieback and Decline in Northern Arizona. National Forest Health Monitoring. USDA, Forest Service, 2006 Poster Presentations.
- Fairweather, M., Geils, B., and Manthei, M. 2008. Aspen Decline on the Coconino National Forest. In: McWilliams, M. G. comp 2008. *Proceedings of the 55th Western International Forest Disease*

Work Conference; 2007 October 15-19; Sedona, AZ. Salem, OR; Oregon Department of Forestry.

- Feth, J.H., and Hem, J.D. 1963. Reconnaissance of headwater springs in the Gila River drainage basin, Arizona: U.S. Geological Survey Water-Supply Paper 1619-H.54pp. <http://pubs.usgs.gov/wsp/1619h/report.pdf>
- Fettig C.J., Klepzig K.D. Billings R.F. Munson A.S., Nebeker T.E., Negrón J.F., Nowak J.T. 2007. The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forests of the western and southern United States. *Forest Ecology and Management* 238: 24–53.
- Fiedler, C.E.; Arno, S.F.; Harrington, M.G. 1996. Flexible silvicultural and prescribed burning approaches for improving health of ponderosa pine forests. Pp 69-74 in Covington, W.W.; Wagner, P.K. (eds.). Conference on adaptive ecosystem restoration and management: Restoration of Cordilleran conifer landscapes of North America. General Technical Report RM-GTR-278. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
- Finch, D.M., and R.T. Reynolds. 1987. Bird response to understory variation and conifer succession in aspen forests. Pp 87-96 In *Proceedings of a national symposium: issues and technology in the management of impacted wildlife* (J. Emerick, S.Q. Foster, L. Hayden-Wing).
- Finch, Deborah M., Editor. 2004. Assessment of grassland ecosystem conditions in the Southwestern United States. Volume 1. Gen. Tech. Rep. RMRS-FTR-135-Vol. 1. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 167pp.
- Ffolliott, P.F., M.B. Baker, G.J. Gottfried. 2000. Heavy Thinning of Ponderosa Pine Stands: An Arizona Case Study. USDA Forest Service.. RMRS-RP-22. 12p.
- Ffolliott, P.F. and G.J. Gottfried. 1991. Natural tree regeneration after clearcutting in Arizona's ponderosa pine forests: two long-term case studies. Res. Note RM-507. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, 6pp.
- Finkral, A.J.; Evans, A.M. 2008. Effects of thinning treatment on carbon stocks in a northern Arizona ponderosa pine forest. *Forest Ecology and Management* 255:2743-2750.
- Fowler, James F.; Sieg, Carolyn Hull. 2004. Postfire mortality of ponderosa pine and Douglas-fir: a review of methods to predict tree death. Gen. Tech. Rep. RMRS-GTR-132. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 25 p.
- Friederici, P. (ed.). 2003. In: *Ecological Restoration of Southwestern Ponderosa Pine Forests*. Washington, DC: Island Press, 559 p.
- Friederici, P. 2004. Establishing reference condition for southwestern ponderosa pine forest. Working papers in southwestern ponderosa pine forest restoration. Ecological Restoration Institute. Flagstaff, AZ. 16 p.
- Fulé, P.Z.; Covington, W.W.; Moore, M.M. 1997. Determining reference conditions for ecosystem management of southwestern ponderosa pine forests. *Ecological Applications* 7:895–908.
- Fulé, P.Z.; Crouse, J.E.; Heinlein, T.A.; Moore, M.M.; Covington, W.W.; Vankamp, G. 2003. Mixed-severity fire regime in high-elevation forest of the Grand Canyon, Arizona, USA. *Landscape Ecology* 18:465-486.
- Fulé, P.Z. et al. 2005. Pine-oak forest dynamics five years after ecological restoration treatments, Arizona, USA. *Forest Ecology and Management*. 218:129-145.

- Fulé, P.Z., T.W. Swetnam, P.M. Brown, D.A. Falk, D.L. Peterson, C.D. Allen, G.H. Aplet, M.A. Battaglia, D. Binkley, C. Farris, R.E. Keane, E.Q. Margolis, H. Grissino-Mayer, C. Miller, C. Hull Sieg, C. Skinner, S.L. Stephens, A. Taylor. 2014. Unsupported inferences of high severity fire in historical western United States dry forests: Response to Williams and Baker. *Global Ecology and Biogeography*. DOI: 10.1111/geb.12136.
- Furniss R.L., Carolin V.M. 1977. *Western Forest Insects*. USDA Forest Service Misc. Publ. No. 1339. 654 p. Washington D.C.
- Ganey, J. L., and J. A. Dick. 1995. Habitat relationships of Mexican spotted owls: Current knowledge. Chapter 4:1-42 in: USDI Fish and Wildlife Service, Recovery plan for the Mexican spotted owl (*Strix occidentalis lucida*), Vol. II - Technical supporting information. USDI Fish and Wildlife Service, Albuquerque, New Mexico, USA.
- Ganey J.L., W.M. Block, S. H. Ackers. 2003. Structural Characteristics of Forest Stands Within Home Ranges of Mexican Spotted Owls in Arizona and New Mexico. *Western Journal of Applied Forestry* 18(3) 189-198.
- Ganey, J.L., J.P. Ward, and D.W. Willey. 2011. Status and ecology of Mexican spotted owls in the Upper Gila Mountains Recovery Unity, Arizona and New Mexico. USDA Rocky Mountain Research Station General Technical Report RMRS-GTR-256WWW.
- Germain C.J., Weiss M.J., Loomis R.C. 1973. Insect & disease conditions – 1972. USDA Forest Service, Southwestern Forest Insect & Disease Bulletin 3(1): 19 p. Albuquerque NM.
- Gill, S.; Biging, G.S.; Murphy, E.C. 2000. Modeling conifer tree crown radius and estimating canopy cover. *Forest Ecology and Management* 126:405-416.
- Gitlin A.R., Sthultz C.M., Bowker M.A., Stump, F. S., Paxton K.L., Kennedy K., Muñoz A., Bailey J.K., Whitham T.G. 2006. Mortality gradients within and among dominant plant populations as barometers of ecosystem change during extreme drought. *Conservation Biology* 20: 1477-1486.
- Graham, R.T., A.E. Harvey, M.F. Jurgensen, T.B. Jain, J.R. Tonn, D. S. Page-Dumroese. 1994. Managing Coarse Woody Debris in Forests of the Rocky Mountains. USDA Forest Service, INT-RP-477. 16p.
- Griffis-Kyle, K.L., and P. Beier. 2003. Small isolated aspen stands enrich bird communities in southwestern ponderosa pine forests. *Biological Conservation* 110:375-385.
- Harper, K.T. et al. 1985. Biology and management of the Gambel oak vegetative type: a literature review. USDA Forest Service GTR INT-179. Intermountain Research Station. Ogden, Utah, USA.
- Hawksworth F.G., Wiens D. 1996. Dwarf mistletoes: biology, pathology, and systematics. USDA Forest Service, Agriculture Handbook 709. Washington, DC. 410 p.
- Hebblewhite, M., C.A. White, C.G. Nietvelt, J.A. McKenzie, T.E. Hurd, J.M. Fryxell, S.E. Bayley, and P.C. Paquet. 2005. Human activity mediates a trophic cascade caused by wolves. *Ecology* 86: 2135-44.
- Hedstrom N. R., Pomeroy J. W., 1998. Measurements and modelling of snow interception in the boreal forest. *Hydrol. Process.* 12, 1611-1625.
- Hendrickson, D.A. and W.L. Minckly. 1984. Ciénegas-vanishing climax communities of the American Southwest. *Desert Plants* 6:1312-175.

- Hessburg P.F., Beatty J.S. 1985. Incidence, severity, and growth losses associated with ponderosa pine dwarf mistletoe on the Coconino National Forest, Arizona. US Forest Service, Southwestern Region, R3-85-12, 30 p.
- Hoffman, J.T. 2010. Management Guide for Dwarf Mistletoe. USDAFS, Forest Health Protection and State Forestry Organizations, WEB Feb 2010. 14p
- Hopkins A.D. 1909. Practical information on the scolytid beetles of North American forests. 1. Bark Beetles in the genus *Dendroctonus*. Bulletin 83. USDA Bureau of Entomology, Washington D.C., 169 p.
- Huffman, D.W., Sanchez-Meador, A.J., Greco, B. 2012. Fact Sheet: Canopy Cover and Forest Conditions. Ecological Restoration Institute/NAU <http://library.eri.nau.edu/gsd/collect/erilibra/index/assoc/HASH4699.dir/doc.pdf>
<http://library.eri.nau.edu/gsd/collect/erilibra/index/assoc/HASH4699.dir/doc.pdf> Hurteau
- Hurteau, M.D., M. North. 2009. Fuel treatment effects on tree-based forest carbon storage and emissions under modeled wildfire scenarios. *Front Ecol Environ* 7(8): 409-414. 6p.
- Hurteau, M. D., M. T. Stoddard, and P. Z. Fulé. 2011. The carbon costs of mitigating high-severity wildfire in southwestern ponderosa pine. *Global Change Biology*, 17:1516–1521.
- Jennings D.T., Stevens R.E. 1982. Southwestern pine tip moth. USDA Forest Service, Forest Insect & Disease Leaflet 58.
- Jones, J.R. 1975. Regeneration on an aspen clearcut in Arizona. U.S. Forest Service Research Note RM-285, Fort Collins, CO, USA.
- Kane, J.M., Kolb, T.E. 2014. Short- and long-term growth characteristics associated with tree mortality in southwestern mixed-conifer forests. *Can. J. For. Res.* 44:1227-1235.
- Kaye, M.W.; Swetnam, T.W. 1999. An assessment of fire, climate, and Apache history in the Sacramento Mountains, New Mexico, USA. *Physical Geography* 20:305-330.
- Keane, R.E., P.F. Hesburg, P.B. Landres, F. J. Swanson. 2009. The use of historical range and variability (HRV) in landscape management. *Forest Ecology and Management*: 258: 1025-1037.
- Keane, R.E., Parsons, R., Hessburg, P., 2002b. Estimating historical range and variation of landscape patch dynamics: Limitations of the simulation approach. *Ecological Modelling* 151, 29–49.
- Kenaley S.C., Mathiasen R.L., Daugherty C.M. 2006. Selection of dwarf mistletoe-infected ponderosa pines by *Ips* species (Coleoptera: Scolytidae) in northern Arizona. *Western North American Naturalist* 66(3): 279-284.
- Kenaley S.C., R.L., Mathiasen, and E.J. Harner. 2008. Mortality Associated with a Bark Beetle Outbreak in dwarf mistletoe-infested ponderosa pine stands in Arizona. *Western Journal of Applied Forestry* 23: 113 - 120.
- Kerhoulas, L.P., Kolb T.E., Hurteau M.D., Koch G.W. 2013. Managing climate change adaptation in forests: a case study from the U.S. Southwest. *Journal of Applied Ecology*: (50), 1311-1320.
- Keyser, Chad E.; Dixon, Gary E., comps. 2008 (revised February 3, 2010). Central Rockies (CR) Variant Overview – Forest Vegetation Simulator. Internal Rep. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Forest Management Service Center. 66p.
- Kilpatrick, S; Clause, D.; Scott, D. 2003. Aspen Response to Prescribed fire, mechanical treatments, and ungulate herbivory. USDAFS Proceedings RMRS-P-29. 10p.

- Klemmedson, J.O. 1987. Influence of oak in pine forests of central Arizona on selected nutrients of forest floor and soil. *Soil Sci. Soc. Am J.* 51:1623-1628.
- Kolb, T.E., K.M. Holmberg, M.R. Wagner, and J.E. Stone. 1998. Regulation of ponderosa pine foliar physiology and insect resistance mechanisms by basal area treatments. *Tree Physiology* 18: 375-381.
- Kolb T.E. Guerard N., Hofstetter R.W., Wagner M.R. 2006. Attack preference of *Ips pini* on *Pinus ponderosa* in northern Arizona: tree size and bole position. *Agricultural and Forest Entomology* 8: 295–303.
- Kruse, W.H. 1992. Quantifying wildlife habitats within Gambel oak/forest/woodland vegetation associations in Arizona. Pages 182-186 In: Ffolliott, P.F., G.J. Gottfried, D.A. Bennett, C. Hernandez, M. Victor, A. Ortega-Rubio, R.H. Hamre, Tech Coords. Ecology and management of oaks and associated woodlands: perspectives in the southwestern United States and northern Mexico; 1992 April 27-30; Sierra Vista, AZ GTR RM-218. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.
- Landres, P.B., Penelope, Morgan, Swanson, F.J., 1999. Overview and use of natural variability concepts in managing ecological systems. *Ecological Applications* 9, 1179–1188.
- Lata, M. 2014. Fire Ecology Specialist Report. Coconino National Forest. Flagstaff, AZ.
- Laughlin, D.C.; Moore, M.M.; Bakker, J.D.; Casey, C.A.; Springer, J.D.; Fulé, P.Z.; Covington, W.W. 2006. Assessing targets for the restoration of herbaceous vegetation in ponderosa pine forests. *Restoration Ecology* 14:548-560.
- Leiberg, J.B., T.F. Rixon, A. Dodwell. 1904. Forest Conditions in the San Francisco Mountains Forest Reserve, Arizona. USGS. Pp 104.
- Lentile, L.B., F. W. Smith, and W.D. Shepperd. 2005. Patch structure, fire-scar formation, and tree regeneration in a large mixed-severity fire in the South Dakota Black Hills, USA. *Can. J. For. Res.* 35:2875-2885
- Lessard G., Jennings D.T. 1976. Southwestern pine tip moth damage to ponderosa pine reproduction. USDA Forest Service, Rocky Mountain Forest & Range Experiment Station, Research Paper RM-168, 8 p. Fort Collins CO.
- Long D.W., Wagner M.R. 1992. Effects of Southwestern pine tip moth and vegetation competition on ponderosa pine growth. *Forest Science* 38: 173-186.
- Long, J.N. and F.W. Smith. 1984. Relation between size and density in developing stands: a description and possible mechanism. *For. Ecol. And Management* 7:191-206.
- Long, J.N. 1985. A practical approach to density management. *Forestry Chronicle* 61:23-27.
- Long, J.N. and T.W. Daniel. 1990. Assessment of growing stock in Uneven-aged stands. *Western Journal of Applied Forestry*. 5:93-96.
- Lynch A.M., Anhold J.A., McMillin J.D., Dudley S.M., Fitzgibbon R.A., Fairweather M.L. 2008a. Forest insect and disease activity on the Coconino N.F., 1918-2006. USDA Forest Service, Report for the Coconino N.F./Regional Analysis Team.
- Lynch A.M., Anhold J.A., McMillin J.D., Dudley S.M., Fitzgibbon R.A., Fairweather M.L. 2008b. Forest insect and disease activity on the Kaibab N.F. and Grand Canyon N.P., 1918-2006. USDA Forest Service, Draft Report for the Kaibab N.F./Regional Analysis Team.

- Martin, T.E. 2007. Climate correlates of 20 years of trophic changes in a high-elevation riparian system. *Ecology* 88(2):367-380.
- Maschinski, J. 2001. Impacts of ungulate herbivores on a rare willow at the southern edge of its range. *Biological Conservation* 101:119-130.
- Mast, J.N.; Fulé, P.Z.; Moore, M.M.; Covington, W.W.; Waltz, A.E.M. 1999. Restoration of presettlement age structure of an Arizona ponderosa pine forest. *Ecological Applications* 9:228-239.
- Mast, J.N.; Veblen, T.T.; Linhart, Y.B. 1998. Disturbance and climatic influences on age structure of ponderosa pine at the pine/grassland ecotone, Colorado Front Range. *Journal of Biogeography* 25:743-767.
- McHugh, C.W.; Kolb, T.E.; Wilson, J.L. 2003. Bark beetle Attacks on Ponderosa Pine Following Fire in Northern Arizona. *Environmental Entomology*: 32(3): 510-522.
- McMillin, Joel D. et al. 2011. Draft hazard rating for Ips beetles during drought in Arizona. Unpublished paper on file at: U.S. Department of Agriculture, Forest Service, Southwestern Region, State and Private Forestry, Forest Health Protection, Flagstaff, AZ. 1 p.
- McMillin, Joel. 2012. Personal communication email: 2/13/2012. U.S. Department of Agriculture, Forest Service, Southwestern Region, State and Private Forestry, Forest Health Protection, Flagstaff, AZ.
- Medina, A.L. and J.E. Steed. 2002. West Fork Allotment riparian monitoring study 1993-1999. USDA Forest Service, Rocky Mountain Research Station, Final Project Report Volume I.
- Menzel, J.P.; Covington, W.W. 1997. Changes from 1876 to 1994 in a forest ecosystem near Walnut Canyon, northern Arizona. Pp 151-172 in van Riper III, C.; Deshler, E.T. (eds.). *Proceedings of the Third Biennial Conference of Research on the Colorado Plateau. Transactions and Proceedings Series NPS/NRNAU/NRTP-97/12.* Dept. of the Interior, National Park Service. 256 pp.
- Moir, W.H. 1966. Influence of ponderosa pine on herbaceous vegetation. *Ecology* 47:1045-1048.
- Moir, W.H.; Geils, B.; Benoit, M.A.; Scurlock, D. 1997. Ecology of southwestern ponderosa pine forests. Pp 3-27 in Block, W.M.; Finch, D.M. (tech. eds.). *Songbird ecology in southwestern ponderosa pine forests: A literature review. General Technical Report RM-GTR-292.* USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 152 pp.
- Moore, M.M.; Huffman, D.W.; Fulé, P.Z.; Covington, W.W.; Crouse, J.E. 2004. Comparison of historical and contemporary forest structure and composition on permanent plots in southwestern ponderosa pine forests. *Forest Science* 50:62-176.
- Mueller R.C., Scudder C.M., Porter M.E., Trotter R.T., Gehring C.A., Whitham T.G.. 2005. Differential tree mortality in response to severe drought: evidence for long-term vegetation shifts. *Journal of Ecology* 93:1085-1093.
- Muldavin, E., P. Durkin, M. Bradley, M. Stuever, and P. Mehlhop. 2000. *Handbook of wetland vegetation communities of New Mexico, Volume I: Classification and community descriptions.* New Mexico Natural Heritage Program, Biology Department, University of New Mexico, Albuquerque, NM, USA.
- Naumburg, E.; DeWald, L.E. 1999. Relationships between *Pinus ponderosa* forest structure, light characteristics, and understory graminoid species presence and abundance. *Forest Ecology and Management* 124:205-215.

- Naumburg, E., DeWald, L.E., Kilb, T.E., 2001. Shade responses of five grasses native to southwestern U.S. *Pinus ponderosa* forest. *Can. J. Bot.* 79: 1001-1009.
- Neary, D.G. and A.L. Medina. 1996. Geomorphic response of a montane riparian habitat to interaction of ungulates, vegetation, and hydrology. Pages 143-147: in Shaw, D.W. and M.M. Finch (tech coords.), *Desired future conditions for southwestern riparian ecosystems: bringing interests and concerns together*. USDA Forest Service General Technical Report RM-FTR-272. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
- Neff, D.J. et al. 1979. Forest, range, and watershed management for enhancement of wildlife habitat in Arizona. Special report no. 7. Phoenix, AZ: Arizona Game and Fish Department. 109pp.
- Negrón, J.F.. 1997. Estimating probabilities of infestation and extent of damage by the roundheaded pine beetle in ponderosa pine in the Sacramento Mountains, New Mexico. *Canadian Journal of Forest Research* Vol. 27, 10 p.
- Negrón, J.F., J.L Wilson, and J.A. Anhold. 2000. Stand conditions associated with roundheaded pine beetle (Coleoptera: Scolytidae) infestations in Arizona and Utah. *Environmental Entomology* 29: 20-27.
- Negrón, J.F., K. Allen, J. McMillin, J Burkwhat. 2006. Testing Verbenone for Reducing Mountain Pine Beetle Attacks in Ponderosa Pine in the Black Hills, South Dakota. USDA Forest Service RMRS-RN-31. 8pp.
- Negrón, J. F., J. D. McMillin, J. A. Anhold and D. Coulson. 2009. Bark beetle-caused mortality in a drought-affected ponderosa pine landscape in Arizona, USA. *Forest Ecology and Management* 257: 1353–1362.
- Noble, W. 2014. Wildlife Specialist Report. Coconino National Forest. Flagstaff, AZ.
- North, M.. 2009. Fuel treatment effects on tree-based carbon storage under modeled wildfire scenarios. *Frontiers in Ecology and the Environment*, 7:409–414.
- Oliver, W.W. 1995. Is self-thinning in ponderosa pine ruled by *Dendroctonus* bark beetles? Pages 213-218 in *Proceedings of the 1995 National Silviculture Workshop*. USDA Forest Service General Technical Report GTR-RM-267. http://www.fs.fed.us/rm/pubs_rm/rm_gtr267.pdf
- Oliver, W.W. 2005. The West-wide ponderosa pine levels-of-growing-stock study at age 40. Pages 71-79 in Ritchie, M.W., D.A. Maguire, and A. Youngblood, eds. *Proceedings of the symposium on ponderosa pine: issues, trends, and management*. Gen. Tech. Report PSW-GTR-198. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.
- Onkonburi, J. 1999. Growth response of Gambel oak to thinning and burning: implications for ecological restoration. Flagstaff, AZ: Northern Arizona University. 129pp. Unpublished dissertation.
- Parmeter J.R. Jr. 1978. Forest stand dynamics and ecological factors in relation to dwarf mistletoe spread, impact, and control. Scharpf, R.F.; Parmeter, J.R., Jr., tech. coords. *Dwarf mistletoe control through forest management*; 1978 April 11-13; Berkeley, DA. Berkeley, CA: General Technical Report PSW-31. U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 16-30.
- Patton, D.R. and B.I. Judd. 1970. The role of wet meadows as wildlife habitat in the Southwest. *Journal of Range Management* 23(4):272-275.
- Pearson, G.A. 1914. The role of aspen in the reforestation of mountain burns in Arizona and New Mexico. *Plant World* 17:249-260.

- Pearson, G.A. 1942. Herbaceous vegetation a factor in natural regeneration of ponderosa pine in the Southwest. *Ecological Monographs* 12:316-338.
- Pearson, G.A. 1950. Management of ponderosa pine in the Southwest: As developed by research and experimental practice. Agriculture Monograph No. 6. USDA Forest Service, Fort Collins, CO. 34 pp.
- Pomeroy, J.W., Gray, D.M., Hedstrom, N.R. and Janowicz, J.R., 2002. Prediction of seasonal snow accumulation in cold climate forests. *Hydrological Processes*, 16(18): 3543-3558.
- Pyne, S.J. 1982. Fire in America: A cultural history of wildland and rural fire. Princeton, N.J.:Princeton University Press.
- Quinn, R.D., and L. Wu. 2001. Quaking Aspen Reproduce From Seed After Wildfire in the Mountains of Southeastern Arizona. USDA Forest Service Proceedings RMRS-P-18.
- Reineke, L.H. 1933. Perfecting a stand-density index for even-aged forests. *Journal of Agricultural Research*. 46:627-638.
- Reynolds, R.T.; Graham, R.T.; Reiser, M.H.; Bassett, R.L.; Kennedy, P.L.; Boyce, D.A., Jr.; Goodwin, G.; Smith, R.; Fisher, E.L. 1992. Management recommendations for the northern goshawk in the Southwestern United States. General Technical Report RMRS-GTR-217. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO. 90 pp.
- Reynolds, Richard T.; Sánchez Meador, Andrew J.; Youtz, James A.; Nicolet, Tessa; Matonis, Megan S.; Jackson, Patrick L.; DeLorenzo, Donald G.; Graves, Andrew D. 2013. Restoring composition and structure in Southwestern frequent-fire forests: A science-based framework for improving ecosystem resiliency. Gen. Tech. Rep. RMRS-GTR-310. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 76 p.
- Ripple, W.J., and R.L. Beschta. 2007. Restoring Yellowstone's aspen with wolves. *Biological Conservation* 138: 514-19.
- Ripple, W.J., and R.L. Beschta. 2011. Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction. *Biological Conservation* 145: 205-13.
- Rolf J.A. 2001. Aspen fencing in Northern Arizona: A 15-year perspective. Pp. 193-196 in Shepperd W.D., Binkley D., Bartos D.L., Stohlgren T.J., Eskew L.G. (compilers). Sustaining aspen in western landscapes: symposium proceedings; 13-15 June 2000; Grand Junction, CO. USDA Forest Service, Rocky Mountain Research Station, Proceedings RMRS-P-18. Fort Collins, CO.
- Rosenstock, S.S 1998. Influence of Gambel oak on breeding birds in ponderosa pine forests of northern Arizona. *Condor* 100:485-492.
- Sánchez Meador, A.J.; Parysow, P.F.; Moore, M.M. 2010. Historical stem-mapped permanent plots increase precision of reconstructed reference data in ponderosa pine forests of northern Arizona. *Restoration Ecology* 18:224-234.
- Savage, M. and T. W. Swetnam. 1990. Early 19th-century fire decline following sheep pasturing in a Navajo ponderosa pine forest. *Ecology* 71(6): 2374-2378.
- Schmid, J.M., and S.A. Mata. 1992. Stand density and mountain pine beetle-caused mortality in ponderosa pine stands. USDA Forest Service Research Note, RM-515.
- Schmid, J.M., S.A. Mata, R.A. Obedzinski. 1994. Stand hazard rating ponderosa pine stands for mountain pine beetles in the Black Hills. USDA Forest Service Research Note, RM-529.

- Schubert, Gilbert H. 1974. Silviculture of southwestern ponderosa pine: The status of our knowledge. Res. Paper RM-123. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 71 p.
- Scurlock, Dan, and Deborah M. Finch. 1997. A historical review. Pages 43-68 in Block, William M.; Finch, Deborah M., technical editors. 1997. Songbird ecology in southwestern ponderosa pine forests: a literature review. Gen. Tech. Rep. RM-GTR-292. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 152 p.
- SER 2004. Society for Ecological Restoration International, Science & Policy Working Group, Version 2.
<http://www.ser.org/resources/resources-detail-view/ser-international-primer-on-ecological-restoration#3>
- Shepperd W.D., Fairweather M.L.. 1994. Impact of large ungulates in restoration of aspen communities in a southwestern ponderosa pine ecosystem. Pp. 344-347 In Covington W.S., DeBano L.F. (editors), Sustainable ecological approach to land management. USDA Forest Service, Rocky Mountain Forest & Range Experiment Station, General Technical Report RM-247, Fort Collins, CO.
- Shepperd, W. D., Asherin, L. A., and Edminister, C. B. 2002. Using individual tree selection silviculture to restore northern goshawk habitat: Lessons from a southwestern study. In Beyond 2001: A Silvicultural Odyssey to Sustaining Terrestrial and Aquatic Ecosystems. Proceedings from the 2001 National Silviculture Workshop, May 6 – 10, 2001, Hood River, Oregon. PNW-GTR-546.
- Simonin, K, T.E. Kolb, M. Montes-Helu, and G.W. Koch. 2007. The influence of thinning on components of stand water balance in a ponderosa pine forest stand during and after extreme drought. *Agricultural and Forest Meteorology* 143:266-276.
- Sisk, Thomas D., J.M Rundall, E. Nielsen, B.G. Dickson, S. E. Sesnie. 2009. The Kaibab Forest Health Focus: Collaborative Prioritization of Landscapes and Restoration Treatments on the Kaibab National Forest. The Forest Ecosystem Restoration Analysis Project, Lab of Landscape Ecology, School of Earth Sciences and Environmental Sustainability, Northern Arizona University.
- Society of American Foresters. 1998. The dictionary of forestry. Bethesda, MD: 210 pp.
<http://www.dictionaryofforestry.org/>
- Society of American Foresters (SAF). 2005. Use of silviculture to achieve and maintain forest health on public lands. Position Statement Available at:
<http://www.eforester.org/fp/documents/silviculture.pdf>
- Steele, R., S.F. Arno, K Geier-Hayes. 1986. Wildfire patterns change in central Idaho's ponderosa pine-Douglas-fir forest. *Western Journal of Applied Forestry* 1(1):16-18.
- Stoddard, M.T. 2011. Compilation of Historical Forest Structural Characteristics across the Southern Colorado Plateau, Ecological Restoration Institute /NAU August 2011. <http://library.eri.nau.edu/gsd/collect/erilibra/index/assoc/HASH40b3.dir/doc.pdf>
- Storck, P., D. P. Lettenmaier, and S. M. Bolton, Measurement of snow interception and canopy effects on snow accumulation and melt in a mountainous maritime climate, Oregon, United States, *Water Resour. Res.*, 38(11), 1223, doi:10.1029/2002WR001281, 2002
- Swetnam, T.W., Allen, C.D., Betancourt, J.L., 1999. Applied historical ecology: using the past to manage for the future. *Ecological Applications* 9, 1189–1206.

- Tew, R.K. 1970. Seasonal variation in the nutrient content of aspen foliage. *Journal of Wildlife Management* 34(2):475-478.
- Thompson, Bruce C., Patricia L, Matusik-Rowan, K.G. Boykin. 2002. Prioritizing conservation potential of arid-land montane natural springs and associated riparian areas. *Journal of Arid Environments* 50:527-547.
- Thompson, Walter, G. 1940. A growth rate classification of southwestern ponderosa pine. *Journal of Forestry* 38: 547-552.
- Tilman, D., J.A. Downing. 1994. Biodiversity and stability in grasslands. *Nature* 367: 363-365.
- Turner, M.G., Romme, W.H., Gardner, R.H., O'Neill, R.V., Kratz, T.K., 1993. A revised concept of landscape equilibrium: disturbance and stability on scaled landscapes. *Landscape Ecology* 8, 213-227.
- USDA Forest Service. 1987. Coconino National Forest Land Management Plan, as amended.
- USDA Forest Service. 1994. Sustaining our aspen heritage into the twenty-first century. USDA Forest Service, Southwestern Region and Rocky Mountain Forest and Range Experiment Station. 7 p.
- USDA Forest Service, 1996. Record of decision for amendment of forest plans, Arizona and New Mexico. United States Department of Agriculture, Forest Service, Southwestern Region.
- USDA Forest Service. 1997. Plant associations of Arizona and New Mexico. 3rd ed. Vol. 1. USDA Forest Service, Southwestern Region, Albuquerque, NM. 291 pp.
- USDA Forest Service. 2000. Forest insect and disease conditions in the Southwestern Region, 1999. USDA Forest Service, Southwestern Region, R3-00-01: 17 p. Albuquerque NM.
- USDA Forest Service. 2002. Forest insect and disease conditions in the Southwestern Region, 2001. USDA Forest Service, Southwestern Region, R3-02-01: 17 p. Albuquerque NM.
- USDA Forest Service. 2003. Forest insect and disease conditions in the Southwestern Region, 2002. USDA Forest Service, Southwestern Region, R3-03-01: 33 p. Albuquerque NM.
- USDA Forest Service. 2004. Forest insect and disease conditions in the Southwestern Region, 2003. USDA Forest Service, Southwestern Region, Forestry and Forest Health, R3-04-02, 34 p. Albuquerque, New Mexico.
- USDA Forest Service. 2006. Cultural Resources Management. Logging Railroads of the Coconino and Kaibab National Forests. Supplemental Report to a National Register of Historic Places Multiple Property Nomination. 1993. Report No. 19. USDA Forest Service. Southwestern Region. Flagstaff, AZ. 302pp.
- USDA Forest Service. 2007. Historic ponderosa pine stand structure of mollisol and mollic integrate soils on the Coconino National Forest. Flagstaff, AZ. Unpublished document on file at the Coconino National Forest Supervisors Office.
- USDA Forest Service. 2008a. Historic ponderosa pine stand structure of mollisol and mollic integrate soils on the Kaibab National Forest. Williams, AZ. Unpublished document on file at the Kaibab National Forest Supervisors Office.
- USDA Forest Service. 2008b. Forest insect and disease conditions in the Southwestern Region, 2007. USDA Forest Service, Southwestern Region, Forestry and Forest Health, PR-R3-16-4, 47 p. Albuquerque, New Mexico.

- USDA Forest Service. 2009. Kaibab National Forest: Comprehensive Evaluation Report. USDA Forest Service, Southwestern Region, pg. 65.
http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm91_050073.pdf
- USDA Forest Service, 2010. Kaibab National Forest: Supplement to the Comprehensive Evaluation Report. USDA Forest Service, Southwestern Region, pg. 10.
http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5154724.pdf
- USDA Forest Service. 2011. Forest insect and disease conditions in the Southwestern Region, 2010. USDA Forest Service, Southwestern Region, Forestry and Forest Health, PR-R3-16-7, 45 p. Albuquerque, New Mexico.
- USDA Forest Service. 2014. Final Environmental Impact Statement for the 2012. Kaibab National Forest Land and Resource Management Plan, USDA Forest Service, Southwestern Region, Kaibab National Forest, MB-R3-07-19, 325pp
- USDA Forest Service. 2013. Forest Insect and Disease Conditions in the Southwestern Region, 2012. PR-R3-16-9. USFS Southwestern Region, Forestry and Forest Health. 66.
- USDA Forest Service. 2014. Land and Resource Management Plan for the Kaibab National Forest, USDA Forest Service, Southwestern Region, Kaibab National Forest, MB-R3-07-17, 219pp.
- USDI Fish and Wildlife Service. 1995. Recovery Plan for the Mexican Spotted Owl : Vol.I. Albuquerque, New Mexico. 172pp.
- USDI Fish and Wildlife Service. 2011. Draft Recovery Plan for the Mexican Spotted Owl (*Strix occidentalis lucida*), First Revision. U.S. Fish and Wildlife Service. Albuquerque, New Mexico, USA. 392 pp.
- USDI Fish and Wildlife Service. 2012. Recovery Plan for the Mexican Spotted Owl : Vol.I. Albuquerque, New Mexico. 172pp.
- Vandendriesche, Don, comp. 2010. A compendium of NFS regional vegetation classification algorithms. Internal Rep. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Forest Management Service Center. 74p.
- Vandendriesche, D. 2013. A Compendium of NFS Regional Vegetation Classification Algorithms. USDA Forest Service, Forest Management Service Center, Fort Collins, CO, 75 pp.
- Veblen, T.T., 2003. Historic range of variability of mountain forest ecosystems: concepts and applications. *The Forestry Chronicle* 79, 223–226.
- Wallin, K.F.; Kolb, T.E.; Skov, K.R.; Wagner, M.R. 2003. Effects of crown scorch on ponderosa pine resistance to bark beetles in northern Arizona. *Environmental Entomology*. 32: 652-661.
- Wagstaff, E.J. 1984. Economic considerations in use and management of Gambel oak for fuelwood. U.S. Forest Service, Intermountain Range Experiment Station, GTR INT-165, Ogden, Utah, USA.
- Weaver, H. 1951. Fire as an ecological factor in southwestern ponderosa pine forests. *Journal of Forestry* 49:93-98.
- Westerling, A.L., Hidalgo H.G., Cayan D. R., Swetnam T.M. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. *Science* 313(5789):940-943.
- White, A.S. 1985. Presettlement regeneration patterns in a southwestern ponderosa pine stand. *Ecology* 66:589-594.

- Woolsey T.S. Jr. 1911. Western yellow pine in Arizona and New Mexico. USDA Forest Service, Bulletin 101. Washington, DC.
- Yasinski F.M., Pierce D.A. 1958. Forest insect conditions in Arizona, New Mexico and west Texas -- 1957. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station #30, 10p. Fort Collins CO.

Appendix A – Implementation Plan

The environmental impact statement (EIS) describes the purpose and need, alternatives and the effects of managing the 4FRI project area. This implementation plan is designed to be integral to the selected alternative and record of decision (ROD). The plan has been updated to add more direction related to grazing, goshawk survey requirements and wildlife corridors.

The implementation plan is designed to be consistent with the Coconino NF and Kaibab NF forest plans and with Collaborative Forest Landscape Restoration Act (CFLRA). The Collaborative Forest Landscape Restoration Act requires that restoration treatments maintain or contribute to the development of old growth components, maximizes the retention of large trees, focuses on small diameter tree thinning, does not allow for the establishment of permanent roads, and requires decommissioning of all temporary roads built for treatment purposes.

The process described in this appendix describes the linkage from the EIS to the project specific work without the need for additional NEPA analysis. It must be considered in conjunction with appendix C that provides the design criteria, best management practices, and mitigation measures. Table 101 to table 104 are checklists designed to ensure compliance with the analysis, decision, and other requirements. Essentially, if the quantity of treatments in table 104 and table 105 by resource unit are within the bounds of the treatments analyzed in chapter 3 of the EIS and the specialist's reports, then the program of work is considered to be consistent with the effects analysis.

Table 103 and table 104 show the compliance evaluation and documentation requirements to also demonstrate this compliance. Sections A through E provide direction that will be used by implementation personnel to ensure that implementation meets the purpose and need and forest plan standards and guidelines. It is the foundation for the formal silvicultural prescriptions. The silvicultural prescriptions will document the desired conditions presented in the analysis, incorporate design features and mitigation (appendix C), and provide the course of action needed to move toward those desired conditions.

Description of Plan Components

Table 101: Annual Implementation Checklist. The checklist is designed to track compliance with the NEPA decision and ensure activities are consistent and compliant with the analysis and decision (correct location, appropriate number of acres by treatment type). The checklist is designed to be used by the implementation team leader. Sources of data to populate row three are found in chapter 3 and the specialists reports.

Table 102: Planned Acres by Treatment Type and Restoration Unit. The checklist is designed to facilitate accomplishment reporting. The checklist is designed to be used (at a minimum) by the implementation team leader and forest program managers. Sources of data to populate row three are found in chapter 3 and the specialists reports.

Table 103: National Environmental Policy Act (NEPA), National Forest Management Act (NFMA), Endangered Species Act (ESA), and Collaborative Forest Landscape Restoration Act (CFLRA) Compliance Evaluation. The checklist is designed to ensure resource surveys are completed as required by the forest plan, policy, U.S. Fish and Wildlife Service biological opinion, the Collaborative Forest Landscape Restoration Act, or other requirements. The checklist also ensures that the site-specific treatments are compliant with the NEPA analysis and decision.

The checklist is designed to be used by the resource specialists who comprise the implementation team and by the Agency's (delegated) approving official.

Table 103: Supporting Documentation. This checklist is designed to ensure required plans and surveys are tracked annually and are readily accessible to the implementation team and approving official. It will be used in combination with appendix E that shows the adaptive management strategy.

Section A: This section includes existing forest plan management direction, desired conditions, and treatment specific silvicultural design. It is designed to be used by the project silviculturist and implementation team.

Section B: Section B is a decision matrix to be used by the project silviculturist and implementation team to facilitate establishing tree groups, interspace, and regeneration openings as appropriate for each individual treatment.

Section C: This section provides old tree descriptions, illustrations, and guidance used to implement the old tree implementation plan.

Section D: Section D includes guidance and the "Modified Large Tree Implementation Plan". The guidance is designed to be reviewed by the project's silviculturist during development of prescriptions and during implementation.

Section E: Section E describes the relationship between treatment intensity, tree group density, and overall average density. It includes density management and stocking guidelines. It is designed to be used by the project silviculturist (in the design of prescriptions) and implementation team.

Table 101. Annual implementation checklist

Implementation Checklist	Details				
Project name:					
Project location (legal):					
Summary of activities proposed in this phase:					
Is the project located within the project boundary displayed in the FEIS/ROD?					
Identify the restoration unit (RU) in which the project phase is located based on the FEIS/ROD.	RU1	RU3	RU4	RU5	RU6
(1) How many acres have been treated by RU since the ROD was signed?					
(2) How many remaining acres are available for treatment by RU over the lifetime of the decision? (1–2)					
(3) How total many acres will this project (or task order) treat by RU?					
(4) Are the acres to be treated by RU less than remaining acres available for treatment? (3–4)					
Are acres proposed for treatment by RU within the limits approved by the decision?	Yes _____ No _____				

Table 102. Planned acres by treatment type and restoration unit (RU)

Acre/Miles by Treatment Type to be Implemented in this Phase	RU1	RU3	RU4	RU5	RU6
Aspen					
Prescribed Fire Only					
ADGF Research					
Grassland Restoration					
Grassland Mechanical					
Intermediate Thin (IT) 10 (10 to 25% interspace)					
Intermediate Thin (IT) 25 (25 to 40% interspace)					
Intermediate Thin (IT) 40 (40 to 55% interspace)					
MSO Threshold					
MSO Target					
MSO Restricted					
MSO PAC					
MSO PAC Grassland Mechanical					
Pine-sage					
Savanna (70 to 90% interspace)					
Stand Improvement (SI) 10 (10 to 25% interspace)					
Stand Improvement (SI) 25 (25 to 40% interspace)					
Stand Improvement (SI) 40 (40 to 55% interspace)					
Uneven-aged (UEA) 10 (10 to 25% interspace)					
Uneven-aged (UEA) 25 (25 to 40% interspace)					

Acre/Miles by Treatment Type to be Implemented in this Phase		RU1	RU3	RU4	RU5	RU6
Uneven-aged (UEA) 40 (40 to 55% interspace)						
Wildland-Urban Interface (WUI) Pinyon-juniper						
Wildland-Urban Interface (WUI) 55						
Pile Burning						
Broadcast Burning						
Jackpot Burning						
Fire Line Construction						
Existing System and Unauthorized Road Decommission						
Temporary Road Construction						
Temporary Road Decommission as required by CFLRA						
Road Reconstruction/Relocation						
Springs	Remove Trees to Pre-settlement Condition					
	Remove Noxious Weeds					
	Prescribed Fire					
	Protective Measures					
Ephemeral Channels	Reestablish Drainage, Slopes, Vegetation					
	Site Protection					
	Remove or Rehab Stock Tanks					
	Other					
Construct Protective Fencing: Springs/Aspen						
Are acres proposed for treatments in this phase within the limits authorized in the decision?		Yes _____ No _____				

Table 103. NEPA, NFMA, ESA, CFLR Act compliance evaluation

Compliance Evaluation	Yes	No	N/A
Is the project within the maximum treatment acres identified in the NEPA decision?			
Is treatment design consistent with desired conditions, design criteria, and mitigation? Does range readiness support the use of fire ?			
Are wildlife and botanical surveys, if necessary, complete? Is the action consistent with the FWS biological opinion dated_____?			
Are heritage surveys complete? Is the action consistent with the letter of concurrence form the AZ SHPO dated_____?			
Have contacts with tribal representatives been made?			
Are rights-of-way and land line locations in place (if applicable)?			
Do treatments fully maintain or contribute toward the restoration of old growth stands as required by CFLR Act and as consistent with the Old Tree Implementation Plan (section C)			
Do treatments maximize the retention of large trees as required by CFLR Act and as consistent with the Large Tree Implementation Plan (section D)?			
Has the monitoring and adaptive management plan been evaluated to document compliance with law, regulation, policy, and forest plans?			
Have additional implementation and effectiveness monitoring needs been identified?			
As required by CFLR Act, is multiparty monitoring underway?			
As required by CFLR Act, are no new permanent roads required and has the decommissioning plan been followed?			
Are adaptive management actions being proposed? If so, clearly analyzed and covered by the decision made?			
Has the administrator checklist been completed and signed by the appropriate resource specialists?			
Is the treatment (burn) plan completed and signed? - Objectives have been developed in interdisciplinary manner and are clearly delineated? - Objectives are consistent with management direction? - Objectives match those described for RU in NEPA analysis? Complexity rating_____			
Do conditions match those described in NEPA analysis? Examples where conditions have changed: New listed species in project area; New invasive species in project area; Change in regulations Burn/treatment plan doesn't allow implementing design criteria			
Have issues identified in the NEPA analysis been reviewed?			
Has a post-implementation review been completed (may be filled out after approval)?			
Are treatments consistent with Large Tree Implementation Plan? (section D)			
Has there been any new or additional NEPA decisions that also need to be considered and is the proposal consistent with these decisions?			
For 18 mechanically-treated PACs, Has MSO occupancy been determined?			

Compliance Evaluation	Yes	No	N/A
For 18 mechanically-treated PACs, have PACs been evaluated to document predominance of 9 inch d.b.h. stands?			
For 18 mechanically-treated PACs, has MSO occupancy and reproduction been tracked for 2 years?			
Has vegetation monitoring occurred in selected			

Table 104. Supporting documentation checklist

Document Name	Attached? Y/N
Silviculture Prescriptions	
Burn Plan (includes coordination with ADEQ)	
Transportation Safety Plan	
Wildlife Surveys	
Botany Surveys	
Archaeological Surveys	
Monitoring Results including range readiness annual operating instructions	
404/401 permit from the U.S. Army Corps of Engineers for channel restoration projects	
ADEQ Water Quality Certification	
Coordination with Tribes on individual task orders	

Project Resource Specialist Review

Based on my review, the project is consistent with the Coconino and Kaibab National Forests final environmental impact statement and record of decision (FEIS/ROD) implementing the Coconino and Kaibab NFs restoration project.

Name/Signature	Date	Resource Area
		Terrestrial and Aquatic Wildlife
		Botany
		Range
		Recreation
		Scenery
		Archaeology and Tribal Relations
		Fire
		Air Quality/Smoke
		Lands
		Soils and Hydrology
		Silviculture
		Planning/NEPA
		Transportation
		Public Affairs

Approving Official

I have reviewed the activities proposed for this year. Based on my review, the project is consistent with the Coconino and Kaibab National Forests final environmental impact statement and record of decision implementing the Coconino and Kaibab NFs restoration project.

Agency Approving Official, Title Date

ATTACHMENTS: (add to as necessary)

Silviculture Specialist Report

Four Forest Restoration Initiative Coconino and Kaibab National Forests

Section A – Management Direction, Desired Conditions, and Treatment Design

Mexican Spotted Owl Habitat

Kaibab NF and Coconino NF

The following vegetation management direction, desired conditions and mechanical treatment and burn for Mexican Spotted Owl habitat applies to alternatives B through E on the Kaibab National Forest and alternative C on the Coconino National Forest which has been designed to implement the current revised Mexican spotted owl Recovery Plan (USDI FWS 2012).

Restricted Other Burn Only Treatment Design

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible.

Prescribed fires are designed to increase tree canopy base height, reduce litter/duff cover, and produce effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired Mexican spotted owl restricted other forest structure, tree densities, snag densities, and coarse woody debris levels.

Core Area

Vegetation Management Direction: Desired conditions should guide management within PACs (USDI FWS 2012). The intent of the core area is to define parts of the PAC that should receive maximum protection by limiting activities that have a high likelihood of disturbing owls or causing abandonment (primarily habitat alteration and certain forms of mechanical noise). The nesting and roosting core area should include habitat that resembles the structural and/or floristic characteristics of the nest and/or roost sites as much as possible (USDI FWS 2012). Vegetation management needs to be coordinated with US Fish and Wildlife Service.

Desired Conditions: Table C.2 of the Recovery Plan (USDI FWS 2012) lists guidance for desired conditions within PACs. The desired conditions include the following: Strive for a diversity of patch sizes with minimum contiguous patch size of 1 ha (2.5 ac) with larger patches near activity center; mix of sizes towards periphery. Forest type may dictate patch size (i.e., mixed conifer forests have larger and fewer patches than pine-oak forest). Strive for between patch heterogeneity; horizontal and vertical habitat heterogeneity within patches, including tree species composition. Patches are contiguous and consist of trees of all sizes, unevenly spaced, with interlocking crowns and high canopy cover; tree species diversity, especially with a mixture of hardwoods and shade-tolerant species; diverse composition of vigorous native herbaceous and shrub species; opening sizes between 0.04 - 1 ha (0.1 - 2.5 ac). Openings within a forest are different than natural meadows. Small canopy gaps within forested patches provide for prey habitat diversity. Openings should be small in nesting and roosting patches, may be larger in rest of PAC; and Minimum canopy cover of 40 percent in pine-oak and 60 percent in mixed conifer. Measure canopy cover within stands (USDI FWS 2012).

Protected Activity Center (PAC)

Vegetation Management Direction: Desired conditions should guide management within PACs (USDI FWS 2012). The intent of the core area is to define parts of the PAC that should receive maximum protection by limiting activities that have a high likelihood of disturbing owls or causing abandonment (primarily habitat alteration and certain forms of mechanical noise). The nesting and roosting core area should include habitat that resembles the structural and/or floristic characteristics of the nest and/or roost sites as much as possible (USDI FWS 2012). Vegetation management needs to be coordinated with US Fish and Wildlife Service.

Desired Conditions: Table C.2 of the Recovery Plan (USDI FWS 2012) lists guidance for desired conditions within PACs. The desired conditions include the following: Strive for a diversity of patch sizes with minimum contiguous patch size of 1 ha (2.5 ac) with larger patches near activity center; mix of sizes towards periphery. Forest type may dictate patch size (i.e., mixed conifer forests have larger and fewer patches than pine-oak forest). Strive for between patch heterogeneity; Horizontal and vertical habitat heterogeneity within patches, including tree species composition. Patches are contiguous and consist of trees of all sizes, unevenly spaced, with interlocking crowns and high canopy cover; Tree species diversity, especially with a mixture of hardwoods and shade-tolerant species; Diverse composition of vigorous native herbaceous and shrub species; Opening sizes between 0.04 - 1 ha (0.1 - 2.5 ac). Openings within a forest are different than natural meadows. Small canopy gaps within forested patches provide for prey habitat diversity. Openings should be small in nesting and roosting patches, may be larger in rest of PAC; and minimum canopy cover of 40 percent in pine-oak and 60 percent in mixed conifer. Measure canopy cover within stands (USDI FWS 2012).

Site Specific Diameter Limits: Attachment 2 displays the location and sites and upper diameter limits for the proposed 18 mechanical treatment PACs. The treatments are designed to improve PAC habitat as well as reduce fire behavior.

Forested Recovery Habitat

Definition: Any stand within the Ponderosa pine series that meets the following criteria simultaneously: a. The stand is located in the Upper Gila Mountain ecosystem management unit; b. Habitat types that reflect Gambel oak or a Gambel oak phase of the habitat type; c. more than 10 percent of the stand basal area or 4.6 m²/ha (20 ft²/ac) of basal area consists of Gambel oak over 13 cm (5 in) in diameter at root collar.

For planning purposes in Forested Recovery Habitat, there are two types of stands with respect to desired nesting and roosting 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 (see table D 5) as recovery nesting and roosting habitat. Thus, managers should identify and protect stands that meet or exceed nesting and roosting conditions and then assess whether or not these stands satisfy the area requirements in table D 5. If these stands are not sufficient to meet the area requirements in table D 5, managers should identify those stands in the planning area that come closest to meeting nesting and roosting conditions and manage those stands to develop nesting and roosting 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 nesting and roosting conditions and are not designated for development of such can be managed to meet other resource objectives.

Forested Recovery Habitat Managed as Nesting and Roosting Habitat

Vegetation Management Direction: The following are excerpts from the current Mexican spotted owl Recovery Plan that display guidelines for forested recovery nesting and roosting habitat (formerly known in USDI FWS 1995 as threshold and target/threshold) as outlined on pages 267 and 268 of the plan.

Recovery nesting and roosting stands that currently meet nesting and roosting conditions:

Treatments are allowed within Recovery Habitat stands identified as meeting nesting and roosting conditions, as long as stand conditions remain at or above the values given in **table 105**. This approach allows for treatments to reduce fire risks, lessen insect or disease problems, maintain seral species, or meet other ecosystem objectives.

Recovery nesting and roosting stands that currently do not meet nesting and roosting conditions:

Stands currently not meeting nesting and roosting conditions but are being managed to meet nesting and roosting area percentages as outlined in **table 105** are managed to develop nesting and roosting conditions as rapidly and as reasonably possible to meet recommended percentages. Prescriptions may include thinning to promote growth of large trees.

Desired Conditions: Management activities that influence the owl and its habitat should be conducted according to the following guidelines:

Manage for Nest / Roost Habitat. Manage mixed-conifer and pine-oak forest types in the designated proportions of Table C.3 (USDI FWS 2012, p. 278) to provide continuous nesting and roosting habitat over space and time. Table C.3 from the Recovery plan is displayed in table D 5. Management of particular stands should be based on their capability to attain the desired conditions (USDI FWS 2012, Table C.2, pp. 275-277).

Table 105. Minimum desired conditions for pine-oak forest areas managed for Recovery nesting/roosting habitat (USDI FWS 2012)

Forest Type	% of area ¹	% basal area (BA) by size class		Minimum tree BA ²	Minimum density of trees ³
		30-46 cm d.b.h. (12-18 in)	over46 cm d.b.h. (over18 in)		
Pine-oak ⁴	20	over30	over30	25.3 (110)	30 (12)

1. Percent 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. As in m²/ha (ft²/acre), and include all trees over1 inch d.b.h. (i.e., any species). We emphasize that values shown are minimums, not targets.

3. Trees over 46 cm (18 inches) d.b.h. 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: at least 10 percent of the stand basal area or 4.6 m²/ha (20 ft²/ac) of basal area consist of Gambel oak at least 13 cm (5 in) diameter at the root collar

Recovery Nesting and Roosting Stands that Currently Do Not Meet Nesting and Roosting Conditions and Recovery Nesting and Roosting Stands that Currently Do Not Meet Nesting and Roosting Conditions Thin and Burn Treatment Design

Treatments Within Recovery Nesting and Roosting Stands: No stand that meets **table 105 conditions** should be treated in such a way as to lower that stand below those conditions until ecosystem assessments can document that a surplus of these stands exist at larger landscape levels (e.g., no less than the size of a

FS District). This does not preclude use of treatments to reduce fire risks or lessen insect or disease problems, nor does it preclude management to meet other ecosystem objectives, as long as stand-level conditions remain at or above the values given in [table 105](#).

Select Appropriate Stands to Manage: Management should emphasize attainment of nesting and roosting conditions as quickly as reasonably possible (USDI FWS 2012). Identify and assign stands that would reach these conditions soonest to satisfy area requirements in [table 105](#).

Retain Large Trees: Stand conditions that provide the owl's nesting habitat frequently vary above the minimum values given in table D 5. Further, important stand conditions cannot be replaced quickly. In particular, removing large trees in a stand identified as habitat could reduce its suitability as nesting habitat or increase the time required to develop suitable nesting habitat. Because it takes many years for trees to reach large size, that trees at least 46- cm (18 inches) d.b.h. not be removed in stands designated as recovery nesting and roosting habitat unless there are compelling safety reasons to do so or if it can be demonstrated that removal of those trees will not be detrimental to owl habitat (USDI FWS 2012).

Strive for Spatial Heterogeneity: Incorporate natural variation, such as irregular tree spacing and various stand/patch/group/clump sizes, into management prescriptions. Strive for heterogeneity both within and between stands. Attempt to mimic natural disturbance patterns and natural landscape heterogeneity. Allow natural canopy gap processes to occur, or mimic those processes through active management, thus producing horizontal variation in stand structure (USDI FWS 2012).

Manage for Species Diversity. Maintain all species of native vegetation on the landscape, including early seral species. Allow for variation in existing stand structures and provide for species diversity (USDI FWS 2012).

Emphasize Large Hardwoods. Within pine-oak and other forest types where hardwoods are a component of owl habitat, emphasis should be placed on management that retains, and promotes the growth of additional, large hardwoods (USDI FWS 2012).

Recovery Nesting and roosting Stands that currently meet Nesting and roosting Conditions and Recovery Nesting and roosting Stands that currently do not meet Nesting and roosting Conditions Burn Only Treatment Design

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible.

Prescribed fires are designed to increase tree canopy base height and reduce litter/duff cover and other surface fuel loading.

Prescribed fires are designed to maintain and enhance desired Mexican spotted owl habitat forest structure, tree densities, snag densities, and coarse woody debris levels.

Forested Recovery Foraging/Non-Breeding Habitat

General Vegetation Management Direction: The following are excerpts from the current Mexican spotted owl Recovery Plan that display guidelines for Forested Recovery Foraging/Non-breeding Habitat as outlined on pages 268-270 of the plan. The intent is to manage recovery habitat so that important but difficult-to-replace habitat elements are conserved while allowing management flexibility. Management should strive to maintain conditions where multiple components occur in proximity to one another. The collective goal of guidelines for Forested Recovery Habitat is to provide spotted owl habitat that is well distributed over space and time. Accomplishing this goal requires maintaining or creating stand structures

typical of nesting and roosting habitats, and sustaining them in sufficient amounts and distribution to support a healthy population of Mexican spotted owls (USDI FWS 2012).

Forested Recovery Foraging/Non-Breeding Habitat Mechanical and Burn Treatment Design

The following treatment designs apply to alternative C on the Coconino NF and alternatives B through E on the Kaibab NF. The treatments are designed to implement the current Mexican spotted owl recovery Plan (USDI FWS 2012).

Emphasize Large Hardwoods: Within pine-oak and other forest types where hardwoods are a component of owl habitat, emphasis should be placed on management that retains, and promotes the growth of additional, large hardwoods (USDI FWS 2012).

Retain Large Trees: Strive to retain (do not cut) all trees over 61 cm (over 24 inches) d.b.h., the average diameter of nest trees, unless overriding management situations require their removal to protect human safety and/or property (e.g., the removal of hazard trees along roads, in campgrounds, and along power lines), or in situations where leaving large trees precludes reducing threats to owl habitat (e.g., creating a fuel break). Manage to take reasonable steps to minimize the loss of trees over 61 cm (24 in) d.b.h. Large trees killed by fire will provide a source for recruitment of large snags and eventual large logs; these snags should be retained unless their removal is necessary for public or worker safety (USDI FWS 2012).

Retain Key Owl Habitat Elements: Design and implement management treatments within Forested Recovery Foraging/Non-breeding habitat so that most hardwoods, large snags (over 46 cm [18 in] d.b.h.), large downed logs (over 46 cm [18 in] diameter at any point), trees (over 46 cm [18 in] d.b.h.) are retained, unless this conflicts with forest restoration and/or owl habitat enhancement goals. When implementing this guideline, managers should strive to achieve a balance between retaining a sufficient density and distribution of important features that spotted owls may require and reducing the risk of losing existing roosting and nesting habitat from insect epidemics and stand-replacing fires.

Forested Recovery Foraging/Non-Breeding Habitat Burn Only Treatment Design

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible.

Prescribed fires are designed to increase tree canopy base height, reduce litter/duff cover, and produce effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired Mexican spotted owl restricted other forest structure, tree densities, snag densities, and coarse woody debris levels.

Goshawk Habitat

General – Ponderosa Pine

The description below includes language from RMRS GTR 217 (1992 Reynolds et al.) and is used for this project as a means to track movement towards desired conditions. This language is consistent with the current Coconino NF forest plan, but the language is absent from the Kaibab NF forest plan. The language is consistent Kaibab NF forest plan components including objectives, desired conditions and guidelines (see forest plan consistency crosswalk in the vegetation specialist report).

Vegetation Management Direction: Manage for uneven-age stand conditions for live trees and retain live reserve trees, snags, downed logs, and woody debris levels throughout ponderosa pine forest cover

Silviculture Specialist Report

types. Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape. Provide for or preserve existing clumps of trees with interlocking crowns. Sustain a mosaic of vegetation densities (overstory and understory), age classes, and species composition across the landscape. Encourage aspen and oak regeneration. Provide habitat for goshawk prey.

Desired Conditions: Highly interspersed, heterogeneous pattern and size of tree groups and interspace across the landscape. Tree groups are dominated by trees of a similar age and range from young to old (uneven-aged). Interspace has a robust herbaceous layer. Where possible create smooth transitions between treated and untreated areas by shaping and feathering edges to make the forest more natural appearing.

Landscapes Outside of Goshawk Post-fledging Areas (LOPFA) – Ponderosa Pine

Vegetation Management Direction: On the Kaibab NF, the predominate vegetation management strategies are for uneven-aged management systems. This is because vegetation management objectives were only developed for the ponderosa pine and frequent fire vegetation types, both of which have uneven aged desired conditions. Even aged management prescriptions are, however, used as a strategy for achieving the desired uneven-aged conditions over the long term. On the Coconino NF for Northern goshawk habitats, distribution of vegetation structural stages for ponderosa pine – 10 percent grass/forb/shrub (VSS 1), 10 percent seedling-sapling (VSS 2), 20 percent young forest (VSS 3), 20 percent mid-aged forest (VSS 4), 20 percent mature forest (VSS 5), 20 percent old forest (VSS6). The distribution of VSS, tree density, and tree age are a product of site quality in the EMA. Use site quality to guide in the distribution of VSS, tree density, and tree ages. Snags are at least 18 inches d.b.h. and at least 30 feet in height, downed logs are 12 inches in diameter and are at least 8 feet long, woody debris is at least 3 inches on the forest floor, canopy cover is measured with vertical crown projection on average across the landscape. Canopy cover guidelines apply only to mid-aged to old forest structural stages (VSS 4, VSS 5 and VSS 6). The VSS distribution of the Coconino NF plan is consistent with the Kaibab NF direction of uneven-aged management and would be used as a metric for moving toward the uneven-aged desired conditions on the Kaibab NF.

Additional project-specific direction is documented in the forest plan amendments that clarify openness and clarify that guidelines for canopy cover apply to mid-aged to old forest structural stage dominated tree groups across the landscapes outside of goshawk post-fledging areas. See FEIS, appendix B.

Desired Conditions: Uneven-aged with a balance of size classes. Within group structure specific to mid-aged to old classes (VSS 4 to 6) includes open understories, interlocking tree crowns, abundant large limbs, and shade.

Landscapes Outside of Goshawk Post-fledging Areas, WUI55, UEA40, UEA25 and UEA10 Mechanical Thin and Burn Treatments Design

Uneven-age thinning and group selection will be used to establish interspace between individual trees and tree groups, thin tree groups, and create regeneration openings within landscapes outside of goshawk post-fledging areas with none to low dwarf mistletoe infections that are uneven age or even age with a quadratic mean diameter at least 8.5 inches.

Treatments will strive to attain an overall average density of 50 to 70 square feet of basal area and 15 to 35 percent of maximum stand density index inclusive of groups, interspaces, and regeneration openings. Density will vary within this range depending on treatment intensity and existing stand structure. See

section E for more detail on the relationship of overall density to interspace, tree groups, and regeneration openings.

Individual trees, tree groups, and interspaces will occupy the following percent of the area by treatment intensity as displayed in **table 106**.

Table 106. Percent of trees, tree groups, and interspaces by treatment intensity (landscapes outside of goshawk post-fledging areas)

Treatment Type and Intensity	Percent of Area Occupied by Individual Trees and Tree	Percent of Area Occupied by Interspace
WUI55	30–45	55–70
UEA40	45–60	40–55
UEA25	60–75	25–40
UEA10	75–90	10–25

Individual trees, tree groups, and interspaces will be managed to move toward a balance of age classes, both within and from tree group to tree group, by reducing the most abundant tree size classes and maintaining the underrepresented tree size classes.

Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments will follow the old tree implementation plan (section C) and old trees will not be targeted for cutting. Live conifer trees with existing cavities, dead tops, and lightning scars will also be favored for retention.

Per the Collaborative Forest Landscape Restoration Act requirements, treatments are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting desired conditions of increasing VSS 5 and 6 age classes as soon as possible. Treatments would also follow the guidance in section D, the large tree implementation plan.

To meet the desired condition of increasing VSS 5 and 6 size class, priority of tree retention within groups will focus on existing large trees (generally, trees within the dominant and codominant crown position). Where age class diversity is not present, suppressed and intermediate trees would be retained for vertical diversity.

Manage for the sustainability of individual/isolated old ponderosa pine trees as defined in the old tree implementation plan (section C) by reducing crown competition and increasing growing space adjacent to these trees. Remove ponderosa pine trees up to 18 inches d.b.h. that do not meet the old tree definition: (1) within a 50-foot radius that are in the intermediate or suppressed crown positions, and, (2) that would eliminate direct crown competition on two of the four sides of the old tree.

Openings, on average, will range in size from 0.1 to 1 acre with some exceeding 1 acre (but not to exceed 4 acres). Expected outcomes include treatment unit and landscape heterogeneity. The range of openings will be implemented with variable distribution of opening size. Variability of opening size and location will be determined by aspect, site quality, existing stand structure and pre-settlement tree evidence. Tree groups, on average, will range in size from 0.1 to 1 acre with northerly aspects. Sites with a preponderance of large trees and highly productive microsites would have larger average group sizes. Overall, the average group size will vary within this range depending on site quality, existing stand structure, and pre-settlement tree evidence.

On the Kaibab NF, the predominant vegetation management strategies are for uneven-aged management systems. This is because vegetation management objectives were only developed for the ponderosa pine and frequent fire vegetation types, both of which have uneven aged desired conditions. Even aged management prescriptions are, however, used as a strategy for achieving the desired uneven-aged conditions over the long term. On the Coconino NF tree group density in goshawk habitat would be managed to meet the canopy cover requirement (Coconino NF only) of 40 plus percent within mid-aged forest (VSS4), mature forest (VSS5), and old forest (VSS6) tree groups except as noted in non-wildland-urban interface stands below. There is no specific guidance in the current Kaibab NF plan for goshawk habitat except in post-fledging family areas. The guidance for the Coconino NF would be used as guidance on the Kaibab NF as well and is consistent with the uneven-aged management guidance of the Kaibab NF plan. This would assure that immature tree groups (VSS 2 and 3) are managed to maintain tree stocking necessary to provide for the desired canopy cover as the groups mature to VSS 4, 5, and 6. By following the stocking guidelines and maintaining interlocking or nearly interlocking tree crowns, tree group density would meet and exceed the canopy cover requirements. Stocking guidelines for tree groups for the WUI55, UEA40, UEA25, and UEA10 mechanical thin treatments are as described in table 107.

Table 107. Landscapes outside of goshawk post-fledging areas wildland-urban interface and uneven-aged treatments stocking guidelines for tree groups

VSS Class (% of area)	d.b.h. Class (inches)	Typical Trees Per Group Stocking at the Midpoint Diameter of the VSS Class ¹					Group Trees Per Acre Range ²		
		1/10-ac group	1/4-ac group	1/2-ac group	3/4-ac group	1-ac group	Lower Density	Middle Density	Upper Density
1 & 2 (20)	0–4.9	19	48	96	144	193	134–302	NA	NA
3 (20)	5–11.9	14	34	68	102	136	83–215	NA	NA
4 (20)	12–17.9	5	12	23	35	46	35–115	70–146	89–185
5 (20)	18–23.9	3	8	15	23	30	19–59	43–79	54–96
6 (20)	at least 24	2	5	11	16	21	18–38	40–49	51–61

- These are typical values for the mid-point diameter of the VSS class. Densities within the VSS 4, 5, and 6 classes are equivalent to 40 percent canopy cover. Densities within the VSS 1, 2, and 3 classes are to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5, and 6.
- Variation in tree group stocking above the minimum required to maintain canopy cover can occur and is desired. The smallest TPA number for the range pertains to the largest diameter of the VSS class; the highest TPA number for the range pertains to the smallest diameter of the VSS class. See section E for further detail on stocking by diameter.

On approximately 28,725 acres (about 16,270 acres on the Coconino and 12,455 acres on the Kaibab NF, respectively) of uneven-aged (UEA) 40, UEA 25 and UEA 10 non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean trees per acre less than 100 of the VSS 4 size class) will be managed for greater residual canopy cover and density of large trees. Residual stand structure will be managed at the upper end of natural range of variability for ponderosa pine in the non-wildland-urban interface stands that meet these conditions. This will be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and will achieve 40 percent canopy cover at the stand scale.

Limited exceptions could occur on areas identified as potential movement corridors for pronghorn and other grassland wildlife species (see AGFD 2011 and Rosenstock and Gist 2014). In those areas, more intensive mechanical thinning of non-old-growth trees and lower levels of residual canopy cover will be

allowed. These will be of limited spatial extent and intended to restore natural openings, increase connectivity between natural openings, openings, and facilitate animal movement through treed areas. Manage for tree groups with different size classes by retaining individual and clumps of vigorous ponderosa pine seedlings, sapling, and poles within larger mid-aged, mature, or old tree groups. Both ground-based and remote sensing monitoring will be used to ensure and compare consistency with expected canopy cover levels. Large trees will be the basis for forming groups. Large trees (generally, dominant and codominant crown position) would have priority for retention within groups. Where size class diversity is not present, 1 to 10 suppressed and intermediate trees per group will be retained for vertical diversity. Interspace width between tree groups will average from 25 to 120 feet with a maximum width of 200 feet. Average interspace width will vary depending on treatment intensity as described in table 108.

Table 108. Interspace percent and width in Landscapes Outside of Goshawk Post-fledging Areas wildland-urban interface (WUI) and uneven-aged (UEA) treatments

Treatment Type and Intensity	Percent of Area Occupied by Interspace	Average Interspace Width (feet)
WUI55	55–70	80–120
UEA40	40–55	60–100
UEA25	25–40	40–60
UEA10	10–25	25–40

Regeneration openings (group selection) account for 10 to 20 percent of tree groups. The percentage will vary within this range depending on current VSS distribution. They will average 0.3 to 0.8 acre and will be no larger than 4 acres or 200 feet wide. Where stand structure dictates, establish regeneration openings by removing groups of trees of VSS3 and smaller diameter VSS4. Regeneration openings will be created adjacent to tree groups and would not be surrounded by interspace.

One group of reserve trees, three to five trees per group, will be left in created regeneration openings greater than an acre in size.

Manage for the sustainability of large oaks by removing ladder fuels and overtopping trees. Remove ponderosa pine that are within 30 feet of the base of oak 10 inches diameter at the root collar or larger as follows: (1) On the southerly side of the oak (135 to 315 degrees) trees up to 18 inches d.b.h. and (2) On the northerly side of the oak (316 to 134 degrees) trees in the intermediate or suppressed crown positions up to 18 inches d.b.h. Exceptions to removal will be trees that meet the old tree definition and trees that have interlocking crown with oaks.

Gambel oak, juniper, and pinyon species will not be cut with the following exceptions: seedling/sapling, young, and mid-aged pinyon and juniper up to 11 inches diameter at the root collar may be cut within a 50-foot radius of individual or groups of old ponderosa pine (as defined in the old tree implementation plan in section C), and when there is no other option to facilitate logging operations (skid trail and landing locations).

Gambel oak, juniper, and pinyon species greater than 5 inches diameter at the root collar may be considered as residual trees in the target group spacing and stocking.

Snags would be managed for two per acre at least 18 inches, coarse woody debris would be managed for 5 to 7 tons per acre, and downed logs would be managed for three per acre at least 12 inches.

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height, reducing litter/duff cover, and producing effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired landscapes outside of goshawk post-fledging areas uneven-aged forest structure, tree densities, snag densities, and coarse woody debris levels.

Landscapes Outside of Goshawk Post-fledging Areas Uneven-aged (UEA) Treatment– Arizona Department of Game and Fish Design Mechanical Thin and Burn Design

The design is the same as landscapes outside of goshawk post-fledging areas UEA 10 with the exception of group size. Tree group size is dependent on experimental design and will range in size from 1 to 15 acres.

Landscapes Outside of Goshawk Post-fledging Areas Intermediate Thin (IT) 40, 25, and 10 Mechanical Thin and Burn Treatments Design

Intermediate thinning (IT) will be used to establish interspace between individual trees and tree groups and thin tree groups within landscapes outside of goshawk post-fledging areas sites with moderate to high dwarf mistletoe infection that are uneven age or even age with a quadratic mean diameter at least 8.5 inches.

Treatments will strive to attain an overall average density of 70 to 90 square feet of basal area and 25 to 40 percent of maximum stand density index inclusive of groups and interspaces.

Density will vary within these ranges depending on treatment intensity and existing stand structure. See section D for more detail on the relationship of overall density to interspace and tree groups.

Individual trees, tree groups, and interspaces will occupy the following percent of the area by treatment intensity as described in table 109.

Table 109. Percent of area occupied by trees, tree groups, and interspace in landscapes outside of goshawk post-fledging areas intermediate thin (IT)

Treatment Type and Intensity	Percent of Area Occupied by Individual Trees and Tree Groups	Percent of Area Occupied by Interspace
IT40	45–60	40–55
IT25	60–75	25–40
IT10	75–90	10–25

Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments will follow the old tree implementation plan (section C), and old trees will not be targeted for cutting. Live conifer trees with existing cavities, dead tops, and lightning scars will also be favored for retention.

Per the Collaborative Forest Landscape Restoration Act requirements, treatments in alternatives B through E are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting desired conditions of increasing VSS 5 and 6 age classes as soon as possible. In alternatives C and E, treatments will also follow the guidance in section D, the large tree implementation plan.

To meet the desired condition of increasing VSS 5 and 6 size class, priority of tree retention within groups will focus on existing large trees (generally, trees within the dominant and codominant crown position). Where age class diversity is not present, suppressed and intermediate trees will be retained for vertical diversity. On approximately 13,300 acres (about 10,430 acres on the Coconino and 2,870 acres on the Kaibab NF, respectively) of IT 40, IT 25 and IT 10 non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean trees per acre less than 100 of the VSS 4 size class) will be managed for greater residual canopy cover and density of large trees. Residual stand structure will be managed at the upper end of natural range of variability for ponderosa pine in the non- wildland-urban interface stands that meet these conditions. This will be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover in these stands (measured with both ground-based and remote sensing methods) would meet or exceed forest plan guidance for canopy cover, and will achieve 40 percent canopy cover at the stand scale. Limited exceptions could occur on areas identified as potential movement corridors for pronghorn and other grassland wildlife species (see AGFD 2011 and Rosenstock and Gist 2014). In those areas, more intensive mechanical thinning of non-old-growth trees and lower levels of residual canopy cover will be allowed. These will be of limited spatial extent and intended to restore natural openings, increase connectivity between natural openings, and facilitate animal movement through treed areas.

Manage for the sustainability of individual/isolated old ponderosa pine trees as defined in the old tree implementation plan (section C) by reducing crown competition and increasing growing space adjacent to these trees. Remove ponderosa pine trees up to 18 inches d.b.h. that do not meet the old tree definition: (1) within a 50-foot radius that are in the intermediate or suppressed crown positions, and, (2) that would eliminate direct crown competition on two of the four sides of the old tree.

Openings, on average, will range in size from 0.1 to 1 acre with some exceeding 1 acre (but not to exceed 4 acres). Expected outcomes include treatment unit and landscape heterogeneity. The range of openings will be implemented with variable distribution of opening size. Variability of opening size and location are determined by aspect, site quality, existing stand structure and pre- settlement tree evidence. Tree groups, on average, will range in size from 0.1 to 1 acre with northerly aspects. Sites with a preponderance of large trees and highly productive microsites would have larger average group sizes. Overall, average group size will vary within this range depending on site quality, existing stand structure, and pre-settlement tree evidence.

Tree groups will be managed to improve tree vigor and growth by retaining the best growing dominant and codominant trees with the least amount of mistletoe within each group.

On the Kaibab NF, the predominant vegetation management strategies are for uneven-aged management systems. This is because vegetation management objectives were only developed for the ponderosa pine and frequent fire vegetation types, both of which have uneven aged desired conditions. Even aged management prescriptions are, however, used as a strategy for achieving the desired uneven-aged conditions over the long term. The following metrics (below) may be used on the Kaibab NF to assess movement towards uneven-aged conditions. Tree group density will be managed to meet the canopy cover requirement (Coconino NF only) of 40 plus percent within mid-aged forest (VSS4), mature forest (VSS5), and old forest (VSS6) tree groups. By following the stocking guidelines and maintaining interlocking or nearly interlocking tree crowns, tree group density will meet and exceed the canopy cover requirements. Stocking guidelines for VSS 4, 5, and 6 tree groups for the IT40, IT25, and IT10 mechanical thin treatments are as described in table 110 and table 111.

Table 110. Stocking guidelines for VSS 4 to 6 tree groups in landscapes outside of goshawk post-fledging areas intermediate thin (IT) treatments

VSS Class (% of area)	d.b.h. Class (inches)	Typical Trees Per Group Stocking at the Midpoint Diameter of the VSS Class ¹					Within Group Trees Per Acre Range ²		
		1/10-ac group	1/4-ac group	1/2-ac group	3/4-ac group	1-ac group	Lower Density	Middle Density	Upper Density
4 (20)	12–17.9	5	12	23	35	46	35–115	70–146	89–185
5 (20)	18–23.9	3	8	15	23	30	19–59	43–79	54–96
6 (20)	at least 24	2	5	11	16	21	18–38	40–49	51–61

These are typical values for the mid-point diameter of the VSS class. Densities within the VSS 4, 5, and 6 classes are equivalent to 40 percent canopy cover. Densities within the VSS 1, 2, and 3 classes are to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5, and 6.

Variation in tree group stocking above the minimum required to maintain canopy cover can occur and is desired. The smallest trees per acre number for the range pertains to the largest diameter of the VSS class. The highest trees per acre number for the range pertains to the smallest diameter of the VSS class. See section E for further detail on stocking by diameter.

Interspace width between tree groups would average from 25 to 80 feet with a maximum width of 200 feet. Average interspace width will vary depending on treatment intensity as described in [table 111](#).

Table 111. Percent and width of interspace in landscapes outside of goshawk post-fledging areas intermediate thin (IT) treatments

Treatment Type and Intensity	Percent of Area Occupied by Interspace	Average Interspace Width (feet)
IT40	40–55	60–80
IT25	25–40	40–60
IT10	10–25	25–40

Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments will follow the old tree implementation plan (section C), and old trees will not be targeted for cutting. Live conifer trees with existing cavities, dead tops, and lightning scars will also be favored for retention.

Per the Collaborative Forest Landscape Restoration Act requirements, treatments are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting desired conditions of increasing VSS 5 and 6 age classes as soon as possible. In alternatives C and E, treatments will also follow the guidance in section D, the large tree implementation plan.

To meet the desired condition of increasing VSS 5 and 6 age class, priority of tree retention within groups will focus on existing large trees (generally, trees within the dominant and codominant crown position). Where age class diversity is not present, suppressed and intermediate trees will be retained for vertical diversity.

Tree groups will be managed to improve tree vigor and growth by retaining the best growing dominant and codominant trees.

Landscapes Outside of Goshawk Post-fledging Areas Stand Improvement (SI) 40, 25, and 10 Mechanical Thin and Burn Treatments Design

On the Kaibab NF, the predominate vegetation management strategies are for uneven-aged management systems. This is because vegetation management objectives were only developed for the ponderosa pine and frequent fire vegetation types, both of which have uneven aged desired conditions. Even aged management prescriptions are, however, used as a strategy for achieving the desired uneven-aged conditions over the long term. The following metrics may be used on the Kaibab NF to assess movement towards uneven-aged conditions. Tree group density will be managed to meet the canopy cover requirement (Coconino NF only) of 40 plus percent within mid-aged forest (VSS 4), mature forest (VSS 5), and old forest (VSS 6) tree groups. This will assure that immature tree groups (VSS 2 and 3) are managed to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5, and 6. By following the stocking guidelines and maintaining interlocking or nearly interlocking tree crowns, tree group density will meet and exceed the canopy cover requirements. Stocking guidelines for tree groups for the SI40, SI25, and SI10 mechanical thin treatments are as **described in table 112.**

Table 112 Stocking guidelines for tree groups in landscapes outside of goshawk post-fledging areas stand improvement (SI) treatments

VSS Class (% of area)	d.b.h. Class (inches)	Typical Trees Per Group Stocking at the Midpoint Diameter of the VSS Class ¹					Group Trees Per Acre Range ²		
		1/10-ac group	1/4-ac group	1/2-ac group	3/4-ac group	1-ac group	Lower Density	Middle Density	Upper Density
1 & 2 (20)	0–4.9	19	48	96	144	193	134–302	NA	NA
3 (20)	5–11.9	14	34	68	102	136	83–215	NA	NA
4 (20)	12–17.9	5	12	23	35	46	35–115	70–146	89–185
5 (20)	18–23.9	3	8	15	23	30	19–59	43–79	54–96
6 (20)	at least 24	2	5	11	16	21	18–38	40–49	51–61

These are typical values for the mid-point diameter of the VSS class. Densities within the VSS 4, 5, and 6 classes are equivalent to 40 percent canopy cover. Densities within the VSS 1, 2, and 3 classes are to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5, and 6.

Variation in tree group stocking above the minimum required to maintain canopy cover can occur and is desired. The smallest trees per acre number for the range pertains to the largest diameter of the VSS class, the highest trees per acre number for the range pertains to the smallest diameter of the VSS class. See section D for further detail on stocking by diameter.

Interspace width between tree groups will average from 25 to 80 feet with a maximum width of 200 feet. Average interspace width will vary depending on treatment intensity as **described in table 113.**

Table 113. Interspace percent and width landscapes outside of goshawk post-fledging areas stand improvement (SI) treatments

Treatment Type and Intensity	Percent of Area Occupied by Interspace	Average Interspace Width (feet)
SI40	40–55	60–80
SI25	25–40	40–60
SI10	10–25	25–40

Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments will follow the old tree implementation strategy, and old trees will not be targeted for cutting. Live conifer trees with existing cavities, dead tops, and lightning scars will also be favored for retention.

Per the Collaborative Forest Landscape Restoration Act requirements, treatments are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting desired conditions of increasing VSS 5 and 6 age classes as soon as possible. Treatments will follow the large tree implementation plan.

To meet the desired condition of increasing VSS 5 and 6 age class, priority of tree retention within groups will focus on existing large trees (generally, trees within the dominant and codominant crown position). Where age class diversity is not present, suppressed and intermediate trees will be retained for vertical diversity.

On approximately 22 acres (22 acres on the Coconino) of SI 25 non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean trees per acre less than 100 of the VSS 4 size class) will be managed for greater residual canopy cover and density of large trees. Residual stand structure will be managed at the upper end of natural range of variability for ponderosa pine in the non-wildland-urban interface stands that meet these conditions. This will be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover (measured with both ground-based and remote sensing methods) in these stands will meet or exceed forest plan guidance for canopy cover, and will achieve 40 percent canopy cover at the stand scale.

Manage for the sustainability of large oaks by removing ladder fuels and overtopping trees. Remove ponderosa pine that are within 30 feet of the base of oak 10 inches diameter at the root collar or larger as follows: (1) On the southerly side of the oak (135 to 315 degrees) trees up to 18 inches d.b.h., and, (2) On the northerly side of the oak (316 to 134 degrees) trees in the intermediate or suppressed crown positions up to 18 inches d.b.h. Exceptions to removal will be trees that meet the old tree definition and trees that have interlocking crown with oaks.

Gambel oak, juniper, and pinyon species will not be cut with the following exceptions: seedling/sapling, young, and mid-aged pinyon and juniper up to 11 inches diameter at the root collar may be cut within a 50-foot radius of individual or groups of old ponderosa pine (as defined in the old tree implementation plan – section C), and when there is no other option to facilitate logging operations (skid trail and landing locations).

Gambel oak, juniper, and pinyon species greater than 5 inches diameter at the root collar may be considered as residual trees in the target group spacing and stocking.

Snags will be managed for two per acre at least 18 inches, coarse woody debris will be managed for 5 to 7 tons per acre, and downed logs will be managed for three per acre at least 12 inches.

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height, reducing litter/duff cover, and producing effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired landscapes outside of goshawk post-fledging areas stand improvement (SI) forest structure, tree densities, snag densities, and coarse woody debris levels.

Landscapes Outside of Goshawk Post-fledging Areas Pine Sage Mechanical and Burn Treatment Design

Restore pre-settlement tree density and pattern using pre-settlement evidence as guidance.

Treatment will strive to attain an overall average density of 30 to 50 square feet of basal area and 15 to 25 percent of maximum stand density index inclusive of individual trees, tree groups, and interspaces. Density will vary within this range depending on existing stand structure. See section E for more detail on the relationship of overall density to interspace and tree groups.

Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments will follow the old tree implementation plan (section C) and old trees will not be targeted for cutting. Live conifer trees with existing cavities, dead tops, and lightning scars will also be favored for retention.

Per the Collaborative Forest Landscape Restoration Act requirements, treatments are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting desired conditions of increasing VSS 5 and 6 age classes as soon as possible. In alternatives C and E, treatments will also follow the guidance in section D, the large tree implementation plan.

To meet the desired condition of increasing VSS 5 and 6 age class, priority of tree retention within groups would focus on existing large trees (generally, trees within the dominant and codominant crown position). Where age class diversity is not present, suppressed and intermediate trees will be retained for vertical diversity.

Retain all pre-settlement trees and the largest post-settlement trees available that most closely resemble old trees in size and form as replacement trees adjacent to pre-settlement tree evidences. Some younger trees will also be retained to maintain uneven-aged structure. On the Kaibab NF, the predominate vegetation management strategies are for uneven-aged management systems. This is because vegetation management objectives were only developed for the ponderosa pine and frequent fire vegetation types, both of which have uneven aged desired conditions. Even aged management prescriptions are, however, used as a strategy for achieving the desired uneven-aged conditions over the long term. The following metrics may be used on the Kaibab NF to assess movement towards uneven-aged conditions. Replacement tree density would be managed to meet the attain a canopy cover of 40 plus percent within mid-aged forest (VSS 4), mature forest (VSS 5), and old forest (VSS 6) tree groups. By following the stocking guidelines and maintaining interlocking or nearly interlocking tree crowns, tree group density will meet and exceed the canopy cover requirements. See table 114 for the stocking guidelines for VSS 4, 5, and 6 tree groups for the pine-sage mechanical thin treatments.

Table 114. Stocking guidelines for VSS 4 to VSS 6 tree groups in landscapes outside of goshawk post-fledging areas pine-sage treatments

VSS Class (% of area)	d.b.h. Class (inches)	Typical Trees Per Group Stocking at the Midpoint Diameter of the VSS Class ¹					Group Trees Per Acre Range ²		
		1/10-ac group	¼-ac group	½-ac group	¾-ac group	1-ac group	Lower Density	Middle Density	Upper Density

VSS Class (% of area)	d.b.h. Class (inches)	Typical Trees Per Group Stocking at the Midpoint Diameter of the VSS Class ¹					Group Trees Per Acre Range ²		
		1/10-ac group	1/4-ac group	1/2-ac group	3/4-ac group	1-ac group	Lower Density	Middle Density	Upper Density
4 (20)	12–17.9	5	12	23	35	46	35–115	70–146	89–185
5 (20)	18–23.9	3	8	15	23	30	19–59	43–79	54–96
6 (20)	at least 24	2	5	11	16	21	18–38	40–49	51–61

1. These are typical values for the mid-point diameter of the VSS class. Densities within the VSS 4, 5, and 6 classes are equivalent to 40 percent canopy cover. Densities within the VSS 1, 2, and 3 classes are to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5, and 6.
2. Variation in tree group stocking above the minimum required to maintain canopy cover can occur and is desired. The smallest trees per acre number for the range pertains to the largest diameter of the VSS class, the highest trees per acre number for the range pertains to the smallest diameter of the VSS class. See section D for further detail on stocking by diameter.

Manage for the sustainability of large oaks by removing ladder fuels and overtopping trees. Remove ponderosa pine that are within 30 feet of the base of oak 10 inches diameter at the root collar or larger as follows: (1) On the southerly side of the oak (135 to 315 degrees) trees up to 18 inches d.b.h. and (2) On the northerly side of the oak (316 to 134 degrees) trees in the intermediate or suppressed crown positions up to 18 inches d.b.h. Exceptions to removal will be trees that meet the old tree definition and trees that have interlocking crown with oaks.

Gambel oak will not be cut unless there is no other option to facilitate logging operations (skid trail and landing locations).

Juniper and pinyon species in the seedling/sapling, young, and mid-aged stages will generally be cut except where needed as replacements for pre-settlement trees. Mature juniper and pinyon will only be cut when there is no other option to facilitate logging operations (skid trail and landing locations).

Gambel oak, juniper, and pinyon species greater than 5 inches diameter at the root collar may be considered as residual trees in the target group spacing and stocking.

Snags will be managed for two per acre at least 18 inches, coarse woody debris will be managed for 5 to 7 tons per acre, and downed logs will be managed for three per acre at least 12 inches.

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height, reducing litter/duff cover, and producing effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired understory composition and cover as well as landscapes outside of goshawk post-fledging areas pine sage forest structure, tree densities, snag densities, and coarse woody debris levels.

Savanna/Grassland Restoration Mechanical and Burn Treatments Design

Restore pre-settlement tree density and pattern using pre-settlement evidence as guidance. Manage for an open reference condition with 10 to 30 percent of the area under ponderosa pine and deciduous tree crowns (see forest plan consistency evaluation in silviculture report).

Manage for the sustainability of identified wildlife corridors for grassland species (see AGFD 2011 and Rosenstock and Gist 2014) by treating these areas to the higher end of percent in interspaces or to a lower

ratio of leave tree to evidence ratio. Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments will follow the old tree implementation plan

(section C) and old trees will not be targeted for cutting. Live conifer trees with existing cavities, dead tops, and lightning scars will also be favored for retention.

Per the Collaborative Forest Landscape Restoration Act requirements, treatments are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting desired conditions of increasing VSS 5 and 6 age

classes as soon as possible. Treatments will also follow the guidance in section D, the large tree implementation plan.

To meet the desired condition of increasing VSS 5 and 6 age class, priority of tree retention within groups will focus on existing large trees (generally, trees within the dominant and codominant crown position). Where age class diversity is not present, suppressed and intermediate trees will be retained for vertical diversity.

Tree group arrangement, size, and density are a function of existing pre-settlement trees and evidence. Retain all pre-settlement trees and the largest post-settlement trees that most closely resemble old trees in size and form as replacement trees adjacent to pre-settlement tree evidences at a 1:1 ratio. Some younger trees will also be retained to maintain uneven-aged structure. A higher leave tree to evidence ratio may be required to maintain the desired tree cover range. Manage for a range of 70 to 90 percent of the treatment area as interspace (grass/forb) between tree groups or individuals. Amount of interspace will vary within this range depending on current conditions.

Manage for the sustainability of large oaks by removing ladder fuels and overtopping trees. Remove ponderosa pine that are within 30 feet of the base of oak 10 inches diameter at the root collar or larger as follows: (1) On the southerly side of the oak (135 to 315 degrees) trees up to 18 inches d.b.h., and, (2) On the northerly side of the oak (316 to 134 degrees) trees in the intermediate or suppressed crown positions up to 18 inches d.b.h. Exceptions to removal will be trees that meet the old tree definition and trees that have interlocking crown with oaks.

Gambel oak will not be cut unless there is no other option to facilitate logging operations (skid trail and landing locations).

Juniper and pinyon species in the seedling/sapling, young, and mid-aged stages will generally be cut except where needed as replacements for pre-settlement trees. Mature juniper and pinyon will only be cut when there is no other option to facilitate logging operations (skid trail and landing locations).

Snags will be managed for two per acre at least 18 inches, coarse woody debris will be managed for 5 to 7 tons per acre, and downed logs will be managed for three per acre at least 12 inches.

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height, reducing litter/duff cover, and producing effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired landscapes outside of goshawk post-fledging areas savanna/grassland forest structure, tree densities, snag densities, and coarse woody debris levels.

Landscapes Outside of Goshawk Post-fledging Areas Burn Only Treatment Design

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible.

Prescribed fires are designed to increase tree canopy base height, reduce litter/duff cover, and produce effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired landscapes outside of goshawk post-fledging areas forest structure, tree densities, snag densities, and coarse woody debris levels.

Goshawk Post-Fledging Family Area – Ponderosa Pine

Vegetation Management Direction: Provide for a healthy, sustainable forest environment for the post-fledging family area (PFA) needs. The principle difference between “within the post-fledging family area” and “outside the post-fledging family area” is the higher canopy cover and smaller opening size within the post-fledging family area. Forest conditions in the post-fledging family areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest for the Kaibab NF. The following guidance for the Coconino NF can be used as a metric to arrive at the higher density of 10 to 20 percent higher basal area recommended in the current Kaibab NF plan. For the Coconino NF, vegetative structural stage distribution and structural conditions are the same within and outside the post-fledging family area. Ponderosa pine canopy cover for mid-aged forest (VSS 4) should average one-third 60 plus percent and two-thirds 50 plus percent. Mature (VSS 5) and old forest (VSS 6) should average 50 plus percent. Forest plan amendment direction (FEIS, appendix B) clarifies that canopy cover guidelines apply to mid-aged to old forest structural stage dominated tree groups (see forest plan consistency crosswalk for the Kaibab NF in the vegetation report)

Desired Conditions: Uneven-aged with a balance of age classes. Within group structure specific to mid-aged to old classes (VSS 4 to 6) includes open understories, interlocking tree crowns, abundant large limbs, and shade.

Dispersal Post-fledging Family Areas / Post-fledging Family Areas in Uneven-aged Treatment (UEA) Types 40, 25, and 10 Mechanical Thin and Burn Treatments Design

Uneven-age thinning and group selection will be used to establish interspace between individual trees and tree groups, thin tree groups, and create regeneration openings within dispersal post-fledging family areas / post-fledging family areas with none to low dwarf mistletoe infections that are uneven age or even age with a quadratic mean diameter at least 8.5 inches.

Treatments will strive to attain an overall average density of 70 to 80 square feet of basal area and 25 to 40 percent of maximum stand density index inclusive of groups, interspaces, and regeneration openings. Density will vary within this range depending on treatment intensity and existing stand structure. See section E for more detail on the relationship of overall density to interspace, tree groups, and regeneration openings.

Individual trees, tree groups, and interspaces will occupy the following percent of the area by treatment intensity as described in table 115.

Table 115. Percent of area occupied by individual trees, tree groups, and interspace in dispersal post-fledging family areas / post-fledging family areas uneven-aged (UEA) treatments

Treatment Type and Intensity	Percent of Area Occupied by Individual Trees and Tree Groups	Percent of Area Occupied by Interspace

Silviculture Specialist Report

Four Forest Restoration Initiative Coconino and Kaibab National Forests

UEA40	45–60	40–55
UEA25	60–75	25–40
UEA10	75–90	10–25

Individual trees, tree groups, and interspaces will be managed to move toward a balance of age classes, both within and from tree group to tree group, by reducing the most abundant tree size classes and maintaining the underrepresented tree size classes.

Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments will follow the old tree implementation plan (section C) and old trees will not be targeted for cutting. Live conifer trees with existing cavities, dead tops, and lightning scars will also be favored for retention.

Per the Collaborative Forest Landscape Restoration Act requirements, treatments are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting desired conditions of increasing VSS 5 and 6 age classes as soon as possible. Treatments would also follow the guidance in section D, the large tree implementation plan.

To meet the desired condition of increasing VSS 5 and 6 age class, priority of tree retention within groups will focus on existing large trees (generally, trees within the dominant and codominant crown position). Where age class diversity is not present, suppressed and intermediate trees would be retained for vertical diversity.

On approximately 2,680 acres (about 1,160 acres on the Coconino and 1,520 acres on the Kaibab) of dispersal post-fledging family area UEA 10, dispersal post-fledging family area UEA 25, dispersal post-fledging family area UEA 40, post-fledging family area UEA 10, post-fledging family area UEA 25 and post-fledging family area UEA 40 non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean trees per acre less than 100 of the VSS 4 size class) will be managed for greater residual canopy cover and density of large trees. Residual stand structure will be managed at the upper end of natural range of variability for ponderosa pine in the non-wildland-urban interface stands that meet these conditions. This will be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover (measured with both ground-based and remote sensing methods) in these stands will meet or exceed forest plan guidance for canopy cover, and will achieve for mid-aged forest (VSS 4) on average 1/3 60+ percent and 2/3 50+ percent and for mature (VSS 5) and old forest (VSS 6) should average 50+ percent canopy cover at the stand scale. Limited exceptions could occur on areas identified as potential movement corridors for pronghorn and other grassland wildlife species (see AGFD 2011 and Rosenstock and Gist 2014). In those areas, more intensive mechanical thinning of non-old-growth trees and lower levels of residual canopy cover will be allowed. These will be of limited spatial extent and intended to restore natural openings, increase connectivity between natural openings, and facilitate animal movement through treed areas.

Manage for the sustainability of individual/isolated old ponderosa pine trees as defined in the old tree implementation plan (section C) by reducing crown competition and increasing growing space adjacent to these trees. Remove ponderosa pine trees up to 18 inches d.b.h. that do not meet the old tree definition: (1) within a 50-foot radius that are in the intermediate or suppressed crown positions, and (2) that will eliminate direct crown competition on two of the four sides of the old tree.

Openings, on average, will range in size from 0.1 to 1 acre with some exceeding 1 acre (but not to exceed 4 acres). Expected outcomes include treatment unit and landscape heterogeneity. The range of openings will be implemented with variable distribution of opening size.

Variability of opening size and location will be determined by aspect, site quality, existing stand structure and pre-settlement tree evidence. Tree groups, on average, will range in size from 0.1 to 1 acre with northerly aspects. Sites with a preponderance of large trees and highly productive microsites will have larger average group sizes (.25 to 1 acre). Overall, average group size will vary within this range depending on site quality, existing stand structure, and pre-settlement tree evidence.

Forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest for the Kaibab NF. The following guidance for the Coconino NF can be used as a metric to arrive at the higher density recommended in the current Kaibab NF plan. Tree group density will be managed to meet the canopy cover requirement (Coconino NF only) of mid-aged forest (VSS 4) should average one-third 60 plus percent and two-thirds 50 plus percent. Mature (VSS 5) and old forest (VSS 6) should average 50 plus percent tree groups and to assure that immature tree groups (VSS 2 and 3) are managed to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5, and 6. By following the stocking guidelines and maintaining interlocking or nearly interlocking tree crowns, tree group density will meet and exceed the canopy cover requirements. Stocking guidelines for tree groups for the dispersal post-fledging family areas / post-fledging family areas UEA40, UEA25, and UEA10 mechanical thin treatments are described in [table 116](#).

Manage for tree groups with different age classes by retaining individual and clumps of vigorous ponderosa pine seedlings, sapling, and poles within larger mid-aged, mature, or old tree groups.

Table 116. Stocking guidelines for tree groups in dispersal post-fledging family areas / post-fledging family areas wildland-urban interface and uneven-aged treatments

VSS Class (% of area)	d.b.h. Class (inches)	Typical Trees Per Group Stocking at the Midpoint Diameter of the VSS Class ¹					Group Trees Per Acre Range ²		
		1/10-ac group	¼-ac group	½-ac group	¾-ac group	1-ac group	Lower Density	Middle Density	Upper Density
1 & 2 (20)	0–4.9	19	48	96	144	193	134–302	NA	NA
3 (20)	5–11.9	14	34	68	102	136	83–215	NA	NA
4 (20)	12–17.9	7	18	35	53	70	51–115	70–146	89–185
5 (20)	18–23.9	4	10	20	29	39	28–59	43–79	54–96
6 (20)	at least 24	3	7	14	20	27	26–38	40–49	51–61

1. These are typical values for the mid-point diameter of the VSS class. Densities within the VSS 4 classes are equivalent to 55 percent canopy cover (guidance for 1/3 60 percent and 2/3 50 is actually 53 percent, 55 percent is a higher average percent canopy cover than the minimum guidance); Densities within the VSS 5 and VSS 6 classes are equivalent to 50 percent canopy cover. Densities within the VSS 1, 2, and 3 classes are to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5, and 6.

2. Variation in tree group stocking above the minimum required to maintain canopy cover can occur and is desired. The smallest trees per acre number for the range pertains to the largest diameter of the VSS class, the highest trees per acre number for the range pertains to the smallest diameter of the VSS class. See section D for further detail on stocking by diameter.

Interspace width between tree groups will average from 25 to 70 feet with a maximum width of 200 feet. Average interspace width will vary depending on treatment intensity as described in [table 117](#).

Table 117. Interspace percent and width in dispersal post-fledging family areas / post-fledging family areas wildland-urban interface and uneven-aged (UEA) treatments

Treatment Type and Intensity	Percent of Area Occupied by Interspace	Average Interspace Width (feet)
UEA40	40–55	55–70
UEA25	25–40	40–55
UEA10	10–25	25–40

Regeneration openings (group selection) account for 10 to 20 percent of tree groups. They will average 0.3 to 0.8 acre and would be no larger than 2 acres or 200 feet wide. Where stand structure dictates, establish regeneration openings by removing groups of trees of VSS3 and smaller diameter VSS4. Regeneration openings will be created adjacent to tree groups and will not be surrounded by interspace.

One group of reserve trees, three to five trees per group, will be left in created regeneration openings greater than an acre in size.

Manage for the sustainability of large oaks by removing ladder fuels and overtopping trees. Remove ponderosa pine that are within 30 feet of the base of oak 10 inches diameter at the root collar or larger as follows: (1) On the southerly side of the oak (135 to 315 degrees) trees up to 18 inches d.b.h., and (2) On the northerly side of the oak (316 to 134 degrees) trees in the intermediate or suppressed crown positions up to 18 inches d.b.h. Exceptions to removal will be trees that meet the old tree definition and trees that have interlocking crown with oaks. Gambel oak, juniper, and pinyon species will not be cut with the following exceptions: seedling/sapling, young, and mid-aged pinyon and juniper up to 11 inches diameter at the root collar may be cut within a 50-foot radius of individual or groups of old ponderosa pine (as defined in the old tree implementation strategy), and when there is no other option to facilitate logging operations (skid trail and landing locations).

Gambel oak, juniper, and pinyon species greater than 5 inches diameter at the root collar may be considered as residual trees in the target group spacing and stocking.

Snags will be managed for two per acre at least 18 inches, coarse woody debris will be managed for 5 to 7 tons per acre, and downed logs will be managed for three per acre at least 12 inches.

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height, reducing litter/duff cover, and producing effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired dispersal post-fledging family areas / post-fledging family areas with uneven-aged forest structure, tree densities, snag densities, and coarse woody debris levels.

Dispersal Post-fledging Family Areas / Post-fledging Family Areas Uneven-aged (UEA) Forest–Arizona Department of Game and Fish Design Mechanical Thin and Burn Design

Treatment design is similar to dispersal post-fledging family areas / post-fledging family areas UEA10 with the exception of group size. Tree group size is dependent on experimental design and will range in size from 1 to 15 acres.

Dispersal Post-fledging Family Areas / Post-fledging Family Areas Intermediate Thin (IT)40, 25 and 10 Mechanical Thin and Burn Treatments Design

Intermediate thinning will be used to establish interspace between individual trees and tree groups and thin tree groups within dispersal post-fledging family areas / post-fledging family areas with moderate to high dwarf mistletoe infection that are uneven age or even age with a quadratic mean diameter at least 8.5 inches.

Treatments will strive to attain an overall average density of 70 to 90 square feet of basal area and 25 to 40 percent of maximum stand density index inclusive of groups and interspaces.

Density will vary within this range depending on treatment intensity and existing stand structure. See section E for more detail on the relationship of overall density to interspace and tree groups.

Individual trees, tree groups, and interspaces will occupy the following percent of the area by treatment intensity as described **in table 118.**

Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments will follow the old tree implementation strategy and old trees will not be targeted for cutting. Live conifer trees with existing cavities, dead tops, and lightning scars will also be favored for retention.

Table 118. Percent of area occupied by trees and interspace for dispersal post-fledging family areas / post-fledging family areas intermediate thin (IT)

Treatment Type and Intensity	Percent of Area Occupied by Individual Trees and Tree Groups	Percent of Area Occupied by Interspace
IT40	45–60	40–55
IT25	60–75	25–40
IT10	75–90	10–25

Manage for the sustainability of individual/isolated old ponderosa pine trees as defined in the old tree implementation plan (section C) by reducing crown competition and increasing growing space adjacent to these trees. Remove ponderosa pine trees up to 18 inches d.b.h. that do not meet the old tree definition: (1) within a 50-foot radius that are in the intermediate or suppressed crown positions, and (2) that would eliminate direct crown competition on two of the four sides of the old tree. Per the Collaborative Forest Landscape Restoration Act requirements, treatments are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting desired conditions of increasing VSS 5 and 6 age classes as soon as possible. Treatments will also follow the guidance in section D, the large tree implementation plan.

VSS4 size class and a mean trees per acre less than 100 of the VSS 4 size class) will be managed for greater residual canopy cover and density of large trees. Residual stand structure will be managed at the upper end of natural range of variability for ponderosa pine in the non- wildland- urban interface stands that meet these conditions. This will be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover (measured with both ground-based and remote sensing methods) in these stands will meet or exceed forest plan guidance for canopy cover, and will achieve for mid-aged forest (VSS 4) on average 1/3 60+ percent and 2/3 50+ percent and for mature (VSS 5) and old forest (VSS should average 50+ percent canopy cover at the stand scale. Limited exceptions could occur on areas identified as potential movement corridors for pronghorn and other grassland wildlife species (see AGFD 20011 and Rosenstock and Gist 2014). In those areas, more intensive mechanical thinning of non-

old-growth trees and lower levels of residual canopy cover will be allowed. These will be of limited spatial extent and intended to restore natural openings, increase connectivity between natural openings, and facilitate animal movement through treed areas. Openings, on average, will range in size from 0.1 to 1 acre with some exceeding 1 acre (but not to exceed 4 acres). Expected outcomes include treatment unit and landscape heterogeneity. The range of openings will be implemented with variable distribution of opening size. Variability of opening size and location will be determined by aspect, site quality, existing stand structure and pre-settlement tree evidence. Tree groups, on average, will range in size from 0.1 to 1 acre with northerly aspects. Sites with a preponderance of large trees and highly productive microsites will have larger average group sizes (.25 to 1 acre). Overall, average group size will vary within this range depending on site quality, existing stand structure, and pre-settlement tree evidence.

Tree groups will be managed to improve tree vigor and growth by retaining the best growing dominant and codominant trees with the least amount of mistletoe within each group.

Forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest for the Kaibab NF. The following guidance for the Coconino NF can be used as a metric to arrive at the higher density recommended in the current Kaibab NF plan. Tree group density will be managed to meet the canopy cover requirement (Coconino NF only) of mid-aged forest (VSS 4) should average one-third 60 plus percent and two-thirds 50 plus percent. Mature (VSS 5) and old forest (VSS 6) should average 50 plus percent tree groups. By following the stocking guidelines and maintaining interlocking or nearly interlocking tree crowns, tree group density will meet and exceed the canopy cover requirements. Stocking guidelines for VSS 4, 5, and 6 tree groups for the dispersal post-fledging family areas / post-fledging family areas IT40, IT25, and IT10 mechanical thin treatments are described in table 137 and table 119.

Table 119. Dispersal post-fledging family areas / post-fledging family areas intermediate thin (IT) treatments stocking guidelines for VSS 4 – 6 tree groups

VSS Class (% of area)	d.b.h. Class (inches)	Typical Trees Per Group Stocking at the Midpoint Diameter of the VSS Class ¹					Group Trees Per Acre Range ²		
		1/10-ac group	1/4-ac group	1/2-ac group	3/4-ac group	1-ac group	Lower Density	Middle Density	Upper Density
4 (20)	12–17.9	7	18	35	53	70	51–115	70–146	89–185
5 (20)	18–23.9	4	10	20	29	39	28–59	43–79	54–96
6 (20)	at least 24	3	7	14	20	27	26–38	40–49	51–61

1. These are typical values for the mid-point diameter of the VSS class. Densities within the VSS 4 classes are equivalent to 55 percent canopy cover (guidance for 1/3 60 percent and 2/3 50 is actually 53 percent, 55 percent is a higher average percent canopy cover than the minimum guidance); Densities within the VSS 5 and VSS 6 classes are equivalent to 50 percent canopy cover. Densities within the VSS 1, 2, and 3 classes are to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5 and 6.

2. Variation in tree group stocking above the minimum required to maintain canopy cover can occur and is desired. The smallest trees per acre number for the range pertains to the largest diameter of the VSS class, the highest trees per acre number for the range pertains to the smallest diameter of the VSS class. See section D for further detail on stocking by diameter.

Interspace width between tree groups will average from 25 to 80 feet with a maximum width of 200 feet. Average interspace width will vary depending on treatment intensity as described in table 120.

Table 120. Interspace percent and width in dispersal post-fledging family areas / post-fledging family areas intermediate thin (IT)

Treatment Type and Intensity	Percent of Area Occupied by Interspace	Average Interspace Width
IT40	40–55	60–80
IT25	25–40	40–60
IT10	10–25	25–40

Manage for the sustainability of large oaks by removing ladder fuels and overtopping trees. Remove ponderosa pine that are within 30 feet of the base of oak 10 inches diameter at the root collar or larger as follows: (1) On the southerly side of the oak (135 to 315 degrees) trees up to 18 inches d.b.h., and, (2) On the northerly side of the oak (316 to 134 degrees) trees in the

intermediate or suppressed crown positions up to 18 inches d.b.h. Exceptions to removal would be trees that meet the old tree definition and trees that have interlocking crown with oaks.

Gambel oak, juniper, and pinyon species will not be cut with the following exceptions: seedling/sapling, young, and mid-aged pinyon and juniper up to 11 inches diameter at the root collar may be cut within a 50-foot radius of individual or groups of old ponderosa pine (as defined in the old tree implementation plan, section C); and when there is no other option to facilitate logging operations (skid trail and landing locations).

Gambel oak, juniper, and pinyon species greater than 5 inches diameter at the root collar may be considered as residual trees in the target group spacing and stocking.

Snags will be managed for two per acre at least 18 inches, coarse woody debris will be managed for 5 to 7 tons per acre, and downed logs will be managed for three per acre at least 12 inches.

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height, reducing litter/duff cover, and producing effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired dispersal post-fledging family areas / post-fledging family areas intermediate thin forest structure, tree densities, snag densities, and coarse woody debris levels.

Dispersal Post-fledging Family Areas / Post-fledging Family Areas Stand Improvement (SI)40, 25, and 10 Mechanical Thin and Burn Treatments Design

Stand improvement thinning will be used to establish interspace between individual trees and tree groups and thin tree groups within dispersal post-fledging family areas / post-fledging family areas even-age sites with a quadratic mean diameter ≤ 8.5 inches and with none to low dwarf mistletoe infection.

Treatments will strive to attain a stand average density of 20 to 25 percent of maximum stand density index inclusive of groups and interspaces. These ranges will vary depending on treatment intensity and existing stand structure. See section E for more detail on the relationship of overall density to interspace and tree groups.

Individual trees, tree groups, and interspaces will occupy the following percent of the area by treatment intensity as described in table 121.

Table 121. Percent of area occupied by individual trees, tree groups, and interspaces in dispersal post-fledging family areas / post-fledging family areas stand improvement (SI) treatments

Treatment Type and Intensity	Percent of Area Occupied by Individual Trees and Tree Groups	Percent of Area Occupied by Interspace
SI40	45–60	40–55
SI25	60–75	25–40
SI10	75–90	10–25

Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments will follow the old tree implementation plan (section C), and old trees will not be targeted for cutting. Live conifer trees with existing cavities, dead tops, and lightning scars would also be favored for retention.

Per the Collaborative Forest Landscape Restoration Act requirements, treatments are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting desired conditions of increasing VSS 5 and 6 age classes as soon as possible. Treatments will also follow the guidance in section D, the large tree implementation plan.

To meet the desired condition of increasing VSS 5 and 6 age class, priority of tree retention within groups will focus on existing large trees (generally, trees within the dominant and codominant crown position). Where age class diversity is not present, suppressed and intermediate trees will be retained for vertical diversity.

On approximately 37 acres (about 37 acres on the Coconino) of post-fledging family area SI 25 non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean trees per acre less than 100 of the VSS 4 size class) will be managed for greater residual canopy cover and density of large trees. Residual stand structure will be managed at the upper end of natural range of variability for ponderosa pine in the non-wildland-urban interface stands that meet these conditions. This will be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover (measured with both ground-based and remote sensing methods) in these stands will meet or exceed forest plan guidance for canopy cover, and will achieve for mid-aged forest (VSS 4) on average 1/3 60+ percent and 2/3 50+ percent and for mature (VSS 5) and old forest (VSS 6) should average 50+ percent canopy cover at the stand scale.

Manage for the sustainability of individual/isolated old ponderosa pine trees as defined in the old tree implementation strategy by reducing crown competition and increasing growing space adjacent to these trees. Remove ponderosa pine trees up to 18 inches d.b.h. that do not meet the old tree definition: (1) within a 50-foot radius that are in the intermediate or suppressed crown positions, and, (2) that would eliminate direct crown competition on two of the four sides of the old tree.

Openings, on average, will range in size from 0.1 to 1 acre with some exceeding 1 acre (but not to exceed 4 acres). Expected outcomes include treatment unit and landscape heterogeneity. The range of openings will be implemented with variable distribution of opening size. Variability of opening size and location will be determined by aspect, site quality, existing stand structure and pre-settlement tree evidence. Tree groups will be managed to improve tree vigor and growth by retaining the best growing dominant and codominant trees.

Forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest for the Kaibab NF. The following guidance for the Coconino NF can be used as a metric to arrive at the higher density recommended in the current Kaibab NF plan. Tree group density will be managed to meet the canopy cover requirement (Coconino NF only) of mid-aged forest (VSS 4) should average one-third 60 plus percent and two-thirds 50 plus percent. Mature (VSS 5) and old forest (VSS 6) should average 50 plus percent tree groups and to assure that immature tree groups (VSS 2 and 3) are managed to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5 and 6. By following the stocking guidelines and maintaining interlocking or nearly interlocking tree crowns, tree group density would meet and exceed the canopy cover requirements. Stocking guidelines for tree groups for the dispersal post-fledging family areas / post-fledging family areas stand improvement types SI40, SI25, and SI10 mechanical thin treatments are described in table 122 (see Kaibab NF forest plan consistency crosswalk in the vegetation report).

Table 122. Stocking guidelines for tree groups in dispersal post-fledging family areas / post-fledging family areas stand improvement (SI) treatments

VSS Class (% of area)	d.b.h. Class (inches)	Typical Trees Per Group Stocking at the Midpoint Diameter of the VSS Class ¹					Group Trees Per Acre Range ²		
		1/10-ac group	1/4-ac group	1/2-ac group	3/4-ac group	1-ac group	Lower Density	Middle Density	Upper Density
1 & 2 (20)	0–4.9	19	48	96	144	193	134–302	NA	NA
3 (20)	5–11.9	14	34	68	102	136	83–215	NA	NA
4 (20)	12–17.9	7	18	35	53	70	51–115	70–146	89–185
5 (20)	18–23.9	4	10	20	29	39	28–59	43–79	54–96
6 (20)	at least 24	3	7	14	20	27	26–38	40–49	51–61

1. These are typical values for the mid-point diameter of the VSS class. Densities within the VSS 4 classes are equivalent to 55 percent canopy cover (guidance for 1/3 60 percent and 2/3 50 is actually 53 percent, 55 percent is a higher average percent canopy cover than the minimum guidance); densities within the VSS 5 and VSS 6 classes are equivalent to 50 percent canopy cover. Densities within the VSS 1, 2, and 3 classes are to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5, and 6.

2. Variation in tree group stocking above the minimum required to maintain canopy cover can occur and is desired. The smallest trees per acre number for the range pertains to the largest diameter of the VSS class, the highest trees per acre number for the range pertains to the smallest diameter of the VSS class. See section D for further detail on stocking by diameter.

Interspace width between tree groups will average from 25 to 80 feet with a maximum width of 200 feet. Average interspace width will vary depending on treatment intensity as described in table 141.

Table 123 Interspace percent and width in dispersal post-fledging family areas / post-fledging family areas stand improvement (SI) treatments

Treatment Type and Intensity	Percent of Area Occupied by Interspace	Average Interspace Width (feet)
SI40	40–55	60–80
SI25	25–40	40–60
SI10	10–25	25–40

Manage for the sustainability of large oaks by removing ladder fuels and overtopping trees. Remove ponderosa pine that are within 30 feet of the base of oak 10 inches diameter at the root collar or larger as follows: (1) On the southerly side of the oak (135 to 315 degrees) trees up to 18 inches d.b.h., and (2) On the northerly side of the oak (316 to 134 degrees) trees in the intermediate or suppressed crown positions up to 18 inches d.b.h. Exceptions to removal would be trees that meet the old tree definition and trees that have interlocking crown with oaks.

Gambel oak, juniper, and pinyon species will not be cut with the following exceptions: seedling/sapling, young, and mid-aged pinyon and juniper up to 11 inches diameter at the root collar may be cut within a 50-foot radius of individual or groups of old ponderosa pine (as defined in the old tree implementation plan, section C); and, when there is no other option to facilitate logging operations (skid trail and landing locations).

Gambel oak, juniper, and pinyon species greater than 5 inches diameter at the root collar may be considered as residual trees in the target group spacing and stocking.

Snags will be managed for two per acre at least 18 inches, coarse woody debris will be managed for 5 to 7 tons per acre, and downed logs will be managed for three per acre at least 12 inches.

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height, reducing litter/duff cover, and producing effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired dispersal post-fledging family areas / post-fledging family areas stand improvement (SI) forest structure, tree densities, snag densities, and coarse woody debris levels.

Dispersal Post-fledging Family Areas / Post-fledging Family Areas Pine Sage Mechanical and Burn Treatment Design

Restore pre-settlement tree density and pattern using pre-settlement evidence as guidance.

Treatments will strive to attain an overall stand average density of 30 to 50 square feet of basal area and 15 to 25 percent of maximum stand density index inclusive of individual trees, tree groups, and interspaces. Density will vary within this range depending on existing stand structure. See section E for more detail on the relationship of overall density to interspace and tree groups.

Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments will follow the old tree implementation plan (section C), and old trees will not be targeted for cutting. Live conifer trees with existing cavities, dead tops, and lightning scars will also be favored for retention.

Retain all pre-settlement trees and the largest post-settlement trees available that most closely resemble old trees in size and form as replacement trees adjacent to pre-settlement tree evidences. Some younger trees will also be retained to maintain uneven-aged structure.

Per the Collaborative Forest Landscape Restoration Act requirements, treatments are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting desired conditions of increasing VSS 5 and 6 age classes as soon as possible. Treatments will also follow the guidance in section D, the large tree implementation plan.

To meet the desired condition of increasing VSS 5 and 6 age class, priority of tree retention within groups will focus on existing large trees (generally, trees within the dominant and codominant crown position). Where age class diversity is not present, suppressed and intermediate trees will be retained for vertical diversity.

On approximately 87 acres (about 87 acres on the Kaibab NF) of post-fledging family areas pine sage non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean trees per acre less than 100 of the VSS 4 size class) will be managed for greater residual canopy cover and density of large trees. Residual stand structure will be managed at the upper end of natural range of variability for ponderosa pine in the non-wildland-urban interface stands that meet these conditions. This will be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed 40 percent, measured at the stand scale (alternative C and E only).

Replacement tree density will be managed to meet the canopy cover requirement of mid-aged forest (VSS 4) should average one-third 60 plus percent and two-thirds 50 plus percent. Mature (VSS 5) and old forest (VSS 6) should average 50 plus percent tree groups. By following the stocking guidelines and maintaining interlocking or nearly interlocking tree crowns, tree group density would meet and exceed the canopy cover requirements. Stocking guidelines for VSS 4, 5 and 6 tree groups for the pine sage mechanical thin treatments are as described in table 123.

Manage for the sustainability of large oaks by removing ladder fuels and overtopping trees. Remove ponderosa pine that are within 30 feet of the base of oak 10 inches diameter at the root collar or larger as follows: (1) On the southerly side of the oak (135 to 315 degrees) trees up to 18 inches d.b.h., and, (2) On the northerly side of the oak (316 to 134 degrees) trees in the intermediate or suppressed crown positions up to 18 inches d.b.h. Exceptions to removal will be trees that meet the old tree definition and trees that have interlocking crown with oaks.

Gambel oak will not be cut unless there is no other option to facilitate logging operations (skid trail and landing locations).

Table 124. Stocking guidelines for VSS 4–6 tree groups in dispersal post-fledging family areas / post-fledging family areas pine-sage treatments

VSS Class (% of d.b.h. area)	Class (inches)	Typical Trees Per Group Stocking at the Midpoint Diameter of the VSS Class ¹					Trees Per Acre Range ²		
		1/10-ac group	1/4-ac group	1/2-ac group	3/4-ac group	1-ac group	Lower Density	Middle Density	Upper Density
4 (20)	12–17.9	7	18	35	53	70	51–115	70–146	89–185
5 (20)	18–23.9	4	10	20	29	39	28–59	43–79	54–96
6 (20)	at least 24	3	7	14	20	27	26–38	40–49	51–61

1. These are typical values for the mid-point diameter of the VSS class. Densities within the VSS 4 classes are equivalent to 55 percent canopy cover (guidance for 1/3 60 percent and 2/3 50 is actually 53 percent, 55 percent is a higher average percent canopy cover than the minimum guidance); Densities within the VSS 5 and VSS 6 classes are equivalent to 50 percent canopy cover. Densities within the VSS 1, 2, and 3 classes are to maintain tree stocking necessary to provide for desired canopy cover as the groups mature to VSS 4, 5 and 6.
2. Variation in tree group stocking above the minimum required to maintain canopy cover can occur and is desired. The smallest trees per acre number for the range pertains to the largest diameter of the VSS class, the highest trees per acre number for the range pertains to the smallest diameter of the VSS class. See section D for further detail on stocking by diameter.

Juniper and pinyon species in the seedling/sapling, young, and mid-aged stages will generally be cut except where needed as replacements for pre-settlement trees. Mature juniper and pinyon will only be cut when there is no other option to facilitate logging operations (skid trail and landing locations).

Gambel oak, juniper, and pinyon species greater than 5 inches diameter at the root collar may be considered as residual trees in the target group spacing and stocking.

Snags will be managed for two per acre at least 18 inches, coarse woody debris will be managed for 5 to 7 tons per acre, and downed logs will be managed for three per acre at least 12 inches.

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height, reducing litter/duff cover, and producing effects that stimulate regeneration and growth of native herbaceous vegetation. Prescribed fires are designed to maintain and enhance desired dispersal post-fledging family areas / post-fledging family areas savanna/grassland forest structure, tree densities, snag densities, and coarse woody debris levels.

Dispersal Post-fledging Family Areas / Post-fledging Family Areas Burn Only Treatment Design

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible.

Prescribed fires are designed to increase tree canopy base height, reduce litter/duff cover, and produce effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired dispersal post-fledging family areas / post-fledging family areas forest structure, tree densities, snag densities, and coarse woody debris levels.

Nest Area

Vegetation Management Direction: Provide unique nesting habitat conditions for goshawks. Important features include trees of mature to old age with high canopy cover. The structure of the vegetation within nest areas is associated with the forest type, and tree age, size and density, and the developmental history of the stand. Table 143 represents RMRS-GTR-217 attributes required for goshawks on location with “low” and “high” site productivity. The nesting area contains only mature to old forest (VSS 5 and 6) having a canopy cover (measured vertically) between 50 to 70 percent with old forest VSS 6 trees 200 to 300 years old. Nonuniform spacing of tree and clumpiness is desirable (see Kaibab NF forest plan consistency crosswalk in the vegetation report).

Desired Conditions: Even-aged dominated by mature and/or old forest structural stages.

Goshawk Nest Area Burn Only Treatment Design

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible.

Prescribed fires are designed to increase tree canopy base height and reduce litter/duff cover and other surface fuel loading.

Prescribed fires are designed to maintain and enhance desired dispersal post-fledging family areas / post-fledging family areas forest structure, tree densities, snag densities, and coarse woody debris levels. Desired goshawk nest stand structural attributes are as described in table 124.

Table 125. Minimum structural attributes in suitable goshawk nest stands*

Structural Attribute	Minimum Metrics	
Site Index	under 55	at least 55
Trees/Acre	40	30
Mean d.b.h. (in.)	16	22
Age (yrs.)	200+	200+
Total basal area (sq. ft./acre)	120	140
Overstory canopy cover	50+	60+
VSS	5B-6	5B-6

* GTR-RM-217, southwest ponderosa pine cover types

Landscapes Outside of Goshawk Post-fledging Areas (LOPFA) – Pinyon-Juniper

Vegetation Management Direction: Manage for uneven-age conditions to sustain a mosaic of vegetation densities (overstory and understory), age classes, and species composition well distributed across the landscape. Provide for reserve trees, snags, and down woody debris.

Desired Conditions: Mosaic of young and mature, species diverse patches of trees interspersed with interspace across the landscape to promote the growth of sagebrush, oak, cliffrose, and other shrubs and herbaceous understory species. Mature patches would be structurally diverse, containing large live and

dead standing trees as well as trees with dead or broken tops, gnarls, and burls. The structure and composition reflects the natural range of variability.

Pinyon Juniper (PJ) Wildland-urban Interface Mechanical Thin and Burn Treatment Design

Uneven-age thinning will be used to establish interspace between tree groups and thin tree groups within landscapes outside of goshawk post-fledging areas pinyon juniper sites.

Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments would follow the old tree implementation plan (section C), and old trees will not be targeted for cutting. Live conifer trees with existing cavities and dead tops will also be favored for retention.

Retain one to three groups per acre containing approximately 5 to 30 trees each (averaging 30 to 60 trees per acre across the site). Form groups around existing concentrations of large, mature trees. Retain additional healthy, young, free-to-grow trees within groups where possible.

Between groups, thin from below to 16 inches diameter at the root collar for pinyon and juniper and 16 inches d.b.h. for ponderosa pine.

Where ponderosa pine is present, retain all pre-settlement yellow pines and one to two replacement blackjacks per existing yellow pine or pre-settlement evidence (i.e., to approximate the naturally occurring stand composition). Replacement blackjacks should be comprised of a variety of size classes. Blackjacks will be retained within 100 feet of the yellow pine or pre-settlement evidence they are replacing.

Manage for the sustainability of large oaks by removing ladder fuels and overtopping trees. Remove ponderosa pine that are within 30 feet of the base of oak 10 inches diameter at the root collar or larger as follows: (1) On the southerly side of the oak (135 to 315 degrees) trees up to 18

inches d.b.h., and, (2) On the northerly side of the oak (316 to 134 degrees) trees in the intermediate or suppressed crown positions up to 18 inches d.b.h. Exceptions to removal will be trees that meet the old tree definition and trees that have interlocking crown with oaks.

Gambel oak will not be cut with the exception of when there is no other option to facilitate logging operations (skid trail and landing locations).

Snags will be managed for one per acre over 75 percent of the area and coarse woody debris will be managed for an after treatment average of 1 to 3 tons per acre. Where available, a portion of the coarse woody debris will include two logs at least 10 inches and at least 10 feet in length.

Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height, reducing litter/duff cover, and producing effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired landscapes outside of goshawk post-fledging areas pinyon juniper wildland-urban interface forest structure, tree densities, snag densities, and coarse woody debris levels.

Other Areas outside Mexican Spotted Owl and Goshawk Habitats

Aspen

Vegetation Management Direction: Conifer removal, partial removal of overstory aspen, ground-disturbing activities, and fire would be used to stimulate aspen sprouting in areas that have or previously had aspen.

Desired Conditions: Aspen is successfully regenerating and recruiting into older and larger size classes. Size classes have a natural distribution, with the greatest number of stems in the smallest classes. Coniferous species comprise less than 10 percent of the overstory.

Aspen Mechanical Thin and Burn Treatment Design

Inclusions of aspen remnants within portions of ponderosa pine stands will be regenerated by removing all post-settlement conifers from within 100 feet of the aspen clone. Some removal of aspen within the clone as well as ground-disturbing activity or burning may occur to stimulate suckering.

Per the Collaborative Forest Landscape Restoration Act requirements, treatments are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting desired conditions of increasing VSS 5 and 6 age classes as soon as possible. Treatments will also follow the guidance in section D, the large tree implementation plan.

To meet the desired condition of increasing VSS 5 and 6 age class, priority of tree retention within groups will focus on existing large trees (generally, trees within the dominant and codominant crown position). Where age class diversity is not present, suppressed and intermediate trees will be retained for vertical diversity.

Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments will follow the old tree implementation plan (section C), and old trees will not be targeted for cutting. Live conifer trees with existing cavities, dead tops, and lightning scars would also be favored for retention.

Snags will be managed for two per acre at least 18 inches, coarse woody debris will be managed for 5 to 7 tons per acre, and downed logs will be managed for three per acre at least 12 inches.

Each clone will be evaluated as to need for fencing or creation of other barriers to reduce ungulate browsing of regenerating aspen.

Prescribed burns may be used where and when feasible to treat fuels, mitigate fuel hazards, and to produce effects that stimulate aspen suckering and regeneration, and growth of native herbaceous vegetation.

Silviculture Specialist Report

Four Forest Restoration Initiative Coconino and Kaibab National Forests

Prescribed fires are designed to maintain and enhance desired aspen forest structure, tree densities, snag densities, and coarse woody debris levels.

Aspen Burn Only Treatment Design

Inclusions of aspen remnants within portions of ponderosa pine stands will be regenerated by prescribed burning to stimulate suckering.

Prescribed burns are designed to reduce post-settlement conifer stocking within 100 feet of the aspen clone and disturb the site with sufficient intensity to encourage aspen regeneration.

Each clone will be evaluated as to need for fencing or creation of other barriers to reduce ungulate browsing of regenerating aspen.

Grassland

Vegetation Management Direction: Reduce conifer encroachment within grasslands as identified by mollisol soils.

Desired Conditions: Restore historic grassland/forest edge as indicated by existing pre-settlement conifers and evidence of pre-settlement conifers.

Grassland Mechanical Thin and Burn Treatment Design (Alternative C Only)

Treatments are designed to promote and reestablish the historic meadow edge as defined by pre-settlement trees and evidences and the current forest structure of young trees encroaching on the edge of the grassland.

Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments will follow the old tree implementation plan (section C), and old trees would not be targeted for cutting. Live conifer trees with existing cavities and dead tops will also be favored for retention.

Tree group arrangement, size, and density are a function of existing pre-settlement trees and evidence. Retain all pre-settlement trees and the largest post-settlement trees that most closely resemble old trees in size and form as replacement trees adjacent to pre-settlement tree evidences at a 1:1 ratio. Ponderosa pine, pinyon, and juniper not meeting long-lived characteristics may be removed.

Gambel oak will be retained.

Prescribed burns may be used where and when feasible to treat fuels, mitigate fuel hazards, and to produce effects that stimulate regeneration and growth of native herbaceous vegetation.

Prescribed fires are designed to maintain and enhance desired grassland conditions.

Section B – Decision Matrix

Table 126. Section B decision matrix for establishing tree groups, interspace, and regeneration openings

Feature	Placement	Reserve Trees within Feature	Thinning	Thinning Leave Tree Criteria	Large Tree Implementation Plan (Alternative C)
Tree Group	1 – Abundance of pre-settlement tree evidence 2 – Underrepresented tree classes (e.g., free to grow seedling/saplings; trees of different cohort than neighboring trees) 3 – High percentage of trees exhibiting good health and vigor 4- Groups dominated by a preponderance of large young trees	1 – Old tree characteristics (old tree implementation plan) regardless of size 2 – Oak, pinyon, and juniper with exceptions 3 – Wildlife trees (cavities, dead tops)	Tree group stocking guidelines.	1 – Trees in the dominant and codominant crown position exhibiting vigor relative to age regardless of size (usually large young trees) 2 – Crown ratio >40% desirable; crown ratio 25–40% acceptable 3 – Free of mistletoe or low dwarf mistletoe rating relative to neighboring trees; free of pine beetle activity 4 – Trees >12" high percentage of interlocking crown; Trees <12" ability to develop interlocking crown	Heavily-Stocked Stands (with high BA) Generated by a Preponderance of Large, Young Trees Does the decision matrix meet the conditions described by the large tree implementation plan category: Yes _____ No _____ If no, describe what the condition(s) is, and why it does not meet the exception: _____ _____ Ponderosa Pine/Gambel Oak Forest Does the decision matrix meet the conditions described by the large tree implementation plan category: Yes _____ No _____ If no, describe what the condition(s) is, and why it does not meet the exception: _____ _____

Feature	Placement	Reserve Trees within Feature	Thinning	Thinning Leave Tree Criteria	Large Tree Implementation Plan (Alternative C)
Interspace	1 – Little to no pre-settlement tree evidence 2 – Existing nonstocked openings 3 – High percentage of trees exhibiting poor health and vigor 4 - Contiguous area of well-represented cohorts	1 – Old tree characteristics (old tree implementation plan) regardless of size. 2 – Oak, pinyon and juniper 3 – Wildlife trees (cavities, dead tops)	NA	NA	Within-Stand Openings: Does the decision matrix meet the conditions described by the large tree implementation plan category: Yes _____ No _____ If no, describe what the condition(s) is, and why it does not meet the exception:
Regeneration Opening	1 – Contiguous area of well-represented cohort. 2 – Isolated patch of mistletoe infected trees within the well-represented cohort. 3 – Adjacent to seed bearing tree groups that are free of mistletoe infection. 4- Where stand structure dictates, establish regeneration openings by removing groups of trees of VSS3 and smaller diameter VSS4. Avoid placing in preponderance of large young trees.	1 – Old tree characteristics (old tree implementation plan) regardless of size. 2 – Oak, pinyon, and juniper 3 – Wildlife trees (cavities, dead tops) 4 – Largest, healthiest, seed bearing ponderosa pine (within openings >1 ac)	NA	NA	NA

Section C – Old Tree Implementation Plan

Old Tree Descriptions and Illustrations

Old trees (approximately over 150 years old) would be retained, with few exceptions, regardless of their diameter, within the 4FRI on the Coconino and Kaibab NF's EIS area. Removal of old trees would be rare. Exceptions would be made for threats to human health and safety, and those rare circumstances where the removal of an old tree is necessary in order to prevent additional habitat degradation. Old trees would not be cut for forest health issues or to balance age or size class distributions.

One example of a situation where the removal of an old tree is necessary in order to prevent additional habitat degradation is in the rare case of an old tree growing on the side of an existing curve in a road. Logging equipment may require a wider turning radius. The options are to relocate the road or cut the old tree and widen the curve to accommodate the larger turning radius. Relocating the road would result in a larger area of the forest being permanently disturbed, versus cutting the large tree and widening the curves radius. This is an example where cutting the old tree would result in less habitat degradation then relocating a road.

Old trees would be determined by the following characteristics described by Thomson (1940) as 3 (intermediate-mature) and 4 (mature to over-mature).

- Age – Approximately 150 years and older.
- D.b.h. – Site dependent.
- Bark – ranging from reddish brown, shading to black in the top with moderately large plates between the fissures to reddish brown to yellow, with very wide, long, and smooth plates.
- Tops – ranging from pyramidal or rounded (occasionally pointed) to flat (making no further height growth).
- Branching – ranging from upturned in upper third of the crown, horizontal in the middle third, and drooping in the lower third of the crown to mostly large, drooping, gnarled, or crooked. Branch whorls range from incomplete and indistinct except at the top to completely indistinct and incomplete.

Figure 65 and figure 66 display illustrations of size class 3 (intermediate-mature) and size class 4 (mature-overmature) from Thompson 1940.

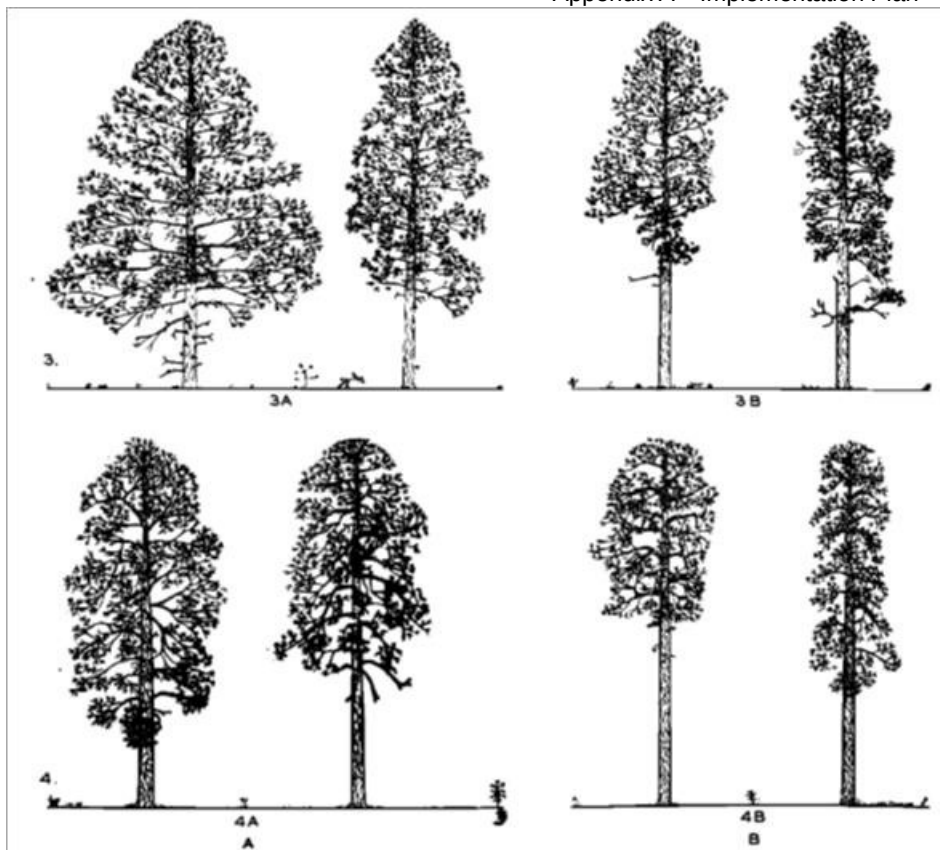


Figure 65. Old tree characteristics (Thompson 1940)

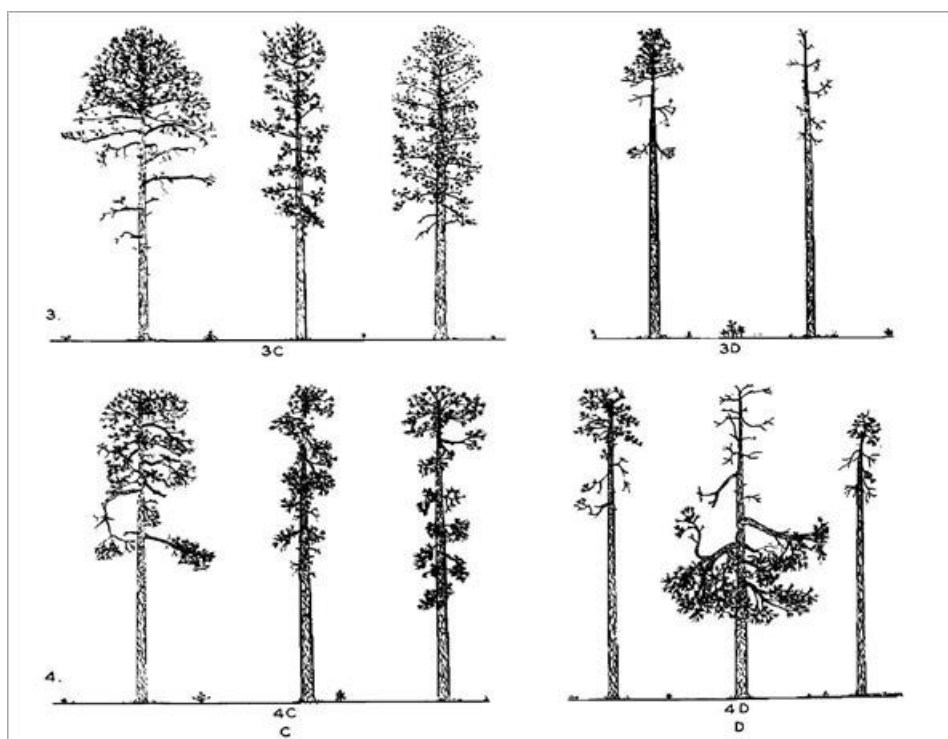


Figure 66. Old age tree characteristics continued (Thompson 1940)

Section D – Modified Large Tree Implementation Plan (Alternatives C and E)

Introduction

The large tree implementation plan is designed to reflect the Collaborative Forest Landscape Restoration Act requirements regarding large tree retention by clarifying the intent to focus restoration treatments on small-diameter tree thinning, to retain large trees whenever possible, and to more specifically design treatments so that large trees would be retained unless they must be cut to meet the desired conditions listed in the categories below. It responds to comments received during scoping (August 2011). The plan's desired conditions are consistent with the summarized desired conditions found in the project's purpose and need and the plan provides additional citations that support the desired conditions. It incorporates the old tree implementation plan by reference.

For the purpose of this document, large post-settlement trees, as defined by the socio-political process, are those that are 16 inches d.b.h. or larger. Trees greater than or equal to 18 inches d.b.h. represent VSS 5 and 6. VSS 5 and 6 represent the largest and (sometimes) oldest trees. These size classes best correspond with the successional age classification system that was developed to address the forest dynamics of southwestern ponderosa pine.

The plan may not include every instance where large post-settlement trees may be cut. There may be additional areas and/or circumstances where large post-settlement trees need to be removed in order to achieve restoration objectives. During implementation (prescription development), if a condition exists that does not meet the desired conditions included in this strategy, no large trees would be cut until the NEPA decision is reviewed by the Forest Service implementation team. The team would decide whether the action is consistent with the analysis and the decision made. This information would be made part of the annual implementation plan checklist/compliance review that is recommended by the team and approved by the forest supervisor.

Seeps and Springs

Seeps are locations where surface-emergent groundwater causes ephemeral or perennial moist soil or bedrock. Standing or running water is infrequent or absent. Vegetation and other biological diversity are adapted to mesic soils. Springs are small areas where surface-emergent groundwater causes ephemeral or perennial standing or running water and wet or moist soils. Vegetation and other biological diversity are adapted to mesic soils or aquatic environments (Feth and Hem 1963).

Seeps and springs exhibit unique, often isolated biophysical conditions that can sustain unique, mesic-adapted biological diversity, and can facilitate endemism and speciation. Springs also provide water and other habitat to terrestrial wildlife. Due to the absence of frequent fires in the presence of livestock grazing, the establishment of large post-settlement trees may reduce available soil moisture (Simonin et al. 2007) and block the sunlight necessary to support the unique biophysical conditions associated with seeps and springs.

Removal of trees that have encroached upon seeps and springs may constitute a relatively small part of an overall seep and spring restoration effort, when compared to fully addressing root causes of overall degradation. Thinning alone, without addressing other sources of degradation, is unlikely to fully restore

seeps and springs (Thompson et al. 2002). However, it is a necessary step leading to the restoration of these ecologically important areas.

Desired Conditions

- The biophysical conditions in seeps and springs upon which terrestrial, mesic-adapted, and aquatic native biological diversity depend are conserved and restored.
- The integrity of the spring's unique biophysical attributes is not compromised by tree shading.
- Mesic soils associated with a seep or spring are not encroached upon by conifers.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.

Riparian

Riparian areas occur along ephemeral or perennial streams or are located downgradient of seeps or springs. These areas exhibit riparian vegetation, mesic soils, and/or aquatic environments.

Riparian areas exhibit unique biophysical conditions that can sustain unique, mesic-adapted, or aquatic biological diversity. Riparian areas and the streams, springs, and seeps connected to them often harbor imperiled species that can be sources of endemism. Riparian areas also provide water and other habitat to terrestrial wildlife. In the absence of frequent fires and in the presence of other competing factors, large post-settlement trees may have become established and grown within riparian areas to the point that they compromise available soil moisture or light that support the unique biophysical conditions that are associated with the riparian areas. However, it is likely to be a very rare circumstance that conifer trees of any size would need to be removed from forested riparian zones.

Desired Conditions

- The biophysical conditions in riparian habitat upon which terrestrial and aquatic native biological diversity depends are conserved and restored.
- The use of soil and water best management practices (BMPs) minimize the impacts of cutting trees within riparian areas.
- Removal of trees constitutes a relatively small part of an overall riparian area restoration effort, when compared to the fundamental causes of overall degradation. Riparian areas are fully restored by using an array of tools that address all sources of degradation.
- Available soil moisture or light that support that area's unique biophysical conditions is not compromised by growing (rooted) trees.

- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.
- Post-treatment snags and logs that include large trees are available onsite.

Wet Meadows

High elevation streamside or spring-fed meadows occur in numerous locations throughout the Southwest. However, less than 1 percent of the landscape in the region is characterized as wetland (Dahl 1990), and wet meadows are just one of several wetland types that occur. Patton and Judd (1970) reported that approximately 17,700 hectares of wet meadows occur on national forests in Arizona and New Mexico.

Wet meadows may be referred to as riparian meadows, montane (or high elevation) riparian meadows, sedge meadows, or simply as wet meadows. Wet meadows are usually located in valleys or swales, but may occasionally be found in isolated depressions, such as along the fringes of ponds and lakes with no outlets. Where wet meadows have not been excessively altered, sedges (*Carex* spp.), rushes (*Juncus* spp.), and spikerush (*Eleocharis* spp.) are common species (Patton and Judd 1970, Hendrickson and Minckley 1984, Muldavin et al. 2000). Willow (*Salix*) and alder (*Alnus*) species often occur in or adjacent to these meadows (Long 2000, Long 2002, Maschinski 2001, Medina and Steed 2002). High elevation wet meadows frequently occur along a gradient that includes aquatic vegetation at the lower end and mesic meadows, dry meadows, and ponderosa pine or mixed conifer forest at the upper end. These vegetation gradients are closely associated with differences in flooding, depth to water table, and soil characteristics (Judd 1972, Castelli et al. 2000, Dwire et al. 2006). While relatively rare, wet meadows are believed to be of disproportionate value because of their use by wildlife and the range of other ecosystem services they provide. Wet meadows perform many of the same ecosystem functions associated with other wetland types, such as water quality improvement, reduction of flood peaks, and carbon sequestration.

Wet meadows are one of the most heavily altered ecosystems. They have been used extensively for grazing livestock, have become the site of many small dams and stock tanks, have had roads built through them, and have experienced other types of hydrologic alterations. Most notably, the lowering of their water tables due to stream downcutting, surface water diversions, or groundwater withdrawal (Neary and Medina 1996) has occurred. In the presence of livestock grazing and hydrologic changes, large post-settlement trees may have established and grown within wet meadows such that they compromise available soil moisture or light creating unique biophysical conditions.

Desired Conditions

- The biophysical conditions of wet meadows upon which terrestrial native biological diversity depend are conserved and restored.
- Wet meadow function is not impaired by growing (rooted) trees.
- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.

- Removal of large trees constitutes a relatively small part of an overall riparian area restoration effort, when compared to the fundamental causes of overall degradation. Wet meadows are fully restored by using an array of tools that address all sources of degradation.

Encroached Grasslands

Encroached grasslands are herbaceous ecosystems that have infrequent to no evidence of pine trees growing prior to settlement. The two prevalent grassland categories in the 4FRI landscape are montane (includes subalpine) grasslands and Colorado Plateau (a subset of Great Basin) grasslands, with montane grasslands being most common (Finch 2004). A key indicator of grasslands is the presence of mollisol soils. Mollisol soils are typically deeper with higher rates of accumulation and decomposition of soil organic matter relative to soils in the surrounding landscape. Grasslands in this region evolved during the Miocene and Pliocene periods, and the dark, rich soils observed in grasslands today have taken more than 3 million years to produce. In addition to their association with mollic soils, grasslands in this region are maintained by a combination of climate, fire, wind desiccation, and, to a lesser extent, by animal herbivory (Finch 2004).

Typical montane grasslands in this region are characterized by Arizona fescue (*Festuca arizonica*) meadows on elevated plains of basaltic and sandstone residual soils. Montane grasslands generally occur in small (under 100 acres) to medium sized (100 to 1,000 acres) patches. Historic maintenance of the herbaceous condition in these grasslands is subject to some debate though appears to be primarily driven by periodic fire. The cool-season growth of Arizona fescue also plays a large role in maintenance of parks and openings by directly competing with ponderosa pine seedlings. Identification of grasslands in this region should use a combination of the TES, Southwest Regional GAP Analysis, and Brown and Lowe Vegetation Classification (Brown and Lowe 1982, TNC GIS Layer 2006) among other existing vegetation and soils data.

Prior to European settlement, pine trees were rarely established in grasslands because they were either outcompeted by production of cool-season grasses or killed by frequent fire (Finch 2004). In the late 1800s, unsustainable livestock grazing practices significantly reduced herbaceous cover, reducing competition pressure on pine seedlings. Coupled with the onset of fire suppression in the early 1900s, pine trees rapidly encroached and recruited into native grasslands (e.g., Moore and Huffman 2004, Coop and Givnish 2007). Plant diversity is particularly important in grassland ecosystems. Grassland plots with greater species diversity have been found to be more resistant to drought and to recover more quickly than less diverse plots (Tilman and Downing 1994). This resilience will become even more important in a warming climate. Pine tree removal, restoration of fire, and complementary reductions in livestock grazing pressure are all necessary to restore structure and function of native grasslands.

Desired Conditions

- Grasslands are enhanced, maintained, and function with potential natural vegetation (as defined by vegetative mapping units).
- Grasslands function with a natural fire regime.
- Existing grasslands are not encroached upon by conifers.

- If treatment occurs, an equivalent number of large replacement trees remain where there is evidence that pre-settlement trees have grown in similar root and crown proximity to a particular seep or spring in the past.

Aspen Forest and Woodland

Quaking aspen (*Populus tremuloides*) occurs in small patches throughout the 4FRI project area. Bartos (2001) refers to three broad categories of aspen: (1) stable and regenerating (stable), (2) converting to conifers (seral), and (3) decadent and deteriorating. Almost all of the aspen occurring within ponderosa pine forests of the 4FRI project area is seral aspen, which regenerates after disturbance through root sprouting and rarely from seed production (Quinn and Wu 2001). Favorable soil and moisture conditions maintain stable aspen over time. Aspen stands have been mapped across the entire 4FRI area and map layers are available from existing databases.

Aspen occurs within ponderosa pine forests. It is ecologically important due to the high concentration of biodiversity that depends on aspen for habitat (Tew 1970, DeByle 1985, Finchand Reynolds 1987, Griffis-Kyle and Beier 2002). In addition, stable aspen stands serve as an indicator of ecological integrity (Di Orio et al. 2005). Aspen is currently declining at an alarming rate (Fairweather et al. 2008).

The lack of fire as a natural disturbance regime in southwestern ponderosa pine forests since European settlement has caused much of the aspen dominated lands to cede to conifers (Bartos 2001). Other factors contributing to gradual aspen decline over the past 140 years include reduced regeneration from browsing ungulates including livestock (Pearson 1914, Larson 1959, Martin 1965, Jones 1975, Shepperd and Fairweather 1993, Martin 2007) and introduced and native wild ungulates in the absence of natural predators like wolves (Ripple and Beschta 2007, 2011, Hebblewhite et al. 2005). More recently, aerial and ground surveys indicate more rapid decline of aspen, with very high mortality occurring in low and mid-elevation aspen sites. Major factors thought to be causing this rapid decline of aspen include frost events, severe drought, and a host of insects and pathogens (Fairweather et al. 2008) that have served as the “final straws” for already compromised stands. Desired Conditions:

- Aspen and woodlands are conserved and restored to their appropriate fire regime.
- Aspen is effectively being regenerated or maintained, and regeneration, saplings, and juvenile trees are protected from browsing.
- There is decreased competition from ponderosa pine. Post-settlement ponderosa pine tree numbers do not exceed residual targets that have been identified using pre-settlement conifer tree evidences, site visitations, and collected data.
- Removal of large trees constitutes a relatively small part of the aspen restoration effort, when compared to the fundamental causes of overall degradation. Aspen forests and woodlands are fully restored by using an array of tools that address all sources of degradation.

Ponderosa Pine/Gambel Oak Forest (Pine-Oak PIPO/QUGA)

A number of habitat types exist in the southwestern United States that could be described as pine-oak. Ponderosa pine forests are interspersed with Gambel oak trees in locations throughout the 4FRI area in a habitat association referred to as PIPO/QUGA (USDA FS 1997, USDI FWS 1995).

In southwestern ponderosa pine forests, Gambel oak has several growth forms distinguished by stem sizes and the density and spacing of stems within clumps. These include shrubby thickets of small stems, clumps of intermediate-sized stems, and large, mature trees that are influenced by age, disturbance history, and site conditions (Kruse 1992, Rosenstock 1998, Abella and Springer 2008, Abella 2008a). Different growth forms provide important habitat for a large number and variety of wildlife species (Neff et al. 1979, Kruse 1992). These include hiding cover in a landscape with limited woody shrub cover, cavity substrate for birds and bats, roost potential for bats, nest sites for birds, and bark characteristics used by invertebrates. Whether as saplings, shrubby thickets, or larger sized trees, oak adds a high value for wildlife in ponderosa pine forests.

Gambel oak provides high quality wildlife habitat in its various growth forms and is a desirable component of ponderosa pine forests (Neff et al. 1979, Kruse 1992, Bernardos et al. 2004).

Gambel oak enhances soils (Klemmedson 1987), wildlife habitat (Kruse 1992, Rosenstock 1998, USDI FWS 1995, Bernardos et al. 2004), and understory community composition (Abella and Springer 2008). Large oak trees are particularly valuable since they typically provide more natural cavities and pockets of decay that allow excavation and use by cavity nesters than conifers. In addition to its important ecological role, Gambel oak has high value to humans as it is a popular firewood that possesses superior heat-producing qualities compared to other tree species (Wagstaff 1984).

Although management on public lands with regard to oak has changed to better protect the species, illegal firewood cutting of Gambel oak, and elk and livestock grazing negatively impact oak growth and regeneration (Harper et al. 1985, Clary and Tiedemann 1992). Illegal firewood cutting of Gambel oak continues to result in the removal of rare, large diameter oak trees (Bernardos et al. 2004).

A literature review by Abella and Fulé (2008) found that Gambel oak densities appear to have increased in many areas with fire exclusion, especially in the small and medium diameter stems (under 8 inches d.b.h.). Chambers (2002) found that Gambel oak on the Kaibab and Coconino NFs was distributed in an uneven-aged distribution, dominated by smaller size classes (under 5 centimeter d.b.h.) and few large diameter oak trees. Because of Gambel oak's slow growth rate, there may be little opportunity for these small Gambel oak trees to attain large diameters (over 85 centimeters) (Chambers 2002).

Pine competition with oak has been identified as an issue in slowing oak growth, particularly for older oaks (Onkonburi 1999). Onkonburi (1999) also found that for northern Arizona forests, pine thinning increased oak incremental growth more than oak thinning and prescribed fire. Fulé (2005) found that oak diameter growth tended to be greater in areas where pine was thinned relative to burn only treatments and controls. Thinning of competing pine trees may promote large oaks with vigorous crowns and enhanced acorn production (Abella 2008b), and may increase oak seedling establishment (Ffolliott and Gottfried 1991).

Desired Conditions

All Gambel Oak

- Small oak trees develop into larger size classes.
- Fire treatments retain small and shrubby oak in numbers and distribution.
- All growth forms of Gambel oak are present and larger, older oak trees are enhanced and maintained.
- Large, post-settlement trees are not restricting oak development.
- Frequent, low intensity surface fire occurs in ponderosa pine-Gambel oak forests.
- Brushy thicket, pole, and dispersed clump growth forms of Gambel oak are present and maintained by allowing natural self-thinning, thinning dense clumps, and/or burning.
- Gambel oak growth forms are protected from damage during restoration treatments including thinning and post-thinning slash burning.
- Non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 and a mean trees per acre less than 100) would be managed for greater residual canopy cover and density of large trees. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non- wildland-urban interface stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes, and/or retaining additional large trees.

In Mexican Spotted Owl Restricted Habitat

- Within Mexican spotted owl habitat and designated critical habitat, the recovery plan for the Mexican spotted owl improves key habitat components and primary biological factors, which includes Gambel oak.
- Within 30 feet of oak 10- inch diameter at the root collar or larger, post-settlement mixed conifer trees up to 18 inches d.b.h. (that do not have interlocking crowns with oak) are not restricting oak development.

Outside Mexican spotted owl Restricted Habitat

- Large post-settlement trees' drip lines or roots do not overlap with those of Gambel oak trees over 8 inch diameter at the root collar.

Within-stand Openings

Within-stand openings are small openings (generally 0.05 to 1.0 acres) that were occupied by grasses and wildflowers before settlement (Pearson 1942, White 1985, Covington and Sackett 1992, Sánchez Meador et al. 2009). For the purposes of this strategy, within-stand openings are equivalent to interspaces. The within-stand opening management approach described below is distinct from, and should not be considered as guidance relating to regeneration openings.

Pre-settlement openings can be identified by the lack of stumps, stump holes, and other evidence of pre-settlement tree occupancy (Covington et al. 1997). These openings are most pronounced on sites with heavy textured (e.g., silt-clay loam) soils (Covington and Moore 1994). Current openings include fine-scaled canopy gaps. It is not necessary to have desired within-stand openings and groups located in the same location that they were in before settlement (the site fidelity assumption). Trees might be retained in areas that were openings before settlement, and openings might be established in areas which had previously supported pre-settlement trees.

Within-stand openings appear to have been self-perpetuating before overgrazing and fire exclusion (Pearson 1942, Sánchez Meador et al. 2009). Fully occupied by the roots of grasses and wildflowers as well as those of neighboring groups of trees, these openings had low water and nutrient availability because of intense root competition (Kaye et al. 1998). Heavy surface fuel loads insured that tree seedlings were killed by frequent surface fires, reinforcing the competitive exclusion of tree seedlings (Fulé et al. 1997).

These natural openings appear to have been very important for some species of butterflies, birds, and mammals (Waltz and Covington 2004). Often the largest post-settlement trees, typically a single tree, became established in these natural within-stand openings as soon as herbaceous vegetation was removed by overgrazing (Sánchez Meador et al. 2009). Contemporary within-stand openings or areas dominated by smaller post-settlement trees should be the starting point for restoring more natural within-stand heterogeneity.

Desired Conditions

- The pattern of openings within stands that provide natural spatial heterogeneity for biological diversity are conserved.
- Openings break up fuel continuity to reduce the probability of torching and crowning and restore natural heterogeneity within stands.
- Openings promote snowpack accumulation and retention which benefits groundwater recharge and watershed processes at the fine (1 to 10 acres) scale.

- The presence of such trees does not prevent the reestablishment of sufficient within-stand openings to emulate natural vegetation patterns based on current stand conditions, pre-settlement evidences, desired future conditions, or other restoration objectives.
- Groups of trees typically range in size from 0.1 acre to 1 acre. Canopy gaps and interspaces between tree groups or individuals are based on site productivity and soil type and range from 10 percent on highly productive sites to as high as 90 percent on those soil types that have an open reference condition.
- Suitable openings for successful natural regeneration in this project would range in size from 3/10 to 8/10 of an acre. Openings would be created by focusing on removal of VSS 3 and lower VSS 4, given the excess of such trees across the project area.
- Non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 and a mean trees per acre less than 100) would be managed for greater residual canopy cover and density of large trees. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-wildland-urban interface stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes, and/or retaining additional large trees.

Heavily-Stocked Stands (with High Basal Area) Generated by a Preponderance of Large, Young Trees

In some areas, the increase in post-settlement trees has been so rapid that current stand structure is characterized by high density and high basal area in large, young ponderosa pine trees. These stands or groups of stands exhibit continuous canopy which promotes unnaturally severe fire effects under severe fire weather conditions. At the fine scale, the management approach would apply on a case-by-case basis. The cutting of large trees may be necessary to meet site-specific ecological objectives as listed below. For example, the cutting of large trees may be necessary in order to reduce the potential for crown fire to spread into communities or important habitats that include Mexican spotted owl and/or goshawk nest stands. This approach would apply when other options would not alleviate severe fire effects.

In stands where pre-settlement evidences, restoration objectives, community protection, or other ecological restoration objectives indicate much lower tree density and basal area would be desirable, large post-settlement pines may need to be removed to achieve post-treatment conditions consistent with a desired restoration trajectory. Where evidence indicates higher tree density and basal area would have occurred pre-settlement, only a few large pines may need to be removed. Many of these areas would support crown fire and, thus, require structural modification to reduce crown fire potential and restore understory vegetation that supports surface fire.

Desired Conditions

- Natural heterogeneity of forest, savanna, and grasslands occurs at the landscape scale and within stands.
- Groups are restored by retaining the largest trees on the landscape to reestablish old growth structure in the shortest timeframe possible.
- Decreased shading and interception from the canopy, decreased needle litter and duff, and surface fire restore and maintain a mosaic of natural vegetative communities.
- Decreased shading and interception from the canopy fuels allow the growth of continuous herbaceous surface fuels to carry surface fire.
- Reduced horizontal and vertical canopy fuels reduce the potential for crown fire.
- Fire is the principle regulator of forest structure over time.
- Regeneration openings that contribute to the ecological objective of natural heterogeneity of historical forest structure and age class diversity are not encroached upon by trees.
- Non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 and a mean trees per acre less than 100) would be managed for greater residual canopy cover and density of large trees. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-wildland-urban interface stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes, and/or retaining additional large trees.

Section E – Density Management and the Relationship Between Treatment Intensity, Tree Group Density, and Overall Average Density

Table 127. Section E the relationship between treatment intensity, tree group density, and overall average density

Treatment Intensity	Percent of Area		Percent of Treed Area		Average Group basal area (BA) to Achieve Overall BA of:					
	Interspace	Tree	Groups and Individuals	Regeneration	40	50	60	70	80	90
10–25	10	90	90	0		56	67	78	89	100
			85	5		59	71	82	94	
			80	10		63	75	88	100	
			75	15		67	80	93	107	
			70	20		71	86	100	114	
	15	85	85	0		59	71	82	94	106
			80	5		63	75	88	100	
			75	10		67	80	93	107	
			70	15		71	86	100	114	
			65	20		77	92	108	123	
	20	80	80	0		63	75	88	100	113
			75	5		67	80	93	107	
			70	10		71	86	100	114	
			65	15		77	92	108	123	
			60	20		83	100	117	133	
25–40	25	75	75	0		67	80	93	107	120
			70	5		71	86	100	114	
			65	10		77	92	108	123	
			60	15		83	100	117	133	
			55	20		91	109	127	145	
	30	70	70	0		71	86	100	114	129
			65	5		77	92	108	123	
			60	10		83	100	117	133	
			55	15		91	109	127	145	
			50	20		100	120	140	160	
	35	65	65	0		77	92	108	123	138
			60	5		83	100	117	133	
			55	10		91	109	127	145	
			50	15		100	120	140	160	
			45	20		111	133	156	178	
40–55	40	60	60	0	67	83	100	117	133	150
			55	5	73	91	109	127	145	

Treatment Intensity	Percent of Area		Percent of Treed Area		Average Group basal area (BA) to Achieve Overall BA of:					
	Interspace	Tree	Groups and Individuals	Regeneration	40	50	60	70	80	90
			50	10	80	100	120	140	160	
			45	15	89	111	133	156	178	
			40	20	100	125	150	175	200	
	45	55	55	0	73	91	109	127	145	164
			50	5	80	100	120	140	160	
			45	10	89	111	133	156	178	
			40	15	100	125	150	175	200	
			35	20	114	143	171	200	229	
	50	50	50	0	80	100	120	140	160	180
			45	5	89	111	133	156	178	
			40	10	100	125	150	175	200	
			35	15	114	143	171	200	229	
			30	20	133	167	200	233	267	
55–70	55	45	45	0	89	111	133	156		
			40	5	100	125	150	175		
			35	10	114	143	171	200		
			30	15	133	167	200	233		
			25	20	160	200	240	280		
	60	40	40	0	100	125	150	175		
			35	5	114	143	171	200		
			30	10	133	167	200	233		
			25	15	160	200	240	280		
			20	20	200	250	300	350		
	65	35	35	0	114	143	171	200		
			30	5	133	167	200	233		
			25	10	160	200	240	280		
			20	15	200	250	300	350		
			15	20	267	333	400	467		

BA = basal area

Note: Red fill indicates red stand density index zone for all diameters. Red zone group BA ranges from 125 square feet of basal area for 8 inches quadratic mean diameter to 195 square feet of basal area for 24 inches quadratic mean diameter.

ATTACHMENT 1: POTENTIAL IMPLICATIONS OF 4FRI LARGE/MATURE TREE RETENTION ON CORRIDORS FOR GRASSLAND WILDLIFE

Prepared by S. Rosenstock and J. Gist, Arizona Game and Fish Dept., Region II Habitat Program, 12/15/14

Background

Rapid population growth and associated development have impacted many native wildlife species in Arizona. One landscape-scale consequence of those changes is reduction in habitat connectivity for ungulates and other highly mobile terrestrial species. This loss of connectivity can prevent access to important habitat resources, limit gene flow, and ultimately effect population viability and persistence. The American Pronghorn (*Antilocapra americana*) is a species for which connectivity is of primary importance and whose habitats in northern Arizona have been adversely impacted by a variety of factors, including encroachment of woody vegetation into mid-elevation grasslands and meadows/openings within the ponderosa pine cover type.

Historically, pronghorn maintained genetic connectivity from the South Rim of the Grand Canyon to the Prescott Valley. Today, a combination of roads, impermeable fences, encroached meadows and forests, and other barriers impede their seasonal migrations and daily movements. The Arizona Game and Fish Department (Department) has aggressively pursued partnership efforts to reconnect pronghorn populations across Northern Arizona. These include cooperative studies with the Arizona Department of Transportation and Federal Highways Administration to identify animal movements, and use these data to facilitate safe crossing of transportation corridors while protecting human safety. The Department is also working with private landowners and public lands managers to retrofit fences for passage by pronghorn and other wildlife. As a cooperating agency for the 4FRI EIS, the Department worked closely with the ID Team to identify places where treatments could be strategically placed to benefit pronghorn and other grassland species. These included savannah/grassland restoration areas and movement corridors located within forested areas. The latter were identified through a multi-stakeholder, collaborative connectivity assessment for Coconino County (Arizona Game and Fish Department. 2011. The Coconino County Wildlife Connectivity Assessment: Report on Stakeholder Input).

Treatment elements intended to benefit grassland species were vetted through the 4FRI stakeholder group and included in the initial treatment design (DEIS). Unfortunately, the selected Alternative C did not carry these forward in full. Approximately 9,800 acres of stands targeted for retention of mature/old-growth and large, young trees (VSS 4-6) and higher levels of canopy cover fall within grassland species movement corridors identified in the 2011 connectivity assessment (Figure 1). Within those stands, the Department has identified approximately 2,500 acres that represent potential high-priority areas for creation or enhancement of connectivity for pronghorn and other open-canopy species. Examples of such areas are given in Figures 2-3.

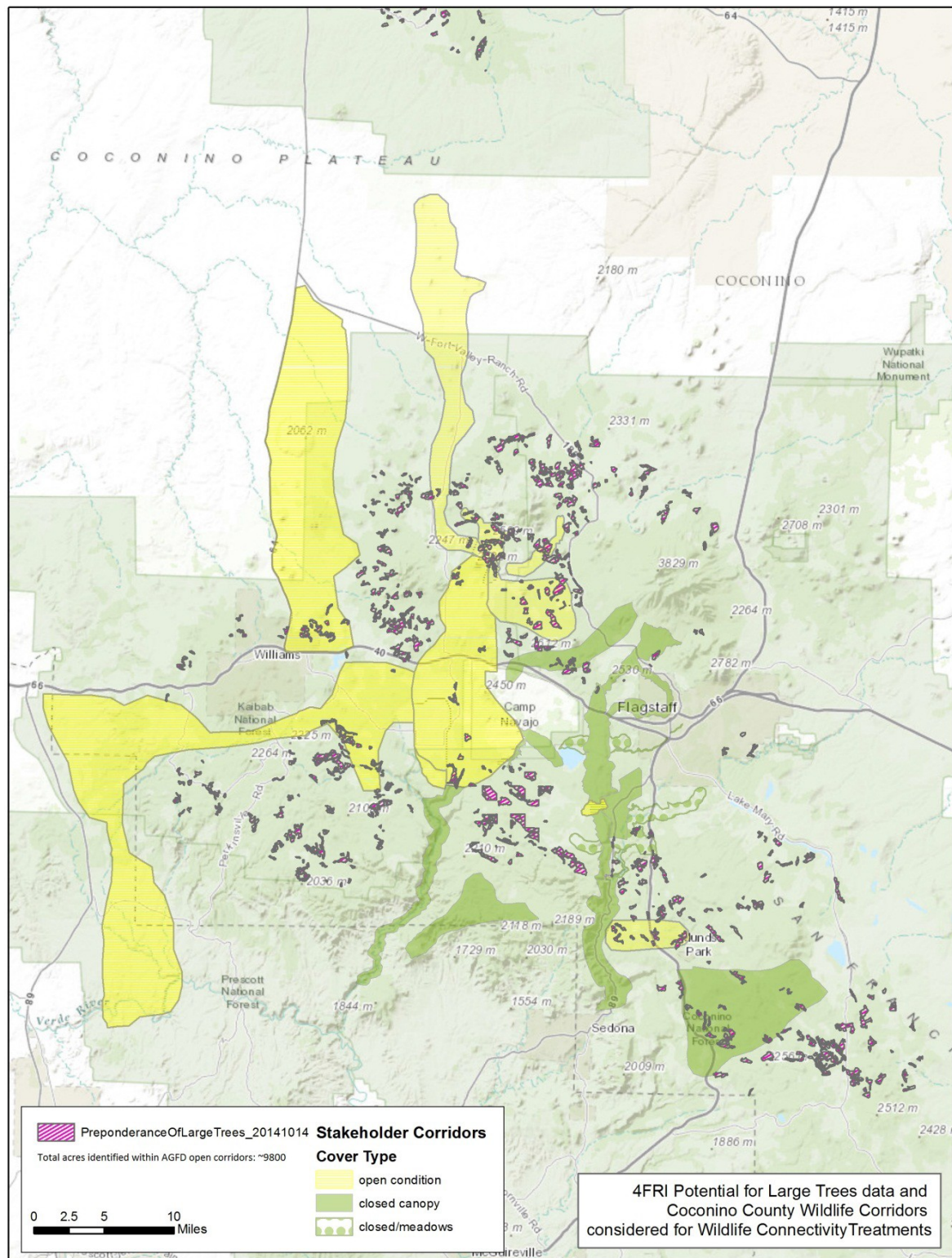


Figure 1. Locations of wildlife movement corridors and VSS 4,5,6 retention stands located therein

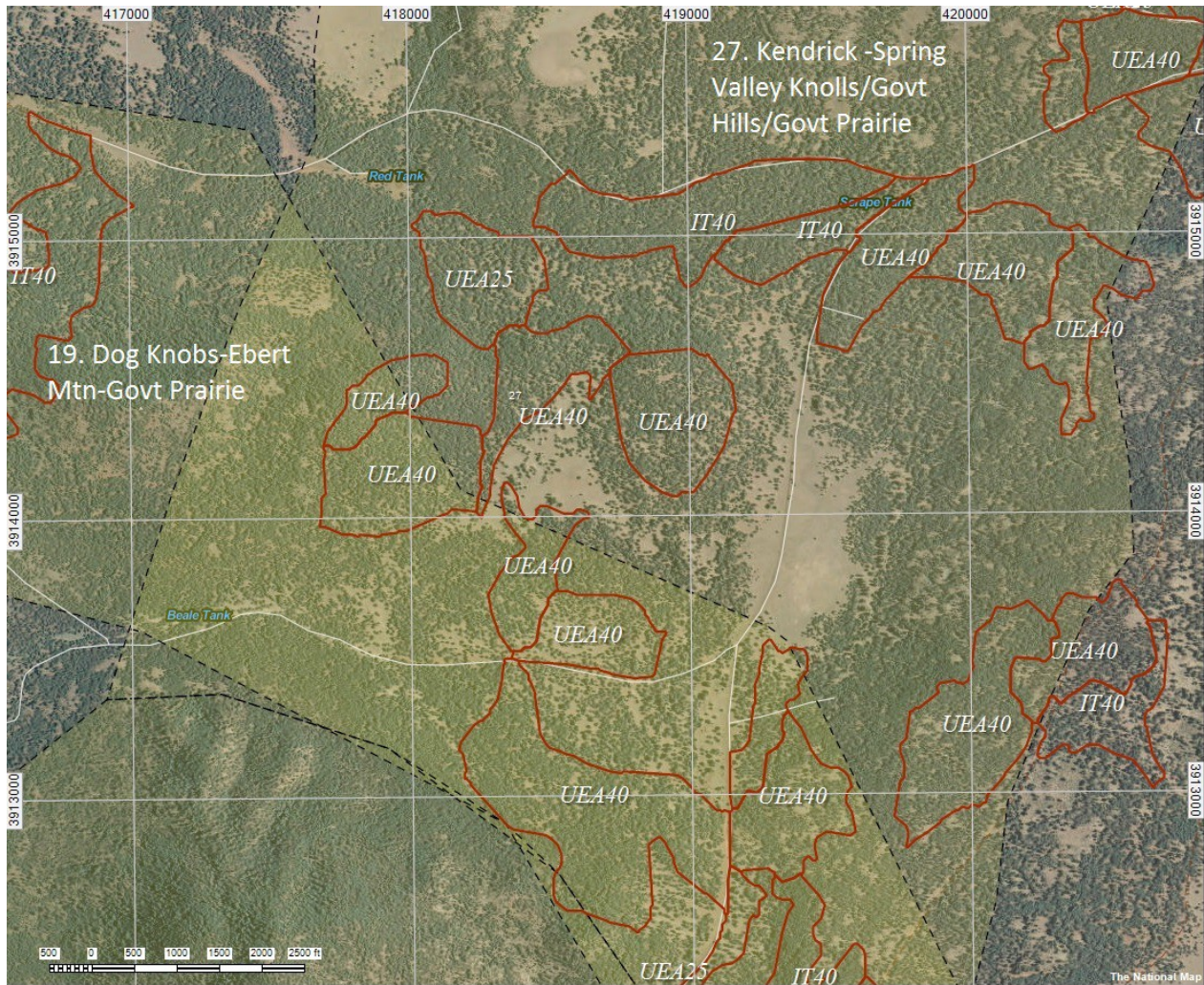


Figure 2. Current satellite imagery showing example grassland wildlife corridors (within dashed lines) that are blocked by large/mature tree retention stands (orange polygons, labeled by treatment type)

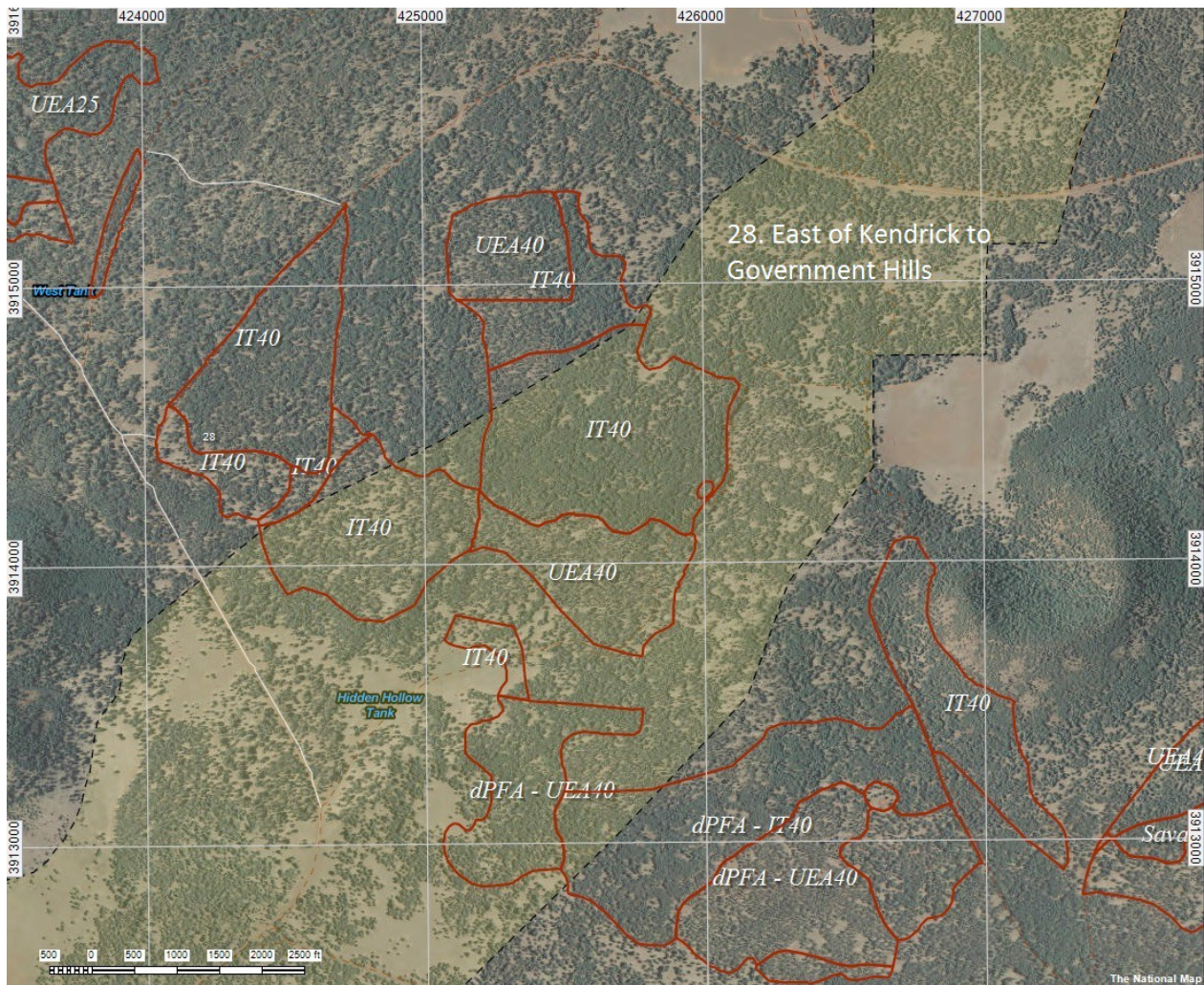


Figure 3. Current satellite imagery showing example grassland wildlife corridors (within dashed lines) that are blocked by large/mature tree retention stands (orange polygons, labeled by treatment type)

We are concerned that strict implementation of the Alternative C treatment design will compromise our ability to meet important conservation objectives for grassland wildlife and miss opportunities to leverage work being done under 4FRI. Where large tree retention objectives overlap with identified grassland-species movement corridors, we recommend adding language to the ROD and Implementation Plan that provide flexibility for more intense mechanical treatment under limited and clearly defined circumstances. This would allow removal of conifers from encroached meadows, restoration and connection of forest openings, and creation of travel corridors through stands with high tree densities. Our expectation is that few, if any of these modifications would impact stands composed of mature or old-growth trees, instead falling into those with a preponderance of large, young trees. It's important to note that delineation of retention stands was based on USFS stand exam data, which are relatively coarse with respect to the scale at which mechanical treatment would be used to create/modify movement corridors.

Actual conditions on the ground may differ, thus the actual number of acres affected could be lower. During implementation, corridor treatments will be informed by existing and future data on pronghorn movements, including that obtained from pronghorn recently capture and collared by the Department.

Suggested Modifications

We suggest the following potential additions (in red) to support restoration and enhancement of grassland wildlife corridors through mechanical treatments implemented during 4FRI.(DROD, pp. 21-22)

In addition, the implementation plan (FEIS, appendix D) now emphasizes that when outside of the wildland-urban interface, restoration treatments in goshawk habitat (approximately 38,260 acres) will focus on the removal of small-diameter trees and will emphasize retaining large trees where applicable to move toward deficit stand structure. This will be accomplished by placing an emphasis on creating regeneration openings and interspace in areas where smaller VSS 3 and VSS 4 trees dominate. The placement of tree groups to be retained will focus on areas where the largest trees are already aggregated. These groups will generally range between 0.25 and 1 acre in size. This will result in stands being composed of groups of larger trees intermixed with relatively small openings. In stands with a preponderance of large young trees the treatment intensity will be managed to the lower end of the available spectrum. Management in these stands still recognizes the need to create regeneration openings to be able to promote uneven- aged stand conditions.

The selected alternative also recognizes that, within the savanna treatment acres, there are some stands that contain a preponderance of large, young trees. On the 3,300 acres where this occurs, we have decided to use the treatments proposed in alternative E that will retain large trees and not implement savanna treatments on these acres.

Within the above areas, there would be limited exceptions for more intensive mechanical treatment in areas previously identified as corridors for grassland wildlife (AGFD 2011), that would not exceed approximately 2,500 acres across the entire analysis area. Old growth trees would not be cut under this exception.

(FEIS Appendix D – Alternatives B through E Implementation Plan)

Landscapes Outside of Goshawk Post-fledging Areas, WUI55, UEA40, UEA25 and UEA10 Mechanical Thin and Burn Treatments Design

On approximately 23,500 acres (about 12,200 acres on the Coconino and 11,300 acres on the Kaibab NF, respectively) of uneven-aged (UEA) 40 and UEA 25 non- wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean trees per acre

less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. Residual stand structure would be managed at the upper end of natural

range of variability for ponderosa pine in the non- wildland-urban interface stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and is intended to achieve 40 percent canopy cover at the stand scale (alternative C and E only). Limited exceptions could occur on areas identified as potential movement corridors for pronghorn and other grassland wildlife species (see AGFD 2011). In those areas, more intensive mechanical thinning of non-old-growth trees and lower levels of residual canopy cover would be allowed. These would be of limited spatial extent and intended to restore natural openings, increase connectivity between natural openings, and facilitate animal movement through treed areas.

Landscapes Outside of Goshawk Post-fledging Areas Intermediate Thin (IT) 40, 25, and 10 Mechanical Thin and Burn Treatments Design

On approximately 11,600 acres (about 8,900 acres on the Coconino and 2,700 acres on the Kaibab NF, respectively) of IT 40 and IT 25 non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean trees per acre less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non- wildland-urban interface stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and is intended to achieve 40 percent canopy cover at the stand scale (alternative C and E only). Limited exceptions could occur on areas identified as potential movement corridors for pronghorn and other grassland wildlife species (see AGFD 2011). In those areas, more intensive mechanical thinning of non-old-growth trees and lower levels of residual canopy cover would be allowed. These would be of limited spatial extent and intended to restore natural openings, increase connectivity between natural openings, and facilitate animal movement through treed areas.

Savanna/Grassland Restoration Mechanical and Burn Treatments Design

In alternatives B-D only, restore pre-settlement tree density and pattern using pre-settlement evidence as guidance. Manage for an open reference condition with 10 to 30 percent of the area under ponderosa pine and deciduous tree crowns (see forest plan consistency evaluation in silviculture report). Manage for the sustainability of identified wildlife corridors for grassland species (see AGFD 2011) by treating these areas to the higher end of percent in interspaces or to a lower ratio of leave tree to evidence ratio.

Dispersal Post-fledging Family Areas / Post-fledging Family Areas in Uneven-aged Treatment (UEA) Types 40, 25, and 10 Mechanical Thin and Burn Treatments Design

On approximately 2,000 acres (about 700 acres on the Coconino and 1,300 acres on the Kaibab) of dispersal post-fledging family area UEA 25, dispersal post-fledging family area UEA 40, post-fledging family area UEA 25 and post-fledging family area UEA 40 non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean trees per acre less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-wildland-urban interface stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and is intended to achieve for mid-aged forest (VSS 4) on average 1/3 60+ percent and 2/3 50+ percent and for mature (VSS 5) and old forest (VSS 6) should average 50+ percent canopy cover at the stand scale (alternative C and E only). Limited exceptions could occur on areas identified as potential movement corridors for pronghorn and other grassland wildlife species (see AGFD 2011). In those areas, more intensive mechanical thinning of non-old-growth trees and lower levels of residual canopy cover would be allowed. These would be of limited spatial extent and intended to restore natural openings, increase connectivity between natural openings, and facilitate animal movement through treed areas.

Dispersal Post-fledging Family Areas / Post-fledging Family Areas Intermediate Thin (IT)40, 25 and 10 Mechanical Thin and Burn Treatments Design

On approximately 1,100 acres (about 900 acres on the Coconino and 200 acres on the Kaibab) of dispersal post-fledging family areas IT 25, dispersal post-fledging family areas IT 40, post-fledging family areas IT 25 and post-fledging family areas IT 40 stands that are not wildland-urban interface with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean trees per acre less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-wildland-urban interface stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and is intended to achieve for mid-aged forest (VSS 4) on average 1/3 60+ percent and 2/3 50+ percent and for mature (VSS 5) and old forest (VSS 6) should average 50+ percent canopy cover at the stand scale (alternative C and E only). Limited exceptions could occur on areas identified as potential movement corridors for pronghorn and other grassland wildlife species (see AGFD 2011). In those areas, more intensive mechanical thinning of non-old-growth trees and lower levels of residual canopy cover would be allowed. These would be of limited spatial extent and intended to restore natural openings, increase connectivity between natural openings, and facilitate animal movement through treed areas.

Dispersal Post-fledging Family Areas / Post-fledging Family Areas Stand Improvement (SI)40, 25, and 10 Mechanical Thin and Burn Treatments Design

On approximately 37 acres (about 37 acres on the Coconino) of post-fledging family area SI 25 non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean trees per acre less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-wildland-urban interface stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and is intended to achieve for mid-aged forest (VSS 4) on average 1/3 60+ percent and 2/3 50+ percent and for mature (VSS 5) and old forest (VSS 6) should average 50+ percent canopy cover at the stand scale (alternative C and E only). Limited exceptions could occur on areas identified as potential movement corridors for pronghorn and other grassland wildlife species (see AGFD 2011). In those areas, more intensive mechanical thinning of non-old-growth trees and lower levels of residual canopy cover would be allowed. These would be of limited spatial extent and intended to restore natural openings, increase connectivity between natural openings, and facilitate animal movement through treed areas.

Dispersal Post-fledging Family Areas / Post-fledging Family Areas Pine Sage Mechanical and Burn Treatment Design

On approximately 87 acres (about 87 acres on the Kaibab NF) of post-fledging family areas pine sage non-wildland-urban interface stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean basal area greater than 70 of the VSS4 size class and a mean trees per acre less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-wildland-urban interface stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes (see below), and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed 40 percent, measured at the stand scale (alternative C and E only). Limited exceptions could occur on areas identified as potential movement corridors for pronghorn and other grassland wildlife species (see AGFD 2011). In those areas, more intensive mechanical thinning of non-old-growth trees and lower levels of residual canopy cover would be allowed. These would be of limited spatial extent and intended to restore natural openings, increase connectivity between natural openings, and facilitate animal movement through treed areas.

Appendix B – 2014 Kaibab National Forests Land Management Plan: Project Consistency Check

Four Forest Restoration Initiative Plan Consistency Check for the 2014 Kaibab National Forest Land Management Plan: Silviculture

Included in this Forest Plan consistency check (Table 131) are only those Desired Conditions, Standards and Guidelines applicable to the Silviculture for the Four Forest Restoration Initiative (4FRI or project). All other Forest-wide and Management Area Desired Conditions, Standards and Guidelines not included here beyond the scope of this project, or not applicable to the project location and activities. Due to the timing of the 4FRI DEIS (December 2012) and the revised Kaibab Forest Plan (April 2014) analysis metrics and methodology for the FEIS have not changed. Some language in the analysis, (e.g., VSS, scales of analysis, metrics, 2012 MSO recovery plan, etc.) is shown to be consistent with the revised 2014 Kaibab forest plan in this check.

Vegetative Structural Stages

Vegetative Structural Stage (VSS) is used to determine separate age classes of forested areas. The revised Kaibab plan does not use VSS but has a consistent desired condition theme to sustain Uneven-aged forests. The use of VSS as a metric for the project analysis remains constant with the revised forest plan for the following reasons: allows for detailed analysis of Uneven-aged forest, provides a quantitative tool to demonstrate effects and maintains consistency with the project analysis. The use of VSS does not violate the desired conditions, standards and guidelines in the revised Kaibab Forest plan.

Mexican Spotted Owl

A crosswalk between the 1995 and 2012 MSO Recovery Plans can be found in an Appendix of the Wildlife Report. The metrics used for analysis of MSO habitat remains relevant due to the project time line and in accordance to the revised MSO Recovery Plan (November 2012) and due to the Coconino remaining to operate under the 1996 Region Wide Forest Plan Amendment which consist of previous recovery plan metrics. With the Wildlife report demonstrating consistency between the two recovery plan's metrics the analysis remain the same from the DEIS.

Scales of Analysis

The project analysis completed 4 scales of analysis for Vegetation. This analysis is constant with the Kaibab forest plan desired condition scales (fine-scale, mid-scale and the landscape scale) based on that the scales are within the intent. The pre-treatment and post-treatment distribution of habitat structure within goshawk habitat evaluated at four scales: ponderosa pine extent, restoration unit, restoration subunit, and strata (groups of like stands with like treatments). A fine-scale is also meeting the desired conditions through the implementation guide. This takes into account activities at the stand level down to the group level (< 1 acre in size).

Terminology

The silviculture specialist report utilizes terminology consistent with the 2012 4FRI DEIS. The following table shows project consistency to the forest plan desired conditions, standards and guidelines.

Table 128. Project Consistency to the Forest Plan Desired Conditions, Standards and Guidelines

Forest Plan Direction	Project Consistency with Forest Plan
Kaibab Desired Conditions Common to All Pinyon-juniper Communities 1. Pinyon-juniper communities occur as a shifting mosaic interspersed with openings across the landscape. The configuration of vegetation and openings provides foraging and browsing opportunities for wildlife, and enough sighting distance and hiding cover for pronghorn to escape predators. (KFP, Page 12) 2. Old growth occurs throughout the landscape, generally in small areas as individual components, or as clumps. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality). (KFP, Page 12) 3. At the mid-scale and above, canopy cover is at least 10 percent with a mix of young and mature groups and clumps of trees. (KFP, Page 12) 4. The mature groups of trees are structurally diverse, containing large live trees, as well as trees with dead or broken tops, gnarls, and burls. Snags, green snags, and downed trees > 10" at root collar are present and average 1 to 2 per acre. Some tree groups have 30 to 40 percent canopy cover that provides habitat for nesting, bedding, and foraging. (KFP, Page 12) 5. The composition, structure, and function of vegetative conditions are resilient to the frequency, extent, and severity of disturbances (e.g. insects, diseases, and fire) and climate variability. (KFP, Page 12) 6. Nurse trees provide understory microclimate with improved nutrient and soil properties, higher soil moisture, lower temperatures, and lower light levels,	The Revised Kaibab Forest Land Management Plan is consistent with the 4FRI project based on the following justification: 1. While all treatments with the exception of Grassland Restoration are designed to reestablish forest openings and attain a mosaic of interspaces and tree groups of varying sizes and shapes, the intensity of the treatment affects the relative tendency toward this condition. This applies to all action alternatives. (also see # 9) 2. The analysis demonstrated the distribution of existing and developing old growth throughout the analysis area at four scales. This applies to all action alternatives. (also see # 9) 3. Canopy cover for forested areas in the analysis is based on an algorithmic regression to basal area density. Canopy cover in all alternatives does not go below 10 percent. Openness is also analyzed as a percentage of the forested area that is grass-forb-shrub interspace. Openness does not go below 10 percent. This applies for mid-scale to above and to all action alternatives. 4. Treatments would not preclude for these Pinyon-juniper components to exist naturally. These desired conditions would be maintained. The implementation guide states that snags would be managed for one per acre over 75 percent of the area and CWD would be managed for an after treatment average of 1 to 3 tons per acre. Where available, a portion of the CWD would include two logs ≥10 inches and ≥10 feet in length. This applies to all action alternatives. 5. It is a project desired condition for a variety of forest conditions (composition, structure and pattern) exists across the landscape, comparable to historic conditions. Forest conditions are resilient to disturbance (insects, disease, fire, climate change) and sustainable through at least several generations of trees. This applies to all action alternatives. 6. Treatments would not preclude for these Pinyon-juniper components to exist naturally. These desired conditions would be maintained. This applies to all

which increases the survival of pinyon seedlings under harsh conditions. (KFP, Page 12) 7. A robust crop of pinyon pine nuts is regularly produced. (KFP, Page 12) Desired Conditions for Pinyon-juniper Woodlands 8. Even-aged patches of pinyons and junipers that at the landscape level form Uneven-aged woodlands characterize pinyon-juniper woodland (persistent). Tree density and canopy cover are high, shrubs are sparse to moderate, and herbaceous cover is low and discontinuous due to soil and other site conditions. (KFP, Page 14) 9. Some very old trees (>300-years old) are present. (KFP, Page 14) 10. Disturbances rarely affect the composition, structure, and function. Insects, disease, and mistletoe occur at endemic levels. Fire disturbance is infrequent and variable due to lack of continuous ground cover. (KFP, Page 14) 11. Fires are mixed to high severity, but generally stand replacing, occurring infrequently at intervals of 200 years or more (Fire Regime V). (KFP, Page 14) Guidelines for Management Activities in Pinyon-juniper Communities	action alternatives. 7. Treatments would not preclude for these Pinyon-juniper components to exist naturally. These desired conditions would be maintained. This applies to all action alternatives. 8. Uneven-age thinning would be used to establish interspace between tree groups and thin tree groups within LOPFA PJ sites. One to three groups would be retained per acre containing approximately 5 to 30 trees each (averaging 30 to 60 trees per acre across the site). Groups would be formed around existing concentrations of large, mature trees. Healthy, young, free-to-grow trees within groups would be retained where possible. (Implementation Plan). This applies to all action alternatives. 9. Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments would follow the Old Tree Implementation Strategy and old trees would not be targeted for cutting. Live conifer trees with existing cavities and dead tops would also be favored for retention (Implementation Plan). This applies to all action alternatives. 10. Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height, reducing litter/duff cover, and producing effects that stimulate regeneration and growth of native herbaceous vegetation. Prescribed fires are designed to maintain and enhance desired LOPFA PJ WUI forest structure, tree densities, snag densities, and CWD levels. (Implementation Plan). This applies to all action alternatives 11. Treatments would not preclude for these Pinyon-juniper components to exist naturally. This project does not propose this desired condition. These desired conditions would be maintained for the future. This applies to all action alternatives. 12. This was completed during the NEPA analysis for

12. The pinyon-juniper vegetation communities (pinyon-juniper grassland, shrubland, or woodland) should be determined before developing project proposals to ensure the applicable desired conditions are applied. (KFP, page 15) 13. Restoration efforts should emphasize the retention of groups of mature trees where they occurred historically. (KFP, page 15) 14. Where pinyon-juniper obligate species occur (e.g. gray vireo), project design should retain key habitat features including snags, and partially dead or dying trees, and downed logs. (KFP, page 15) 15. Pinyon-juniper communities should maintain tree densities that maximize herbaceous plant growth and wildlife species diversity typical for their respective community subtype. (KFP, page 15) 16. Project design for vegetation management activities should prioritize analysis areas along known wildlife corridors, in the wildland-urban interface, and in historic openings. (KFP, page 15) 17. Restoration treatments in pinyon-juniper should be rotated over time and various successional stages to maximize wildlife habitat and diversity. (KFP, page 15) Desired Conditions for Ponderosa Pine Fine-scale (10 acres or less) 18. Trees typically occur in irregularly shaped groups and are variably spaced with some tight clumps. Trees within groups are of similar or variable ages and may contain species other than ponderosa pine. (KFP, Page 17)	4FRI within GIS for all forest communities. This applies to all action alternatives 13. The implementation guide for pinyon-juniper treatments emphasizes to, “Retain one to three groups per acre containing approximately 5 to 30 trees each (averaging 30 to 60 trees per acre across the site). Form groups around existing concentrations of large, mature trees. Retain additional healthy, young, free-to-grow trees within groups where possible. This applies to all action alternatives. 14. Treatments would not preclude for these pinyon-juniper components to exist naturally. These desired conditions would be maintained. The implementation guide states that snags would be managed for one per acre over 75 percent of the area and CWD would be managed for an after treatment average of 1 to 3 tons per acre. Where available, a portion of the CWD would include two logs ≥ 10 inches and ≥ 10 feet in length. This applies to all action alternatives. 15. Based on the implementation guide, the structure and composition would reflect the natural range of variability. This would qualify as managing the diversity within the respective community type. This applies to all action alternatives. 16. Project design and treatments were developed based on these three priorities. This applies to all action alternatives. 17. The project incorporated one entry of restoration treatments. Thinning beyond the intent of this project is out of the scope. See #8 which describes Uneven-aged management. This applies to all action alternatives. 18. A desired condition, within the project, is to re-establish non-forested openings that have been invaded by ponderosa pine since fire exclusion and reconfigure the forests toward their natural spatial pattern. At the fine scale, groups of trees would typically range from

19. Tree groups are made up of clumps of various age classes and size classes that typically occur in areas less than one acre, but may be larger, such as on north-facing slopes. (KFP, Page 17) 20. Crowns of trees within the mid-aged to old groups are interlocking or nearly interlocking and consist of approximately 2 to 40 trees per group. (KFP, Page 17) 21. The interspaces between groups are variably shaped, are comprised of a native grass/forb/shrub mix, and may contain individual trees or snags. Regeneration openings occur as a mosaic and are similar in size to nearby groups. (KFP, Page 17) 22. Organic ground cover and herbaceous vegetation provide protection for soil and moisture infiltration, and contribute to plant and animal diversity and ecosystem function. Herbaceous vegetation reflects the site potential. (KFP, Page 17) 23. Where historically occurring, Gambel oak thickets with various diameter stems and low growing, shrubby oak are present. These thickets provide forage, cover, and habitat for species that depend on them such as small mammals, foliage nesting birds, deer, and elk. Gambel oak mast (acorns) provides food for wildlife species. Large tree form oaks, snags, and partial snags with hollow boles or limbs are	0.1 acre to 1.0 acre in size. This applies to all action alternatives. 19. The project does not directly specifically/prescriptively state this desired condition. Indirectly the project meets this desired condition through reconfiguring the forests toward their natural spatial pattern (see #18) and being within the natural range of variability This applies to all action alternatives. 20. Groups of trees within the project will vary due to the variety of habitats (i.e. Old Growth, Goshawk and MSO). Mid-age to old groups of trees can be related to the VSS 4-6 classification in the project. Some of the trees per group, primarily at the larger groups, exceed the 40 trees but move within the plan's desired trees per group as they become older. This makes it constant with the plan. This applies to all action alternatives. 21. According to the Silviculture specialist report, the term openness was used in the analysis to convey the percentage of the forested area that is grass-forb-shrub interspace. Regeneration areas , depending on objectives, are designed into areas needing or not needing additional age classes at this time. Regeneration openings and interspaces for the project are consistent with the plan. This applies to all action alternatives. 22. Project design and treatments were developed based on these Region 3 plant association habitat typing. This applies to all action alternatives. 23. Oak will not be prescribed for removal in this project. Desired conditions for oak in the project would support and move toward the plan's desired condition. This applies to all action alternatives.

present. (KFP, Page 17)

24. Where Gambel oak comprises more than 10 percent of the basal area, it is not uncommon for canopy cover to be greater than 40 percent. (KFP, Page 17)
25. Isolated infections of Southwestern dwarf mistletoe may occur, but the degree of severity and amount of mortality varies among the infected trees. Witches' brooms may form on infected trees, providing habitat and food for wildlife and invertebrate species. (KFP, Page 17)
26. Fires generally burn as surface fires, but single-tree torching and isolated group torching is not uncommon. (KFP, Page 17)

Desired Conditions for Ponderosa Pine Mid-scale (100 to 1,000 acres)

27. The ponderosa pine forest vegetation community is characterized by variation in the size and number of tree groups depending on elevation, soil type, aspect, and site productivity. The mosaic of tree groups generally comprises an Uneven-aged forest with all age classes and structural stages present. Stands are dominated by ponderosa pine, but other native hardwood and conifer species occur. The more biologically productive sites contain more trees per group and more groups per area. (KFP, Page 17)
28. Basal area within forested areas generally ranges from 20 to 80 square feet per acre, with larger trees (i.e. >18 inches in diameter) contributing the greatest percent of the total basal area. (KFP, Page 17)
29. Interspaces with native grass, forb, and shrub vegetation are variably shaped and typically range from 10 to 70 percent, with the more open conditions typically occurring on less productive sites. (KFP, Page 17)

24. See #23

25. Project design and treatments were developed to maintain Southwestern dwarf mistletoe within the natural range of variability. This applies to all action alternatives. The project will meet the plan desired condition for mistletoe.

26. Vegetation prescriptions support these types of burning effects which is within the natural range of variability. This applies to all action alternatives.

27. The project was developed and analyzed based on the characteristics labeled in the plan's desired condition. At the mid-scale the variable habitats create the mosaic of variability. The project maintains or moves toward tree groups to generally comprise an Uneven-aged forest with all age classes and structural stages present within the natural range of variability. This applies to all action alternatives.

28. The project analyzed basal area per habitat at the midscale. The majority of habitats fall within the desired condition ranges or moves toward the desired range. Some MSO habitats (PAC and recovery nest roost) prevent management of stand conditions below 80 square feet of basal area. However, at the midscale level for ponderosa pine fine-scale conditions would dissolve the basal area range within the plan's desired condition. This applies to all action alternatives.

29. The project analyzed openness at the midscale. Open to closed conditions in the project ranged from 70 to 0% interspace. Project design for forested ponderosa pine is within this guideline. Very open conditions 70-90% were grassland restoration treatments, Savanna and areas already in a less dense state. Forested areas in a less dense state are moving toward the desired condition. Grassland & Savanna Treatments typically maintain 30%+ forest cover at the 500 & 1,000 acre scale, but show mixed densities at the 100 acre scale.

30. Forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest (e.g., goshawk post-fledging family areas, Mexican spotted owl nesting/roosting habitat, drainages, and steep north-facing slopes). (KFP, Page 18) 31. Patches of even-aged forest structure are present, but infrequent. Disturbances sustain the overall variation in age and structural distribution. (KFP, Page 18) 32. Snags and green snags 18 inches diameter at breast height (DBH) or greater average 1 to 2 per acre. Snags and green snags of various sizes and forms are common. (KFP, Page 18) 33. Downed logs (greater than 12 inches diameter at mid-point and greater than 8 feet long) average 3 logs per acre. Coarse woody debris greater than 3 inches in diameter (including downed logs), ranges from 3 to 10 tons per acre. (KFP, Page 18) 34. Fires burn primarily on the forest floor and typically do not spread between tree groups as crown fire. (KFP, Page 18) Desired Conditions for Ponderosa Pine Landscape-scale (over 10,000 acres) 35. The ponderosa pine forest vegetation community is a mosaic of forest conditions composed of structural stages ranging from young to old trees. The forest is generally Uneven-aged and open. Groups of old trees are mixed with groups of younger trees. Occasional areas of even-aged structure are present. Denser tree conditions exist in some locations such as north-facing slopes, canyons, and drainage bottoms. (KFP, Page 18)	30. Project design and treatments were developed based on these habitats and abiotic factors. The project is within the guideline. This applies to all action alternatives. 31. See #30 and Treatments would not preclude a variation of age and structural distribution to exist naturally. These desired conditions would be maintained, where appropriate. This applies to all action alternatives. 32. The project analyzed snags 18" DBH at the mid-scale. Certain habitats fall within desired conditions and others are moving toward desired conditions based on the projects desired condition. Treatments would not preclude green snags to exist naturally. This applies to all action alternatives. 33. The project analyzed downed logs 12 inches diameter at mid-point and greater than 8 feet long and coarse woody debris greater than 3 inches at the mid-scale. Certain habitats fall within desired conditions and others are moving toward desired conditions based on the projects desired condition. This applies to all action alternatives. 34. Vegetation prescriptions support these types of burning effects which is within the natural range of variability. This applies to all action alternatives. 35. There would be a mix of very open, open, moderately closed, and closed canopy conditions at the landscape (ponderosa pine vegetation) scale. Moderate-to-closed canopy conditions would be widely distributed on the landscape. Habitat for goshawk and MSO, steep slopes, and buffers for resources such as bald eagle roosts, other raptor nests, caves, and special designations that would not be treated (including wilderness and most research natural areas) provide connectivity with moderate-to-closed canopy conditions. At the landscape scale (extent of ponderosa pine vegetation), openness would range from very open (up to 90

36. The ponderosa pine forest is composed predominantly of vigorous trees, but declining trees are present. Snags, green snags, and coarse woody debris occur across the landscape. (KFP, Page 18) 37. Where it naturally occurs, Gambel oak is present with all structure classes represented. It is reproducing and maintaining or expanding its presence within its natural range. (KFP, Page 18) 38. Old growth 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, snags, coarse woody debris, and structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality). (KFP, Page 18) 39. The landscape is a functioning ecosystem that contains all components, processes, and conditions associated with endemic levels of disturbances (e.g., fire, dwarf mistletoe, insects, diseases, lightning, drought, and wind). (KFP, Page 18) 40. Forest vegetation conditions are resilient to the frequency, extent, and severity of disturbances and climate variability. Grasses and needle cast provide the fine flashy fuels needed to maintain the natural fire regime. Fire and other disturbances are sufficient to maintain desired overall tree density, structure, species composition, coarse woody debris loads, and nutrient cycling. (KFP, Page 18) 41. The risk of uncharacteristic high-severity fire and associated loss of key ecosystem components is low. (KFP, Page 18)	percent) within the savanna and grassland matrix to closed (as low as 10 percent) on the highly productive forest areas to achieve a heterogeneous condition across the landscape. This applies to all action alternatives (FEIS). 36. Treatments would not preclude for these ponderosa pine components to exist naturally. These desired conditions would be maintained and managed toward. This applies to all action alternatives. 37. In most cases oak will not be prescribed for removal in this project. Desired conditions for oak in the project would support and move toward the plan's desired condition and be within the natural range of variability. This applies to all action alternatives. 38. Plan treatments desired condition is for uneven-aged management with at least three age classes and proportional size class representations within the treated stands. Large trees and residual old trees are a defined component of Uneven-aged management. This applies to all action alternatives. 39. Project treatments and desired conditions reflect putting the landscape on an ecological trajectory to be within the natural range of variability. This means structure, species composition, and function would be resistant to and resilient from certain frequent natural disturbances. This applies to all action alternatives. 40. See #39 41. Project treatments desired conditions is to have high canopy overlap within groups, but to separate groups and interlocking canopies with interspace. These interspaces will be for the establishment of grasses, forbs, and brush species. This natural break in fuels (canopy and surface) will decrease the likelihood of uncharacteristically high-severity fire.

42. Frequent, low-severity fires (Fire Regime I) occur across the entire landscape with a return interval of 0 to 35 years. (KFP, Page 18) <i>Desired Conditions for Aspen (General)</i> 43. Aspen stands are characterized by disturbances that may include fire, mechanical treatments, insects, pathogens, and abiotic factors. Collectively, these agents of change promote healthy tree regeneration, decadence, and nutrient cycling. These processes further contribute to high quality wildlife habitat and biodiversity. (KFP, Page 28) 44. Aspen occurs in natural patterns of abundance and distribution at levels similar to or greater than those at time of plan approval. (KFP, Page 28) 45. Aspen is successfully regenerating and recruiting into older and larger size classes. 46. Size classes have a natural distribution, with the greatest number of stems in the smallest classes. (KFP, Page 28) 47. Fire intervals are similar to reference conditions and maintain aspen. (KFP, Page 28) 48. Understory vegetation consists of shrubby or herbaceous species, providing forage and cover for wildlife and habitat for invertebrates such as pollinators. 49. Aspen provides opportunities for scenic enjoyment, recreation, and cultural or spiritual experiences. (KFP, Page 28) Guidelines for Aspen Management 50. Small patch clear-cuts (less than 5 acres in size), conifer removal, and wildland fire should be used to stimulate aspen sprouting in areas that have or previously had aspen. (KFP, page 29)	42. Vegetation prescriptions support these types of fire effects that is within the natural range of variability. This applies to all action alternatives. 43. The project would contribute to high quality wildlife habitat and biodiversity. Treatments would not preclude aspen disturbances to exist naturally. These desired conditions would be maintained. This applies to all action alternatives. 44. The project is consistent with the forest plan. The desired condition for the project is to maintain and/or regenerate aspen. Where possible, there is a need to stimulate growth and increase individual recruitment of aspen. This applies to all action alternatives. 45. See #44 46. The project would move aspen conditions to be within the plan's desired conditions. These desired conditions would be maintained and managed toward their natural range of variation. This applies to all action alternatives. 47. Vegetation prescriptions support these types of burning effects which is within the natural range of variability. This applies to all action alternatives. 48. See #43 49. Aspen restoration is a part of this project. This applies to all action alternatives. 50. The implementation guide for the project states that inclusions of aspen remnants within portions of ponderosa pine stands would be regenerated by removing all post-settlement conifers from within 100 feet of the aspen clone. Some removal of aspen within the clone as well as ground disturbing activity or burning may occur to stimulate suckering. This applies

51. Aspen trees 10 inches or greater DBH (both live and dead) should be protected during project activities, except where they may pose a risk to safety, fences, or regeneration efforts. (KFP, page 29) 52. Fences should be regularly inspected and maintained while aspen recovers. Fences should be removed when no longer needed. (KFP, page 29) Standards for Vegetation Management in All Forested Communities 53. The maximum size opening that may be created in one harvest operation for the purpose of creating an even-aged stand shall not exceed 40 acres except when it is following a large-scale disturbance event such as a stand replacing fire, wind storm, or insect or disease outbreak. (KFP, page 30) 54. When openings are created with the intent of regeneration, effort shall be made to ensure that lands can be adequately restocked within 5 years of final harvest. (KFP, page 30) 55. Clearcutting shall only be used where it is the optimum harvesting method for making progress towards the desired conditions. (KFP, page 30) Guidelines for Vegetation Management in All Forested Communities 56. Projects in forested communities that change stand structure should generally retain at least historic frequencies of trees by species across broad age and diameter classes at the mid-scale. As such, the largest and oldest trees are usually retained. (KFP, page 30) 57. On suitable timberlands, projects should retain somewhat higher frequencies of trees across broad diameter classes to allow for future tree harvest. (KFP, page 30)	to all action alternatives. 51. Protection to residual aspen trees and snags are incorporated in implementation contracts. The exceptions are consistent with the project. This applies to all action alternatives. 52. Fence inspection and maintenance is regular program of work for the Coconino and Kaibab NF. This applies to all action alternatives. 53. There are no treatments in forested communities in the project where regeneration openings would exceed 40 acres in size. This applies to all action alternatives. 54. Project monitoring requirements are in place to ensure that adequately restocked within 5 years. This applies to all action alternatives. 55. Clearcuts are defined as a stand in which essentially all trees have been removed in one operation to regenerate within 5 years. The project does not propose clearcutting. This applies to all action alternatives. 56. The project Implementation Guide and Old Tree Retention Strategy addresses the consistency with guideline. This applies to all action alternatives. 57. The silviculture specialist report demonstrates how project densities are on the higher end of the historic range of variability. Some treatments due to habitat needs go above the historic range of variability but remain in the range of variability to be resilient to disturbances. This applies to all action alternatives.

58. Project design should manage for replacement structural stages to assure continuous representation of old growth over time. (KFP, page 30) 59. Project design and treatment prescriptions should generally not remove: 59a . Large, old ponderosa pine trees with reddish-yellow, wide platy bark, flattened tops, with moderate to full crowns and large drooping or gnarled limbs (e.g. Thomson's age class 4, Dunning's tree class 5 and/or Keen's Tree Class 4, A & B [appendix C]). (KFP, page 30) 59b. Mature trees with large dwarf mistletoe induced witches' brooms suitable for wildlife nesting, caching, and denning, except where retaining such trees would prevent the desired development of Uneven-aged conditions over time. (KFP, page 30) 59c. Large snags, partial snags, and trees (>18 inches DBH) with broken tops, cavities, sloughing bark, lightning scars >4 inches wide, and large stick nests (>18 inches in diameter). (KFP, page 30) 59d. Gambel oak >8 inches, diameter at root collar. (KFP, page 30) 59e. Known bat roost trees. (KFP, page 30) 60. The location and layout of vegetation management activities should effectively disconnect large expanses of continuous predicted active crown fire. (KFP, page 30)	58. The projects desired condition is to maintain an uneven-aged stand structure that incorporates proportional representation of all structural components. The project used the Vegetative Structural Stages 1 through 6 to ensure forest sustainability. This applies to all action alternatives. 59. The implementation guide covers special habitat features. This applies to all action alternatives. 59a. Implementation Guide and Old Tree Retention Strategy ensure this guideline will be met. 59b. See # 59a 59c Snags are not proposed to be felled in this project. Project design and treatment would generally retain trees (>18 inches DBH) with broken tops, cavities, sloughing bark, lightning scars >4 inches wide, and large stick nests (>18 inches in diameter). 59d. Oaks are not proposed to be felled in this project. 59e. Known bat roost trees are not proposed to be felled in this project. 60. The project identifies that there is a need to increase forest resiliency and sustainability, protect soil productivity, and improve soil and watershed function. Resiliency increases the ability of the ponderosa pine forest to survive natural disturbances such as fire, insect and disease, fire, and climate change. The project would bring forest conditions within the natural range of variability therefore reducing the extent of

61. Vegetation management prescriptions should provide for sufficient canopy breaks to limit crown fire spread between groups, allow for the redevelopment and maintenance of a robust understory, and mimic the spatial arrangement of the reference conditions. (KFP, page 30) 62. Vegetation management activities should meet or exceed goals for scenic beauty (scenic integrity objectives) by creating natural patterns, structure and composition of trees, shrubs, grasses, and other plants. (KFP, page 31) 63. Vegetation management should favor the development of native understory species in areas where they have the potential to establish and grow. (KFP, page 31) 64. Even-aged silvicultural practices may be used as a strategy for achieving the desired conditions over the long term, such as bringing dwarf mistletoe infection levels to within a sustainable range, or old tree retention. (KFP, page 31) Guidelines for Restoring Grasslands 65. Prior to implementation of grassland restoration treatments, consideration should be given to making the residual firewood available for personal collection. (KFP, page 32) Desired Conditions for All Grasslands 66. Tree and shrub canopy cover are each less than 10 percent (KFP, Page 36) Desired Conditions for Montane/Subalpine Grasslands 67. Montane and subalpine meadow vegetation has high soil productivity and biological diversity. Native species occur in natural patterns of abundance, composition, and distribution. Vegetation is healthy and at least stable. (KFP, Page 37) 68. Vegetation and litter are sufficient to maintain and improve water infiltration, nutrient cycling, and soil productivity. (KFP, Page 37) Desired Conditions for Colorado Plateau/Great Basin Grasslands	crown fires. This applies to all action alternatives. 61. The project will use groups and interspace treatments and the historic range of variation conditions as a guide. This applies to all action alternatives. See #60 62. Scenic beauty was analyzed in this project against the silviculture treatments. The project is constant with this direction. This applies to all action alternatives. 63. All vegetative cutting within the project would favor the development of native grass/shrub/forb understory by allowing more sunlight and growing space to the forest floor. This applies to all action alternatives. 64. The project would use even-aged treatments to intermediately thin for old and large tree retention. This applies to all action alternatives. 65. The project is consistent in allowing for fuel wood products. This applies to all action alternatives. 66. Grasslands in the project would be restored to the reference condition which would be below ten percent. 67. Montane and subalpine grasslands would have over story trees consistent with the reference condition. 68. See #67

69. Vegetation height and canopy cover are sufficient to carry fire under low wind conditions to support a 10 to 30-year fire return interval. (KFP, Page 38)	69. Vegetation prescriptions support these types of burning effects which is within the natural range of variability. This applies to all action alternatives.
Forest Plan Direction	Project Consistency with Forest Plan
Kaibab Desired Conditions Common to All Pinyon-juniper Communities 70. Pinyon-juniper communities occur as a shifting mosaic interspersed with openings across the landscape. The configuration of vegetation and openings provides foraging and browsing opportunities for wildlife, and enough sighting distance and hiding cover for pronghorn to escape predators. (KFP, Page 12) 71. Old growth occurs throughout the landscape, generally in small areas as individual components, or as clumps. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality). (KFP, Page 12) 72. At the mid-scale and above, canopy cover is at least 10 percent with a mix of young and mature groups and clumps of trees. (KFP, Page 12) 73. The mature groups of trees are structurally diverse, containing large live trees, as well as trees with dead or broken tops, gnarls, and burls. Snags, green snags, and downed trees > 10" at root collar are present and average 1 to 2 per acre. Some tree groups have 30 to 40 percent canopy cover that provides habitat for nesting, bedding, and foraging. (KFP, Page 12) 74. The composition, structure, and function of vegetative conditions are resilient to the frequency, extent, and severity of disturbances (e.g. insects, diseases, and fire) and climate variability. (KFP, Page 12)	The Revised Kaibab Forest Land Management Plan is consistent with the 4FRI project based on the following justification: 70. While all treatments with the exception of Grassland Restoration are designed to reestablish forest openings and attain a mosaic of interspaces and tree groups of varying sizes and shapes, the intensity of the treatment affects the relative tendency toward this condition. This applies to all action alternatives. (also see # 9) 71. The analysis demonstrated the distribution of existing and developing old growth throughout the analysis area at four scales. This applies to all action alternatives. (also see # 9) 72. Canopy cover for forested areas in the analysis is based on an algorithmic regression to basal area density. Canopy cover in all alternatives does not go below 10 percent. Openness is also analyzed as a percentage of the forested area that is grass-forb-shrub interspace. Openness does not go below 10 percent. This applies for mid-scale to above and to all action alternatives. 73. Treatments would not preclude for these Pinyon-juniper components to exist naturally. These desired conditions would be maintained. The implementation guide states that snags would be managed for one per acre over 75 percent of the area and CWD would be managed for an after treatment average of 1 to 3 tons per acre. Where available, a portion of the CWD would include two logs ≥10 inches and ≥10 feet in length. This applies to all action alternatives. 74. It is a project desired condition for a variety of forest conditions (composition, structure and pattern) exists across the landscape, comparable to historic conditions. Forest conditions are resilient to disturbance (insects, disease, fire, climate change) and sustainable through at least several generations of trees. This applies to all action alternatives.

75. Nurse trees provide understory microclimate with improved nutrient and soil properties, higher soil moisture, lower temperatures, and lower light levels, which increases the survival of pinyon seedlings under harsh conditions. (KFP, Page 12) 76. A robust crop of pinyon pine nuts is regularly produced. (KFP, Page 12) Desired Conditions for Pinyon-juniper Woodlands 77. Even-aged patches of pinyons and junipers that at the landscape level form Uneven-aged woodlands characterize pinyon-juniper woodland (persistent). Tree density and canopy cover are high, shrubs are sparse to moderate, and herbaceous cover is low and discontinuous due to soil and other site conditions. (KFP, Page 14) 78. Some very old trees (>300-years old) are present. (KFP, Page 14) 79. Disturbances rarely affect the composition, structure, and function. Insects, disease, and mistletoe occur at endemic levels. Fire disturbance is infrequent and variable due to lack of continuous ground cover. (KFP, Page 14) 80. Fires are mixed to high severity, but generally stand replacing, occurring infrequently at intervals of 200 years or more (Fire Regime V). (KFP, Page 14)	75. Treatments would not preclude for these Pinyon-juniper components to exist naturally. These desired conditions would be maintained. This applies to all action alternatives. 76. Treatments would not preclude for these Pinyon-juniper components to exist naturally. These desired conditions would be maintained. This applies to all action alternatives. 77. Uneven-age thinning would be used to establish interspace between tree groups and thin tree groups within LOPFA PJ sites. One to three groups would be retained per acre containing approximately 5 to 30 trees each (averaging 30 to 60 trees per acre across the site). Groups would be formed around existing concentrations of large, mature trees. Healthy, young, free-to-grow trees within groups would be retained where possible. (Implementation Plan). This applies to all action alternatives. 78. Treatments are designed to manage for old age trees in order to have and sustain as much old forest structure as possible across the landscape. Treatments would follow the Old Tree Implementation Strategy and old trees would not be targeted for cutting. Live conifer trees with existing cavities and dead tops would also be favored for retention (Implementation Plan). This applies to all action alternatives. 79. Prescribed burns may be used to treat fuels and mitigate fuel hazards where and when feasible by increasing tree canopy base height, reducing litter/duff cover, and producing effects that stimulate regeneration and growth of native herbaceous vegetation. Prescribed fires are designed to maintain and enhance desired LOPFA PJ WUI forest structure, tree densities, snag densities, and CWD levels. (Implementation Plan). This applies to all action alternatives 80. Treatments would not preclude for these Pinyon-juniper components to exist naturally. This project

Guidelines for Management Activities in Pinyon-juniper Communities 81. The pinyon-juniper vegetation communities (pinyon-juniper grassland, shrubland, or woodland) should be determined before developing project proposals to ensure the applicable desired conditions are applied. (KFP, page 15) 82. Restoration efforts should emphasize the retention of groups of mature trees where they occurred historically. (KFP, page 15) 83. Where pinyon-juniper obligate species occur (e.g. gray vireo), project design should retain key habitat features including snags, and partially dead or dying trees, and downed logs. (KFP, page 15) 84. Pinyon-juniper communities should maintain tree densities that maximize herbaceous plant growth and wildlife species diversity typical for their respective community subtype. (KFP, page 15) 85. Project design for vegetation management activities should prioritize analysis areas along known wildlife corridors, in the wildland-urban interface, and in historic openings. (KFP, page 15) 86. Restoration treatments in pinyon-juniper should be rotated over time and various successional stages to maximize wildlife habitat and diversity. (KFP, page 15) Desired Conditions for Ponderosa Pine Fine-scale (10 acres or less) 87. Trees typically occur in irregularly shaped groups and are variably spaced with some tight clumps. Trees	does not propose this desired condition. These desired conditions would be maintained for the future. This applies to all action alternatives. 81. This was completed during the NEPA analysis for 4FRI within GIS for all forest communities. This applies to all action alternatives 82. The implementation guide for pinyon-juniper treatments emphasizes to, “Retain one to three groups per acre containing approximately 5 to 30 trees each (averaging 30 to 60 trees per acre across the site). Form groups around existing concentrations of large, mature trees. Retain additional healthy, young, free-to-grow trees within groups where possible. This applies to all action alternatives. 83. Treatments would not preclude for these pinyon-juniper components to exist naturally. These desired conditions would be maintained. The implementation guide states that snags would be managed for one per acre over 75 percent of the area and CWD would be managed for an after treatment average of 1 to 3 tons per acre. Where available, a portion of the CWD would include two logs ≥ 10 inches and ≥ 10 feet in length. This applies to all action alternatives. 84. Based on the implementation guide, the structure and composition would reflect the natural range of variability. This would qualify as managing the diversity within the respective community type. This applies to all action alternatives. 85. Project design and treatments were developed based on these three priorities. This applies to all action alternatives. 86. The project incorporated one entry of restoration treatments. Thinning beyond the intent of this project is out of the scope. See #8 which describes Uneven-aged management. This applies to all action alternatives. 87. A desired condition, within the project, is to re-

within groups are of similar or variable ages and may contain species other than ponderosa pine. (KFP, Page 17) 88. Tree groups are made up of clumps of various age classes and size classes that typically occur in areas less than one acre, but may be larger, such as on north-facing slopes. (KFP, Page 17) 89. Crowns of trees within the mid-aged to old groups are interlocking or nearly interlocking and consist of approximately 2 to 40 trees per group. (KFP, Page 17) 90. The interspaces between groups are variably shaped, are comprised of a native grass/forb/shrub mix, and may contain individual trees or snags. Regeneration openings occur as a mosaic and are similar in size to nearby groups. (KFP, Page 17) 91. Organic ground cover and herbaceous vegetation provide protection for soil and moisture infiltration, and contribute to plant and animal diversity and ecosystem function. Herbaceous vegetation reflects the site potential. (KFP, Page 17) 92. Where historically occurring, Gambel oak thickets with various diameter stems and low growing, shrubby oak are present. These thickets provide forage, cover, and habitat for species that depend on them such as small mammals, foliage nesting birds,	establish non-forested openings that have been invaded by ponderosa pine since fire exclusion and reconfigure the forests toward their natural spatial pattern. At the fine scale, groups of trees would typically range from 0.1 acre to 1.0 acre in size. This applies to all action alternatives. 88. The project does not directly specifically/prescriptively state this desired condition. Indirectly the project meets this desired condition through reconfiguring the forests toward their natural spatial pattern (see #18) and being within the natural range of variability This applies to all action alternatives. 89. Groups of trees within the project will vary due to the variety of habitats (i.e. Old Growth, Goshawk and MSO). Mid-age to old groups of trees can be related to the VSS 4-6 classification in the project. Some of the trees per group, primarily at the larger groups, exceed the 40 trees but move within the plan's desired trees per group as they become older. This makes it constant with the plan. This applies to all action alternatives. 90. According to the Silviculture specialist report, the term openness was used in the analysis to convey the percentage of the forested area that is grass-forb-shrub interspace. Regeneration areas , depending on objectives, are designed into areas needing or not needing additional age classes at this time. Regeneration openings and interspaces for the project are consistent with the plan. This applies to all action alternatives. 91. Project design and treatments were developed based on these Region 3 plant association habitat typing. This applies to all action alternatives. 92. Oak will not be prescribed for removal in this project. Desired conditions for oak in the project would support and move toward the plan's desired condition. This

deer, and elk. Gambel oak mast (acorns) provides food for wildlife species. Large tree form oaks, snags, and partial snags with hollow boles or limbs are present. (KFP, Page 17) 93. Where Gambel oak comprises more than 10 percent of the basal area, it is not uncommon for canopy cover to be greater than 40 percent. (KFP, Page 17) 94. Isolated infections of Southwestern dwarf mistletoe may occur, but the degree of severity and amount of mortality varies among the infected trees. Witches' brooms may form on infected trees, providing habitat and food for wildlife and invertebrate species. (KFP, Page 17) 95. Fires generally burn as surface fires, but single-tree torching and isolated group torching is not uncommon. (KFP, Page 17) Desired Conditions for Ponderosa Pine Mid-scale (100 to 1,000 acres) 96. The ponderosa pine forest vegetation community is characterized by variation in the size and number of tree groups depending on elevation, soil type, aspect, and site productivity. The mosaic of tree groups generally comprises an Uneven-aged forest with all age classes and structural stages present. Stands are dominated by ponderosa pine, but other native hardwood and conifer species occur. The more biologically productive sites contain more trees per group and more groups per area. (KFP, Page 17) 97. Basal area within forested areas generally ranges from 20 to 80 square feet per acre, with larger trees (i.e. >18 inches in diameter) contributing the greatest percent of the total basal area. (KFP, Page 17) 98. Interspaces with native grass, forb, and shrub vegetation are variably shaped and typically range from 10 to 70 percent, with the more open conditions typically occurring on less productive sites. (KFP, Page 17)	applies to all action alternatives. 93. See #23 94. Project design and treatments were developed to maintain Southwestern dwarf mistletoe within the natural range of variability. This applies to all action alternatives. The project will meet the plan desired condition for mistletoe. 95. Vegetation prescriptions support these types of burning effects which is within the natural range of variability. This applies to all action alternatives. 96. The project was developed and analyzed based on the characteristics labeled in the plan's desired condition. At the mid-scale the variable habitats create the mosaic of variability. The project maintains or moves toward tree groups to generally comprise an Uneven-aged forest with all age classes and structural stages present within the natural range of variability. This applies to all action alternatives. 97. The project analyzed basal area per habitat at the midscale. The majority of habitats fall within the desired condition ranges or moves toward the desired range. Some MSO habitats (PAC and recovery nest roost) prevent management of stand conditions below 80 square feet of basal area. However, at the midscale level for ponderosa pine fine-scale conditions would dissolve the basal area range within the plan's desired condition. This applies to all action alternatives. 98. The project analyzed openness at the midscale. Open to closed conditions in the project ranged from 70 to 0% interspace. Project design for forested ponderosa pine is within this guideline. Very open conditions 70-90% were grassland restoration treatments, Savanna and areas already in a less dense state. Forested areas in a less dense state are moving toward the desired condition. Grassland & Savanna

99. Forest conditions in some areas contain 10 to 20 percent higher basal area in mid-aged to old tree groups than in the general forest (e.g., goshawk post-fledging family areas, Mexican spotted owl nesting/roosting habitat, drainages, and steep north-facing slopes). (KFP, Page 18) 100. Patches of even-aged forest structure are present, but infrequent. Disturbances sustain the overall variation in age and structural distribution. (KFP, Page 18) 101. Snags and green snags 18 inches diameter at breast height (DBH) or greater average 1 to 2 per acre. Snags and green snags of various sizes and forms are common. (KFP, Page 18) 102. Downed logs (greater than 12 inches diameter at mid-point and greater than 8 feet long) average 3 logs per acre. Coarse woody debris greater than 3 inches in diameter (including downed logs), ranges from 3 to 10 tons per acre. (KFP, Page 18) 103. Fires burn primarily on the forest floor and typically do not spread between tree groups as crown fire. (KFP, Page 18) Desired Conditions for Ponderosa Pine Landscape-scale (over 10,000 acres) 104. The ponderosa pine forest vegetation community is a mosaic of forest conditions composed of structural stages ranging from young to old trees. The forest is generally Uneven-aged and open. Groups of old trees are mixed with groups of younger trees. Occasional areas of even-aged structure are present. Denser tree conditions exist in some locations such as north-facing slopes, canyons, and drainage bottoms. (KFP, Page 18)	Treatments typically maintain 30%+ forest cover at the 500 & 1,000 acre scale, but show mixed densities at the 100 acre scale. 99. Project design and treatments were developed based on these habitats and abiotic factors. The project is within the guideline. This applies to all action alternatives. 100. See #30 and Treatments would not preclude a variation of age and structural distribution to exist naturally. These desired conditions would be maintained, where appropriate. This applies to all action alternatives. 101. The project analyzed snags 18" DBH at the mid-scale. Certain habitats fall within desired conditions and others are moving toward desired conditions based on the project's desired condition. Treatments would not preclude green snags to exist naturally. This applies to all action alternatives. 102. The project analyzed downed logs 12 inches diameter at mid-point and greater than 8 feet long and coarse woody debris greater than 3 inches at the mid-scale. Certain habitats fall within desired conditions and others are moving toward desired conditions based on the project's desired condition. This applies to all action alternatives. 103. Vegetation prescriptions support these types of burning effects which is within the natural range of variability. This applies to all action alternatives. 104. There would be a mix of very open, open, moderately closed, and closed canopy conditions at the landscape (ponderosa pine vegetation) scale. Moderate-to-closed canopy conditions would be widely distributed on the landscape. Habitat for goshawk and MSO, steep slopes, and buffers for resources such as bald eagle roosts, other raptor nests, caves, and special designations that

105.The ponderosa pine forest is composed predominantly of vigorous trees, but declining trees are present. Snags, green snags, and coarse woody debris occur across the landscape. (KFP, Page 18) 106.Where it naturally occurs, Gambel oak is present with all structure classes represented. It is reproducing and maintaining or expanding its presence within its natural range. (KFP, Page 18) 107.Old growth 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, snags, coarse woody debris, and structural diversity. The location of old growth shifts on the landscape over time as a result of succession and disturbance (tree growth and mortality). (KFP, Page 18) 108.The landscape is a functioning ecosystem that contains all components, processes, and conditions associated with endemic levels of disturbances (e.g., fire, dwarf mistletoe, insects, diseases, lightning, drought, and wind). (KFP, Page 18) 109.Forest vegetation conditions are resilient to the frequency, extent, and severity of disturbances and climate variability. Grasses and needle cast provide the fine flashy fuels needed to maintain the natural fire regime. Fire and other disturbances are sufficient to maintain desired overall tree density, structure, species composition, coarse woody debris loads, and nutrient cycling. (KFP, Page 18) 110.The risk of uncharacteristic high-severity fire and associated loss of key ecosystem components is low. (KFP, Page 18)	would not be treated (including wilderness and most research natural areas) provide connectivity with moderate-to-closed canopy conditions. At the landscape scale (extent of ponderosa pine vegetation), openness would range from very open (up to 90 percent) within the savanna and grassland matrix to closed (as low as 10 percent) on the highly productive forest areas to achieve a heterogeneous condition across the landscape. This applies to all action alternatives (FEIS). 105.Treatments would not preclude for these ponderosa pine components to exist naturally. Theses desired conditions would be maintained and managed toward. This applies to all action alternatives. 106.In most cases oak will not be prescribed for removal in this project. Desired conditions for oak in the project would support and move toward the plan’s desired condition and be within the natural range of variability. This applies to all action alternatives. 107.Plan treatments desired condition is for uneven-aged management with at least three age classes and proportional size class representations within the treated stands. Large trees and residual old trees are a defined component of Uneven-aged management. This applies to all action alternatives. 108.Project treatments and desired conditions reflect putting the landscape on an ecological trajectory to be within the natural range of variability This means structure, species composition, and function would be resistant to and resilient from certain frequent natural disturbances. This applies to all action alternatives. 109. See #39 110.Project treatments desired conditions is to have high canopy overlap within groups, but to separate groups and interlocking canopies with interspace. These

111.Frequent, low-severity fires (Fire Regime I) occur across the entire landscape with a return interval of 0 to 35 years. (KFP, Page 18) <i>Desired Conditions for Aspen (General)</i> 112.Aspen stands are characterized by disturbances that may include fire, mechanical treatments, insects, pathogens, and abiotic factors. Collectively, these agents of change promote healthy tree regeneration, decadence, and nutrient cycling. These processes further contribute to high quality wildlife habitat and biodiversity. (KFP, Page 28) 113.Aspen occurs in natural patterns of abundance and distribution at levels similar to or greater than those at time of plan approval. (KFP, Page 28) 114.Aspen is successfully regenerating and recruiting into older and larger size classes. 115.Size classes have a natural distribution, with the greatest number of stems in the smallest classes. (KFP, Page 28) 116.Fire intervals are similar to reference conditions and maintain aspen. (KFP, Page 28) 117.Understory vegetation consists of shrubby or herbaceous species, providing forage and cover for wildlife and habitat for invertebrates such as pollinators. 118.Aspen provides opportunities for scenic enjoyment, recreation, and cultural or spiritual experiences. (KFP, Page 28) Guidelines for Aspen Management 119.Small patch clear-cuts (less than 5 acres in size), conifer removal, and wildland fire should be used to stimulate aspen sprouting in areas that have or previously had aspen. (KFP, page 29)	interspaces will be for the establishment of grasses, forbs, and brush species. This natural break in fuels (canopy and surface) will decrease the likelihood of uncharacteristically high-severity fire. 111.Vegetation prescriptions support these types of fire effects that is within the natural range of variability. This applies to all action alternatives. 112.The project would contribute to high quality wildlife habitat and biodiversity. Treatments would not preclude aspen disturbances to exist naturally. Theses desired conditions would be maintained. This applies to all action alternatives. 113.The project is consistent with the forest plan. The desired condition for the project is to maintain and/or regenerate aspen. Where possible, there is a need to stimulate growth and increase individual recruitment of aspen. This applies to all action alternatives. 114.See #44 115.The project would move aspen conditions to be within the plan's desired conditions. Theses desired conditions would be maintained and managed toward their natural range of variation. This applies to all action alternatives. 116.Vegetation prescriptions support these types of burning effects which is within the natural range of variability. This applies to all action alternatives. 117.See #43 118.Aspen restoration is a part of this project. This applies to all action alternatives. 119.The implementation guide for the project states that inclusions of aspen remnants within portions of

120. Aspen trees 10 inches or greater DBH (both live and dead) should be protected during project activities, except where they may pose a risk to safety, fences, or regeneration efforts. (KFP, page 29) 121. Fences should be regularly inspected and maintained while aspen recovers. Fences should be removed when no longer needed. (KFP, page 29) Standards for Vegetation Management in All Forested Communities 122. The maximum size opening that may be created in one harvest operation for the purpose of creating an even-aged stand shall not exceed 40 acres except when it is following a large-scale disturbance event such as a stand replacing fire, wind storm, or insect or disease outbreak. (KFP, page 30) 123. When openings are created with the intent of regeneration, effort shall be made to ensure that lands can be adequately restocked within 5 years of final harvest. (KFP, page 30) 124. Clearcutting shall only be used where it is the optimum harvesting method for making progress towards the desired conditions. (KFP, page 30) Guidelines for Vegetation Management in All Forested Communities 125. Projects in forested communities that change stand structure should generally retain at least historic frequencies of trees by species across broad age and diameter classes at the mid-scale. As such, the largest and oldest trees are usually retained. (KFP, page 30) 126. On suitable timberlands, projects should retain somewhat higher frequencies of trees across broad diameter classes to allow for future tree harvest. (KFP, page 30)	ponderosa pine stands would be regenerated by removing all post-settlement conifers from within 100 feet of the aspen clone. Some removal of aspen within the clone as well as ground disturbing activity or burning may occur to stimulate suckering. This applies to all action alternatives. 120. Protection to residual aspen trees and snags are incorporated in implementation contracts. The exceptions are consistent with the project. This applies to all action alternatives. 121. Fence inspection and maintenance is regular program of work for the Coconino and Kaibab NF. This applies to all action alternatives. 122. There are no treatments in forested communities in the project where regeneration openings would exceed 40 acres in size. This applies to all action alternatives. 123. Project monitoring requirements are in place to ensure that adequately restocked within 5 years. This applies to all action alternatives. 124. Clearcuts are defined as a stand in which essentially all trees have been removed in one operation to regenerate within 5 years. The project does not propose clearcutting. This applies to all action alternatives. 125. The project Implementation Guide and Old Tree Retention Strategy addresses the consistency with guideline. This applies to all action alternatives. 126. The silviculture specialist report demonstrates how project densities are on the higher end of the historic range of variability. Some treatments due to habitat

127. Project design should manage for replacement structural stages to assure continuous representation of old growth over time. (KFP, page 30) 128. Project design and treatment prescriptions should generally not remove: 59a . Large, old ponderosa pine trees with reddish-yellow, wide platy bark, flattened tops, with moderate to full crowns and large drooping or gnarled limbs (e.g. Thomson's age class 4, Dunning's tree class 5 and/or Keen's Tree Class 4, A & B [appendix C]). (KFP, page 30) 59b. Mature trees with large dwarf mistletoe induced witches' brooms suitable for wildlife nesting, caching, and denning, except where retaining such trees would prevent the desired development of Uneven-aged conditions over time. (KFP, page 30) 59c. Large snags, partial snags, and trees (>18 inches DBH) with broken tops, cavities, sloughing bark, lightning scars >4 inches wide, and large stick nests (>18 inches in diameter). (KFP, page 30) 59d. Gambel oak >8 inches, diameter at root collar. (KFP, page 30) 59e. Known bat roost trees. (KFP, page 30) 129. The location and layout of vegetation management activities should effectively disconnect large expanses of continuous predicted active crown fire. (KFP, page 30)	needs go above the historic range of variability but remain in the range of variability to be resilient to disturbances. This applies to all action alternatives. 127. The projects desired condition is to maintain an uneven-aged stand structure that incorporates proportional representation of all structural components. The project used the Vegetative Structural Stages 1 through 6 to ensure forest sustainability. This applies to all action alternatives. 128. The implementation guide covers special habitat features. This applies to all action alternatives. 59a. Implementation Guide and Old Tree Retention Strategy ensure this guideline will be met. 59b. See # 59a 59c Snags are not proposed to be felled in this project. Project design and treatment would generally retain trees (>18 inches DBH) with broken tops, cavities, sloughing bark, lightning scars >4 inches wide, and large stick nests (>18 inches in diameter). 59d. Oaks are not proposed to be felled in this project. 59e. Known bat roost trees are not proposed to be felled in this project. 129. The project identifies that there is a need to increase forest resiliency and sustainability, protect soil productivity, and improve soil and watershed function.

130. Vegetation management prescriptions should provide for sufficient canopy breaks to limit crown fire spread between groups, allow for the redevelopment and maintenance of a robust understory, and mimic the spatial arrangement of the reference conditions. (KFP, page 30) 131. Vegetation management activities should meet or exceed goals for scenic beauty (scenic integrity objectives) by creating natural patterns, structure and composition of trees, shrubs, grasses, and other plants. (KFP, page 31) 132. Vegetation management should favor the development of native understory species in areas where they have the potential to establish and grow. (KFP, page 31) 133. Even-aged silvicultural practices may be used as a strategy for achieving the desired conditions over the long term, such as bringing dwarf mistletoe infection levels to within a sustainable range, or old tree retention. (KFP, page 31) Guidelines for Restoring Grasslands 134. Prior to implementation of grassland restoration treatments, consideration should be given to making the residual firewood available for personal collection. (KFP, page 32) Desired Conditions for All Grasslands 135. Tree and shrub canopy cover are each less than 10 percent (KFP, Page 36) Desired Conditions for Montane/Subalpine Grasslands 136. Montane and subalpine meadow vegetation has high soil productivity and biological diversity. Native species occur in natural patterns of abundance, composition, and distribution. Vegetation is healthy and at least stable. (KFP, Page 37) 137. Vegetation and litter are sufficient to maintain and improve water infiltration, nutrient cycling, and soil	Resiliency increases the ability of the ponderosa pine forest to survive natural disturbances such as fire, insect and disease, fire, and climate change. The project would bring forest conditions within the natural range of variability therefore reducing the extent of crown fires. This applies to all action alternatives. 130. The project will use groups and interspace treatments and the historic range of variation conditions as a guide. This applies to all action alternatives. See #60 131. Scenic beauty was analyzed in this project against the silviculture treatments. The project is constant with this direction. This applies to all action alternatives. 132. All vegetative cutting within the project would favor the development of native grass/shrub/forb understory by allowing more sunlight and growing space to the forest floor. This applies to all action alternatives. 133. The project would use even-aged treatments to intermediately thin for old and large tree retention. This applies to all action alternatives. 134. The project is consistent in allowing for fuel wood products. This applies to all action alternatives. 135. Grasslands in the project would be restored to the reference condition which would be below ten percent. 136. Montane and subalpine grasslands would have over story trees consistent with the reference condition. 137. See #67

productivity. (KFP, Page 37) Desired Conditions for Colorado Plateau/Great Basin Grasslands 138.Vegetation height and canopy cover are sufficient to carry fire under low wind conditions to support a 10 to 30-year fire return interval. (KFP, Page 38)	138.Vegetation prescriptions support these types of burning effects which is within the natural range of variability. This applies to all action alternatives.

Appendices C-D ~ Natural Range of Variability (NVR)

Forest ecology, historical (reference) conditions, and the natural range of variability are frequently used to define restoration goals, to estimate the restoration potential of sites, and to evaluate the success of restoration efforts (Reynolds et al, 2014, 2013). The idea of using historical conditions as reference for land management has been around for some time (Keane et al, 2009, Friederici et al, 2003). Establishing pre-Euro-American settlement structure uses many tools to describe the structure of the historical reference condition: soil, tree-ring scars, historical records, dendrochronology, stand reconstruction, relic stands, etc. (Covington, 2003; In Friederici, P. (ed.). 2003). Forest restoration, guided by these reference conditions, provides for the approximation of the historical effects of characteristic disturbances (Reynolds, 2014). However, the inclusion of temporal variability of ecosystem elements and processes into land management has only recently been proposed (Keane et al, 2009). In a special issue of Ecological Applications, Landres et al. (1999) presented some of the theoretical underpinnings behind the concept of Historical Range of Variability (HRV). As stated in Keane et al (2009) the theory of HRV assume the following: (1) ecosystems are dynamic, not static, and their responses to changing processes are represented by past variability (Veblen, 2003); (2) ecosystems are complex and have a range of conditions within which they are self-sustaining, and beyond this range they transition to disequilibrium; (3) historical conditions can serve as a proxy for ecosystem health (Swetnam et al., 1999); (4) time and space domains of HRV are sufficient to quantify variation (Turner et al., 1993); and (5) the ecological characteristics being assessed or the ecosystem or landscapes match the management objective (Keane et al., 2002b). It is this Historical/Natural Range of Variability that is discussed and displayed here for this programs alternatives and treatments.

Kaibab National Forest and the Natural Range of Variability

Today, the Kaibab NF contains uncharacteristically dense forests with many more young trees than were present historically (KFP). The Kaibab NF uses the historical occurrences of certain ecosystem structure to inform the forest planning process. Through the descriptions of the plans Desired Conditions, Objective, and Guidelines the plan describes the use of restoration-like activities to accomplish the plan objectives. The Kaibab management direction is guided by the Potential Natural Vegetation¹², Vegetation Structure¹³, Natural Variability¹⁴, and Ranges of Values¹⁵.

¹² **Potential natural vegetation types** are the “climax” vegetation that will occupy a site without disturbance or climatic change. PNV is an expression of environmental factors such as topography, soils, and climate across an area.

¹³ **Vegetation Structure** includes both the vertical and horizontal dimensions. Horizontal structure may refer to patterns of trees or groups of trees and openings, as well as tree size and tree density. Vertical structure may refer to the layers, appearance, and composition of vegetation between the forest floor and the top of the canopy.

¹⁴ **Natural variability** references past conditions and processes that provide important context and guidance relevant to the environments and habitats in which **native species** evolved. Disturbance driven spatial and temporal variability is vital to ecological systems. Biologically appropriate disturbances provide for heterogeneous conditions and subsequent diversity, whereas “uncharacteristic disturbance” such as high-intensity fire can have the effect of reducing diversity, increasing homogeneity, and resulting in states that may be permanently altered.

¹⁵ **Ranges of Values** presented in desired conditions account for natural or desired variation in the composition and structure within a community or resource area. Desired conditions may have a wide range due to spatial variability in soils, elevation, aspect, or social values. Where desired conditions specify a range, the full spectrum of values within that range is desirable, although the desirable distribution of values within that range may vary depending on the resource. It may also be desirable to manage for desired conditions at the upper or lower end of a range in a particular area, such as lower vegetation density in the wildland-urban interface (WUI) to achieve the desired fire behavior within proximity of private property and human occupancy. Higher densities may be desired in other areas to meet habitat requirements for specific species

For the ponderosa pine forests the plan states: “Ponderosa pine forests on the Kaibab NF are generally denser and more continuous across all developmental states than in **reference conditions**. The open, park-like stands characteristic of the **reference conditions** for ponderosa pine forests promoted greater floral and faunal diversity and fire resilience than the dense stands of today.” (emphasis added)? The plans stated management goals for the ponderosa pine type is to “strive to mimic the structure and patterns of **reference conditions** using historical evidences and soil characteristics.”

The current Kaibab forest plan (2014) clearly has an emphasis to restore the ponderosa pine forests because these forest are highly departed from desired conditions and were identified as a priority need for change. The analysis here of the Natural Range of Variability is very consistent with the intent of the Kaibab NF LRMP (2014).

Coconino National Forest and Natural Range of Variability

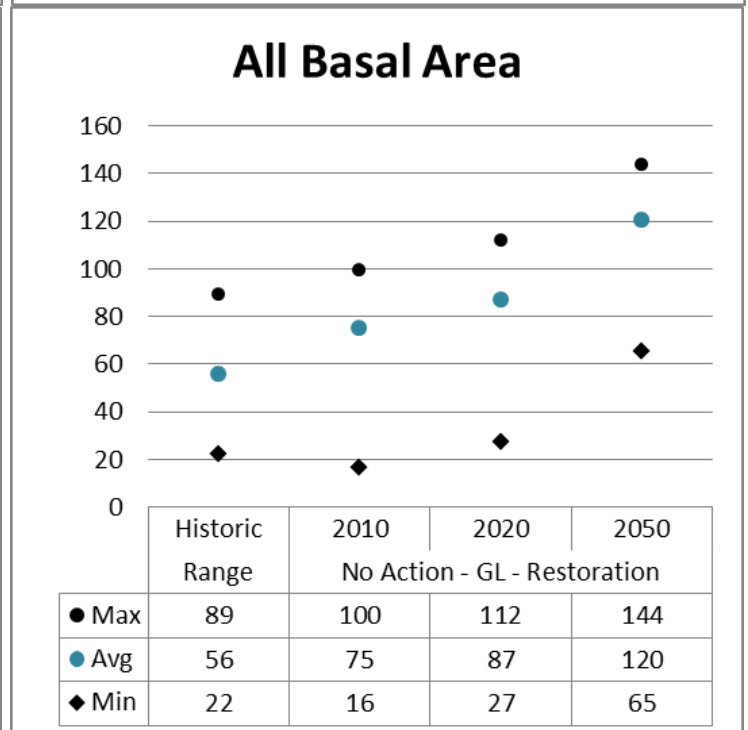
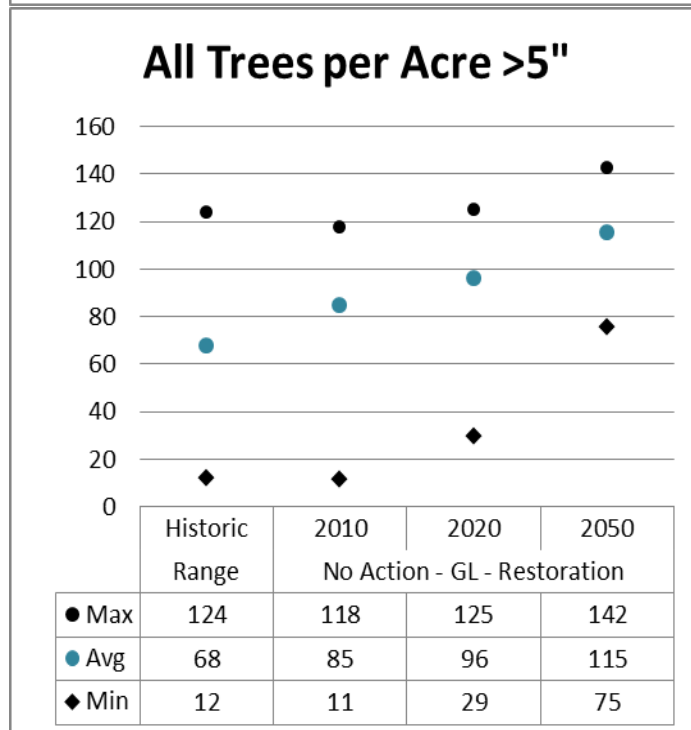
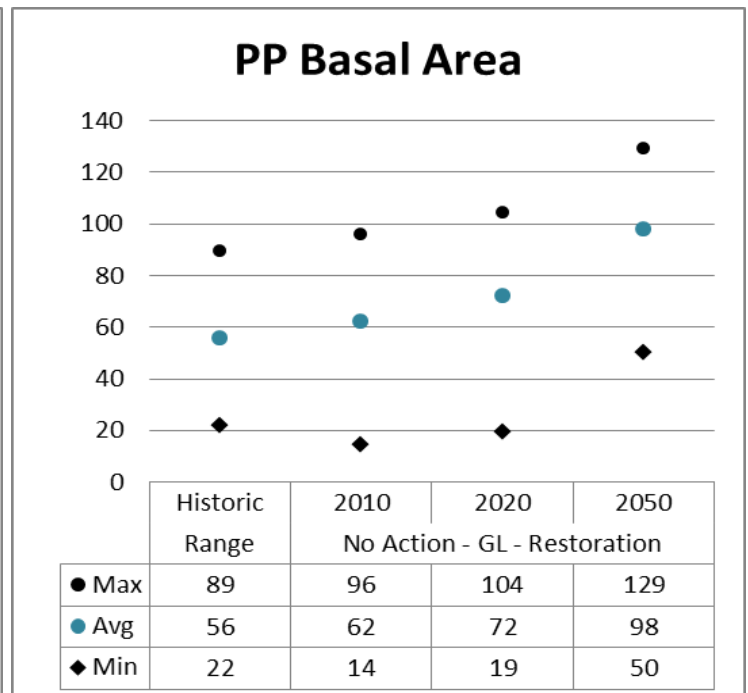
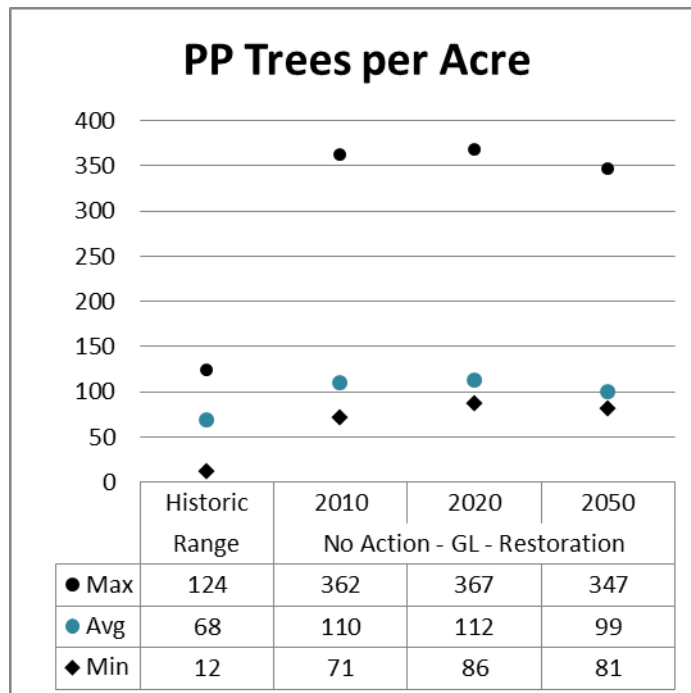
The Coconino NF LRMP (1987 amended) refers to the Natural Range of Variability (CFP, page 206-7) in reference to the Goals, Objective, Standards and guidelines for the entire Sedona/Oak Creek Planning Area. Therefore, the concept of Historical/Natural Range of Variability and reference conditions is not totally void in the older planning process. The Coconino NF uses the references to “Historical” in terms of recent historical (i.e., “Nest (goshawk) site selection will be based first on using active nest sites followed by the most recently used historical nest areas.”). However, in using the term Historical to refer to pre-Euro-American settlement references are lacking. The forest plan uses a concept called Integrated Stand Management (ISM, CFP page 49). ISM emphasizes sustainable yield in terms of timber production, however, ISM does not equate treatments to a pre-settlement historical condition. In this regards the NRV tables here do not relate to the current Coconino NF plan, but instead related to best science and best current management practices available. It is still important to compare the current stand natural range of variability and stand structure on the Coconino NF to the Natural Range of Variability to garner a feeling for the amount of departure there is from reference conditions. The Coconino NF plan does not preclude the use of the concept of Natural Range of Variability. The mission of the Coconino NF plan is to “manage National Forest lands and resources using the best systems available to meet the needs and desires of present and future generations, while protecting and enhancing the environment and effectively and efficiently administering Forest programs.” To this end historical reference conditions and understanding their Natural Range of Variation is compliant with the plan.

The NRV tables that follow help track the various treatments, by alternative, as modeled. The desire is to bring the forest structure back towards the historical reference condition while remaining within the NRV. In some stands the objective is to be at the lower end of the NRV for more intense treatments (IT40) or to remain nearer the top end of the NRV for less intensive treatments (PACs). The use of the tables gives an easy format to compare effects between treatments.

NOTE: Alternative A: NRV tables use the stand level information (shape files and treatment designators) for Alternative C, the preferred alternative, as the basis of this NRV analysis.

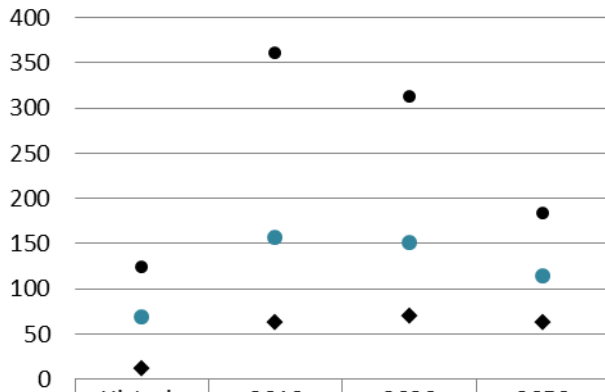
Appendix C - Natural Range of Variability Comparison by Treatment Type (Alt A)

No Action (Alt C Grassland Restoration Stands)



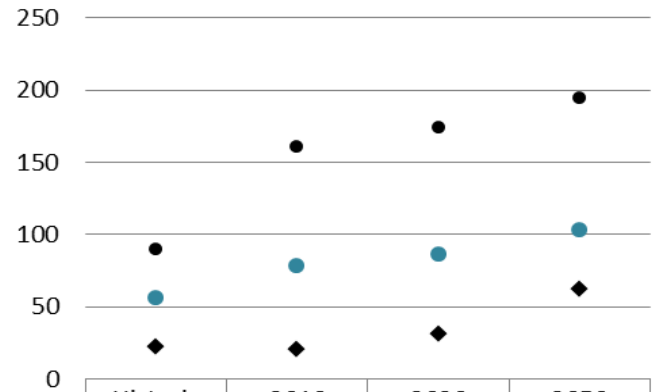
No Action (Alt C Savanna Stands)

PP Trees per Acre



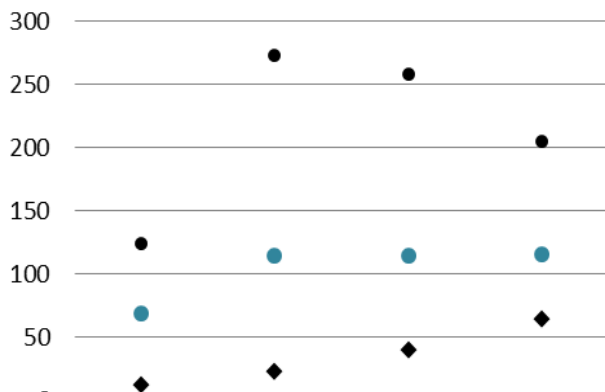
	Historic Range	No Action - Savanna		
● Max	124	360	312	184
● Avg	68	157	150	114
◆ Min	12	63	69	62

PP Basal Area



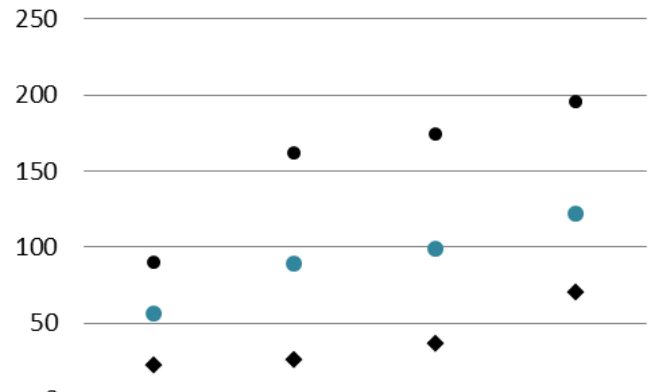
	Historic Range	No Action - Savanna		
● Max	89	161	174	194
● Avg	56	78	86	103
◆ Min	22	21	31	62

All Trees per Acre >5"



	Historic Range	No Action - Savanna		
● Max	124	272	257	204
● Avg	68	114	114	115
◆ Min	12	23	40	63

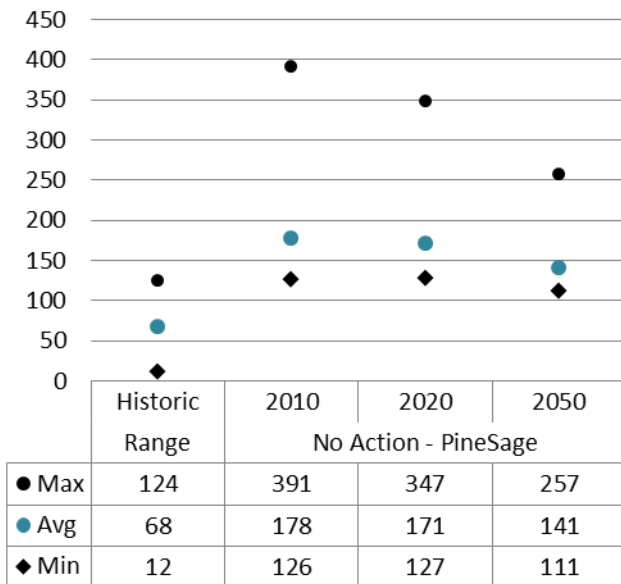
All Basal Area



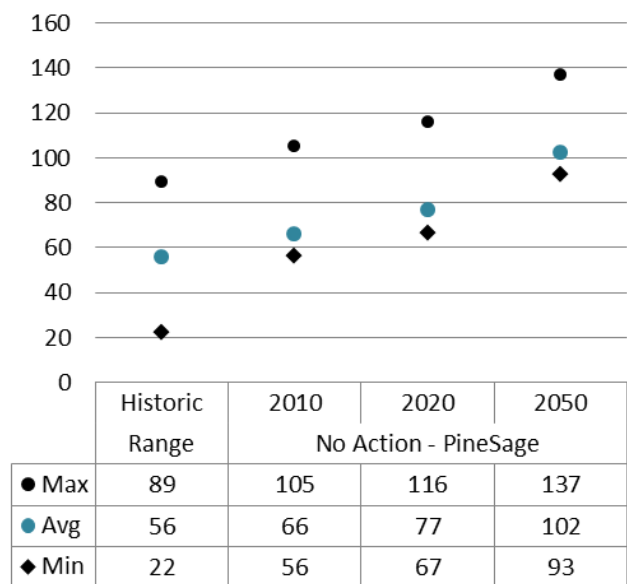
	Historic Range	No Action - Savanna		
● Max	89	161	174	195
● Avg	56	88	98	121
◆ Min	22	26	37	70

No Action (Alt C Pine Sage Stands)

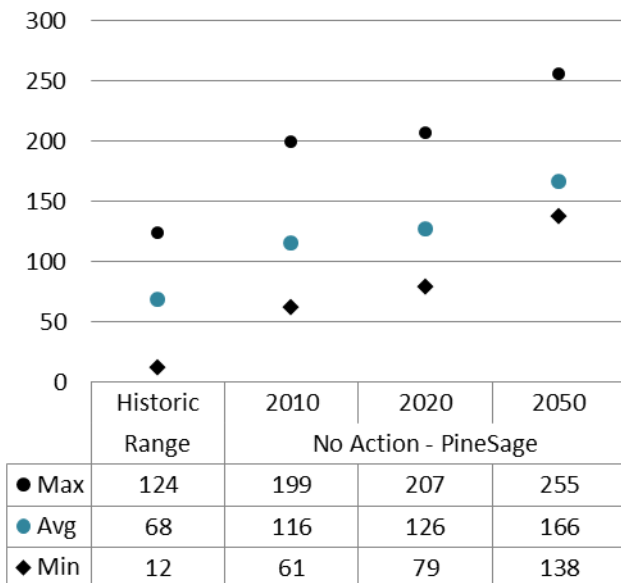
PP Trees per Acre



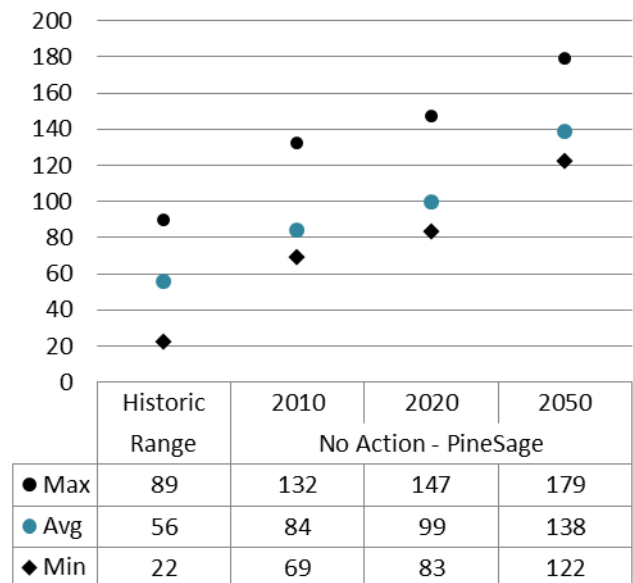
PP Basal Area



All Trees per Acre >5"

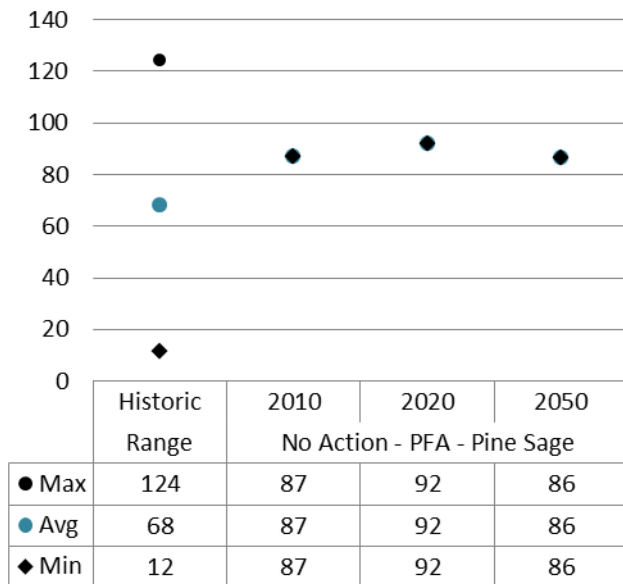


All Basal Area

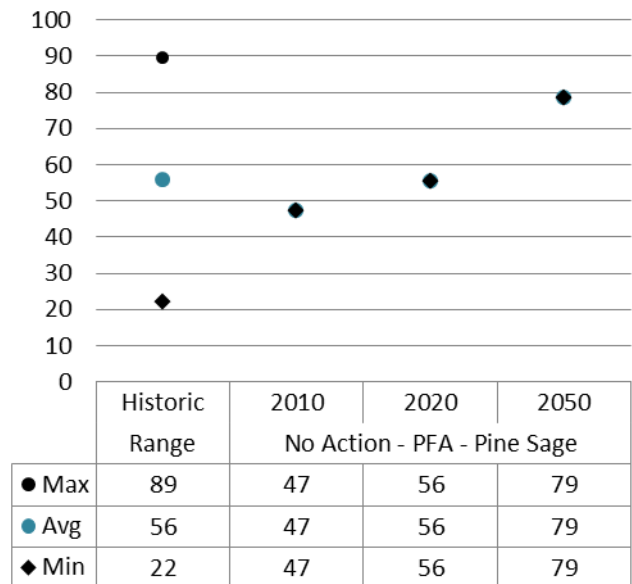


No Action (Alt C PFA Pine Sage Stands)

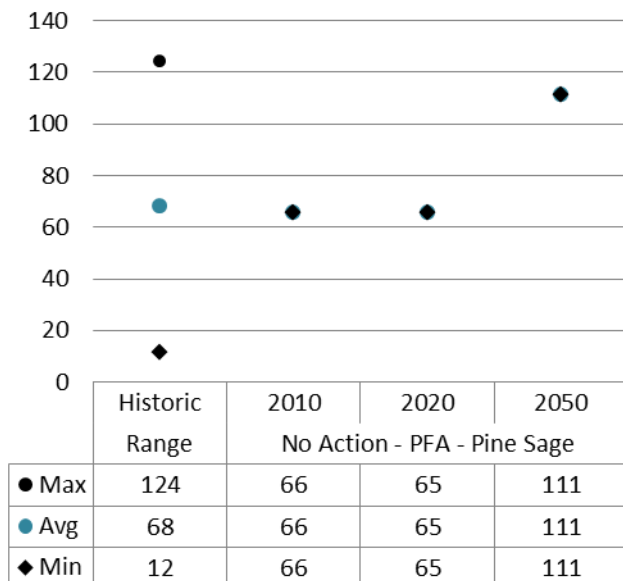
PP Trees per Acre



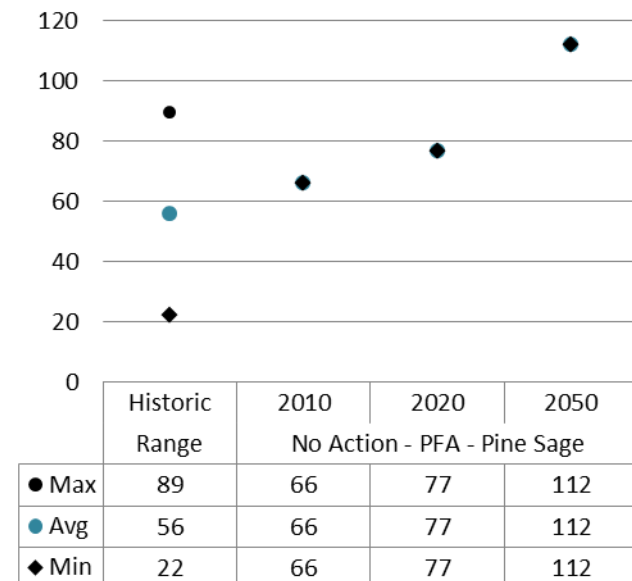
PP Basal Area



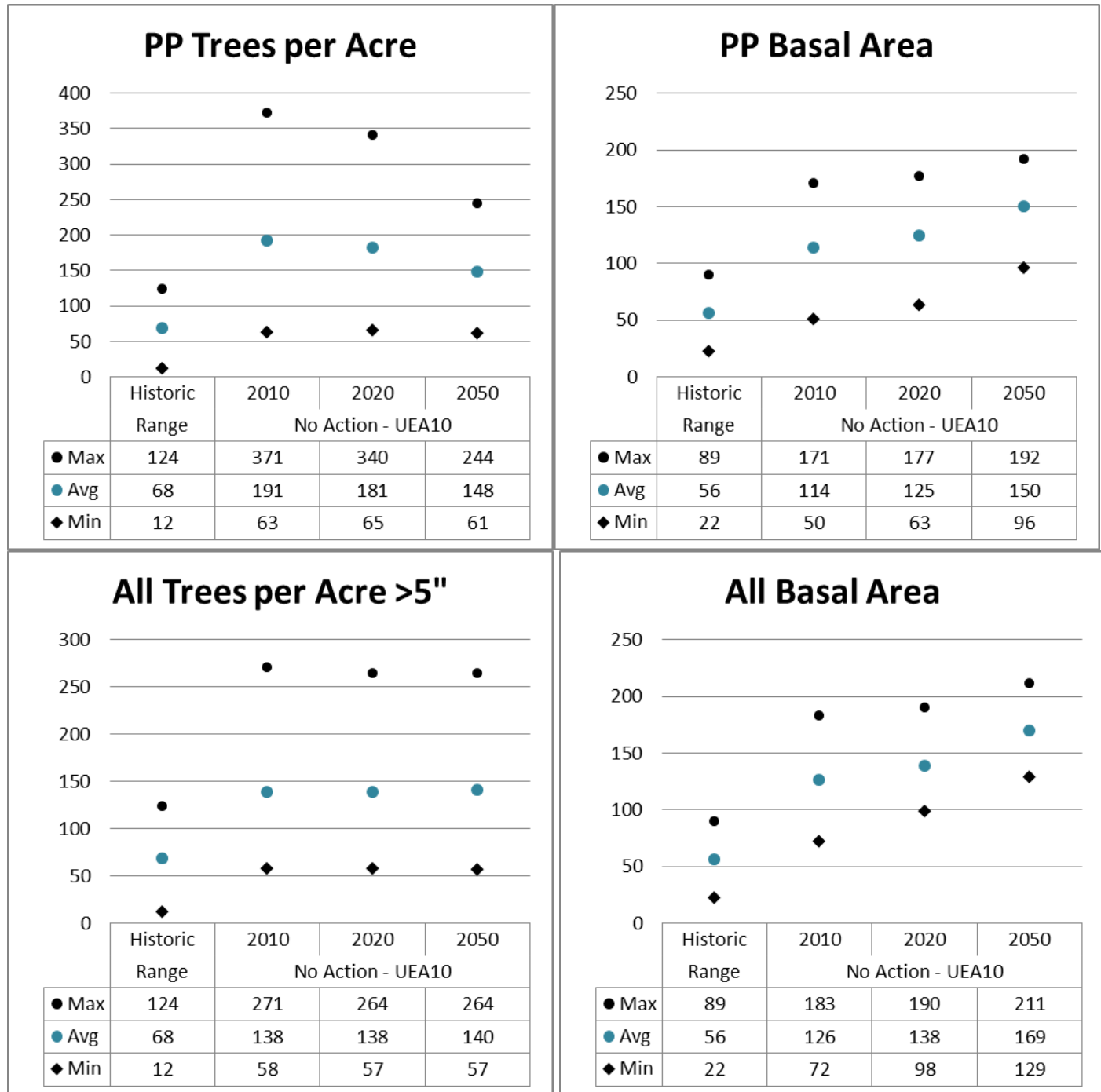
All Trees per Acre >5"



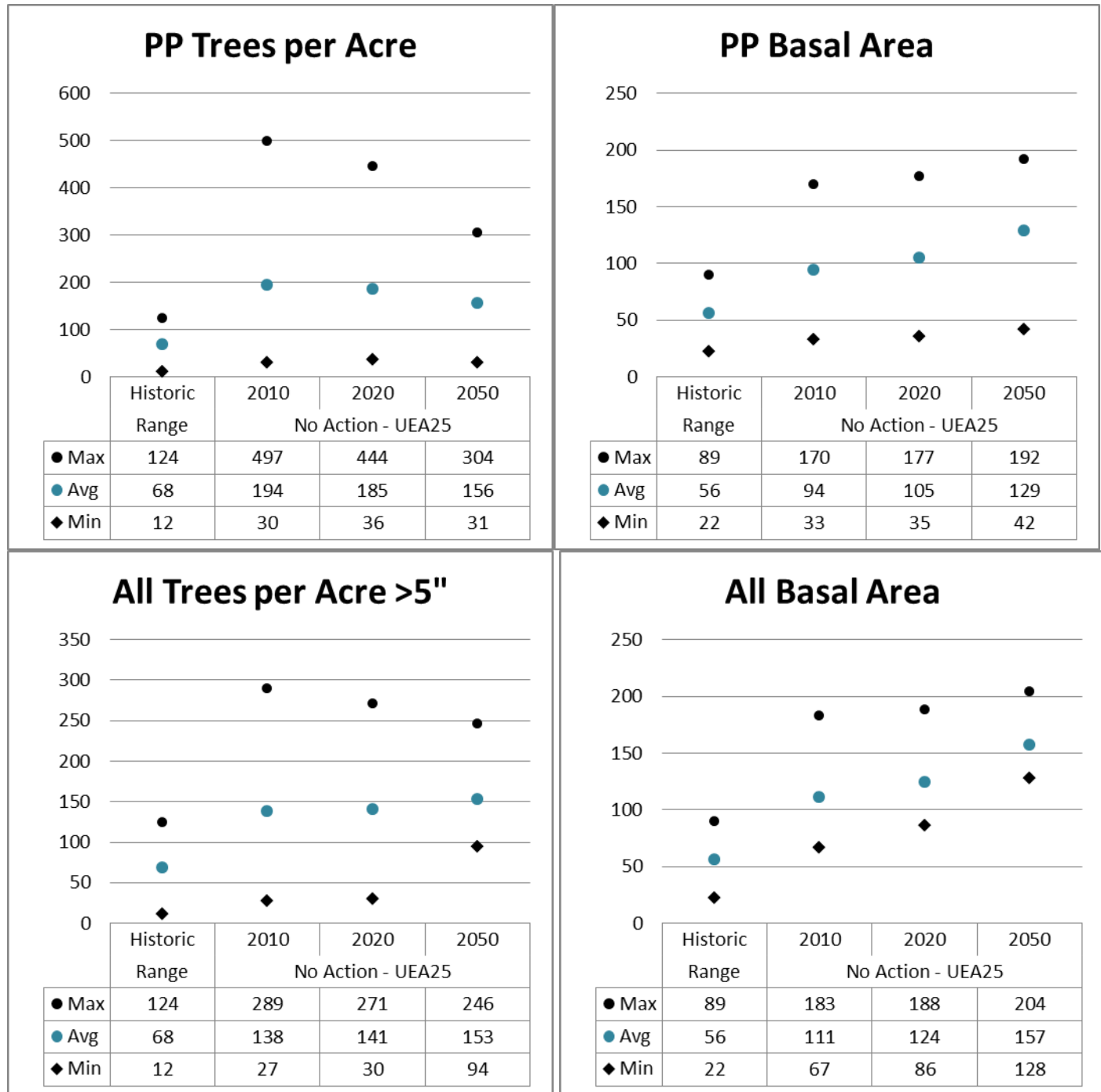
All Basal Area



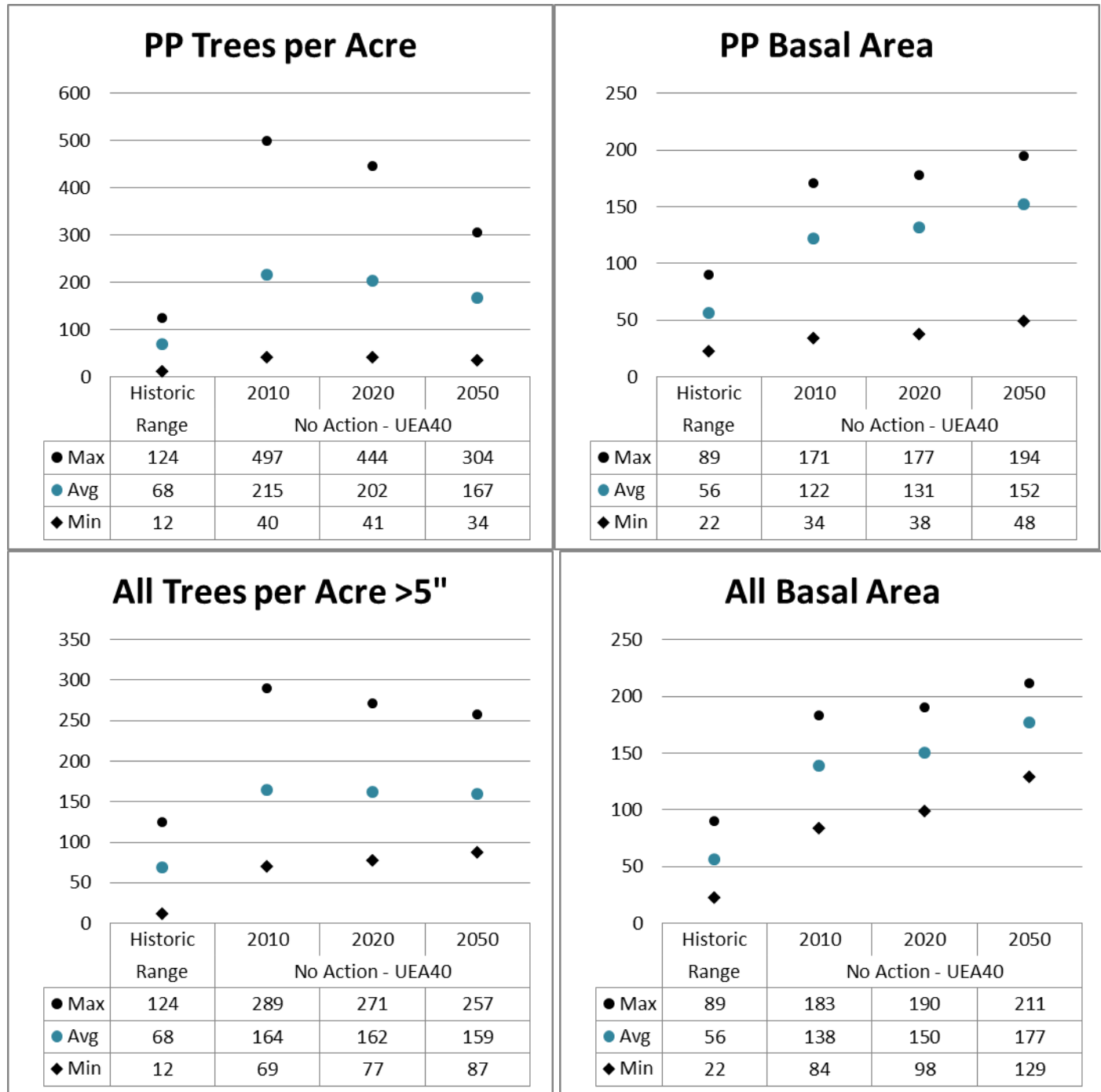
No Action (Alt C Uneven Age – 10-25% Stands)



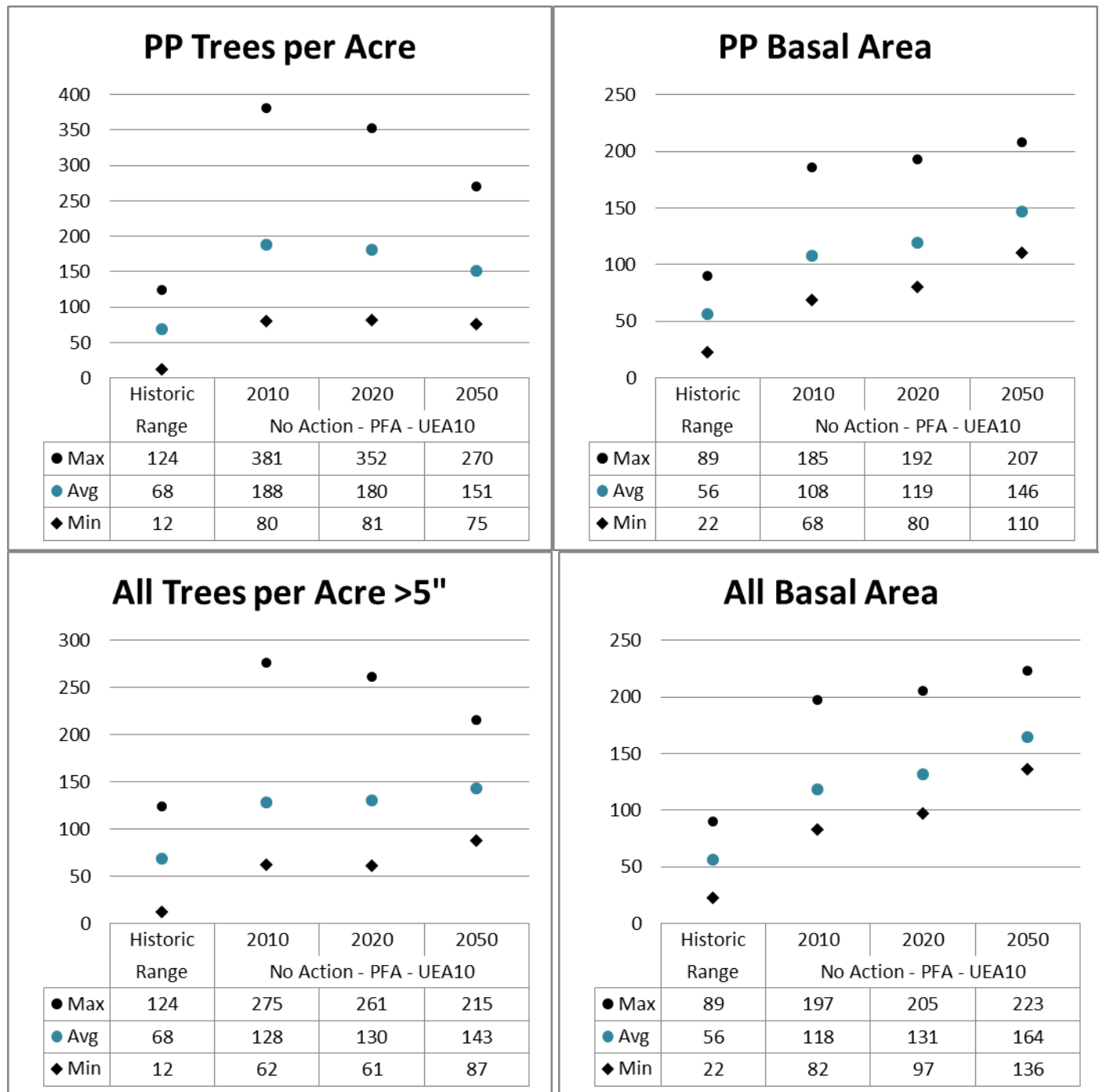
No Action (Alt C Uneven Age – 25-40% Stands)



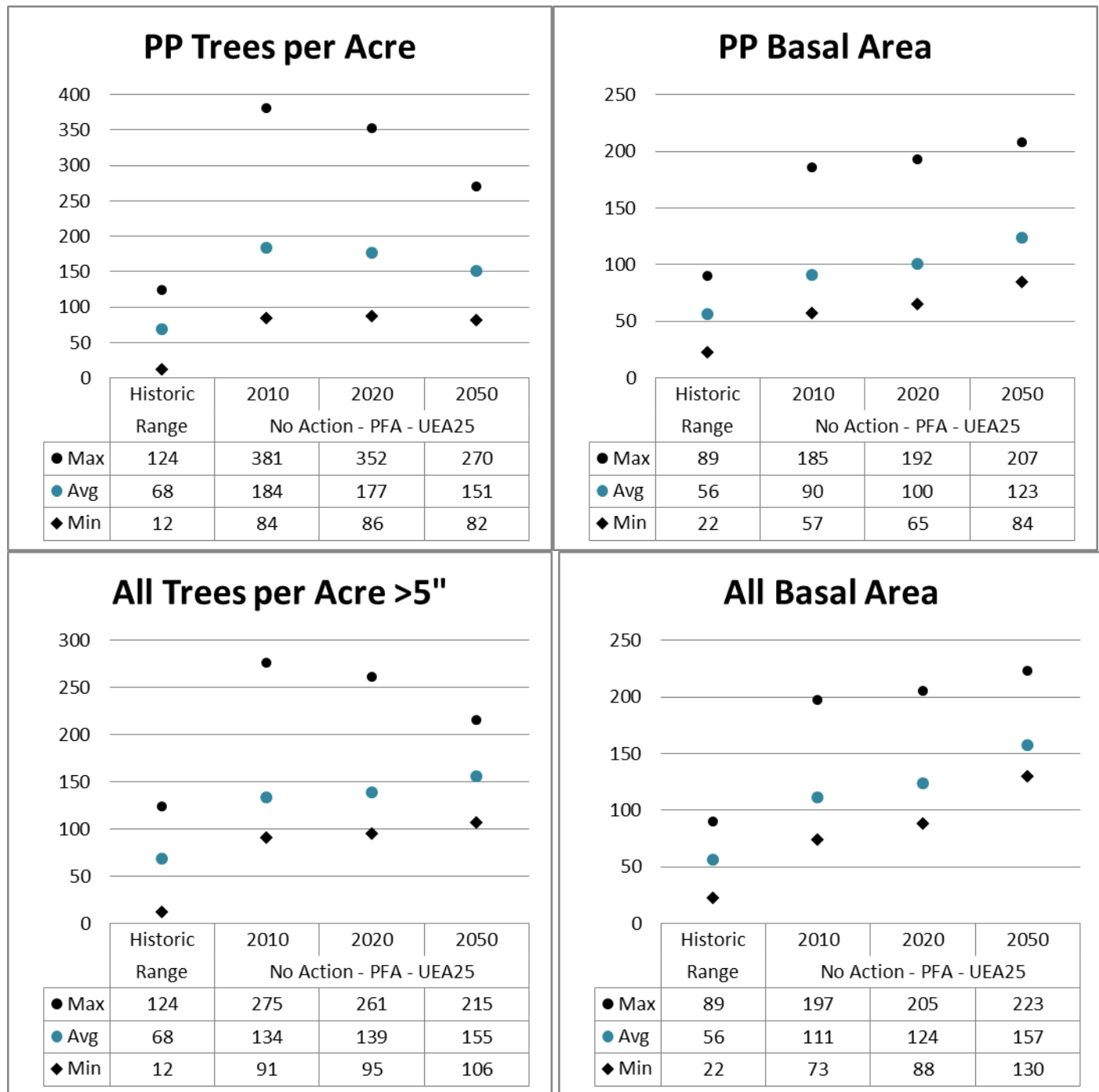
No Action (Alt C Uneven Age – 40-55% Stands)



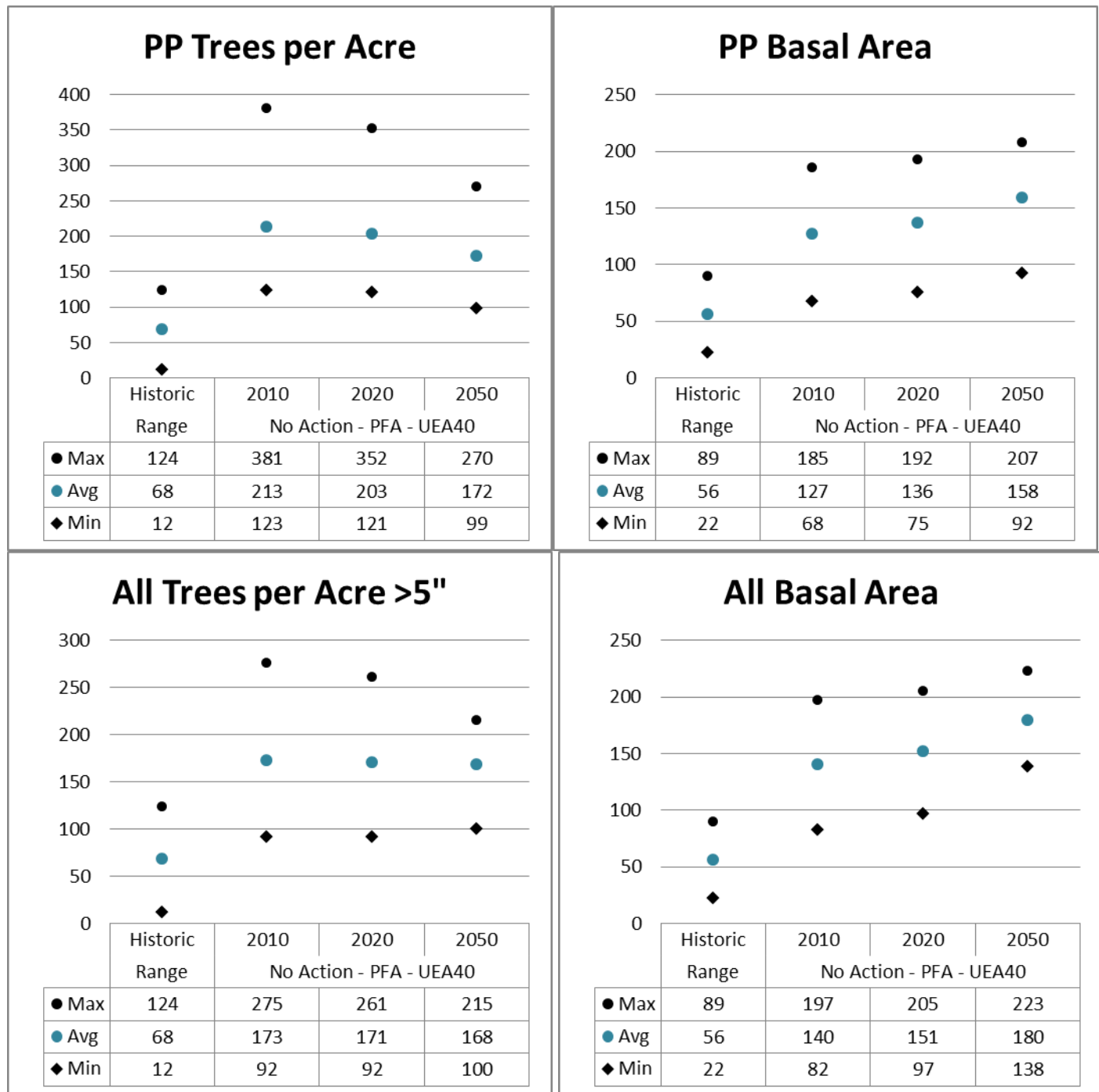
No Action (Alt C PFA Uneven Age – 10-25% Stands)



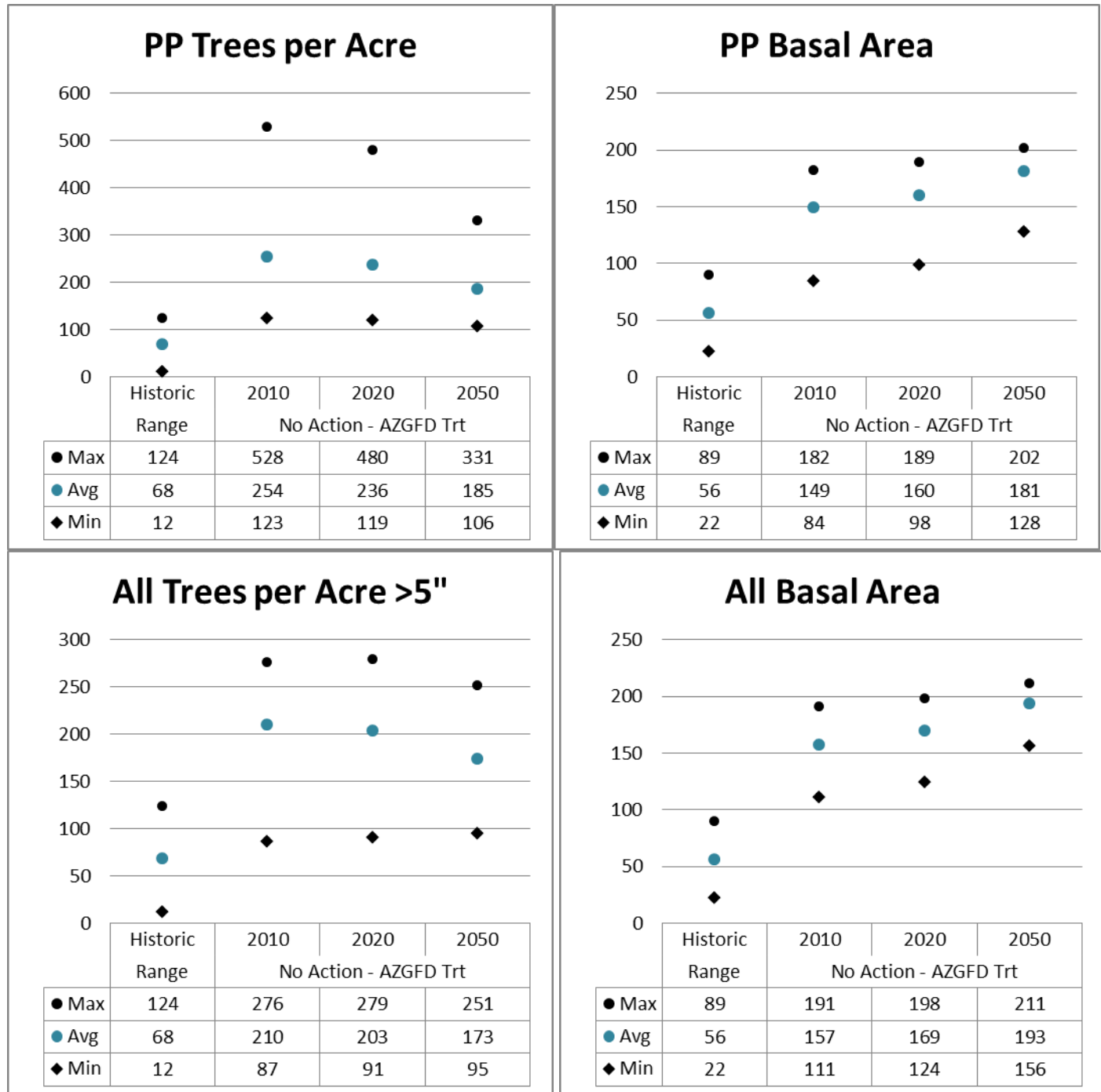
No Action (Alt C PFA Uneven Age – 25-40% Stands)



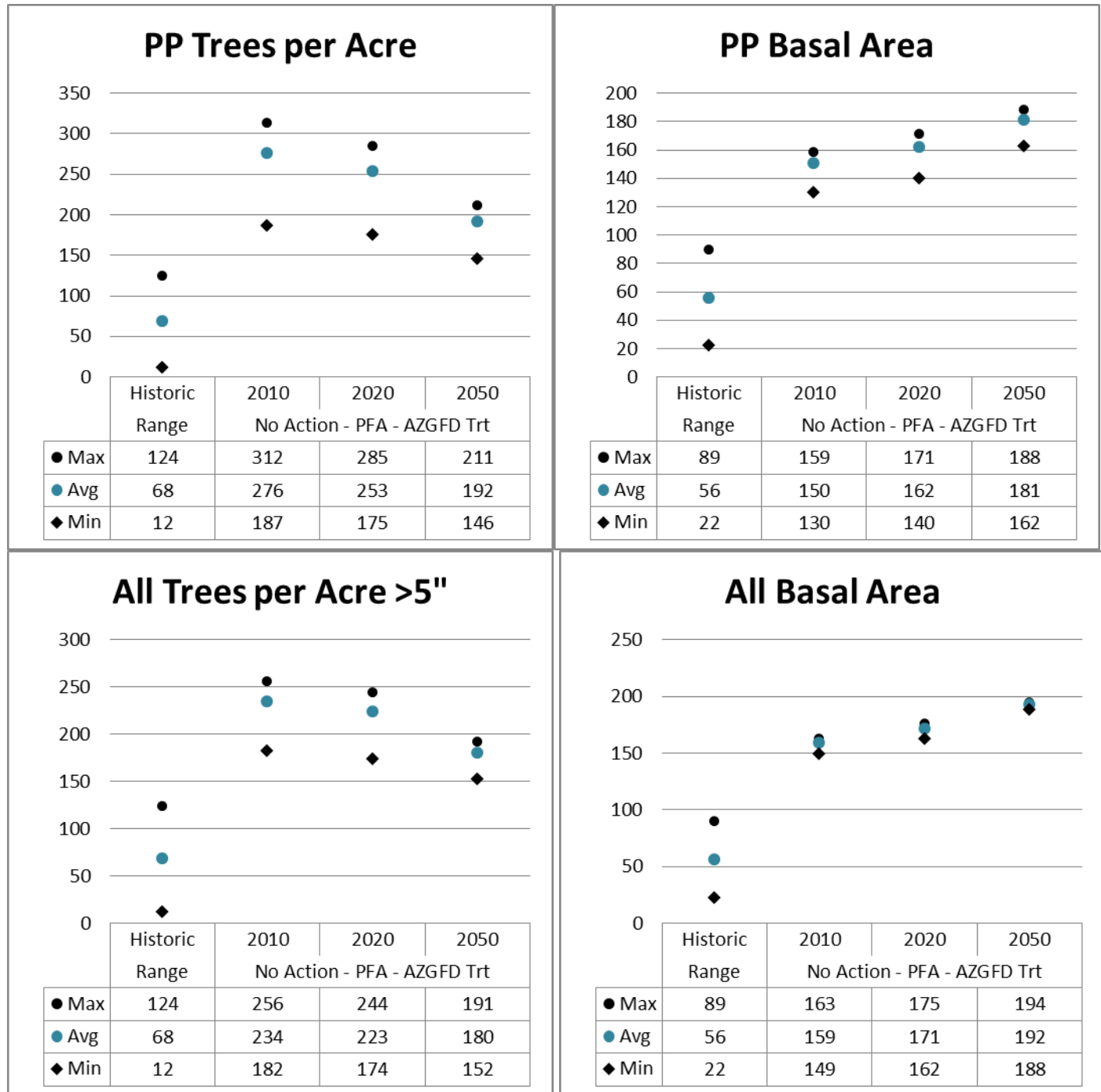
No Action (Alt C PFA Uneven Age – 40-55% Stands)



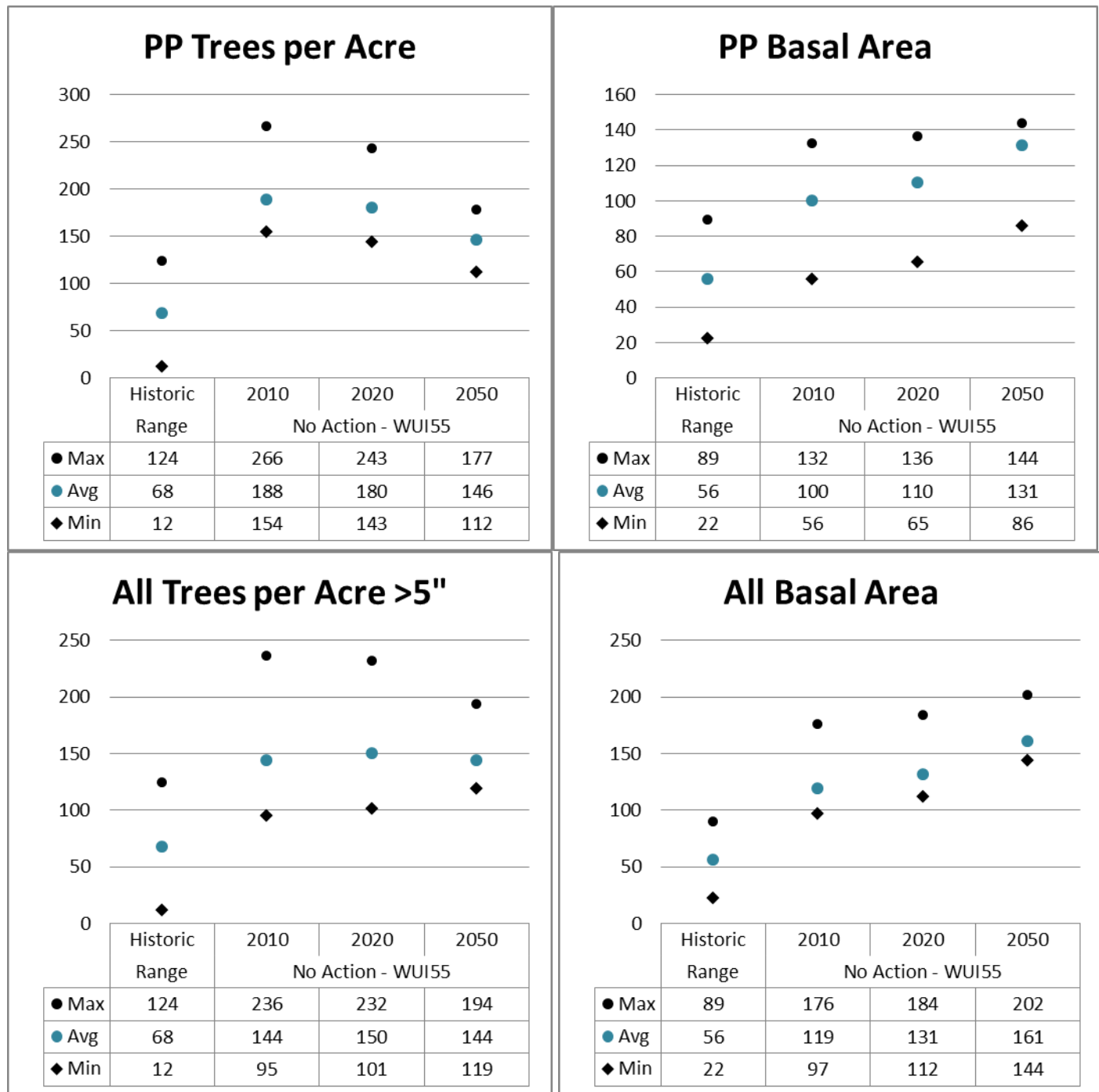
No Action (Alt C Uneven Age – Arizona Game and Fish Design Stands)



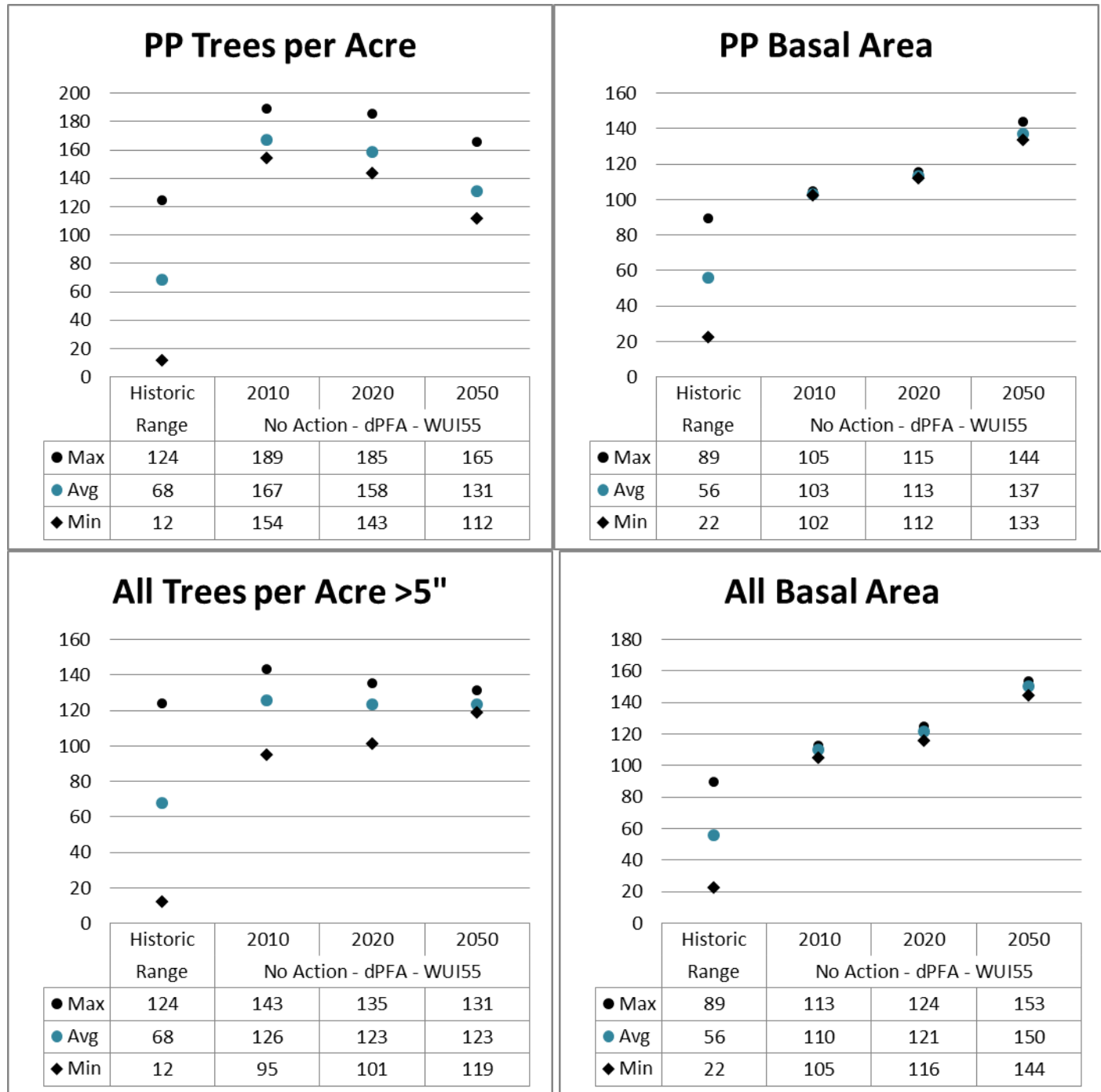
No Action (Alt C PFA Uneven Age – Arizona Game and Fish Design Stands)



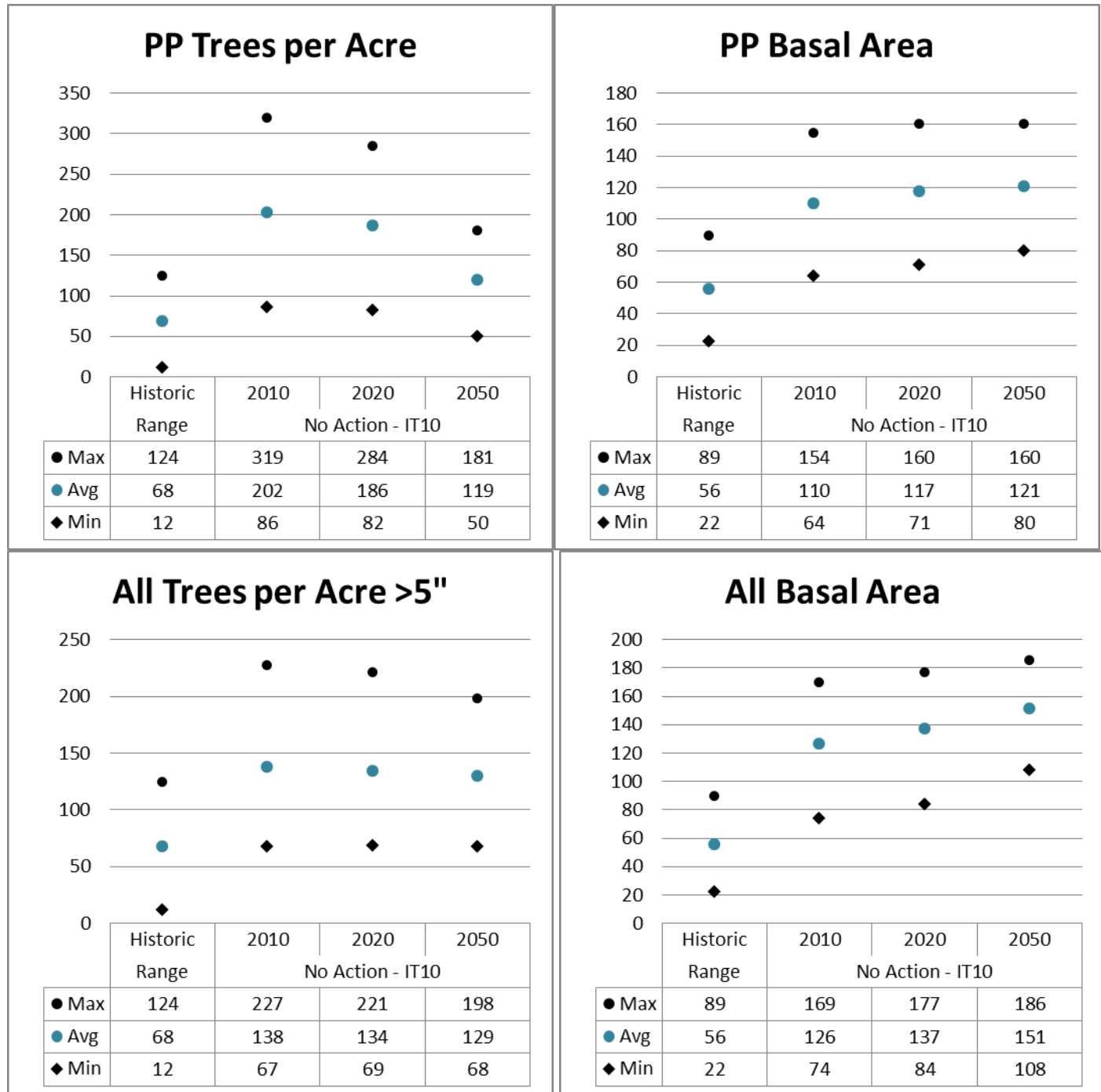
No Action (Alt C Uneven Age – Wildland Urban Interface 55% Stands)



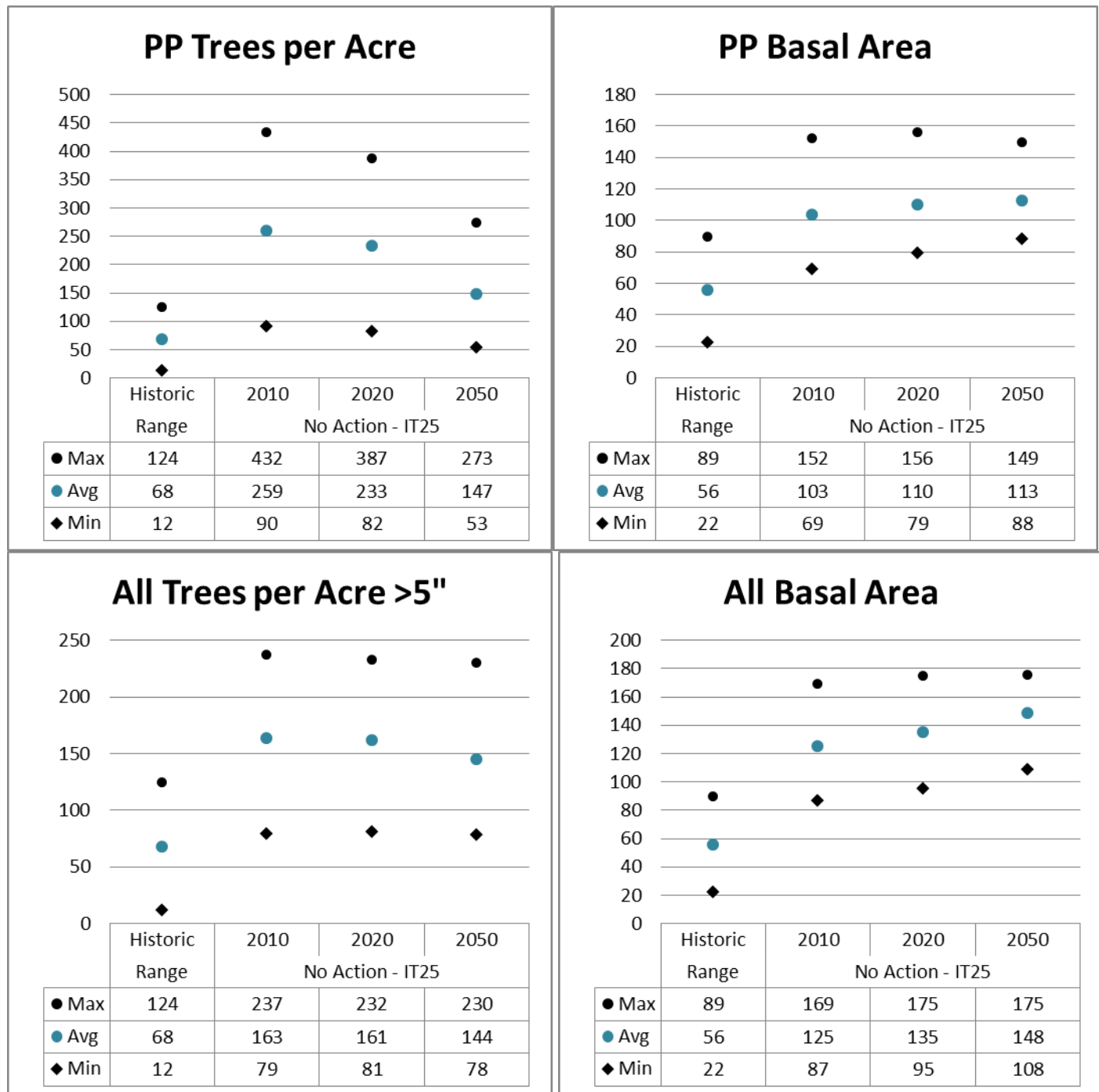
No Action (Alt C Dispersal PFA Uneven Age – Wildland Urban Interface 55% Stands)



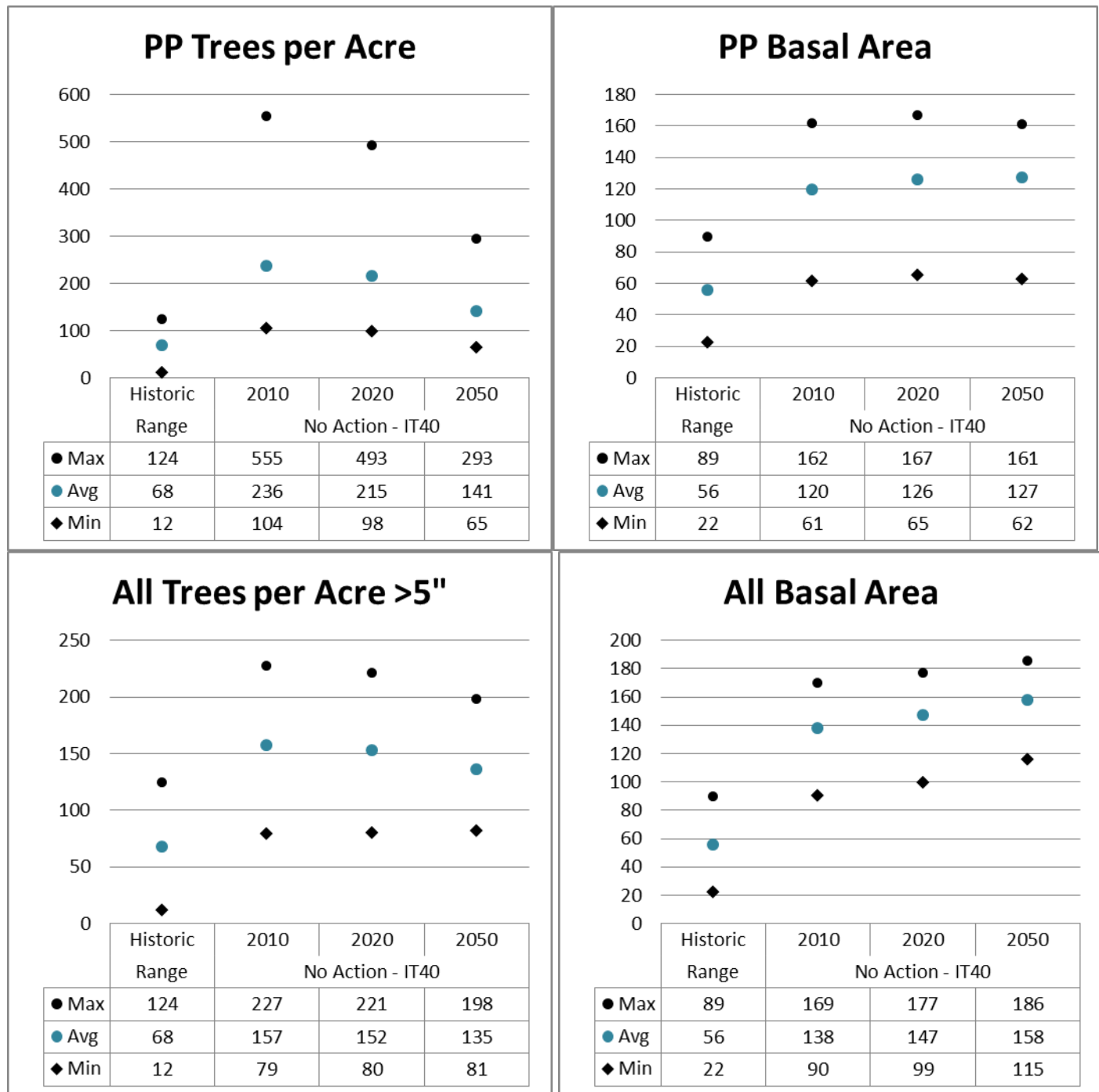
No Action (Alt C Intermediate Thin – 10-25% Stands)



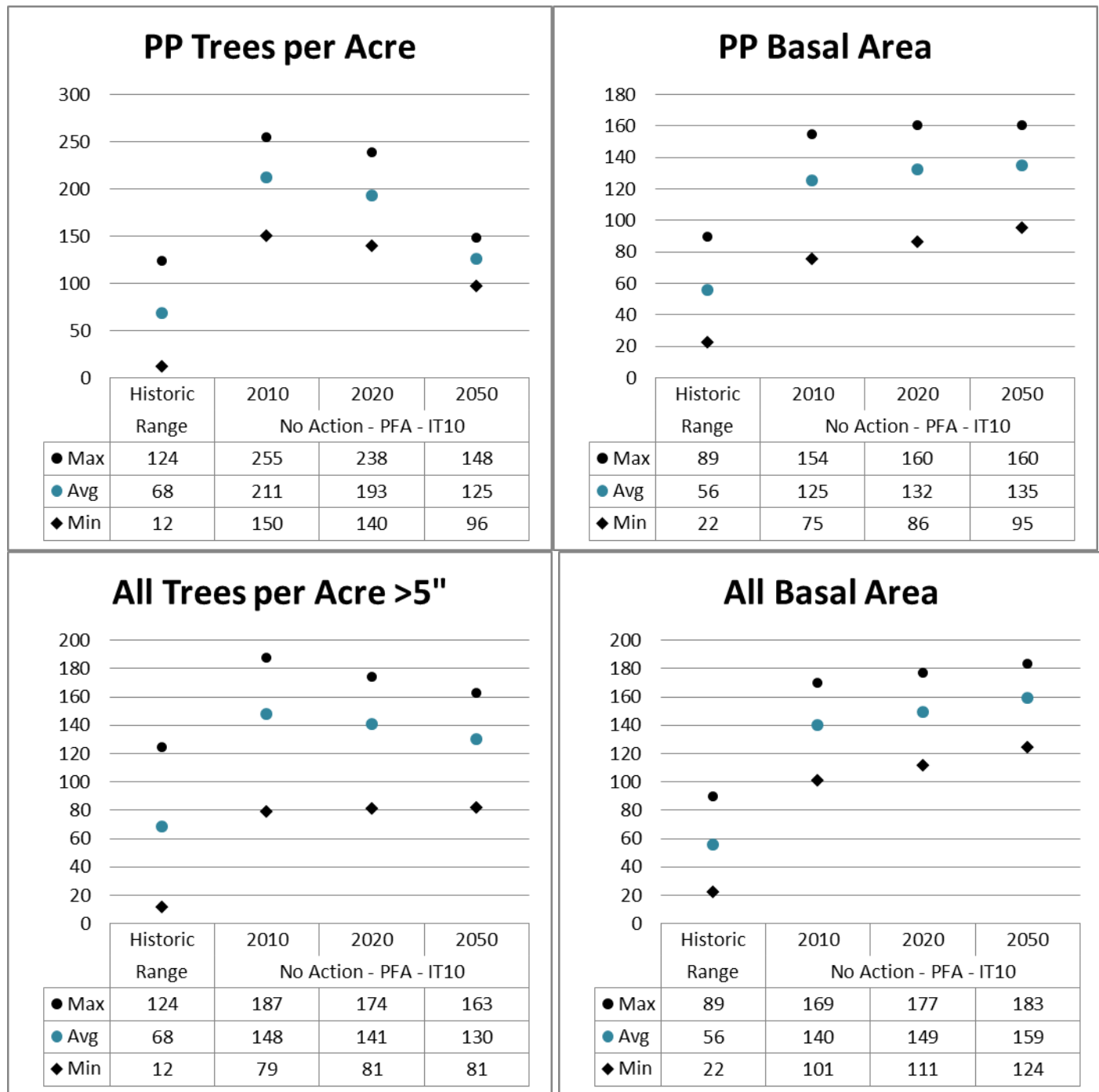
No Action (Alt C Intermediate Thin – 25-40% Stands)



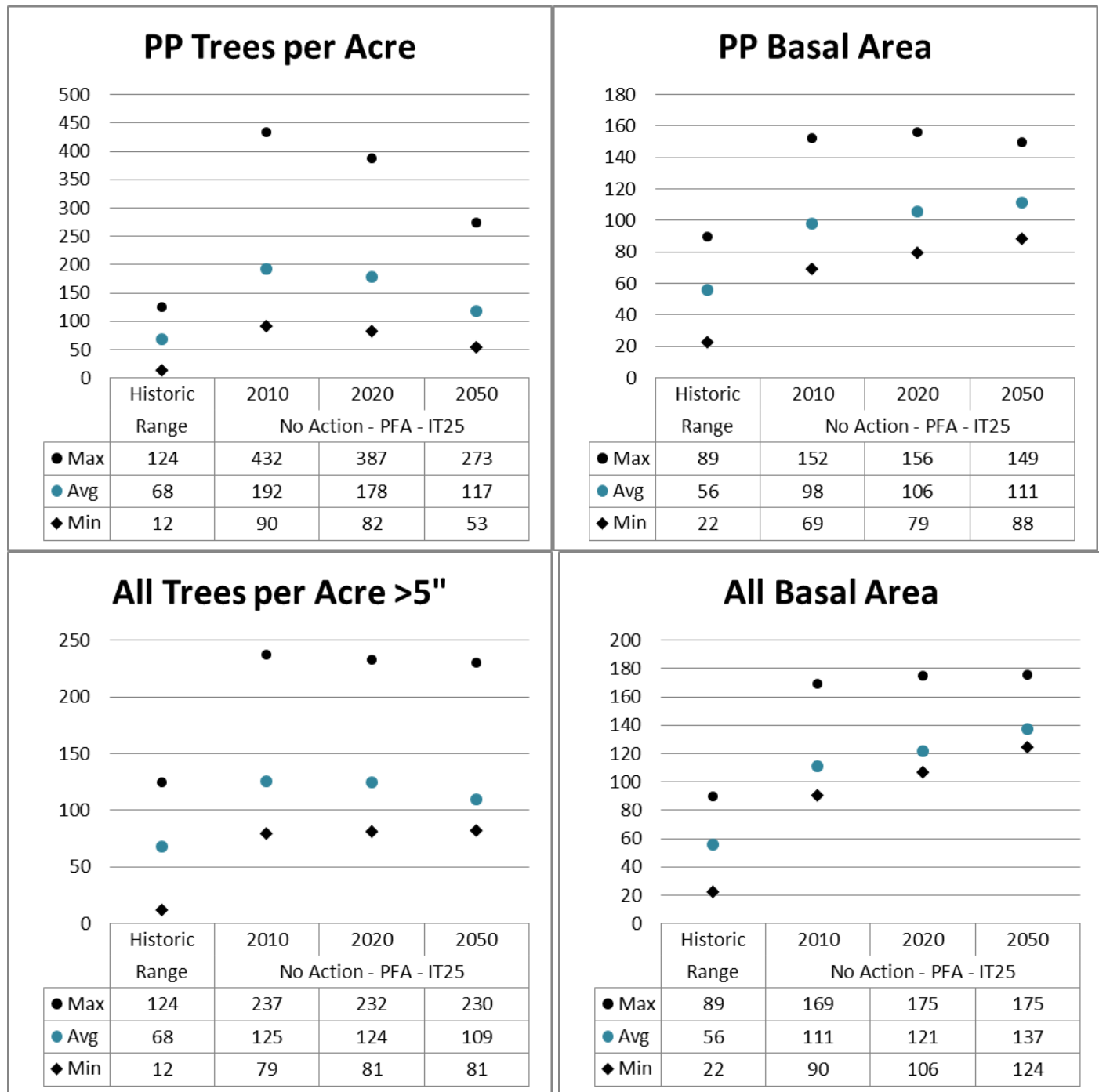
No Action (Alt C Intermediate Thin – 40-55% Stands)



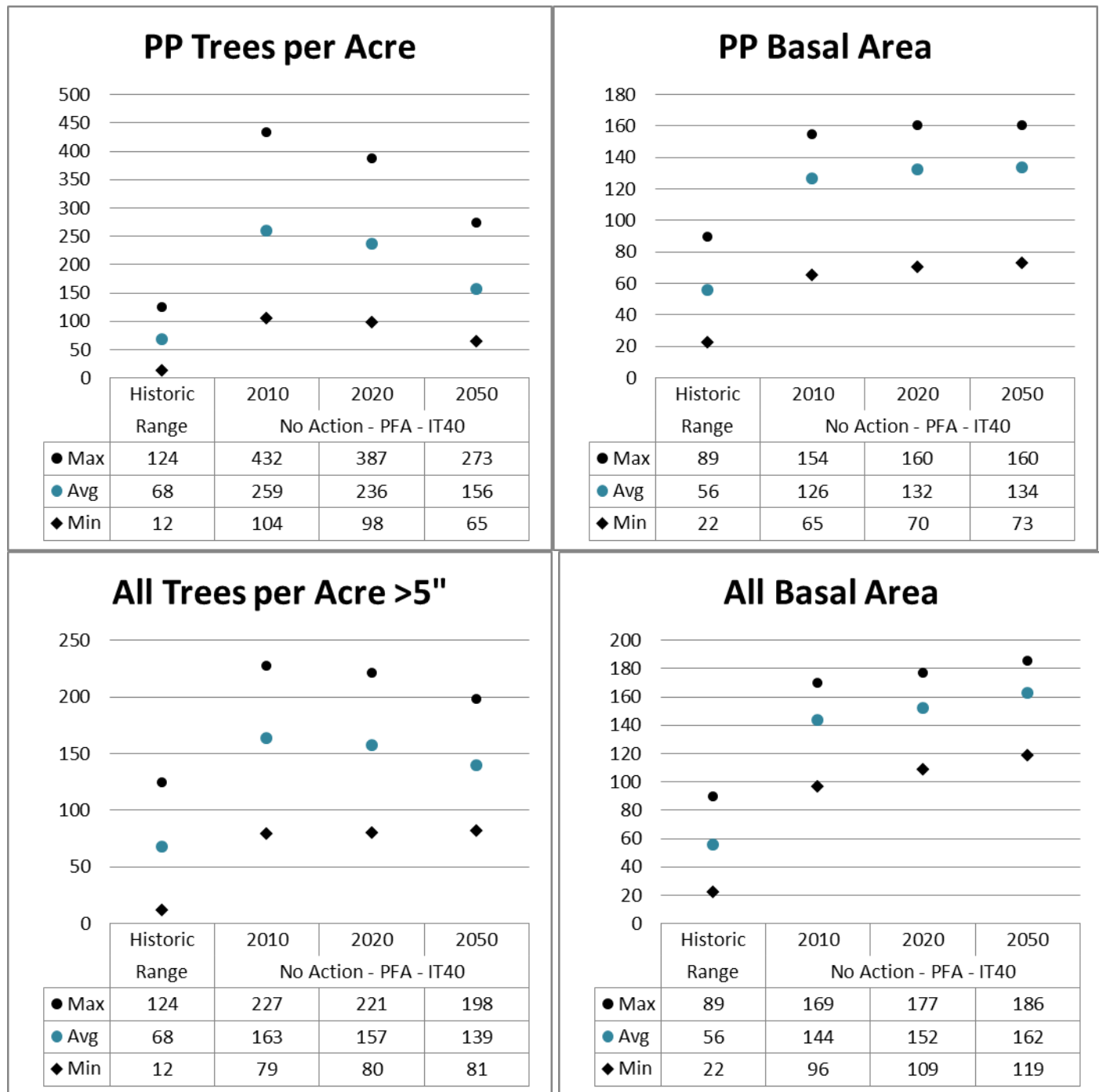
No Action (Alt C PFA Intermediate Thin – 10-25% Stands)



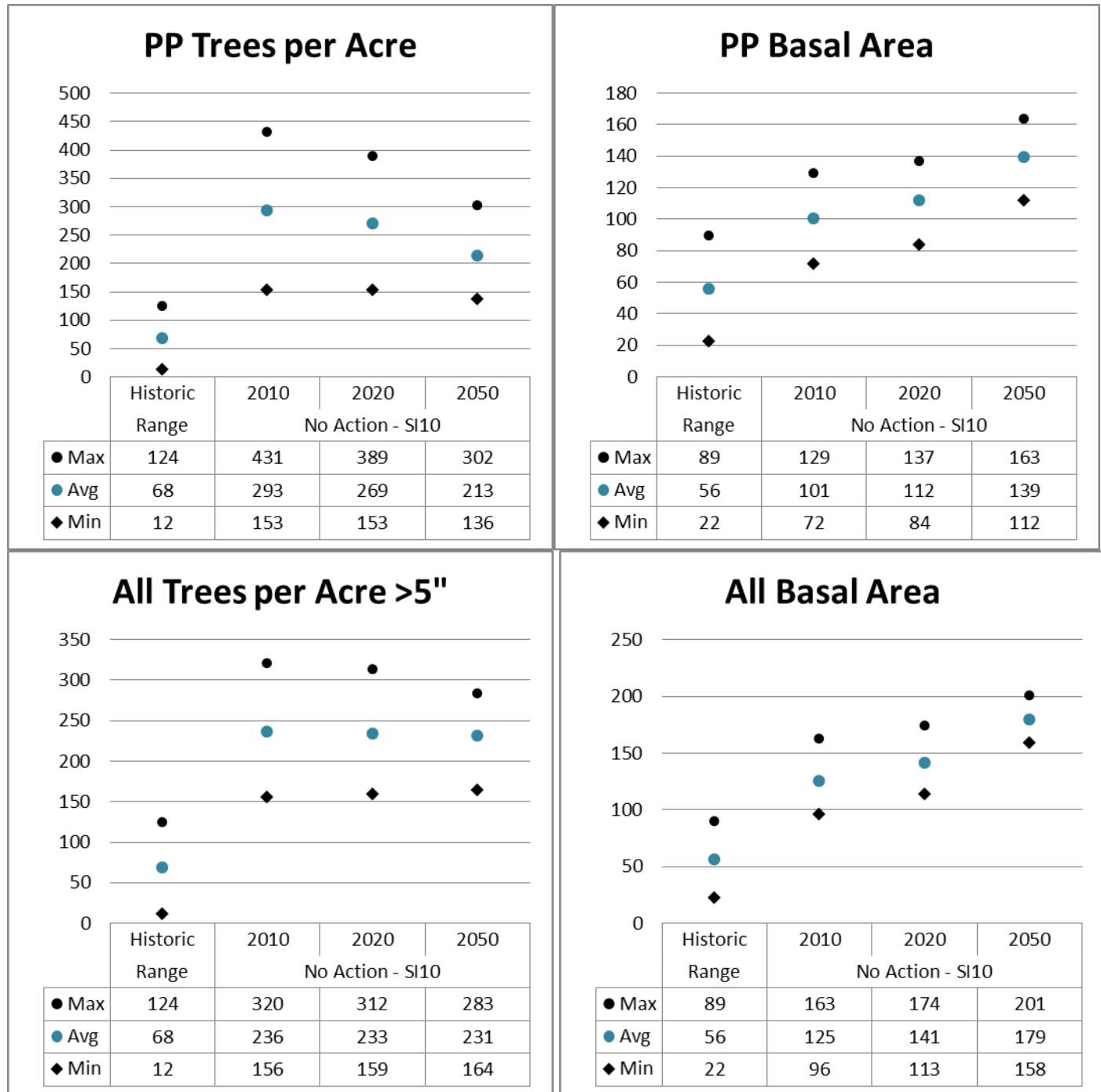
No Action (Alt C PFA Intermediate Thin – 25-40% Stands)



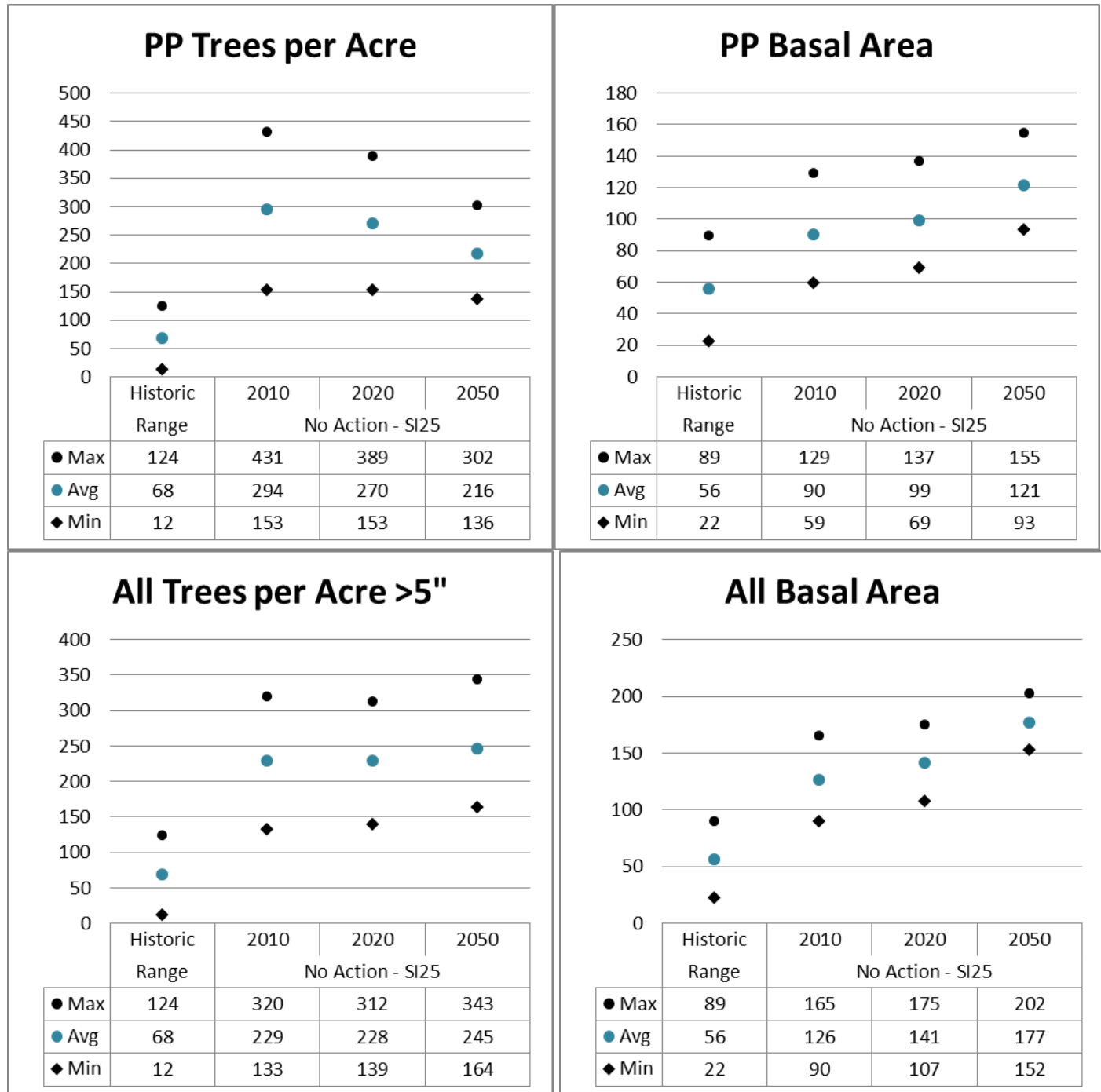
No Action (Alt C PFA Intermediate Thin – 40-55% Stands)



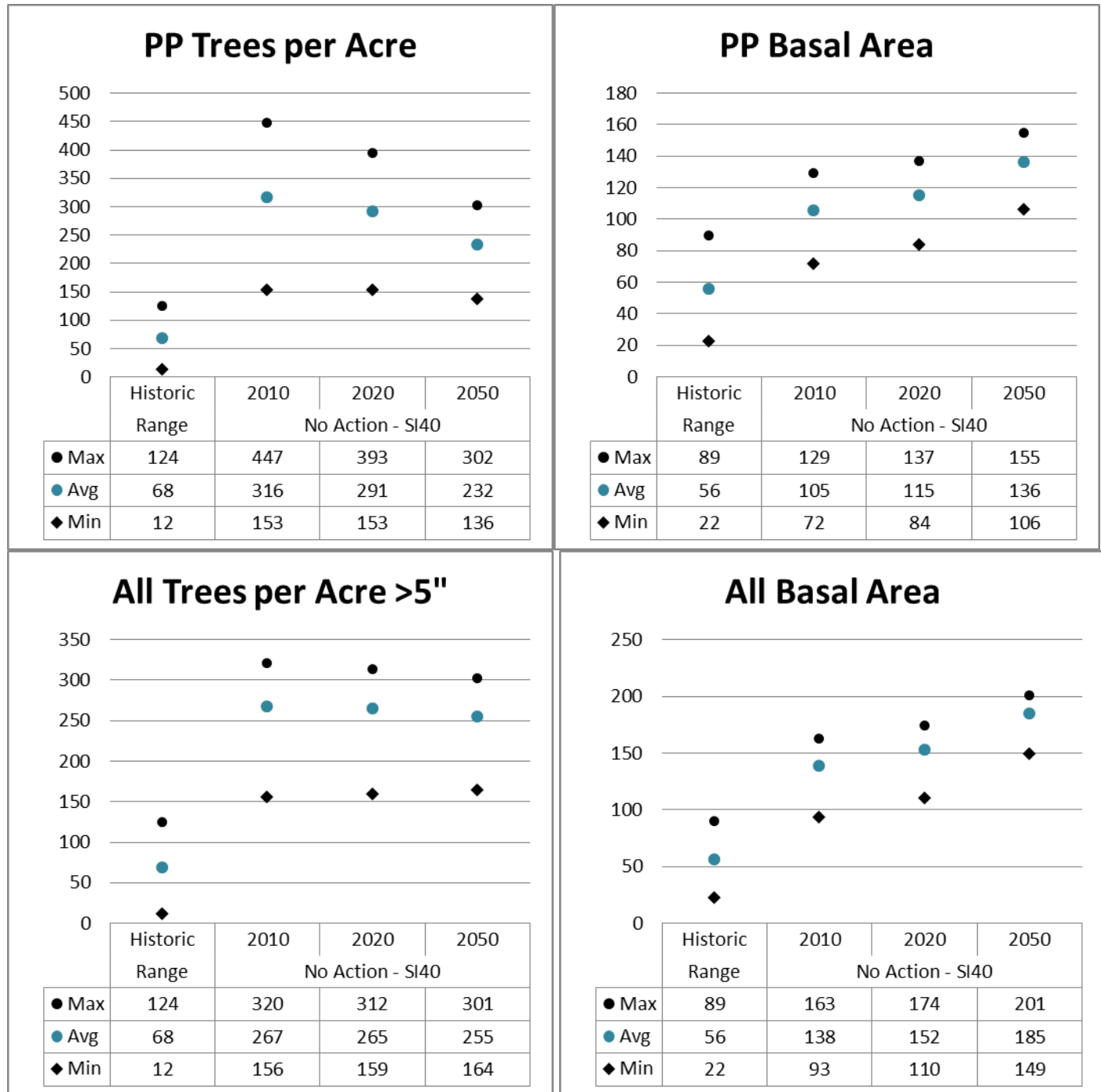
No Action (Alt C Stand Improvement – 10-25% Stands)



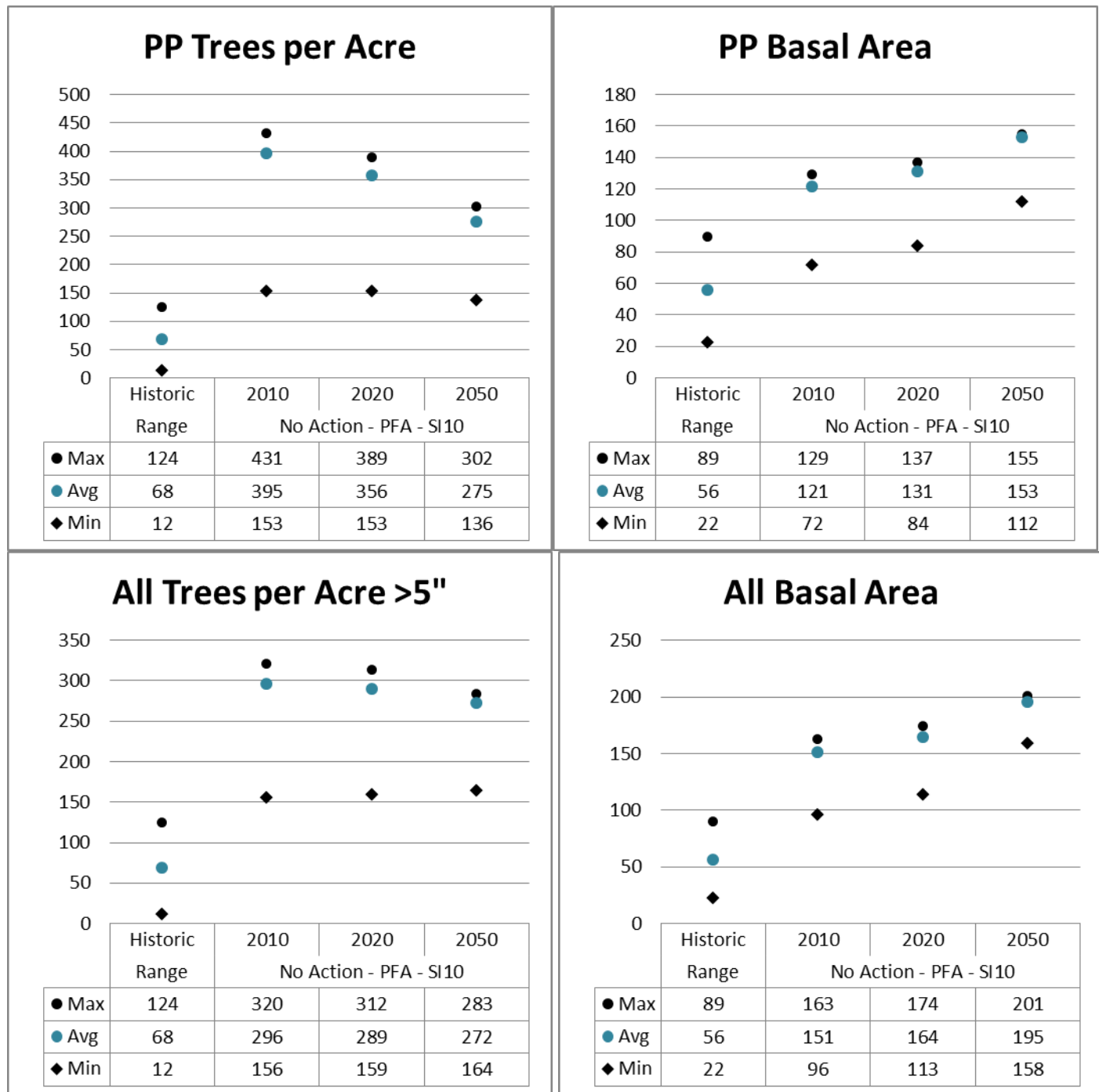
No Action (Alt C Stand Improvement – 25-40% Stands)



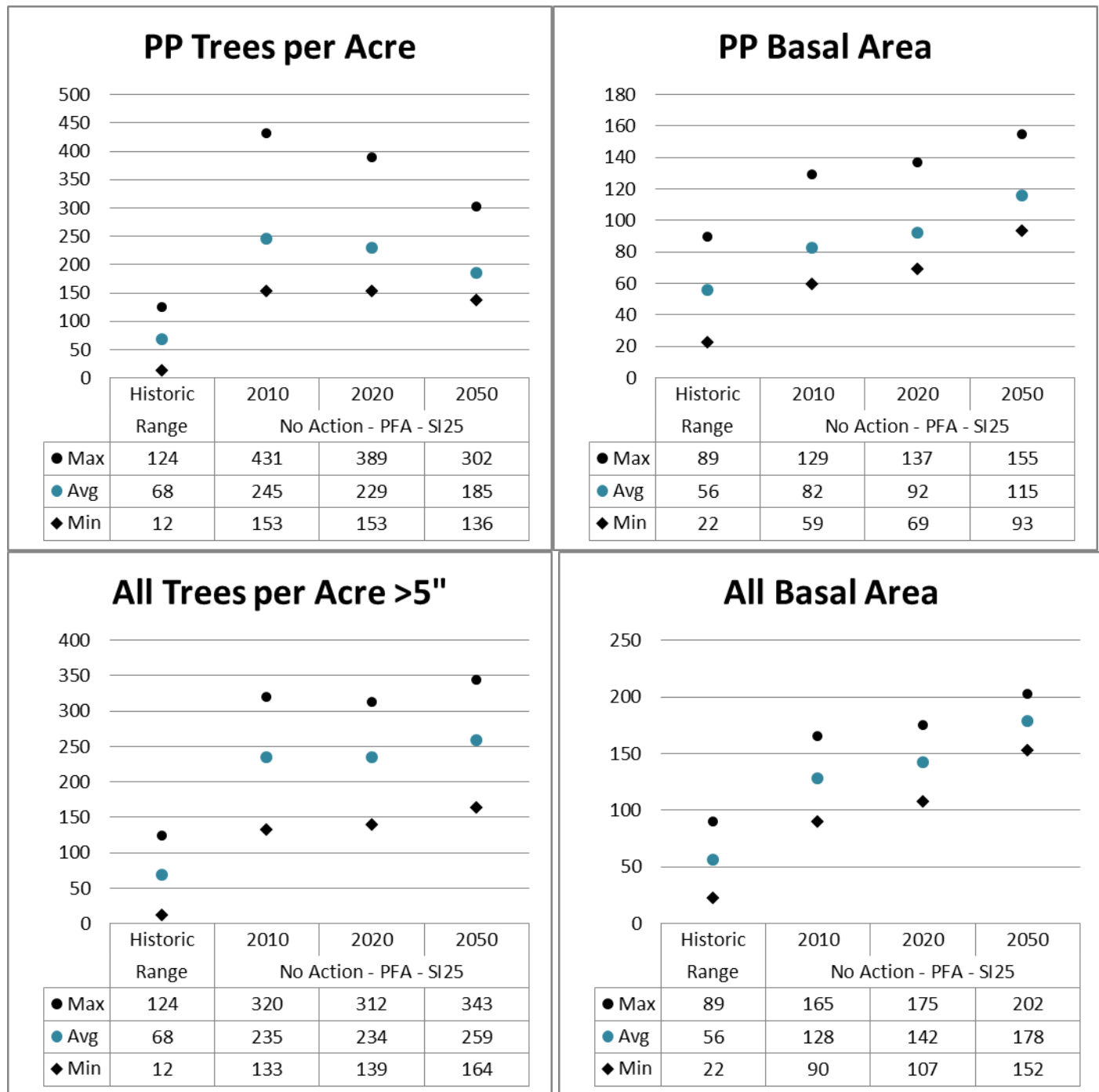
No Action (Alt C Stand Improvement – 40-55% Stands)



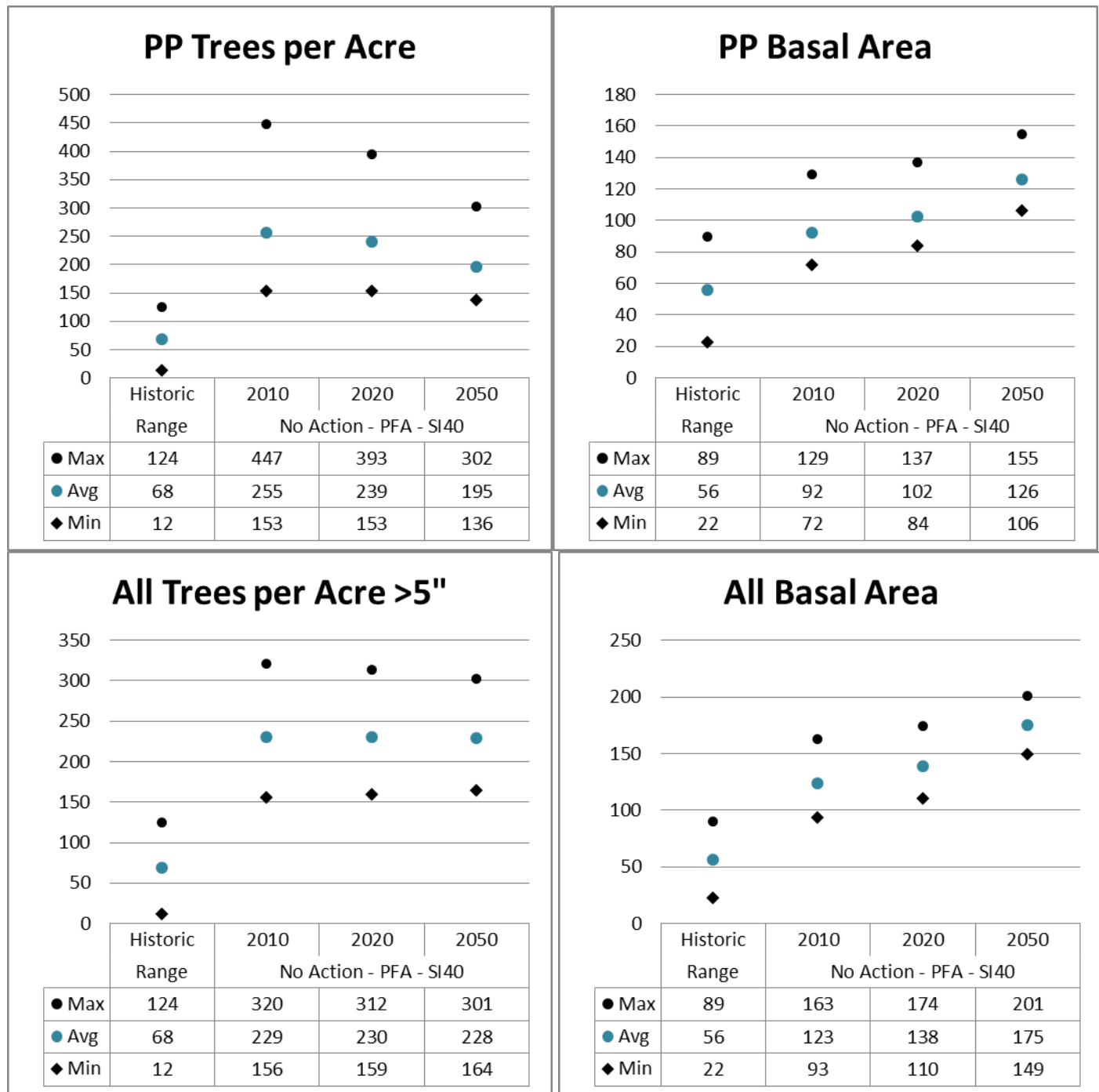
No Action (Alt C PFA Stand Improvement – 10-25% Stands)



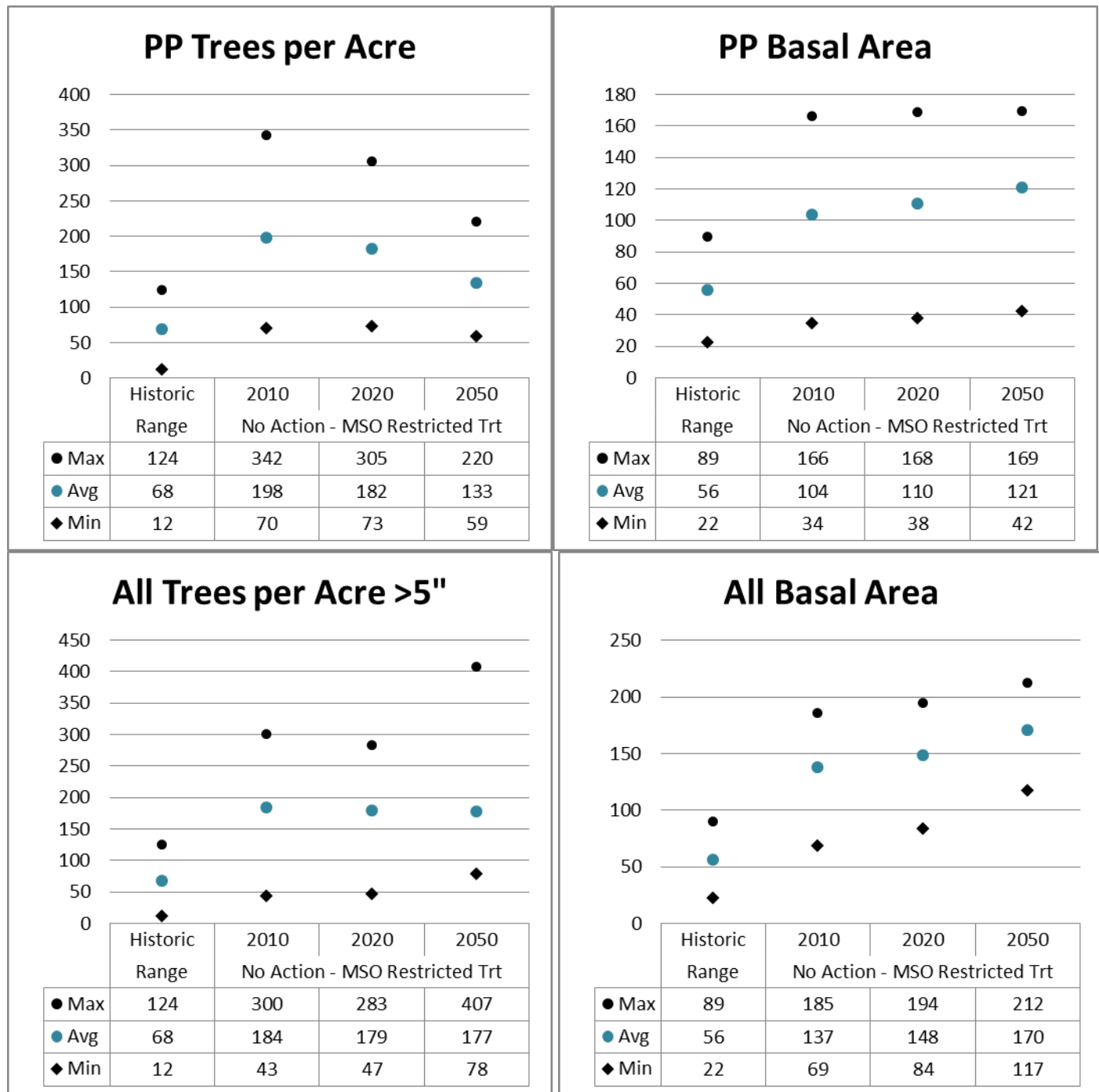
No Action (Alt C PFA Stand Improvement – 25-40% Stands)



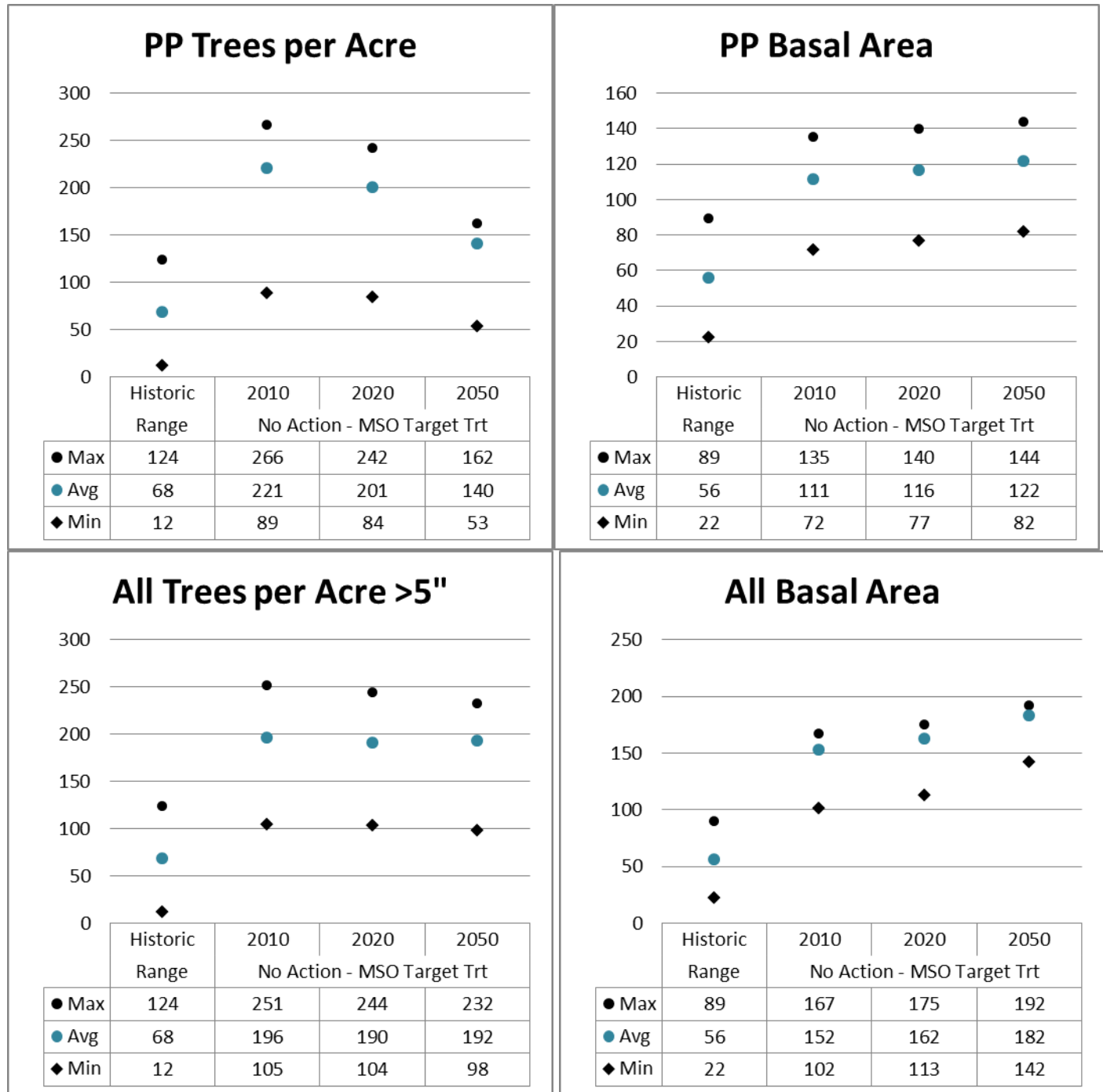
No Action (Alt C PFA Stand Improvement – 40-55% Stands)



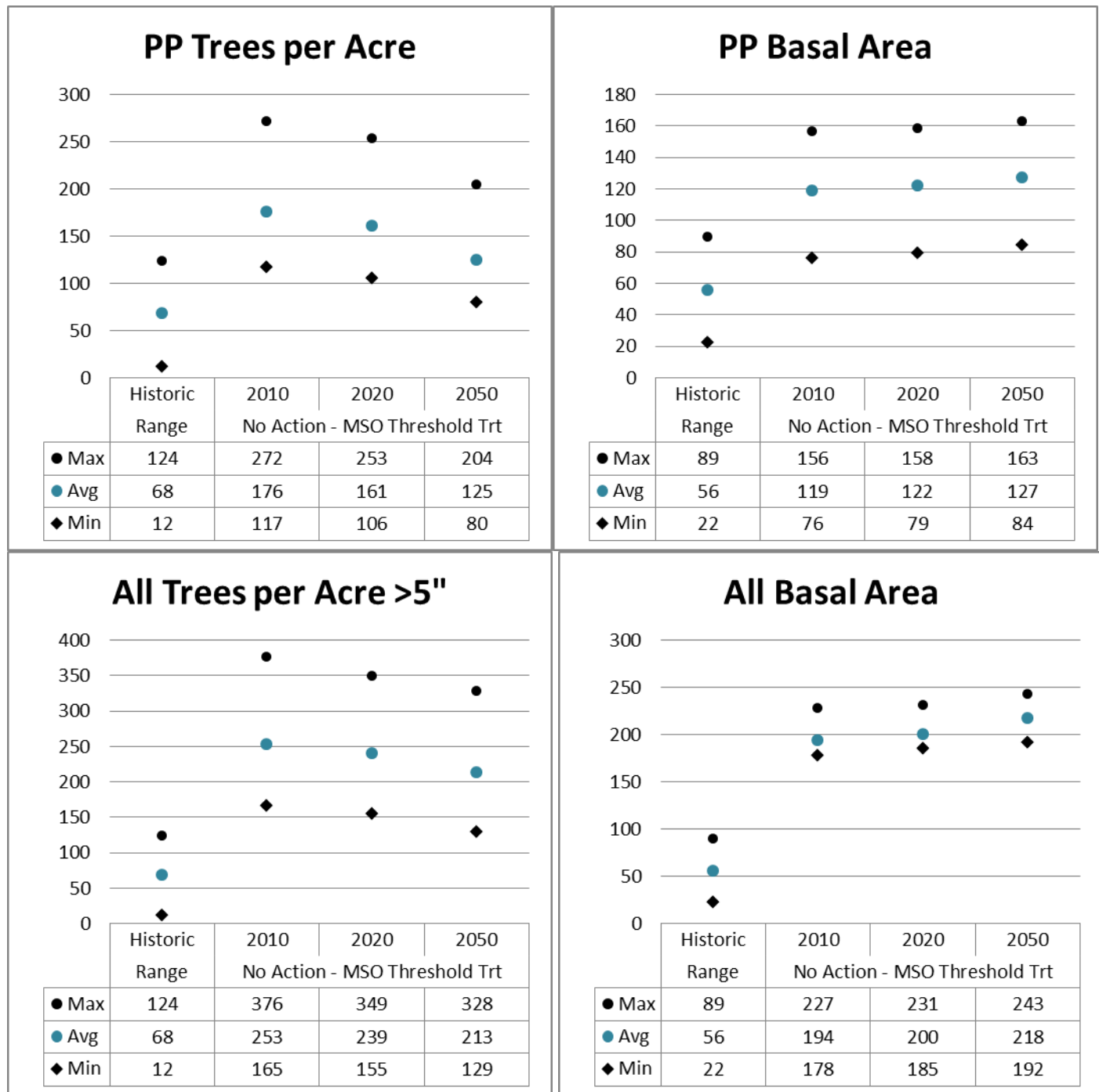
No Action (Alt C MSO Restricted Treatment Stands)



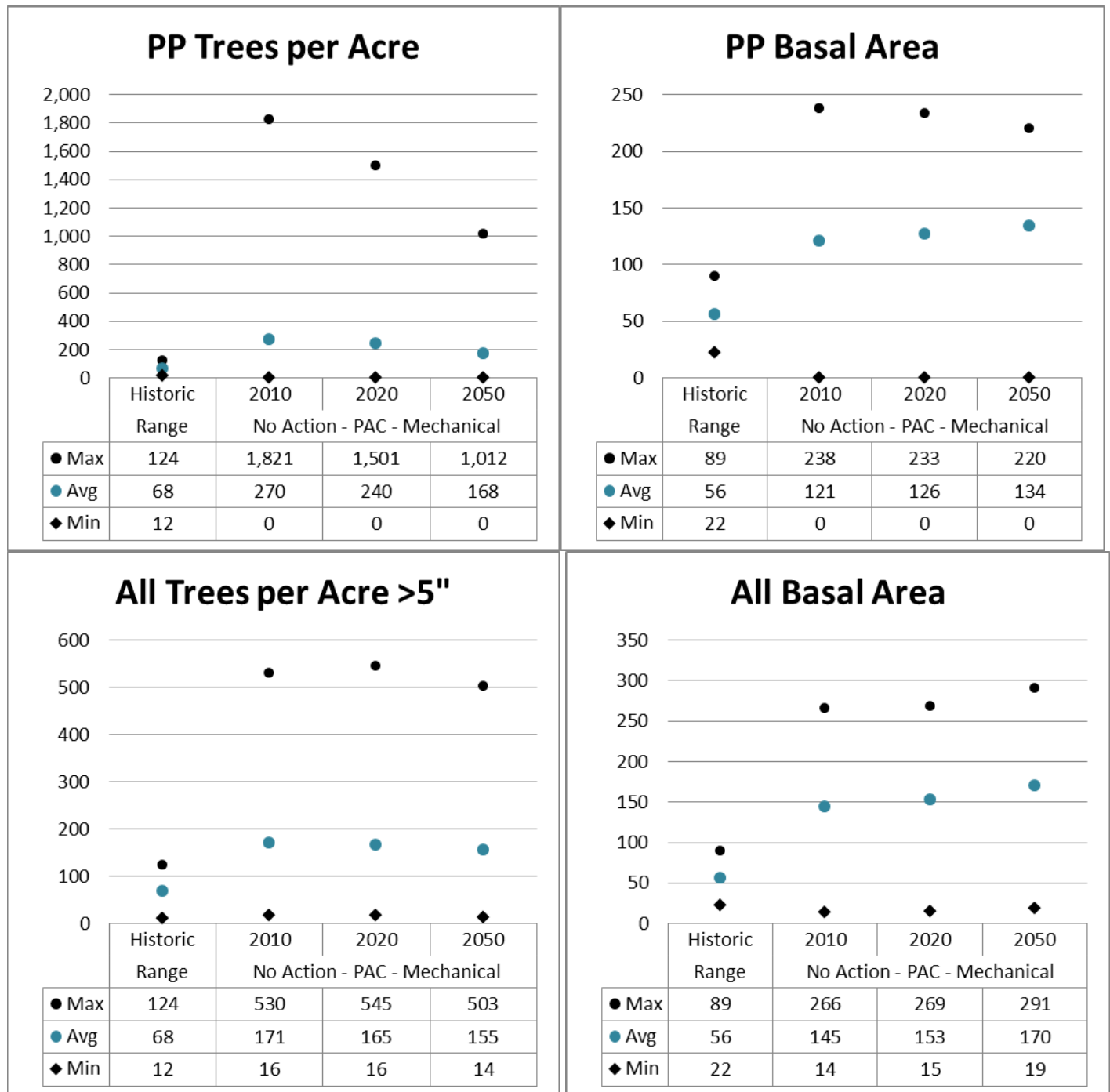
No Action (Alt C MSO Target Treatment Stands)



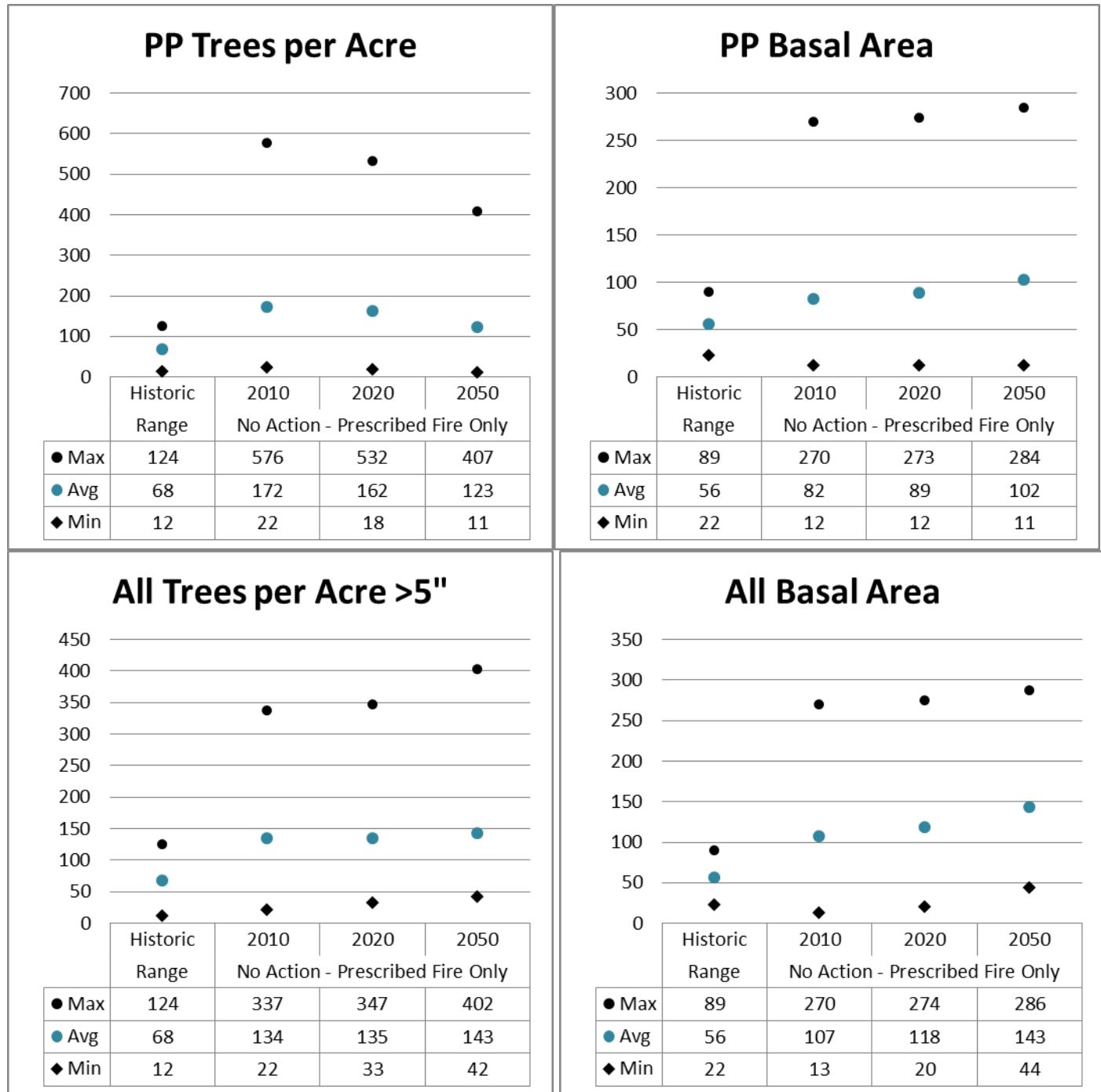
No Action (Alt C MSO Threshold Treatment Stands)



No Action (Alt C PAC – Mechanical Stands)

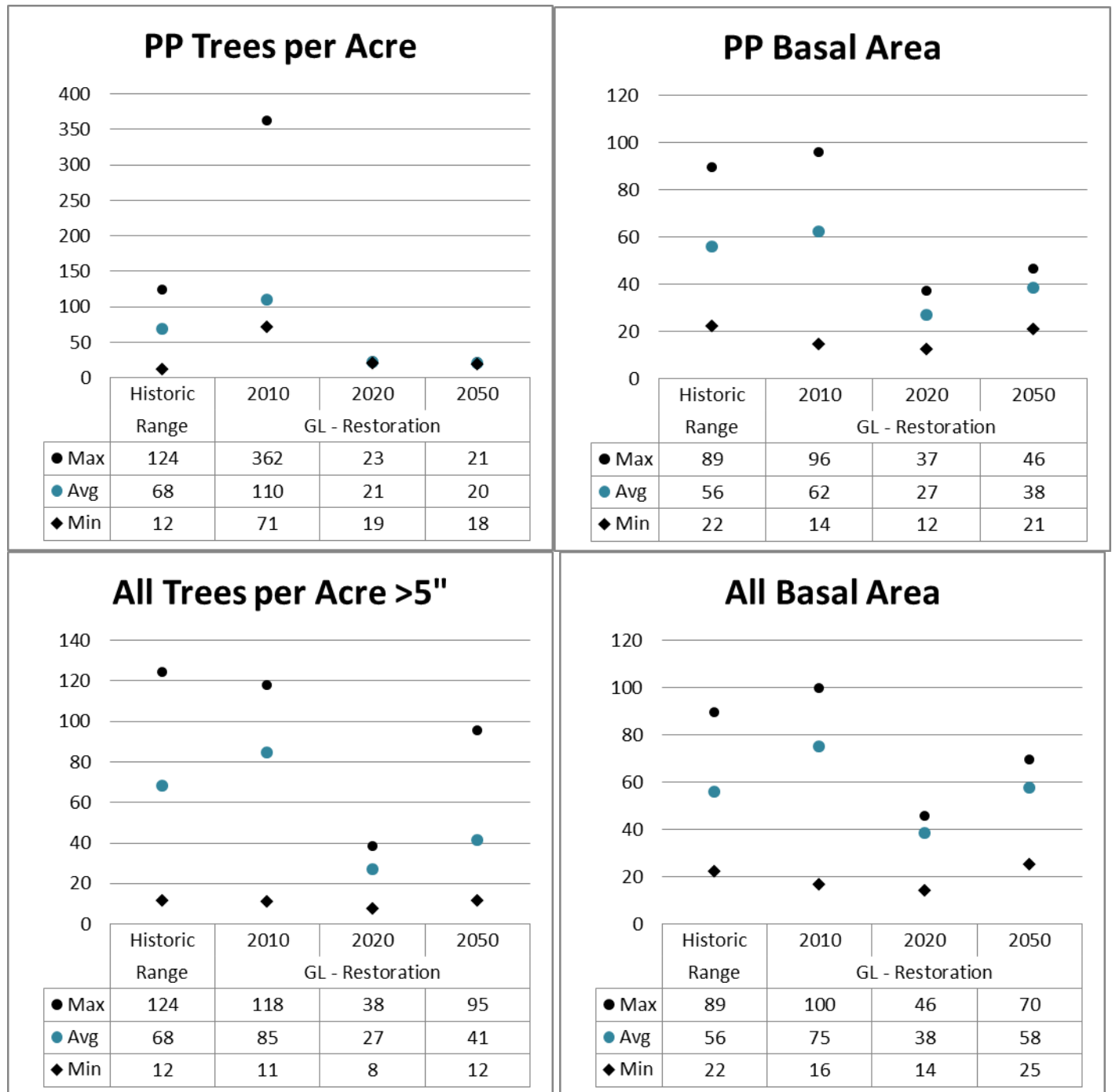


No Action (Alt C Prescribed Fire Only Stands)



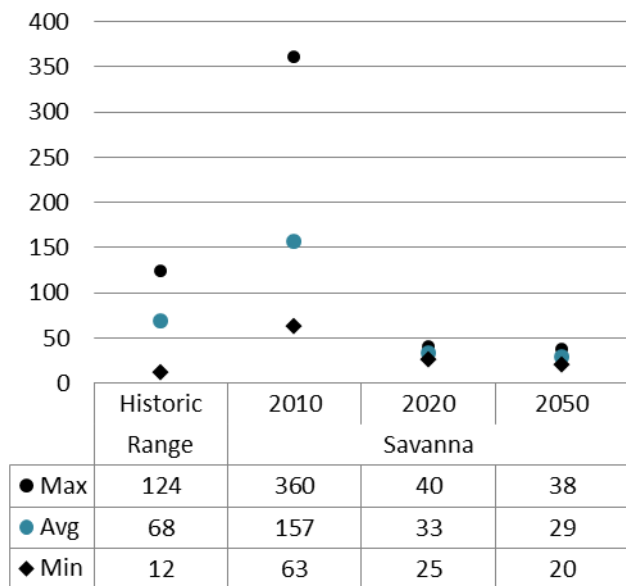
Appendix D - Natural Range of Variability Comparison by Treatment Type (Alt B)

Grassland Restoration

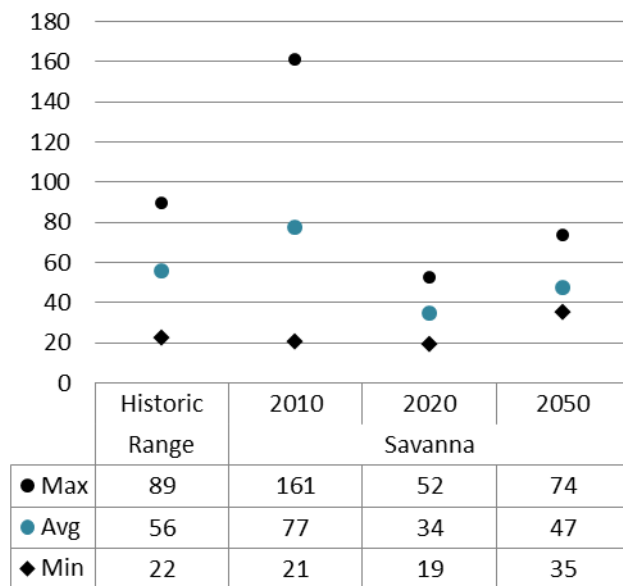


Savanna

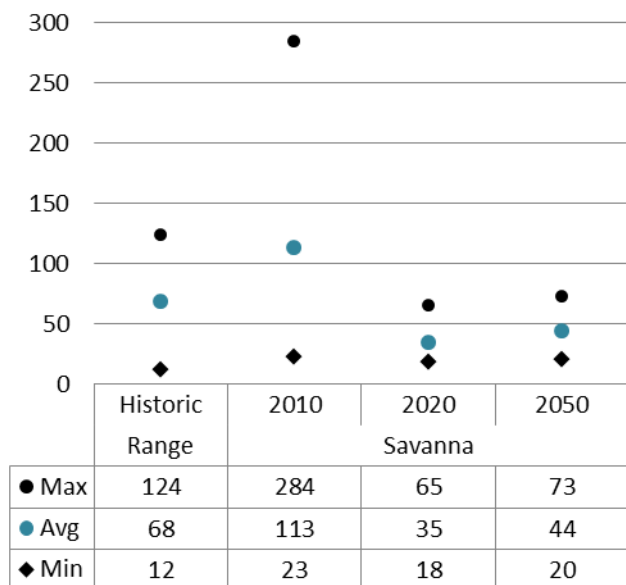
PP Trees per Acre



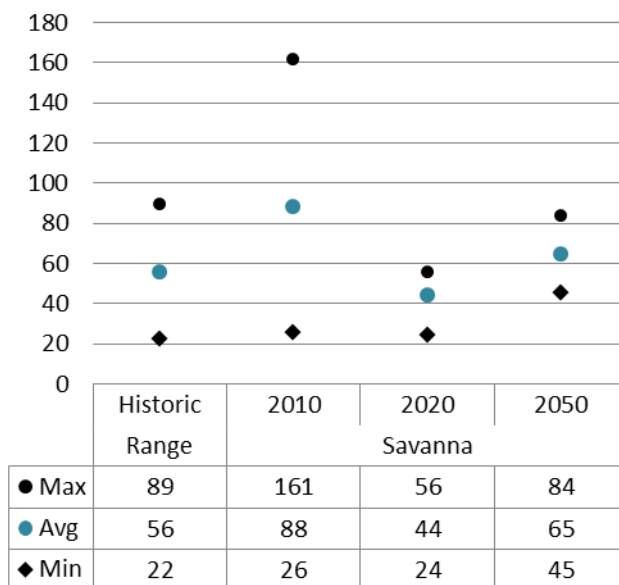
PP Basal Area



All Trees per Acre >5"

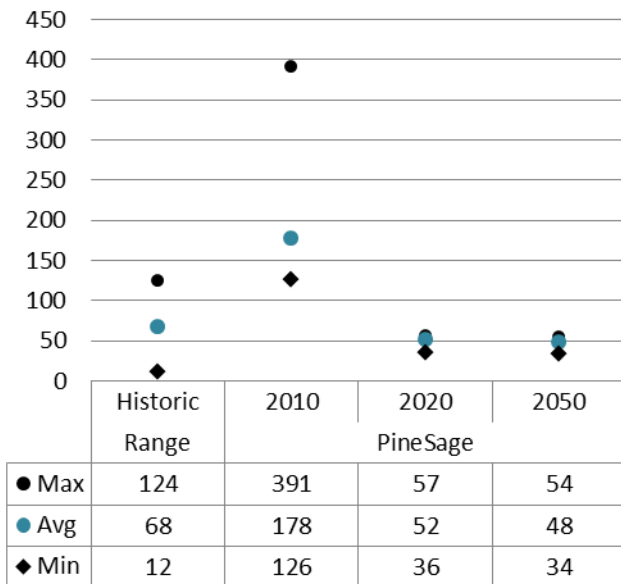


All Basal Area

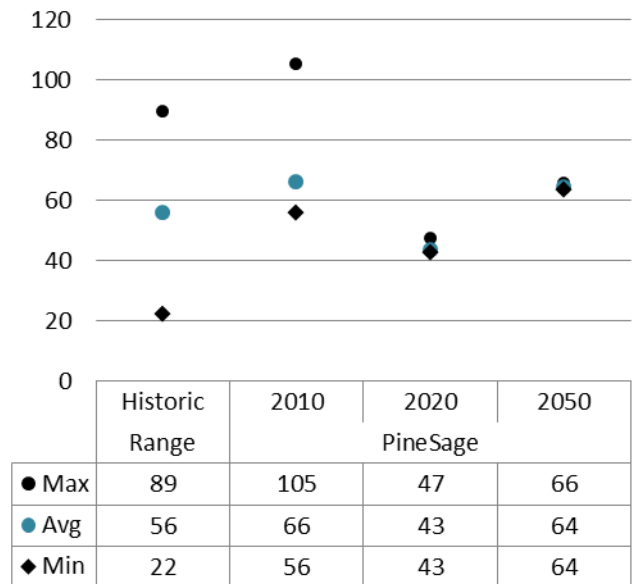


Pine-Sage

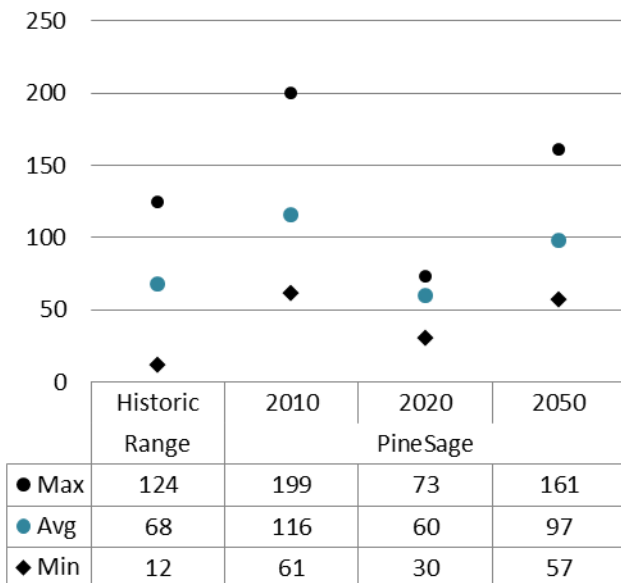
PP Trees per Acre



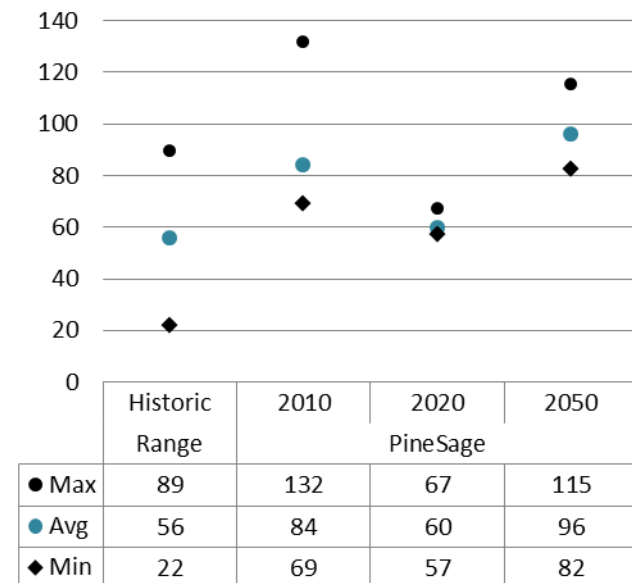
PP Basal Area



All Trees per Acre >5"

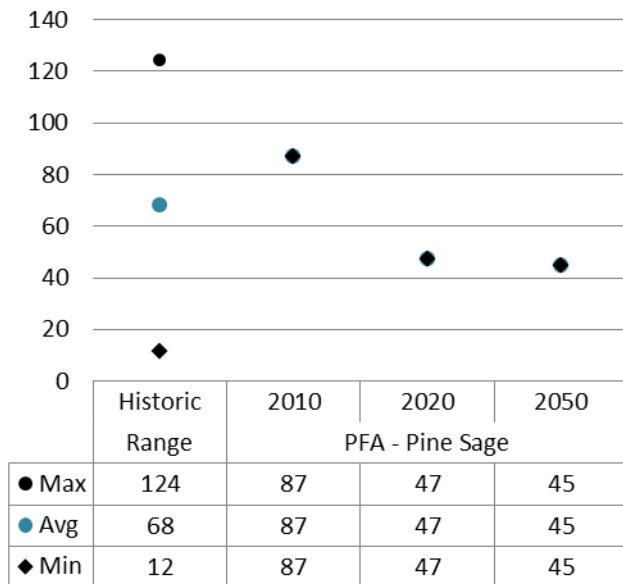


All Basal Area

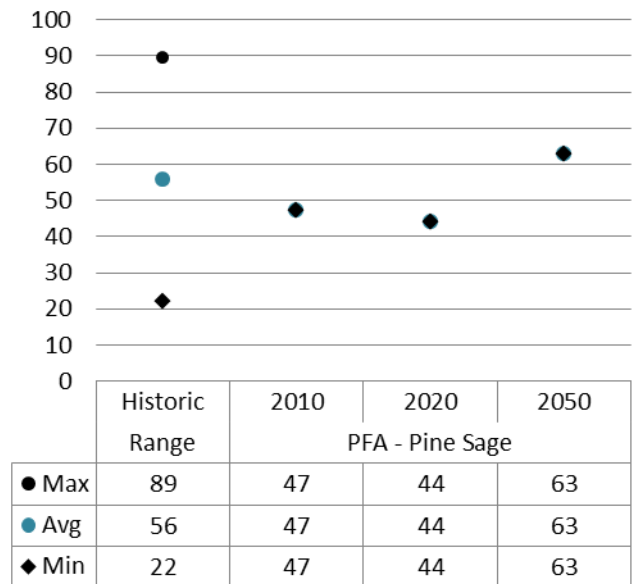


PFA Pine-Sage

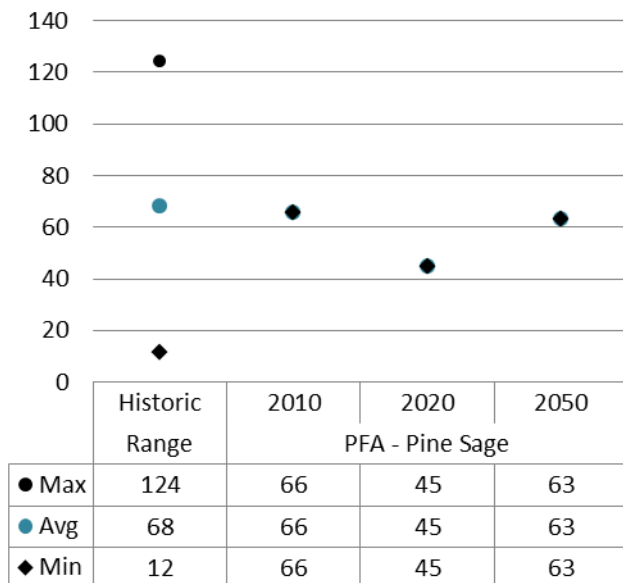
PP Trees per Acre



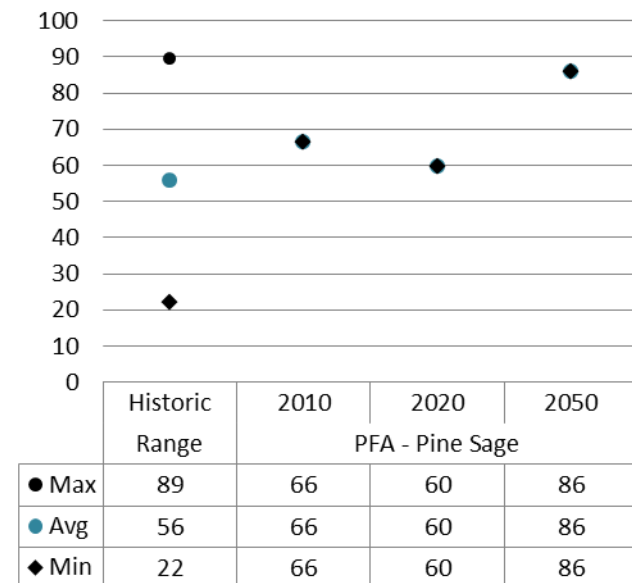
PP Basal Area



All Trees per Acre >5"

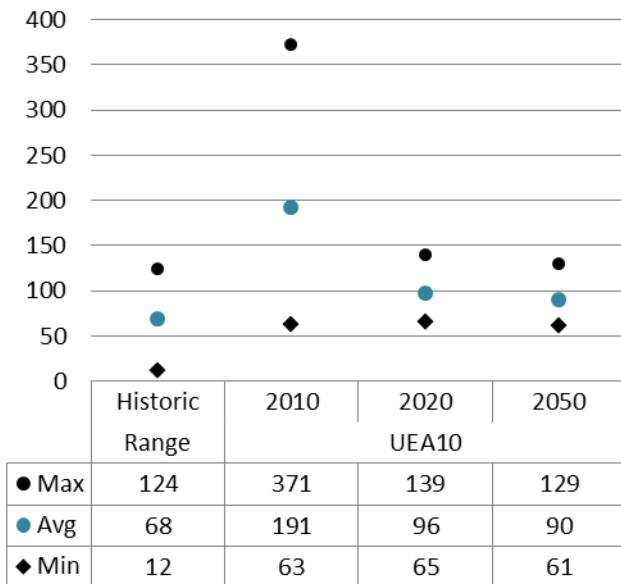


All Basal Area

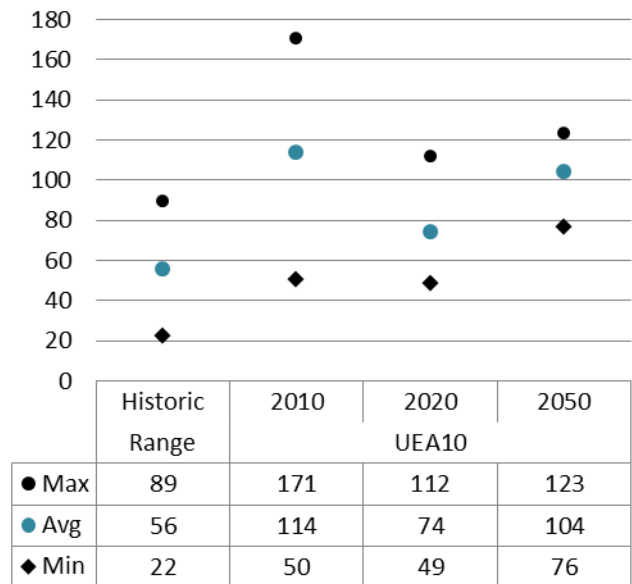


Uneven Age – 10-25%

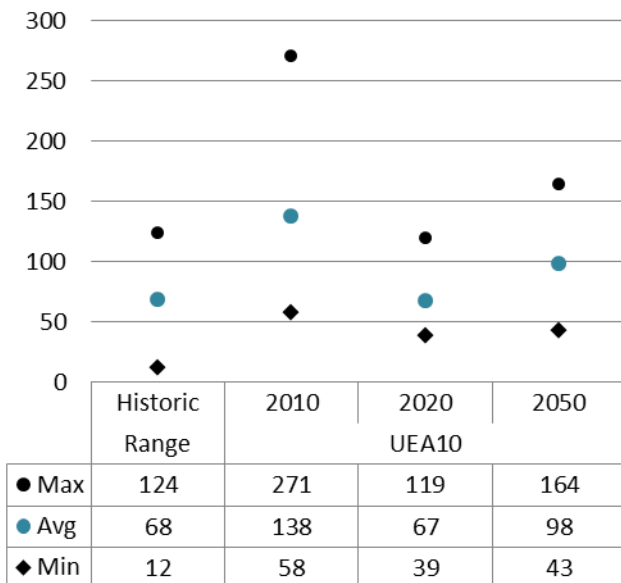
PP Trees per Acre



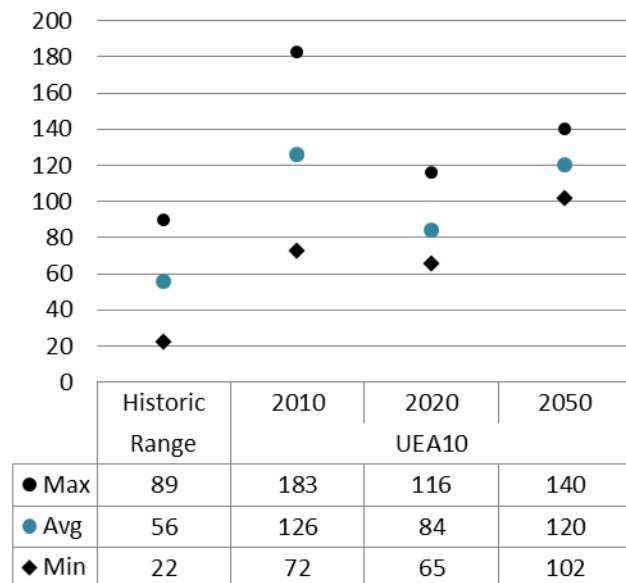
PP Basal Area



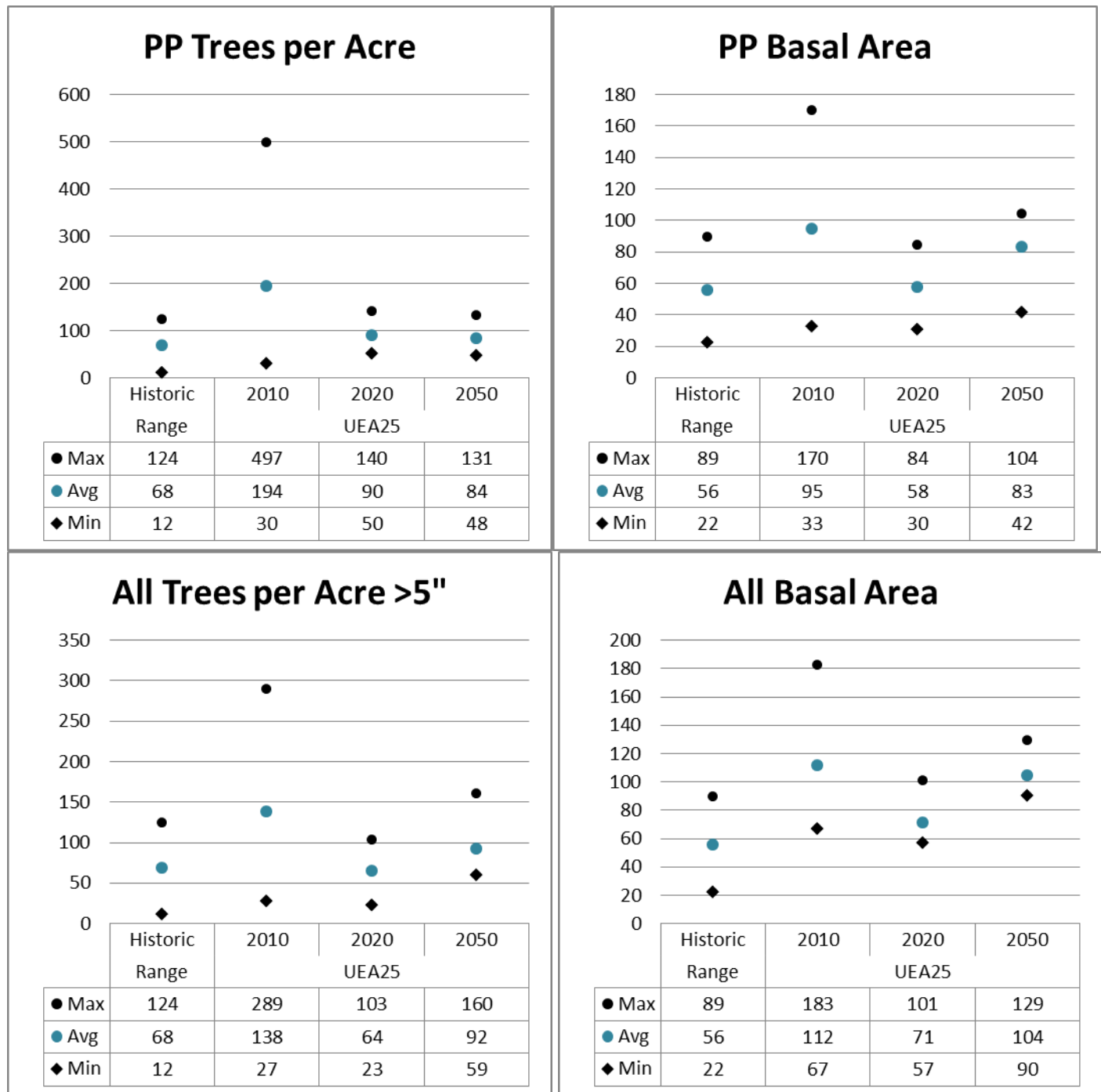
All Trees per Acre >5"



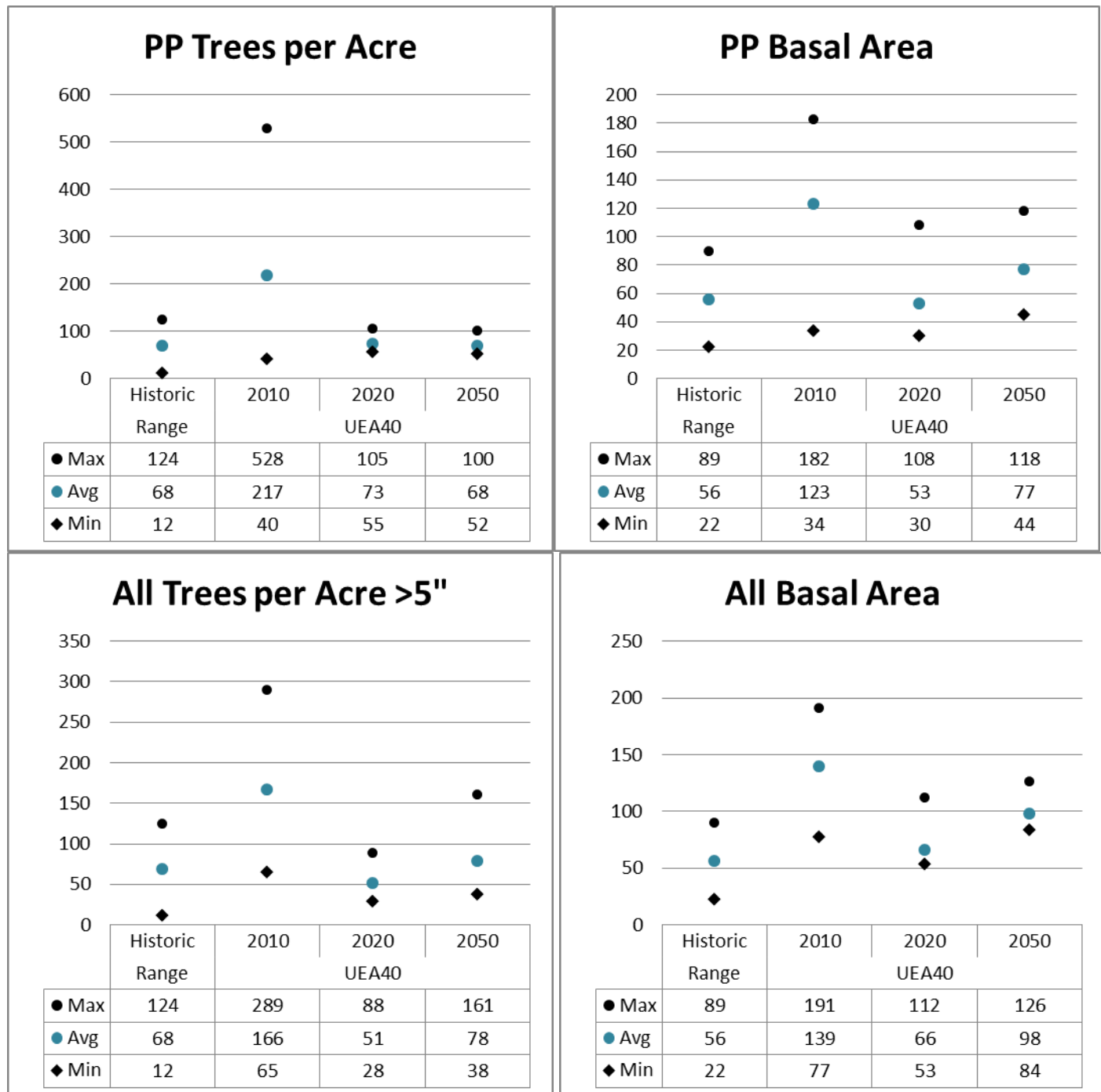
All Basal Area



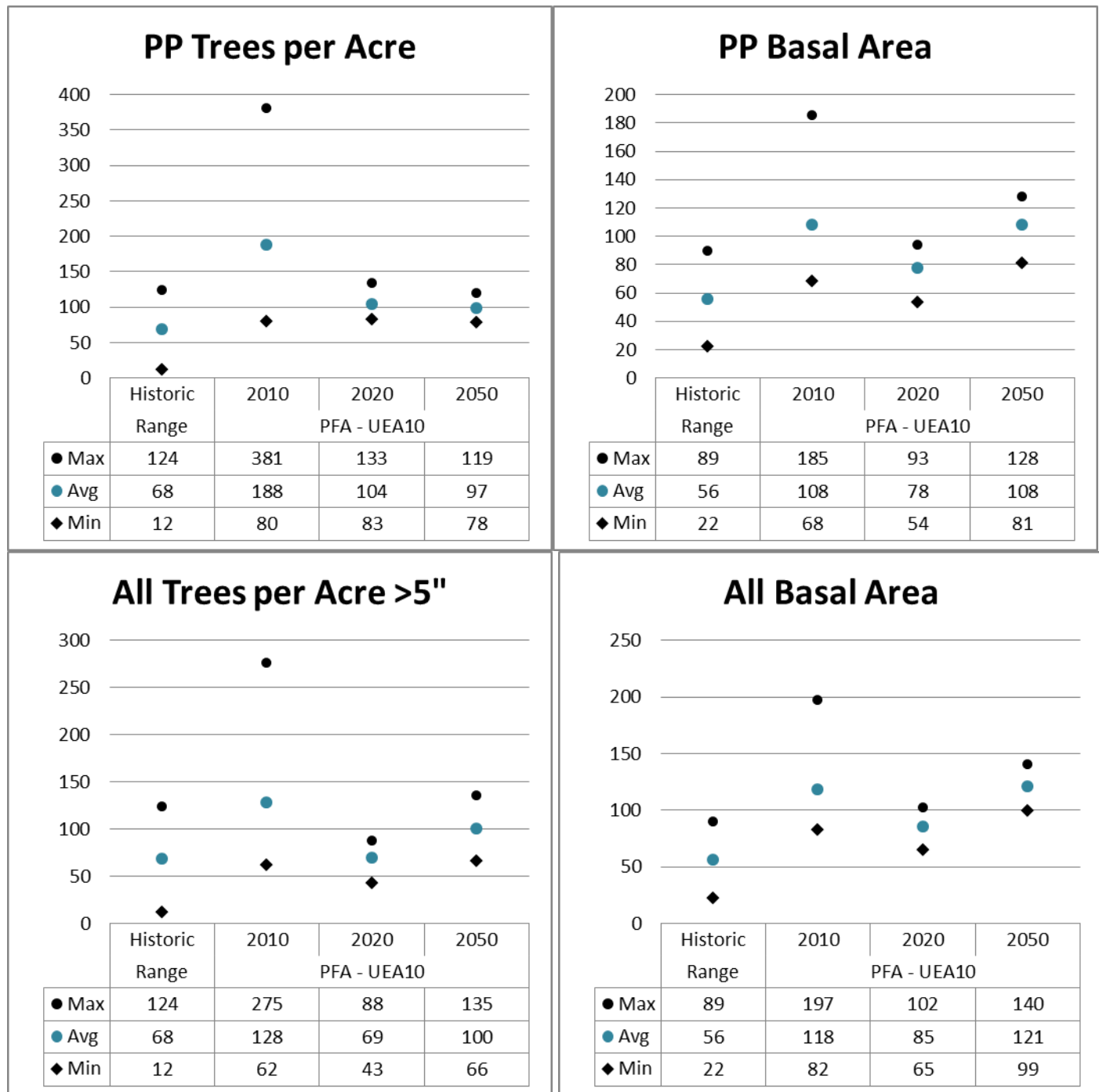
Uneven Age – 25-40%



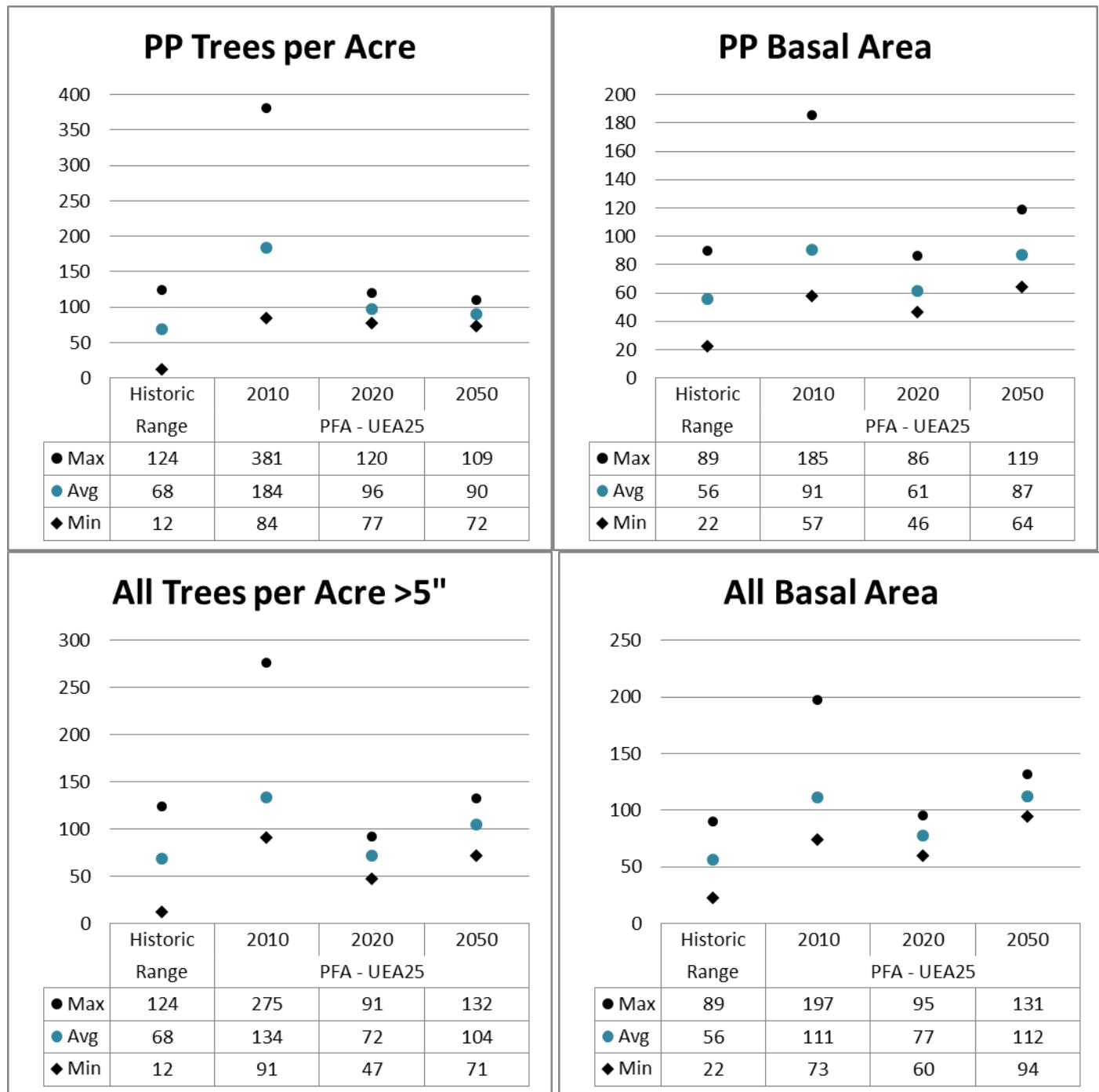
Uneven Age – 40-55%



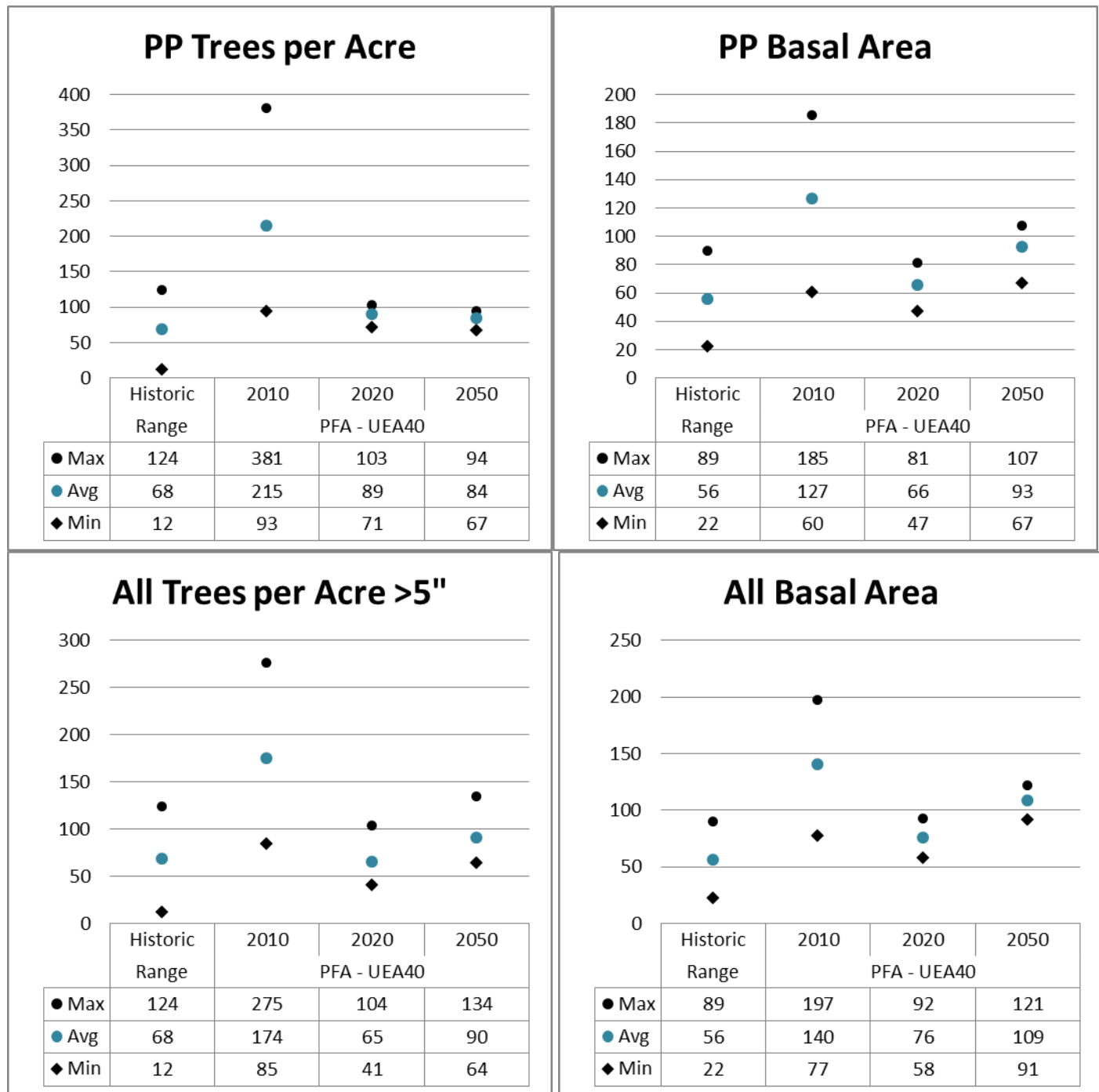
PFA Uneven Age – 10-25%



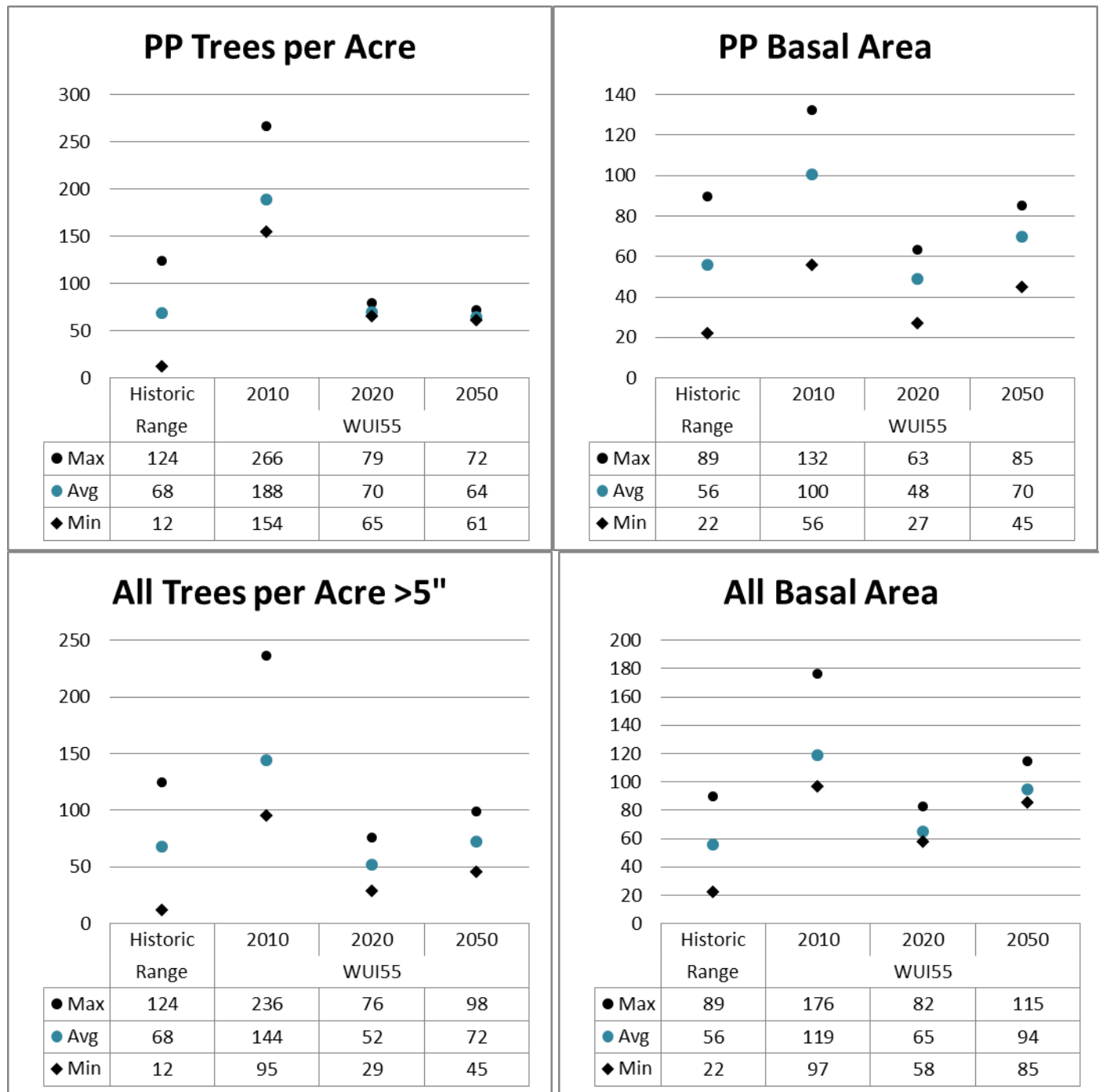
PFA Uneven Age – 25-40%



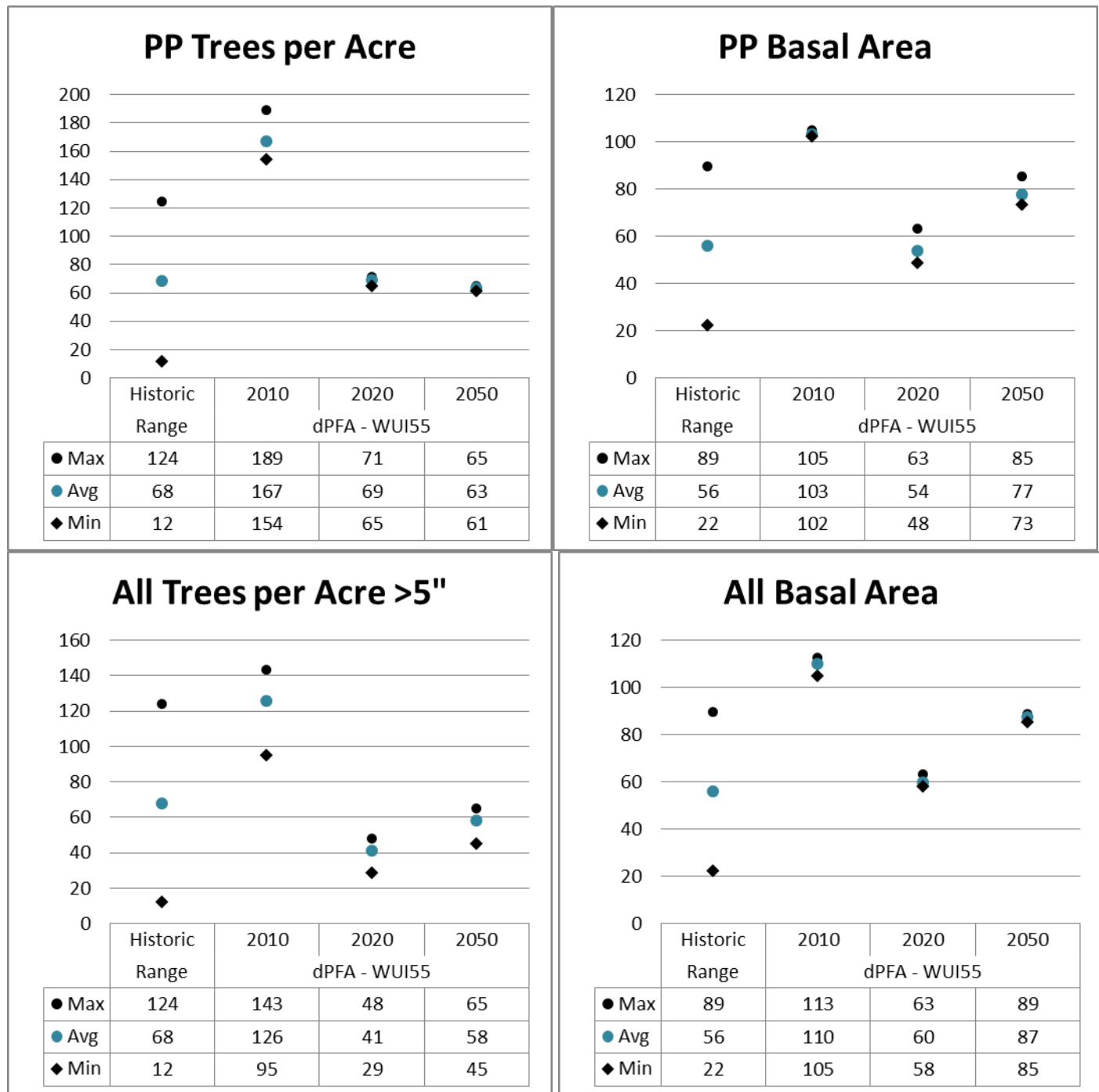
PFA Uneven Age – 40-55%



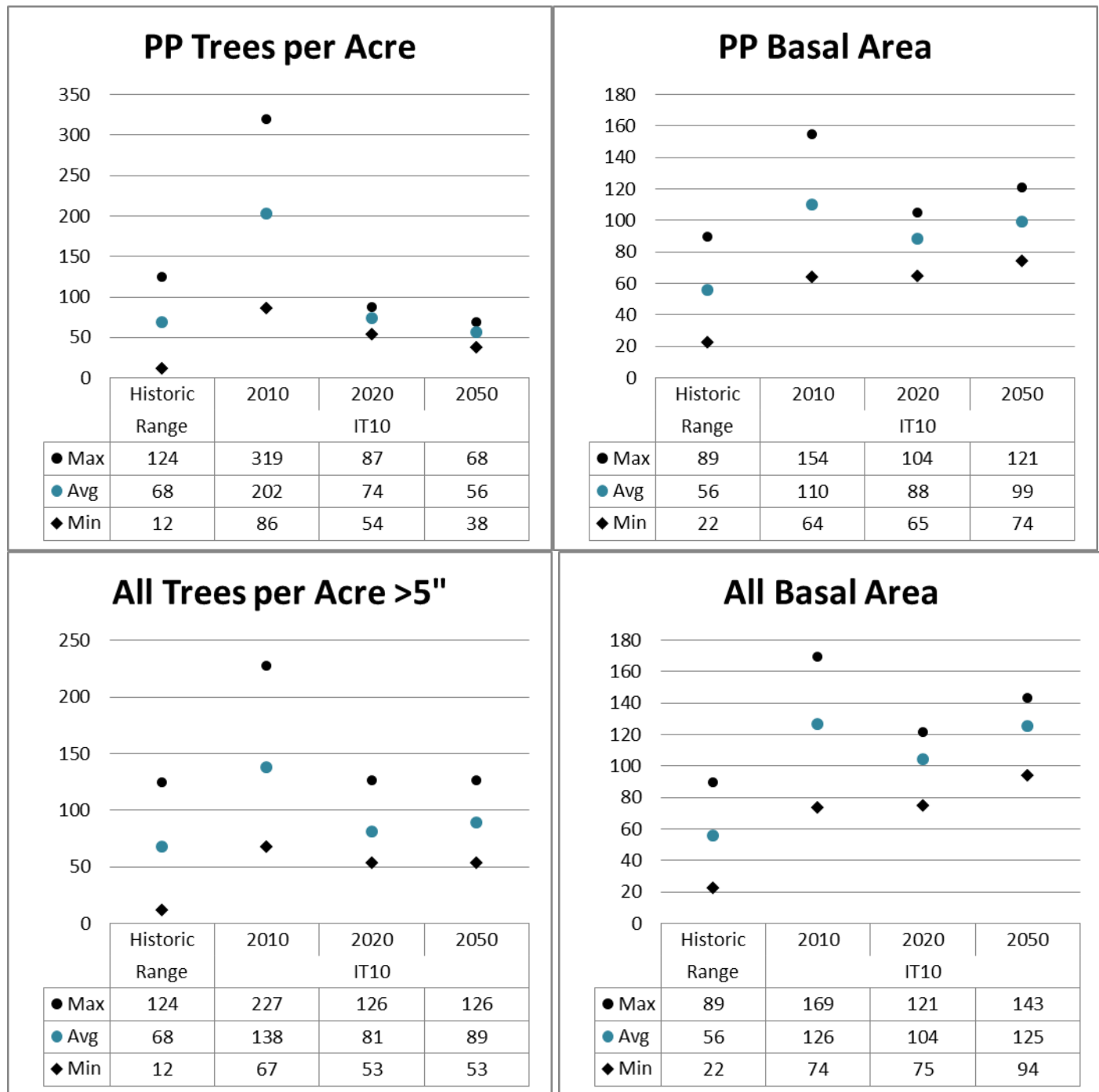
Uneven Age – Wildland Urban Interface 55%



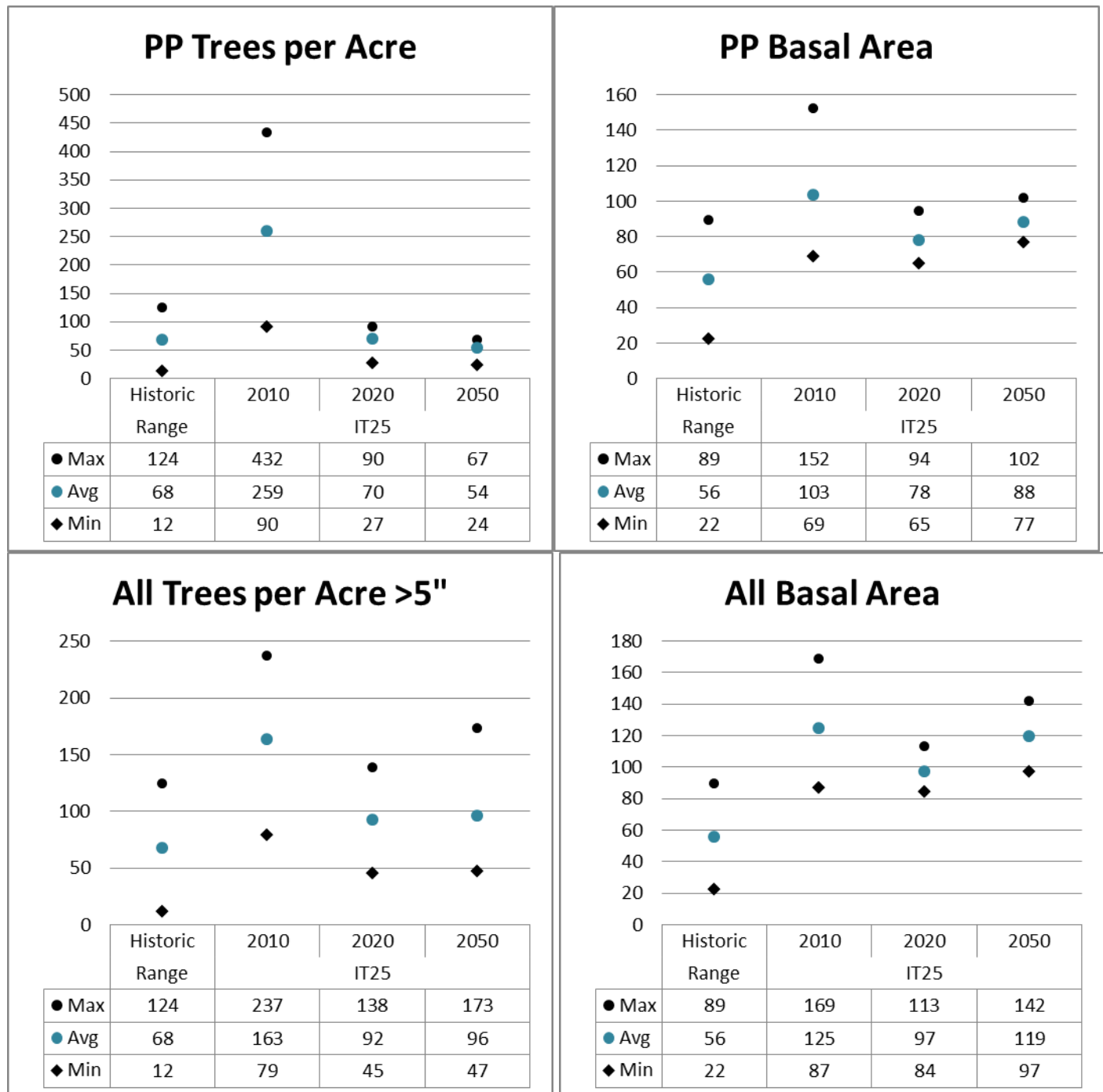
Dispersal PFA Uneven Age – Wildland Urban Interface 55%



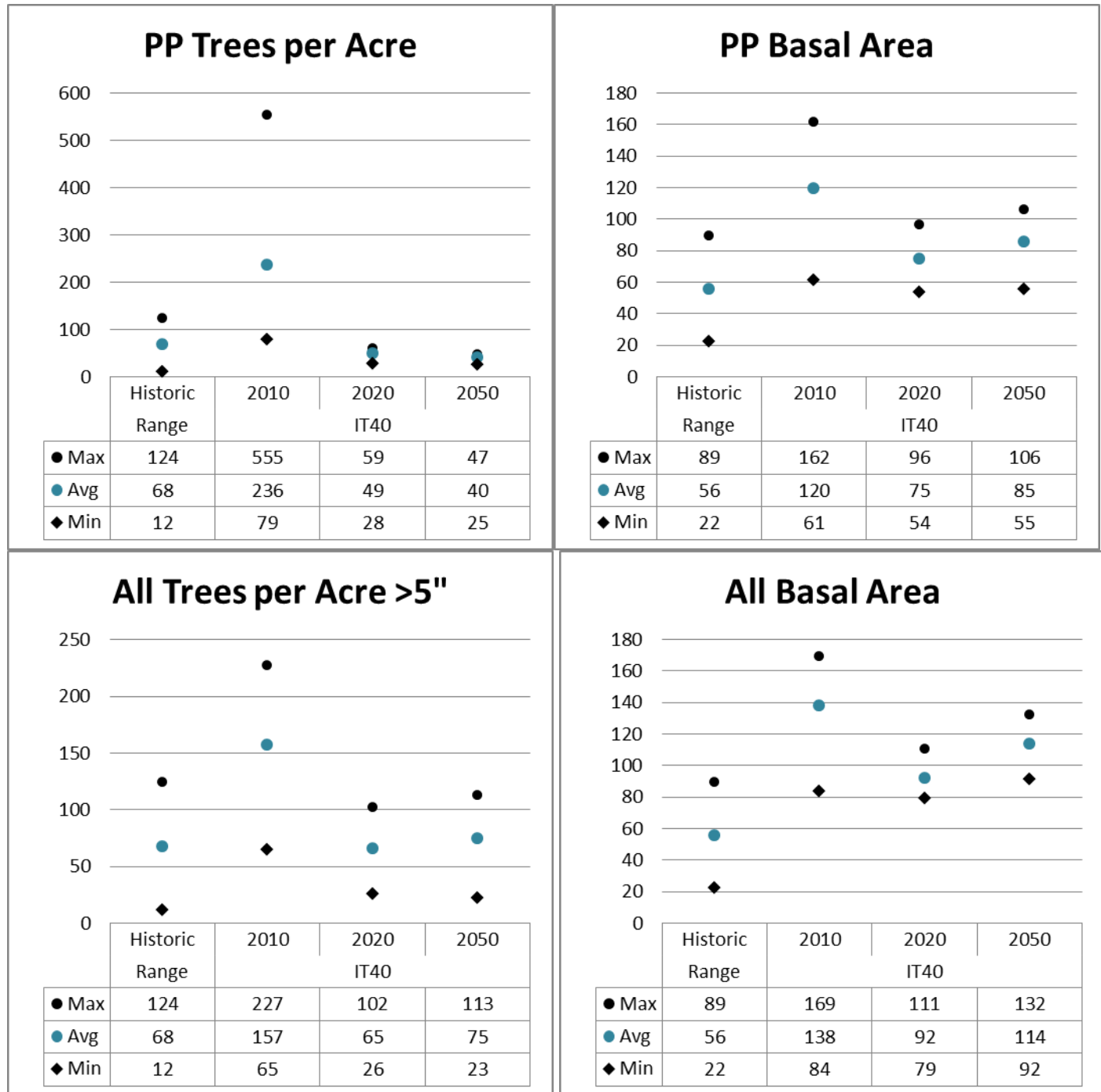
Intermediate Thin – 10-25%



Intermediate Thin – 25-40%

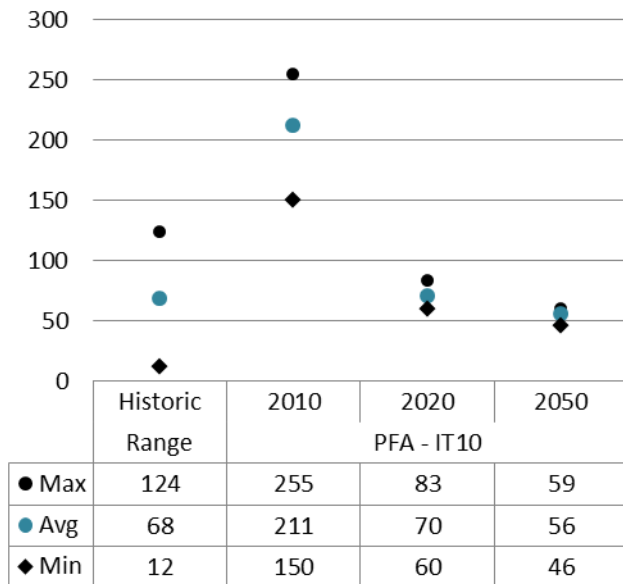


Intermediate Thin – 40-55%

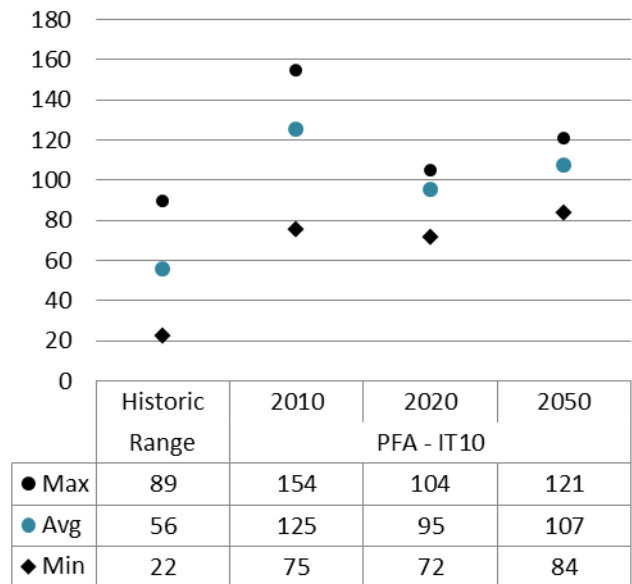


PFA Intermediate Thin – 10-25%

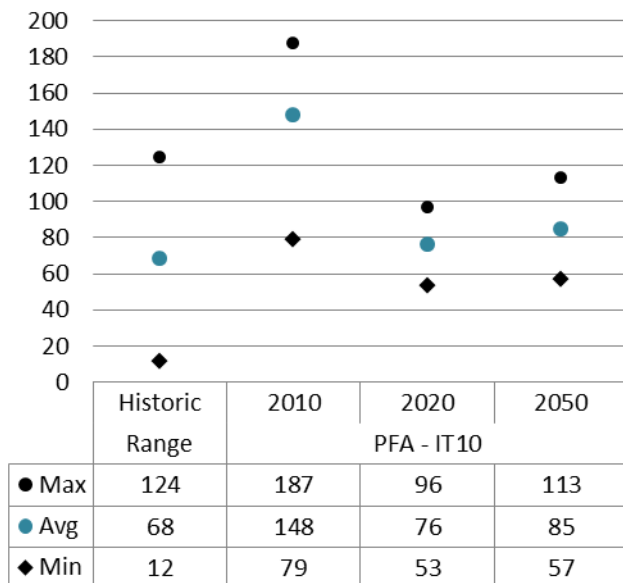
PP Trees per Acre



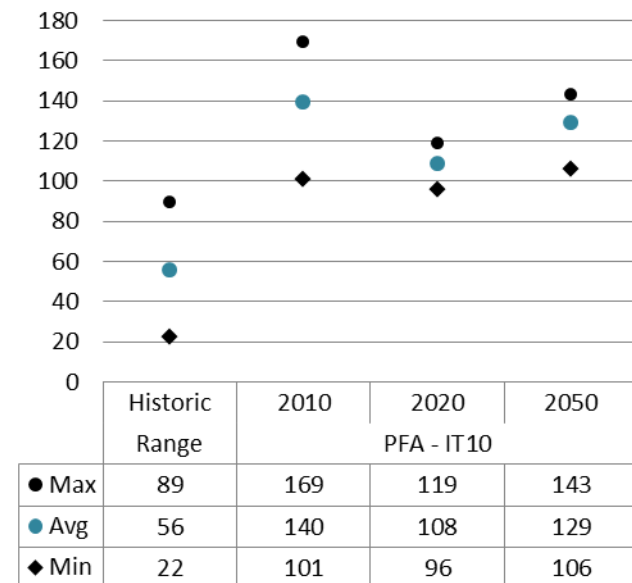
PP Basal Area



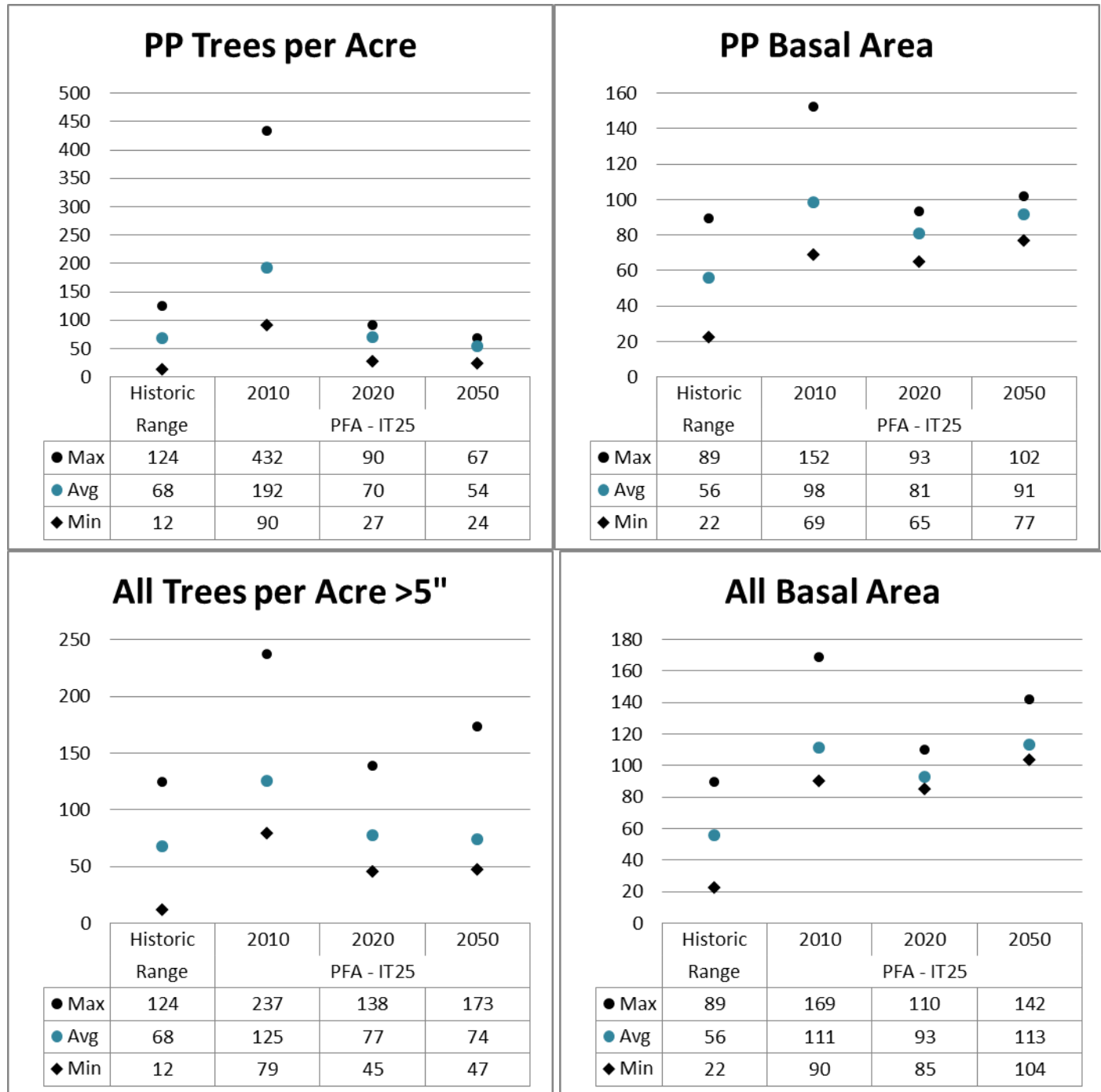
All Trees per Acre >5"



All Basal Area

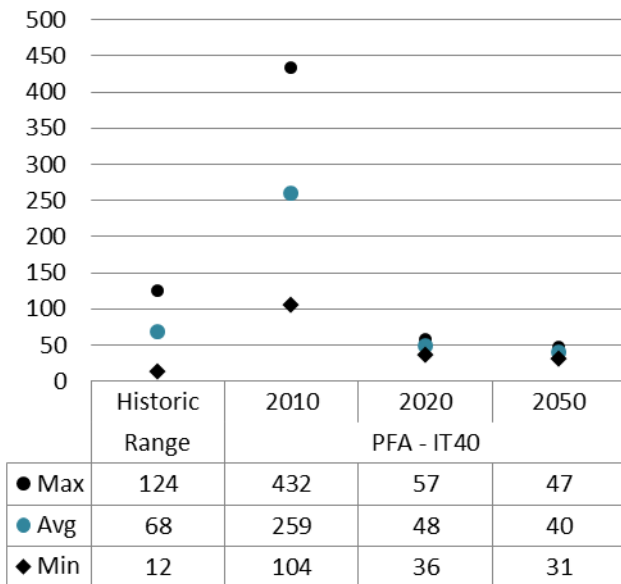


PFA Intermediate Thin – 25-40%

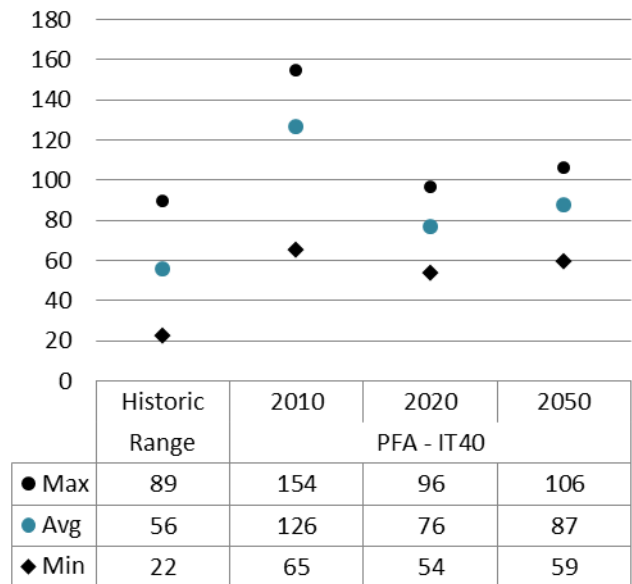


PFA Intermediate Thin – 40-55%

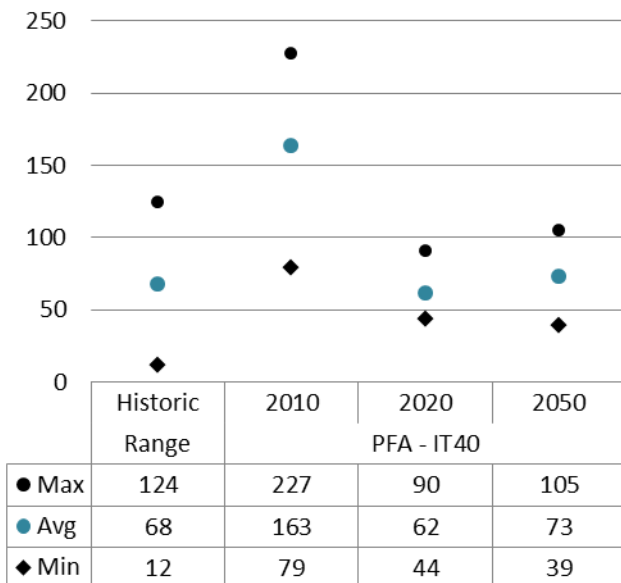
PP Trees per Acre



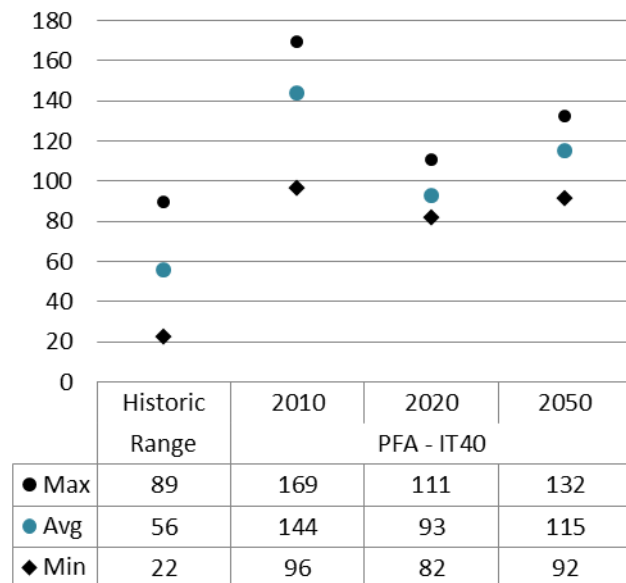
PP Basal Area



All Trees per Acre >5"

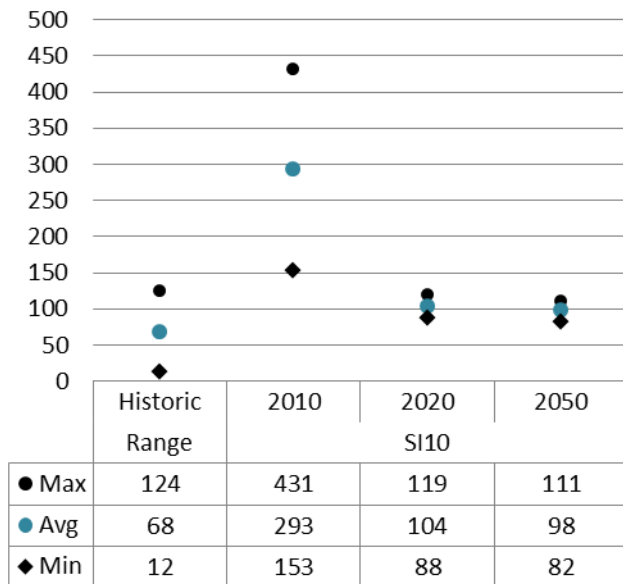


All Basal Area

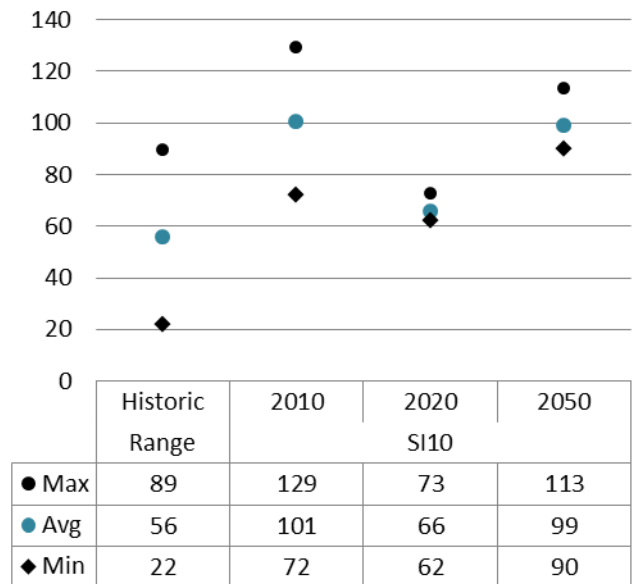


Stand Improvement – 10-25%

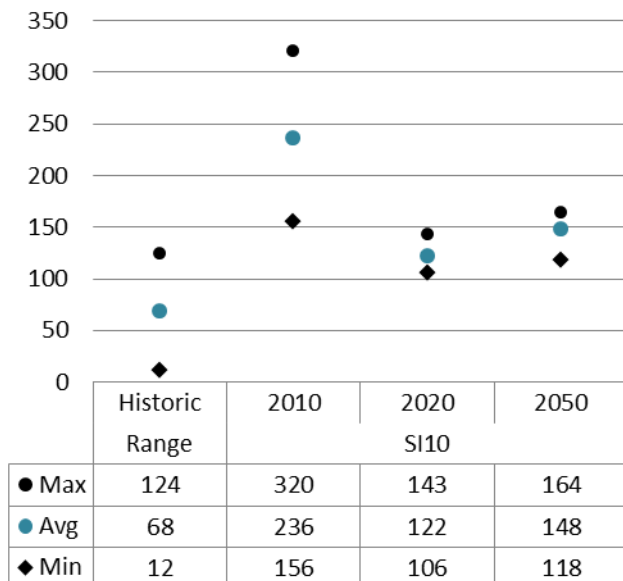
PP Trees per Acre



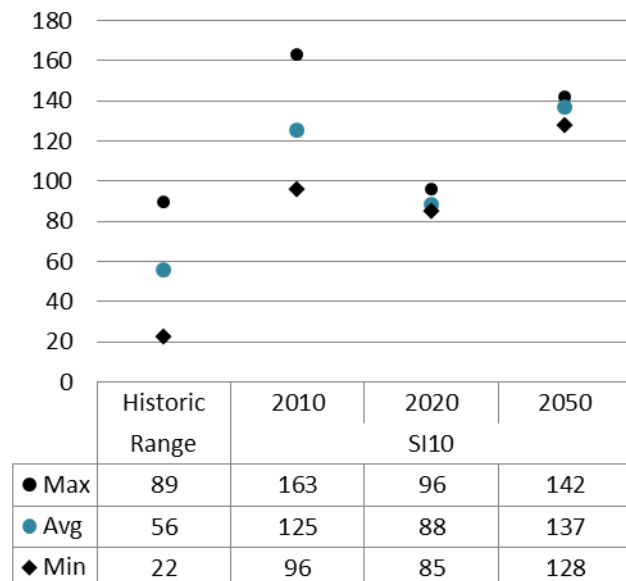
PP Basal Area



All Trees per Acre >5"

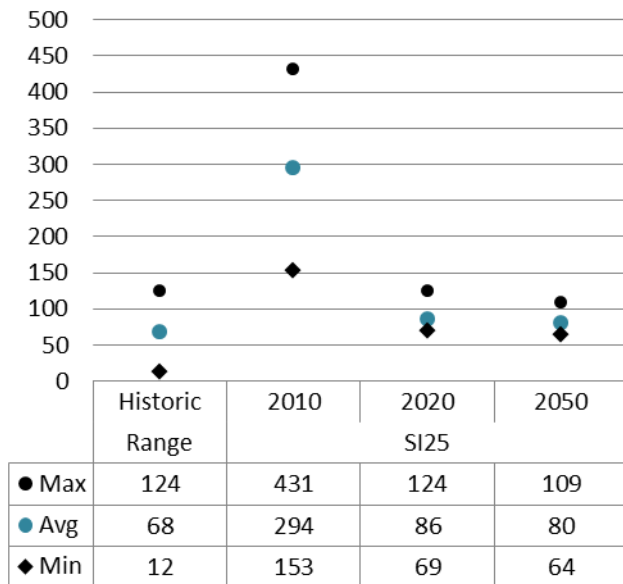


All Basal Area

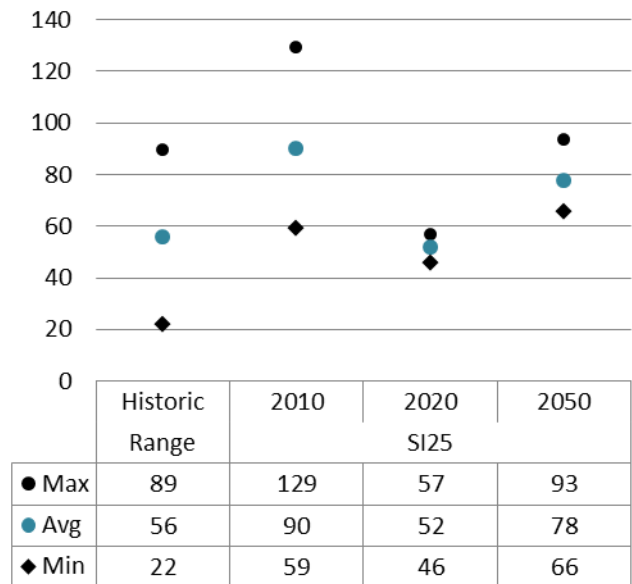


Stand Improvement – 25-40%

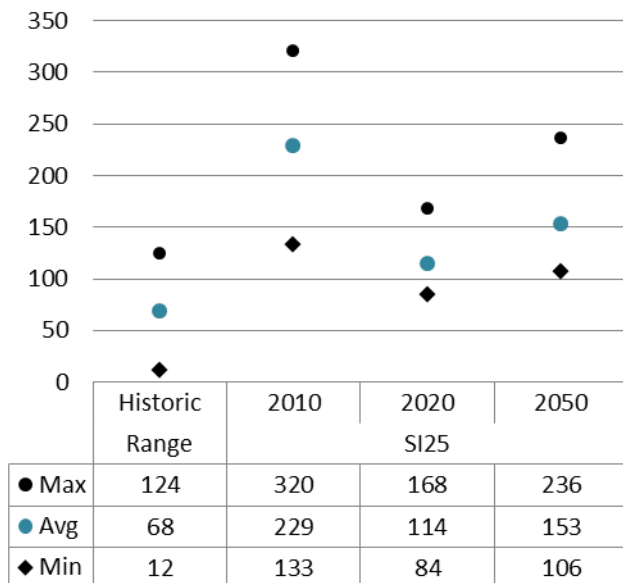
PP Trees per Acre



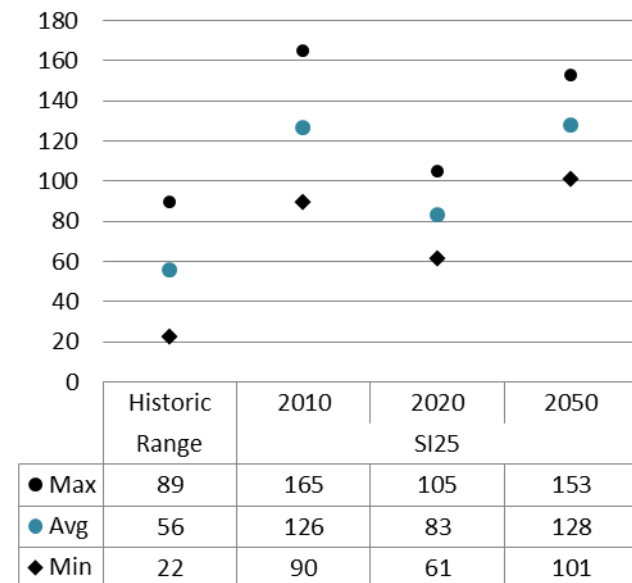
PP Basal Area



All Trees per Acre >5"

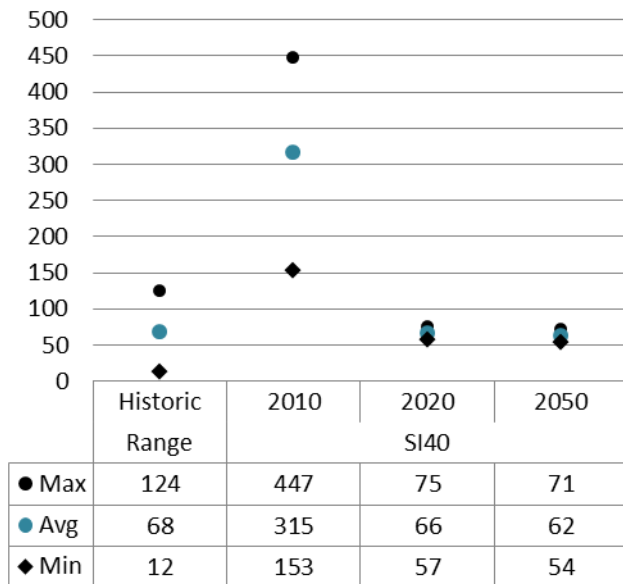


All Basal Area

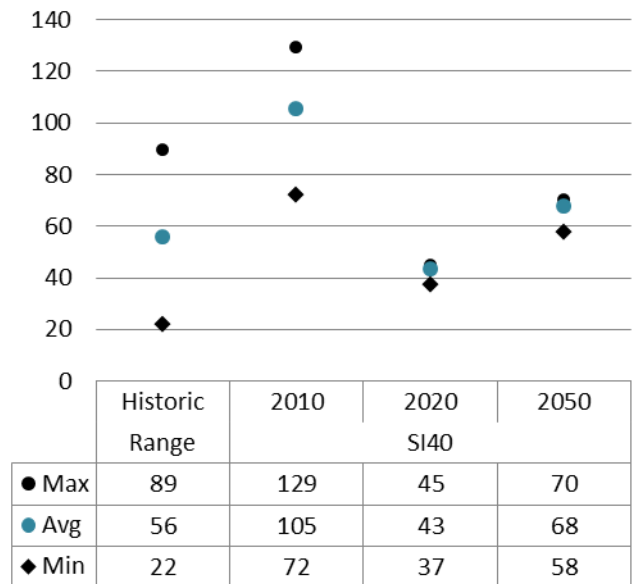


Stand Improvement – 40-55%

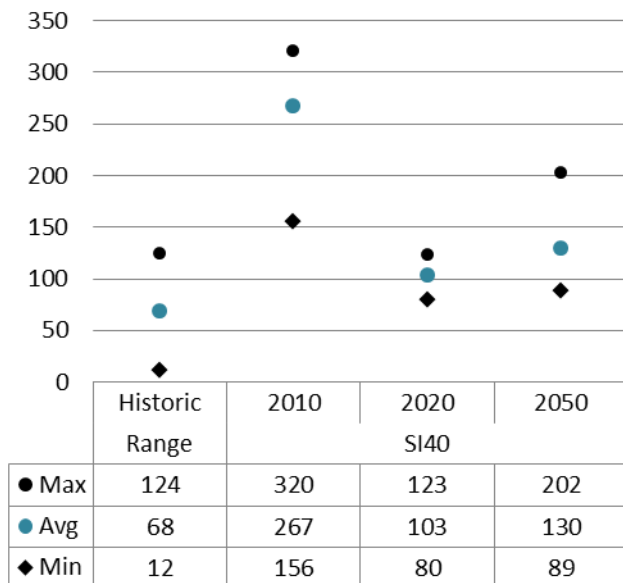
PP Trees per Acre



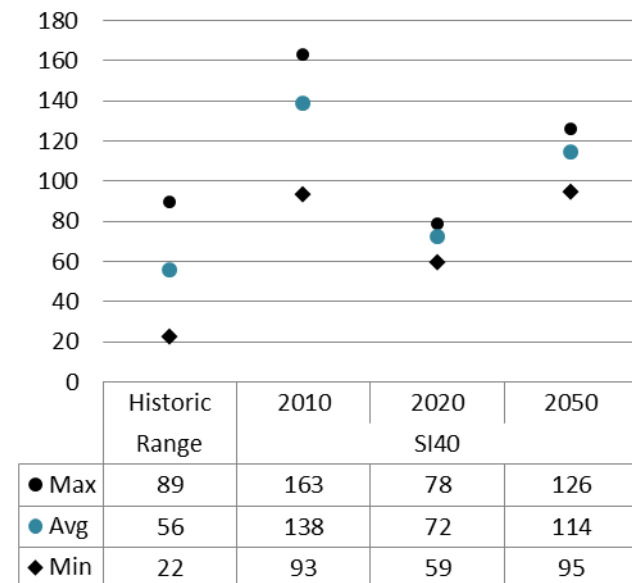
PP Basal Area



All Trees per Acre >5"

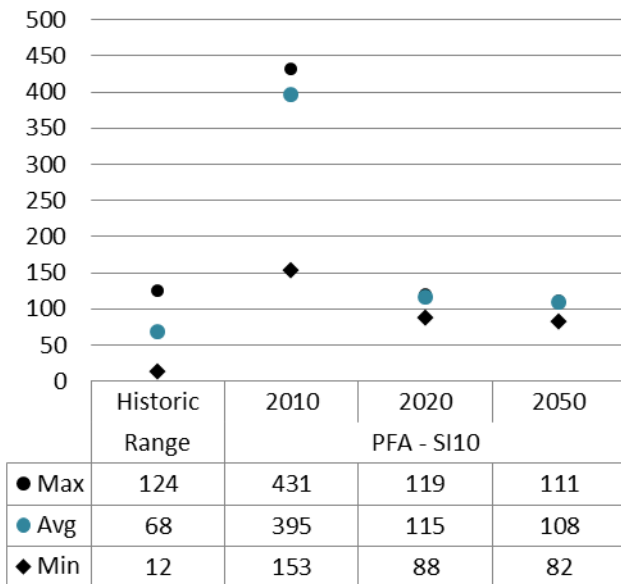


All Basal Area

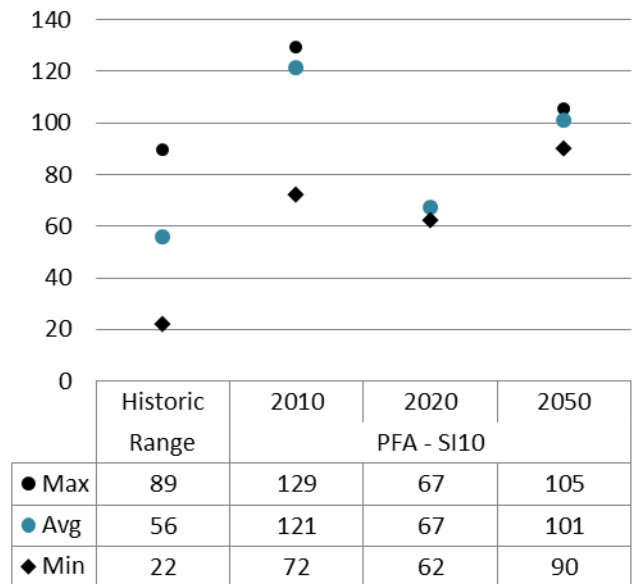


PFA Stand Improvement – 10-25%

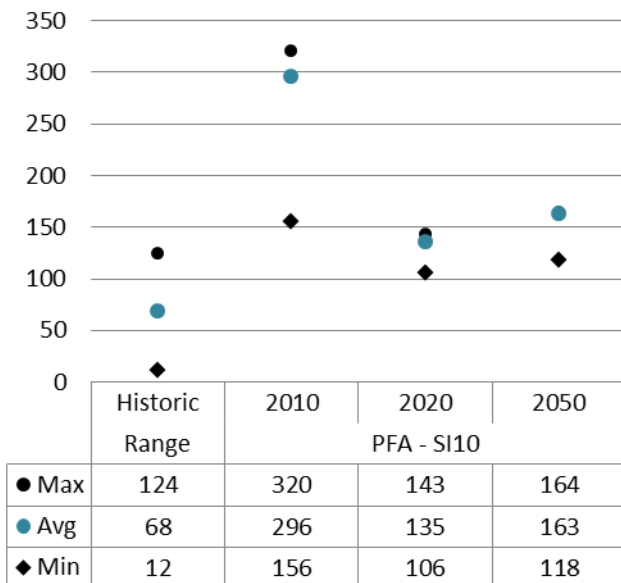
PP Trees per Acre



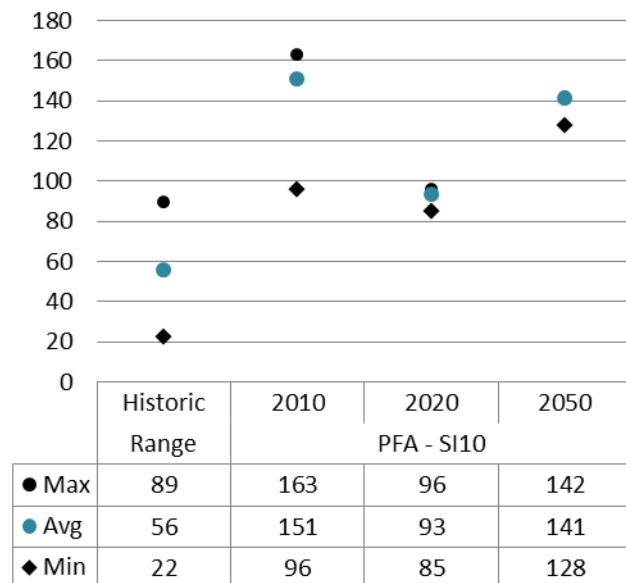
PP Basal Area



All Trees per Acre >5"

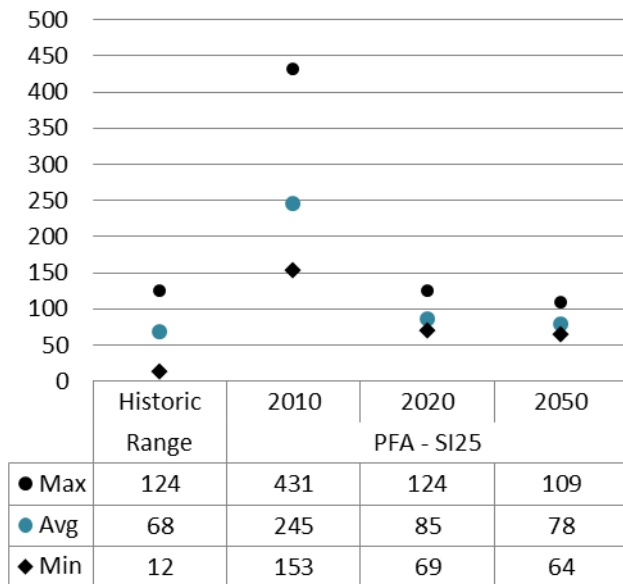


All Basal Area

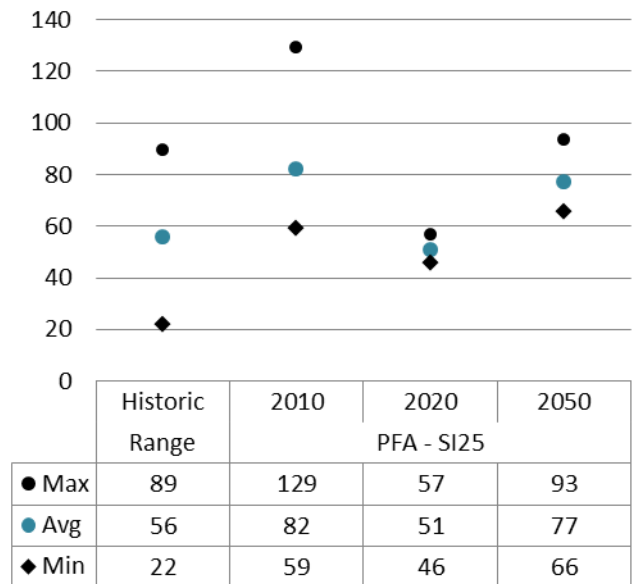


PFA Stand Improvement – 25-40%

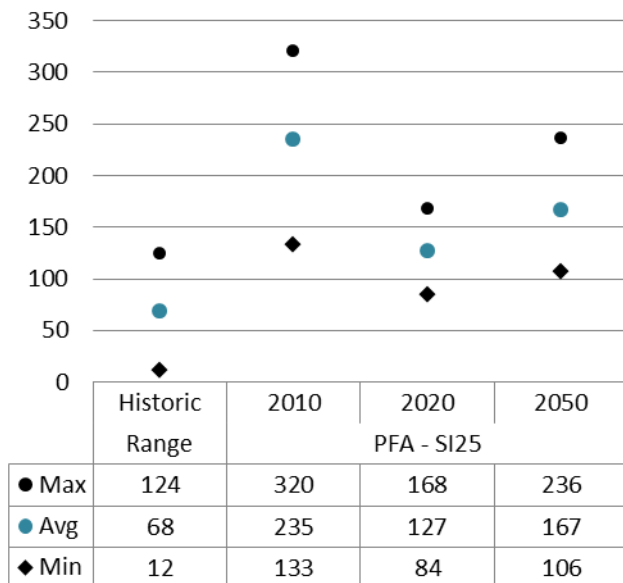
PP Trees per Acre



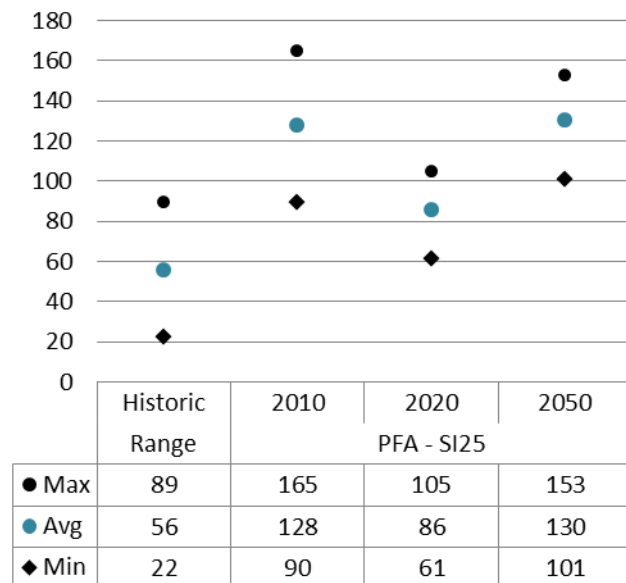
PP Basal Area



All Trees per Acre >5"

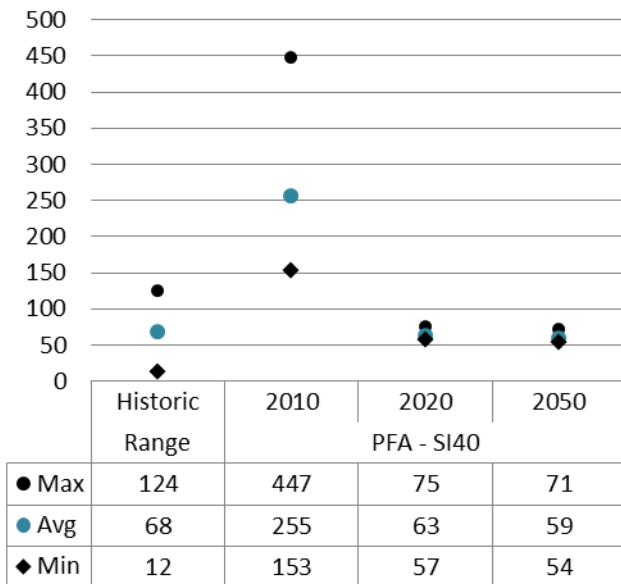


All Basal Area

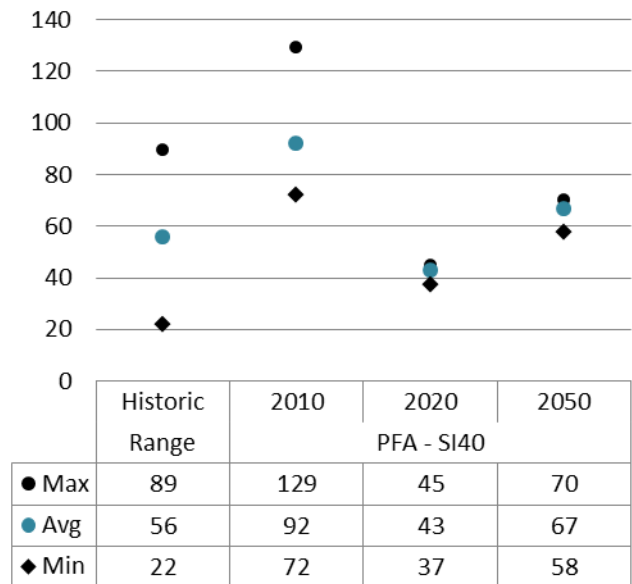


PFA Stand Improvement – 40-55%

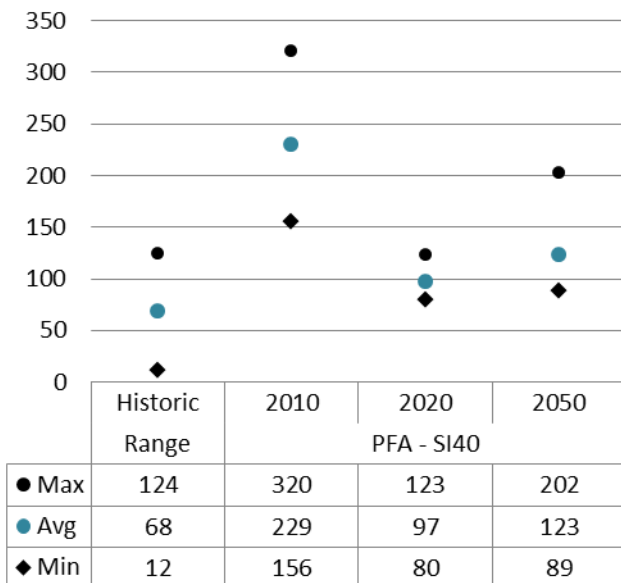
PP Trees per Acre



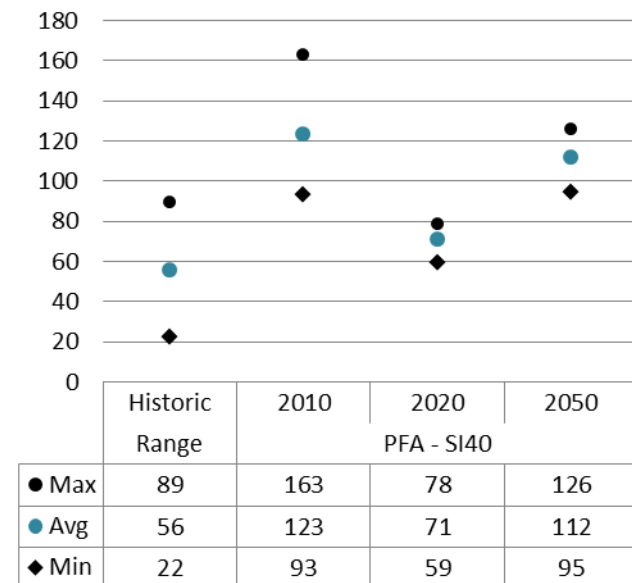
PP Basal Area



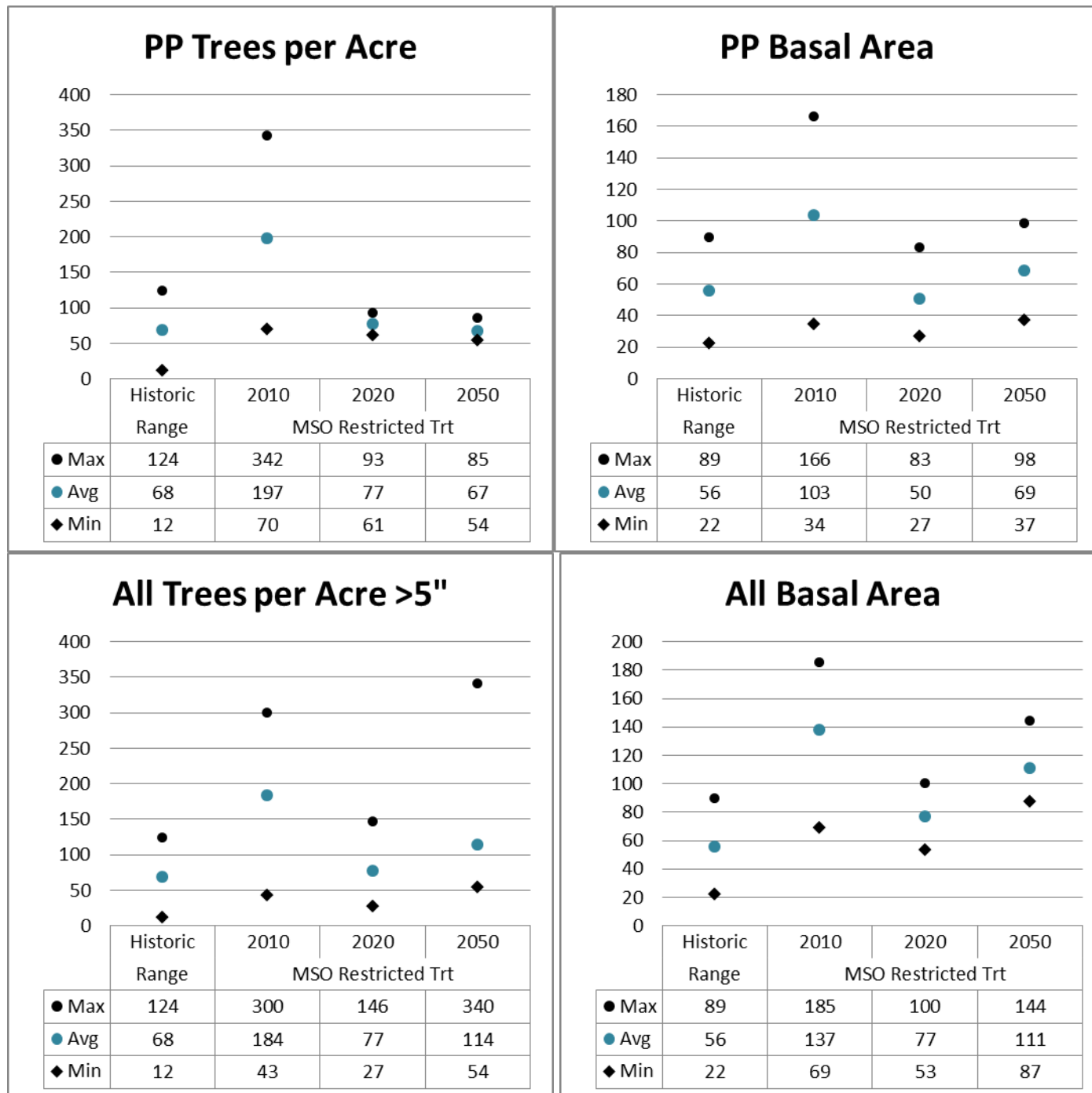
All Trees per Acre >5"



All Basal Area

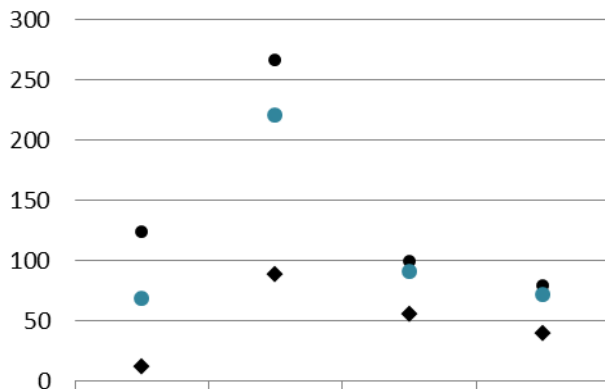


MSO Restricted Treatment



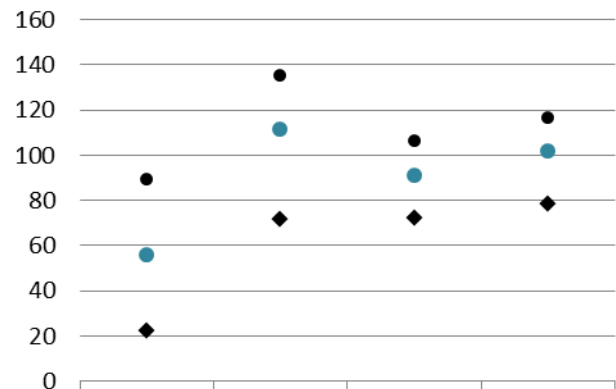
MSO Target Treatment

PP Trees per Acre



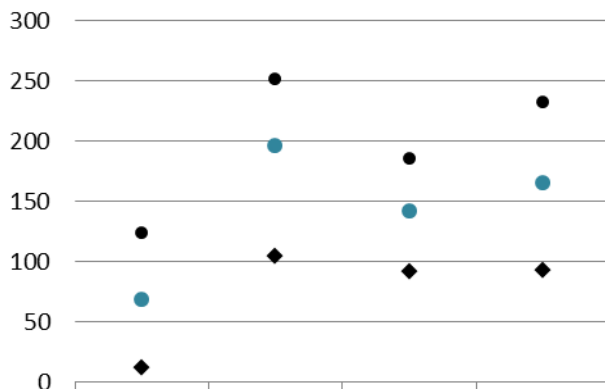
	Historic Range	MSO Target Trt		
● Max	124	266	99	79
● Avg	68	221	91	71
◆ Min	12	89	56	40

PP Basal Area



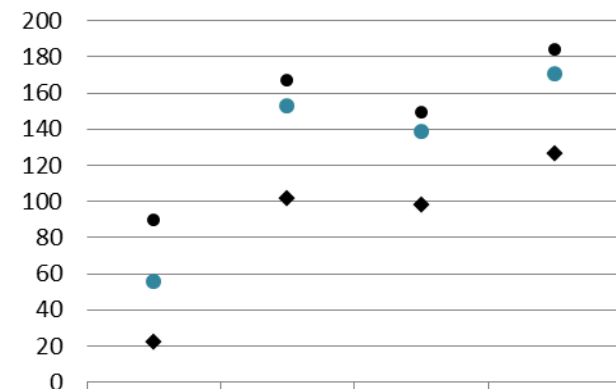
	Historic Range	MSO Target Trt		
● Max	89	135	106	116
● Avg	56	111	91	102
◆ Min	22	72	72	78

All Trees per Acre >5"



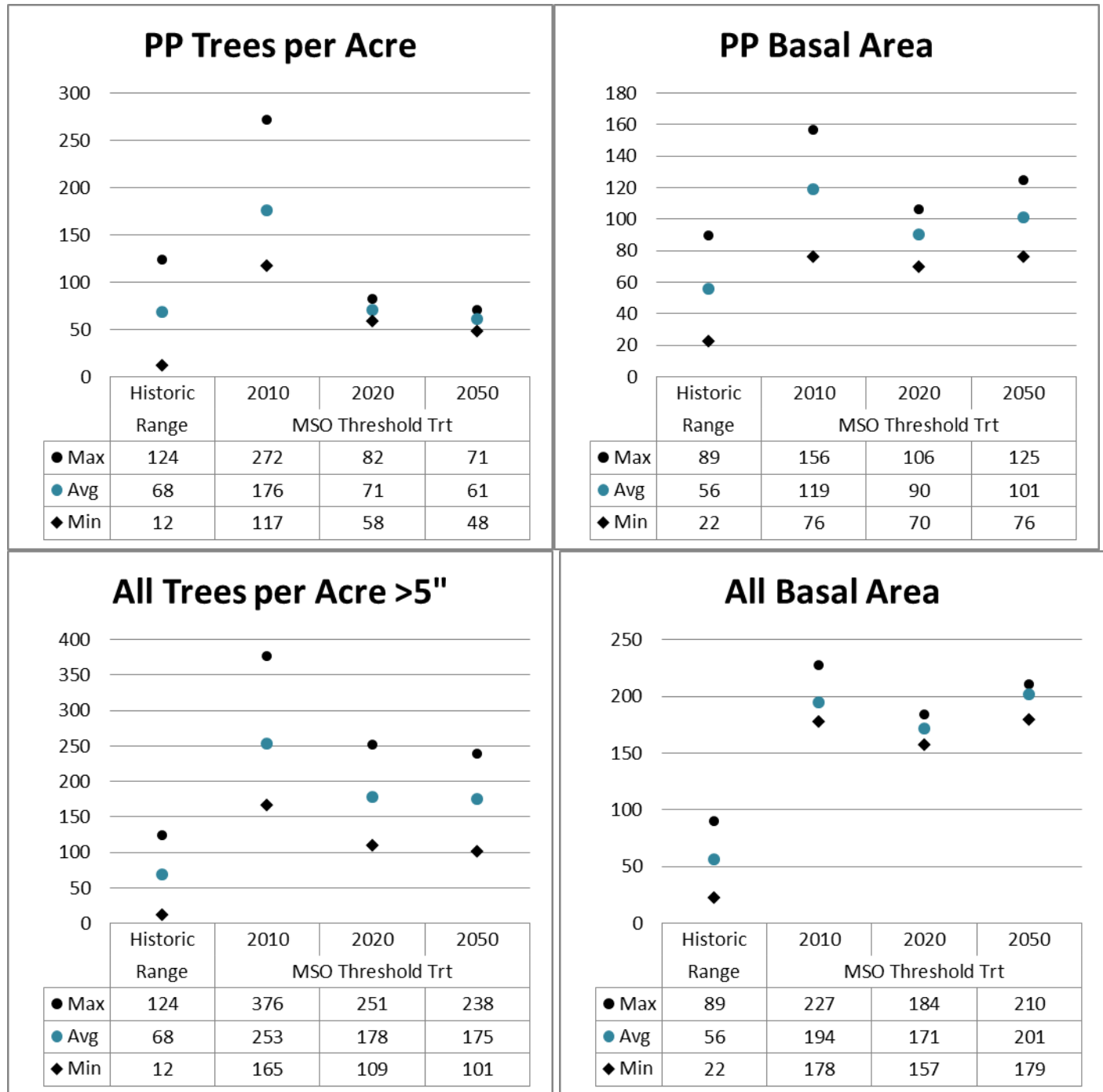
	Historic Range	MSO Target Trt		
● Max	124	251	185	232
● Avg	68	196	142	165
◆ Min	12	105	92	92

All Basal Area

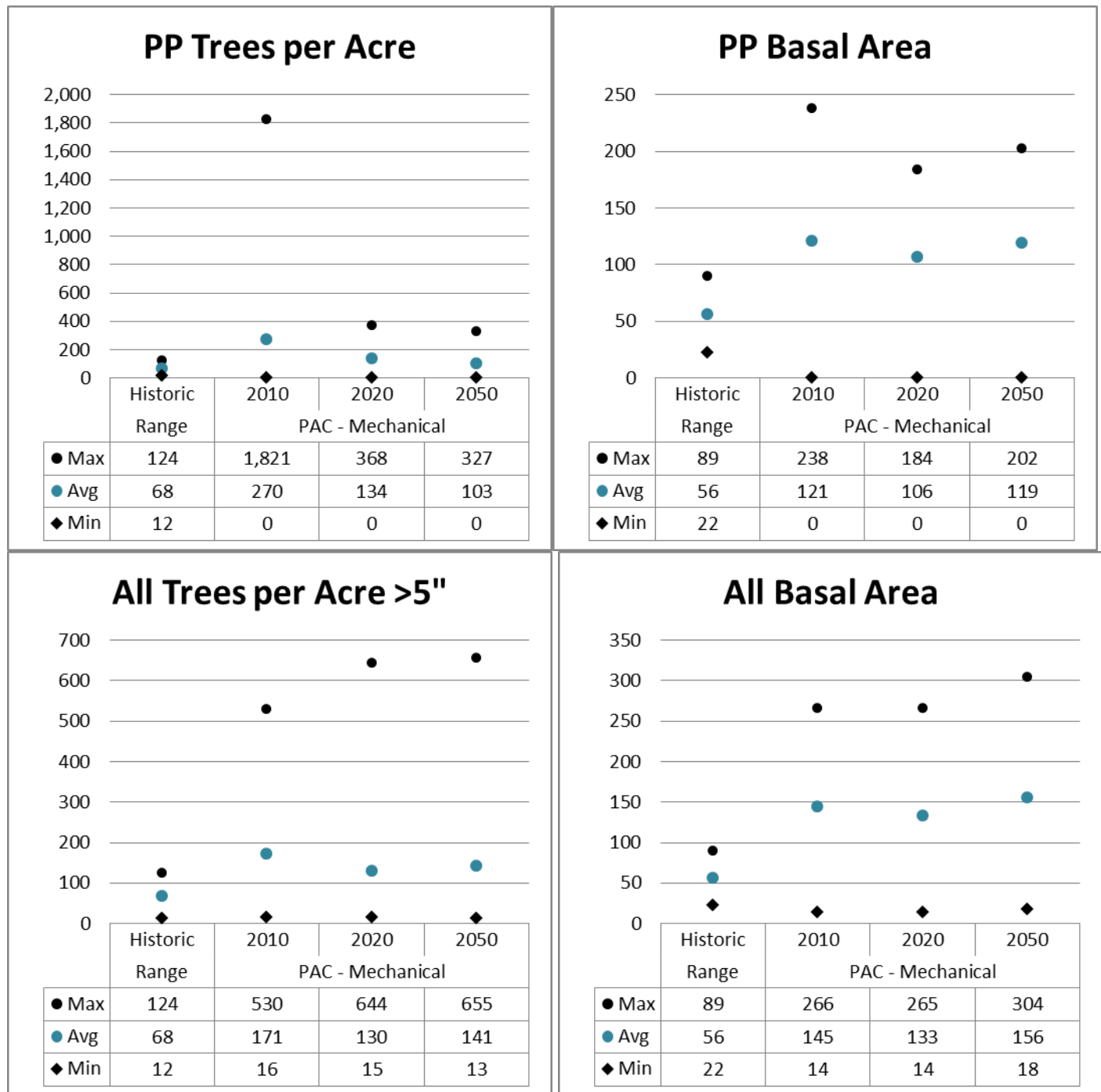


	Historic Range	MSO Target Trt		
● Max	89	167	149	184
● Avg	56	152	138	170
◆ Min	22	102	98	126

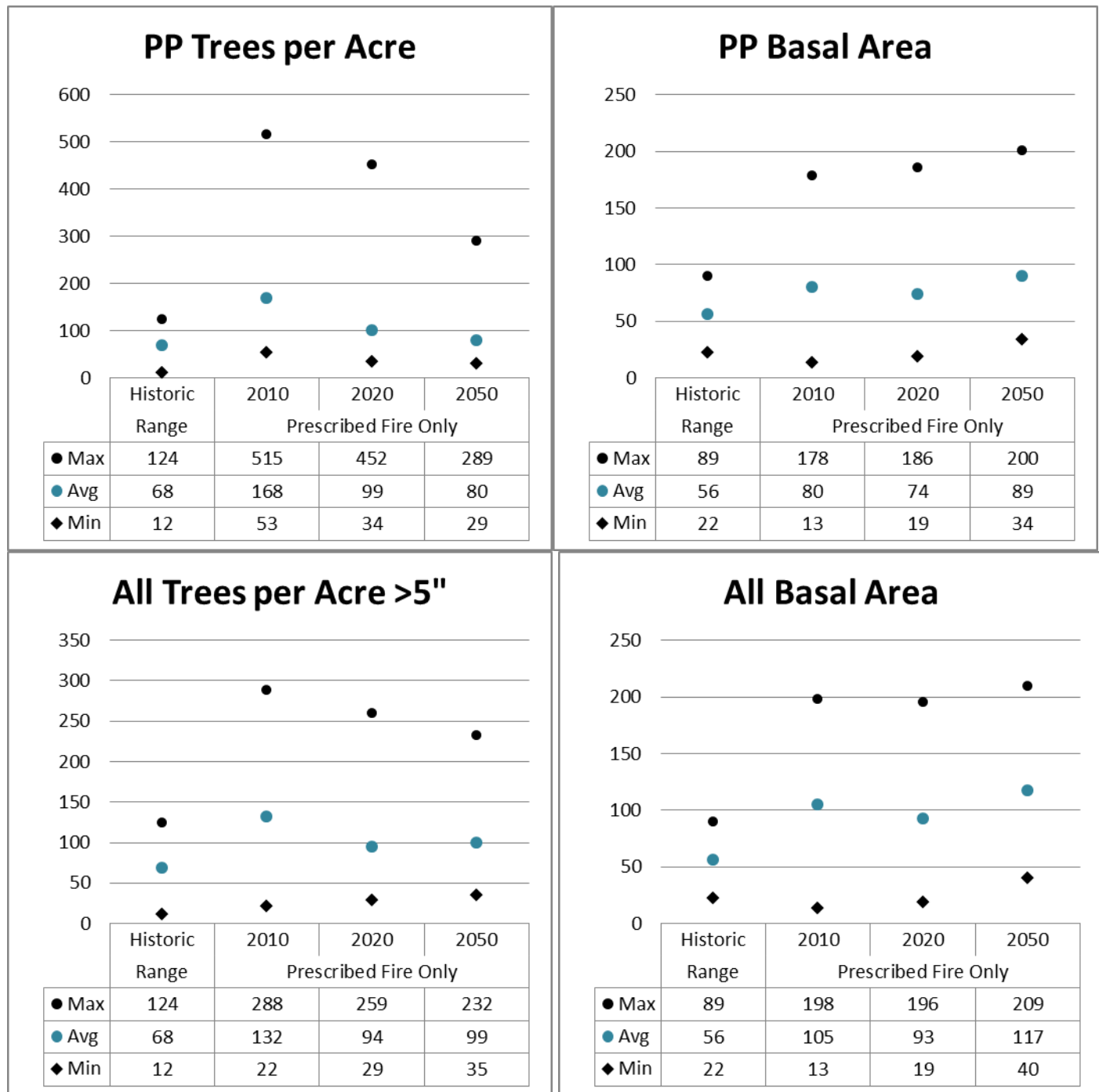
MSO Threshold Treatment



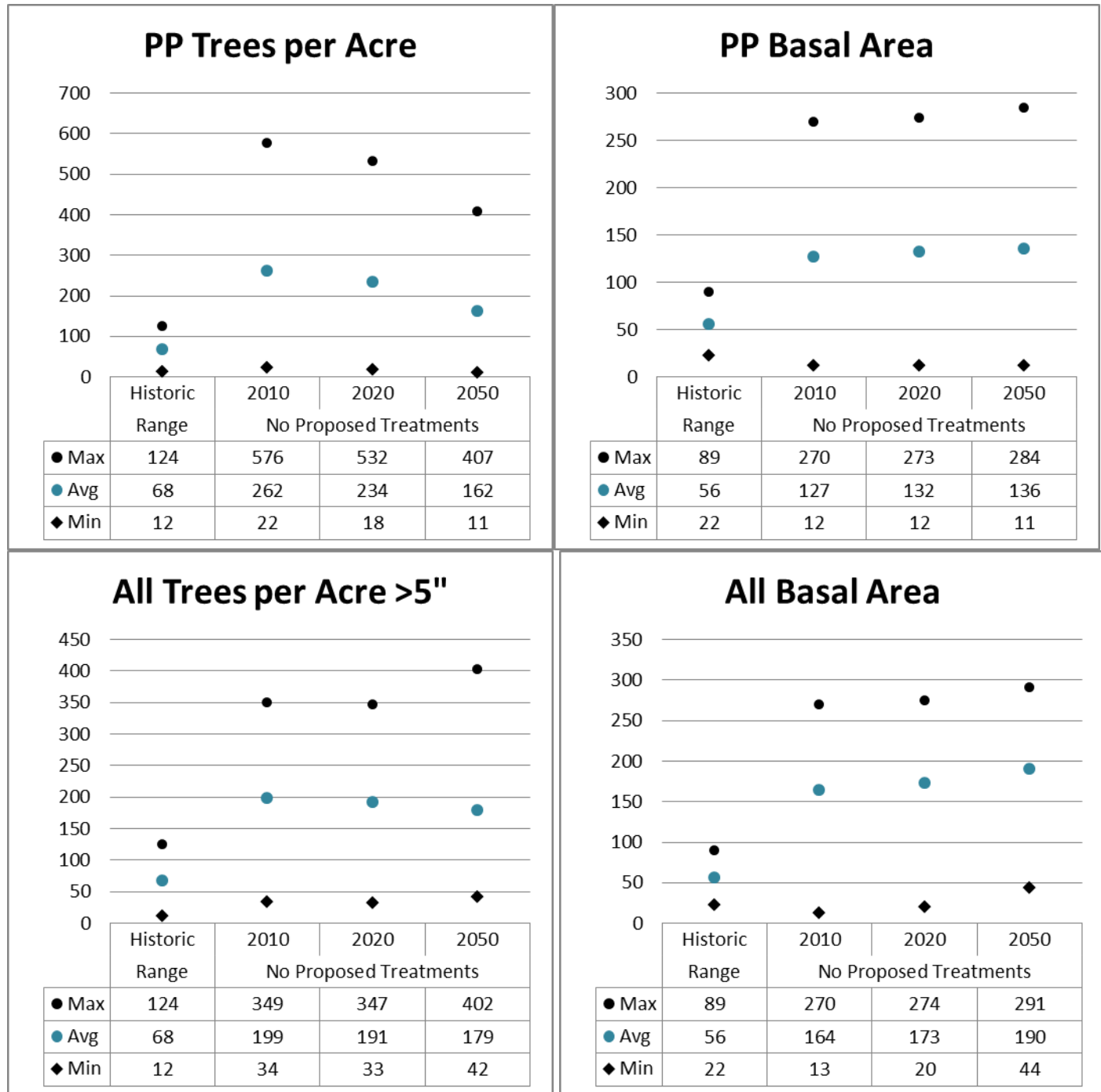
PAC – Mechanical



Prescribed Fire Only

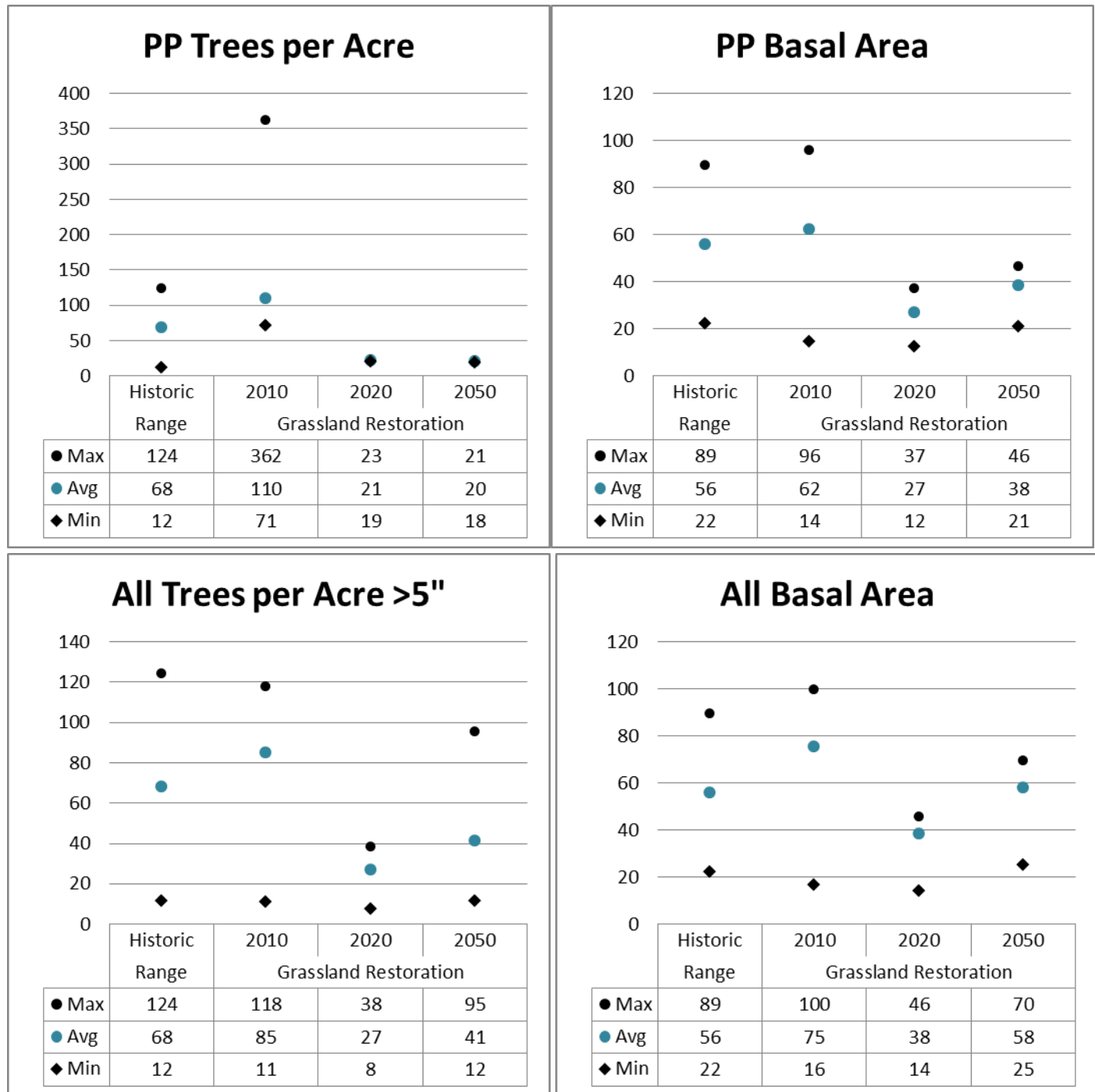


No Proposed Treatments



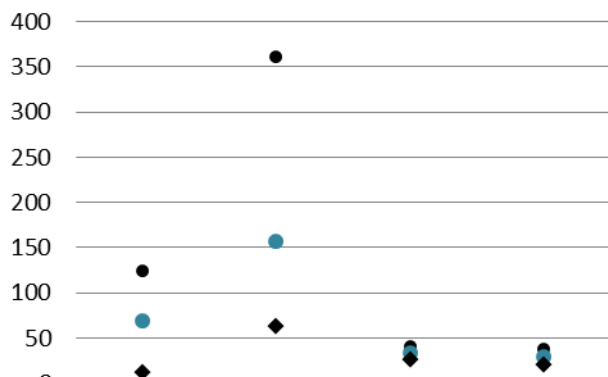
Appendix E - Natural Range of Variability Comparison by Treatment Type (Alt C)

Grassland Restoration



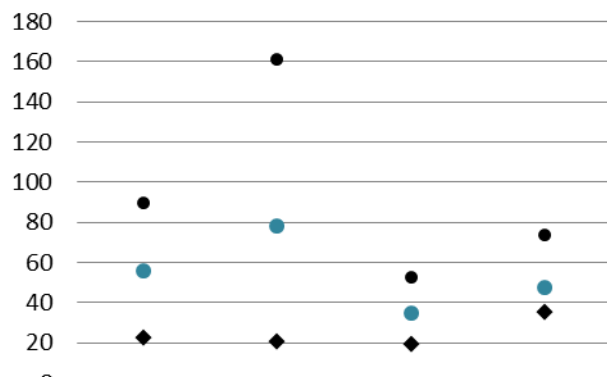
Savanna

PP Trees per Acre



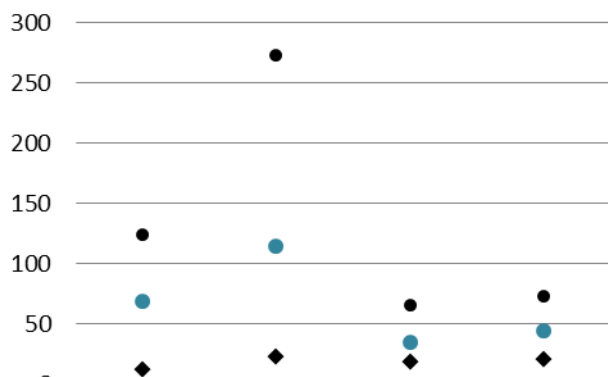
	Historic Range	Savanna		
● Max	124	360	40	38
● Avg	68	157	33	29
◆ Min	12	63	25	20

PP Basal Area



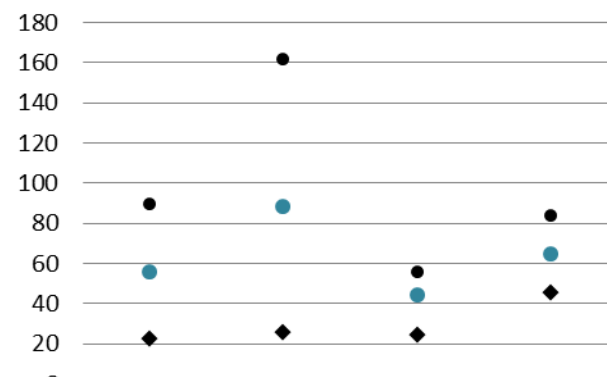
	Historic Range	Savanna		
● Max	89	161	52	74
● Avg	56	78	35	47
◆ Min	22	21	19	35

All Trees per Acre >5"



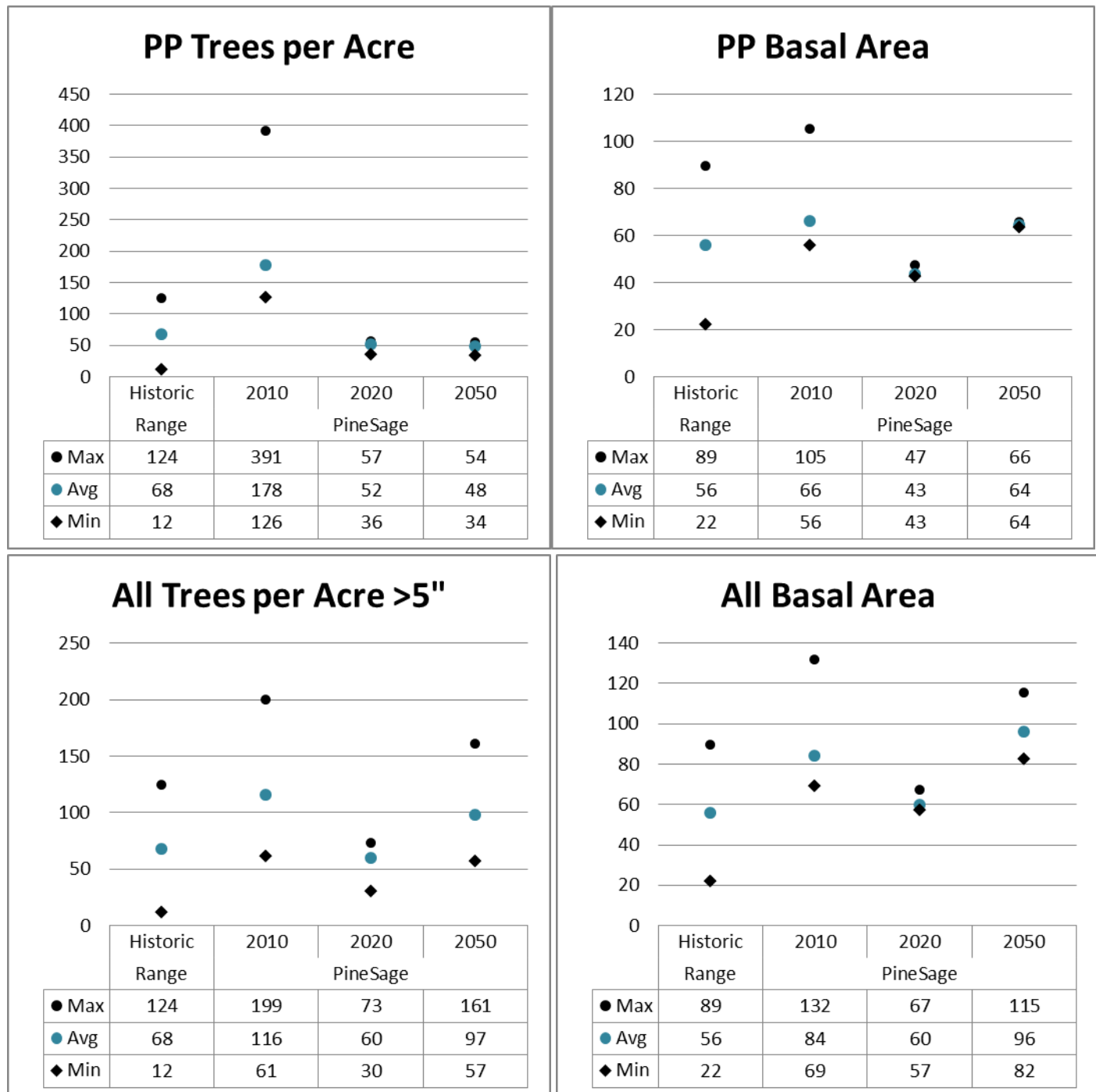
	Historic Range	Savanna		
● Max	124	272	65	73
● Avg	68	114	35	44
◆ Min	12	23	18	20

All Basal Area



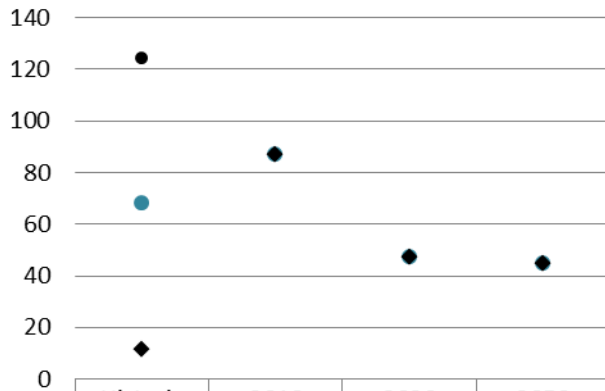
	Historic Range	Savanna		
● Max	89	161	56	84
● Avg	56	88	44	65
◆ Min	22	26	24	45

Pine Sage



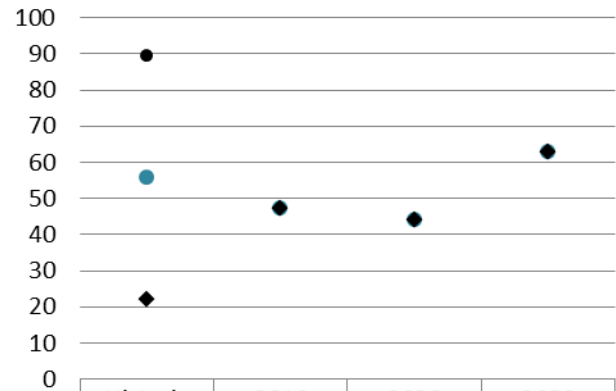
PFA Pine Sage

PP Trees per Acre



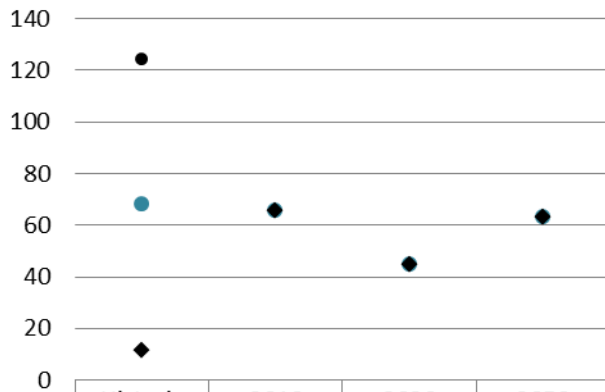
	Historic Range	PFA - PineSage		
● Max	124	87	47	45
● Avg	68	87	47	45
◆ Min	12	87	47	45

PP Basal Area



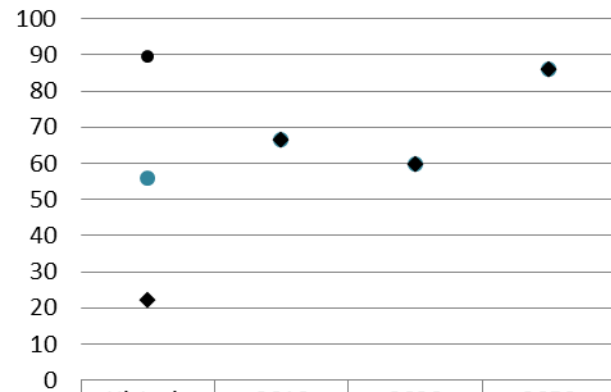
	Historic Range	PFA - PineSage		
● Max	89	47	44	63
● Avg	56	47	44	63
◆ Min	22	47	44	63

All Trees per Acre >5"



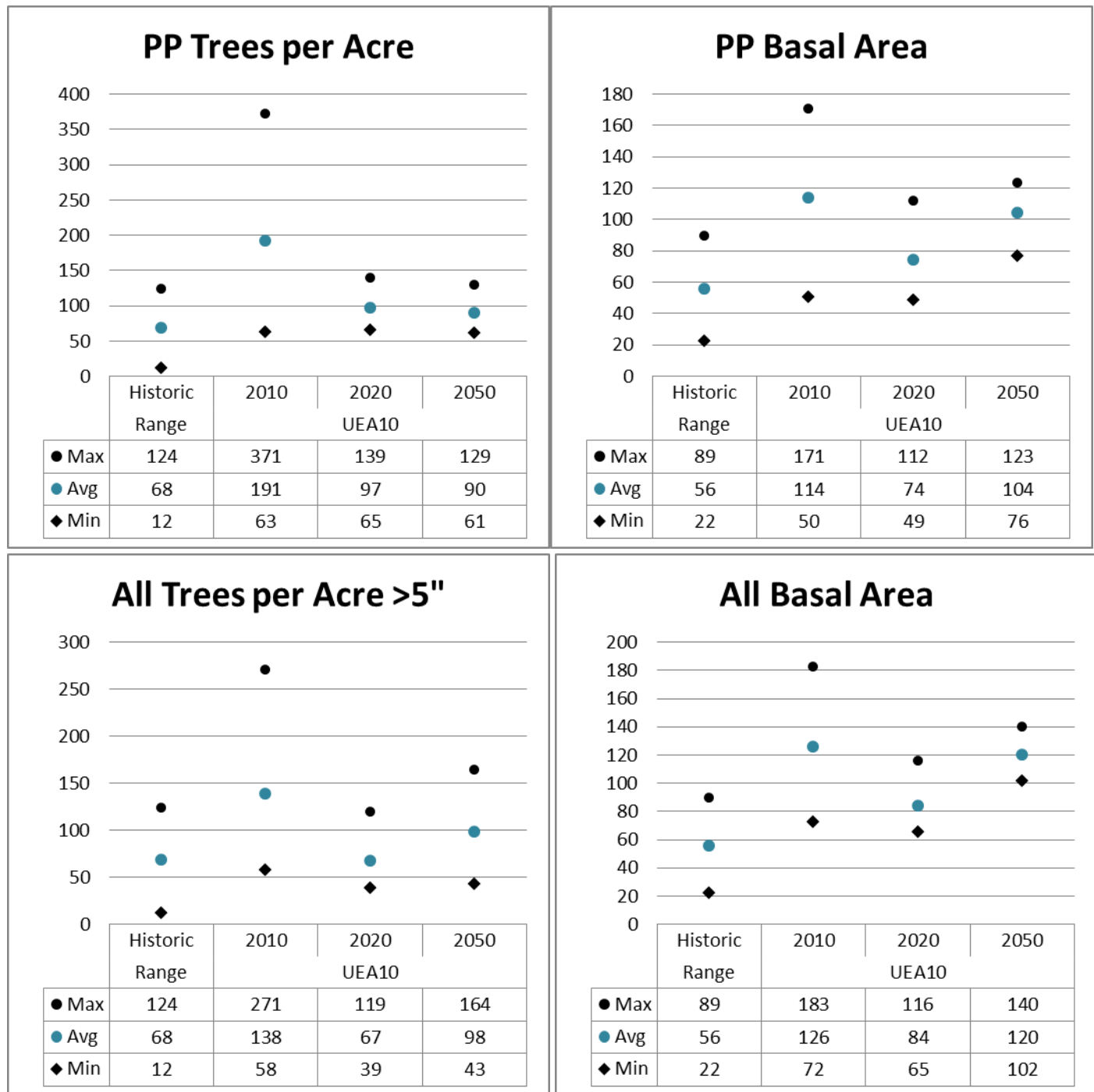
	Historic Range	PFA - PineSage		
● Max	124	66	45	63
● Avg	68	66	45	63
◆ Min	12	66	45	63

All Basal Area

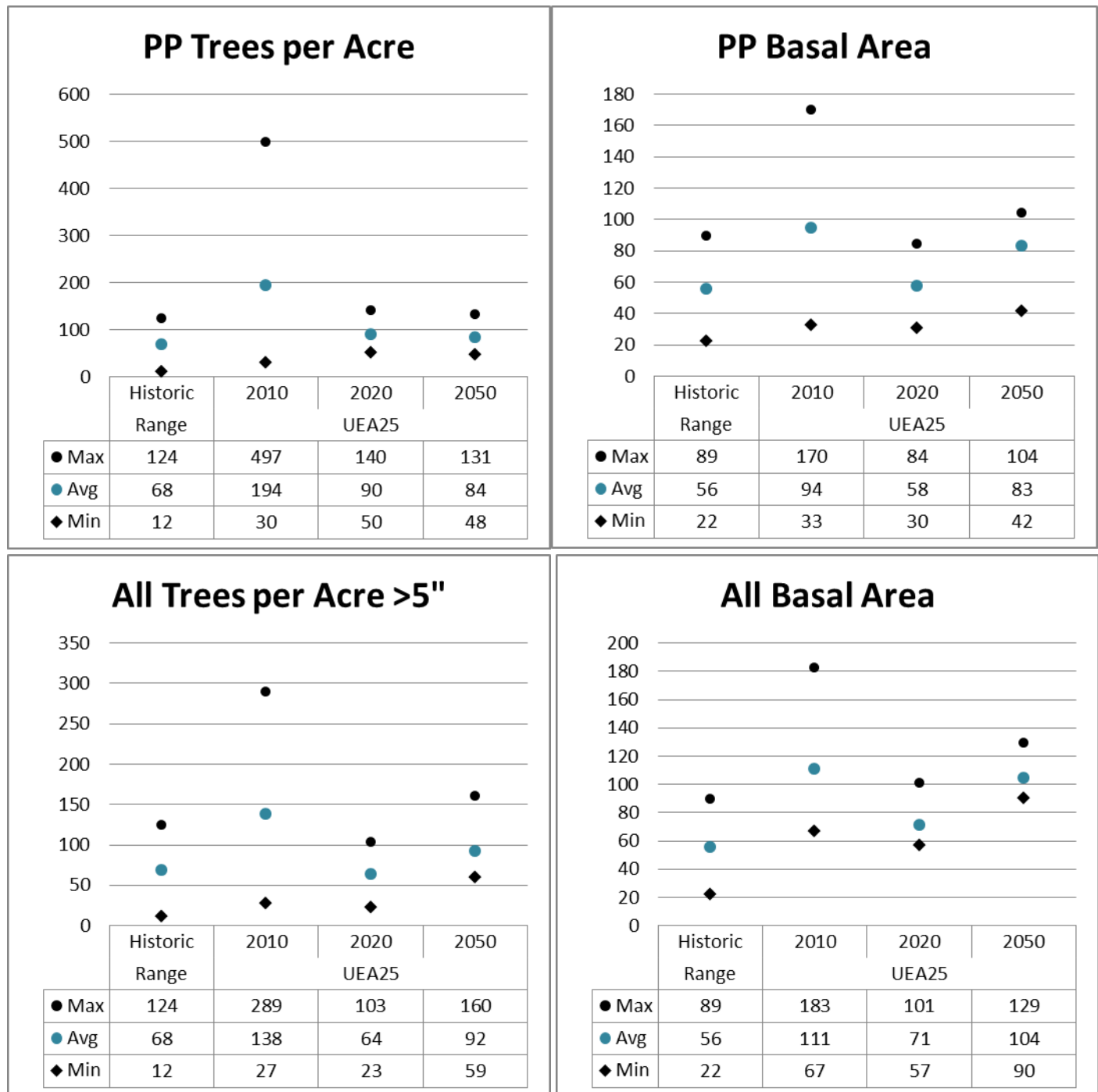


	Historic Range	PFA - PineSage		
● Max	89	66	60	86
● Avg	56	66	60	86
◆ Min	22	66	60	86

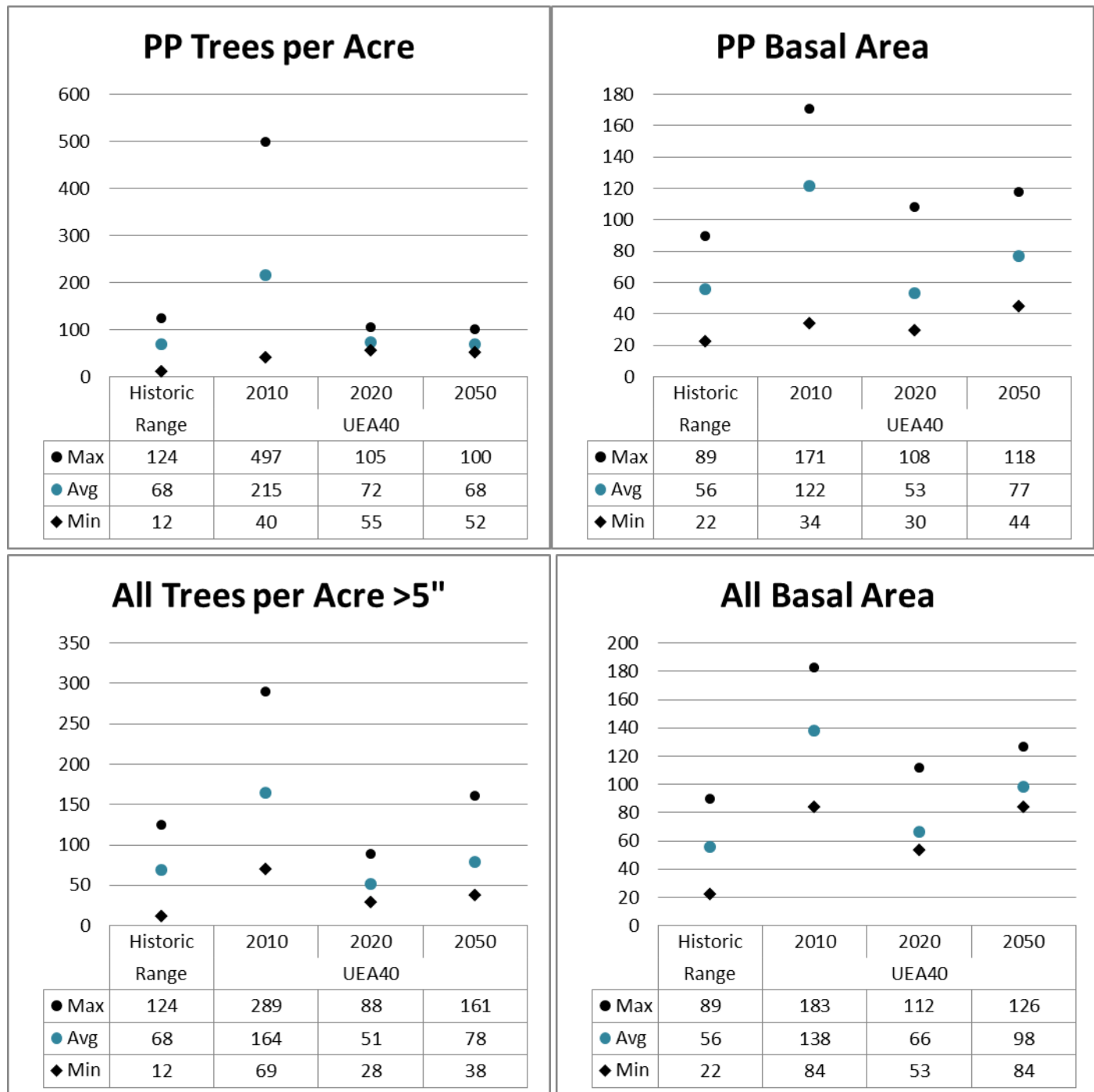
Uneven Age – 10-25%



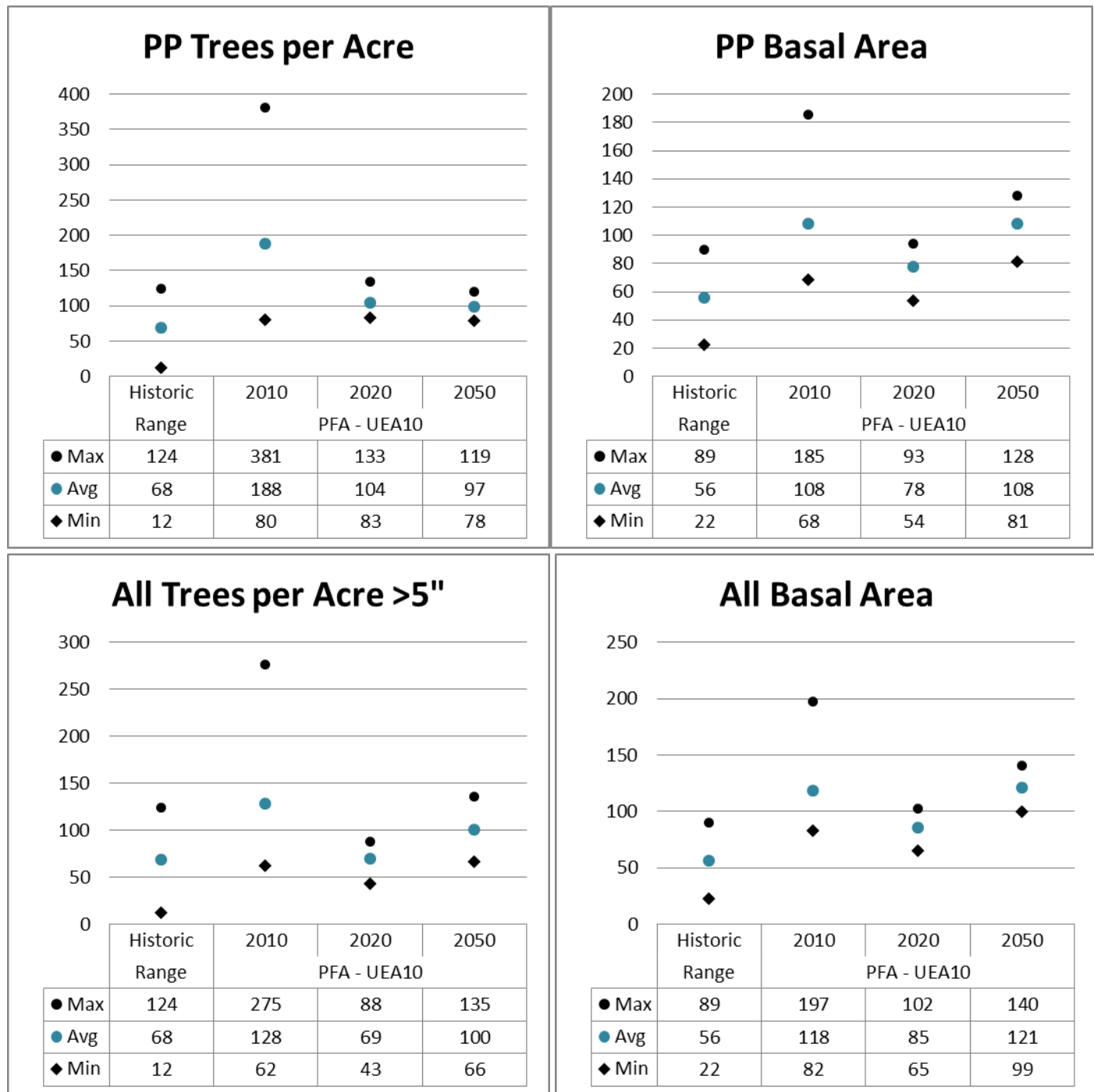
Uneven Age – 25-40%



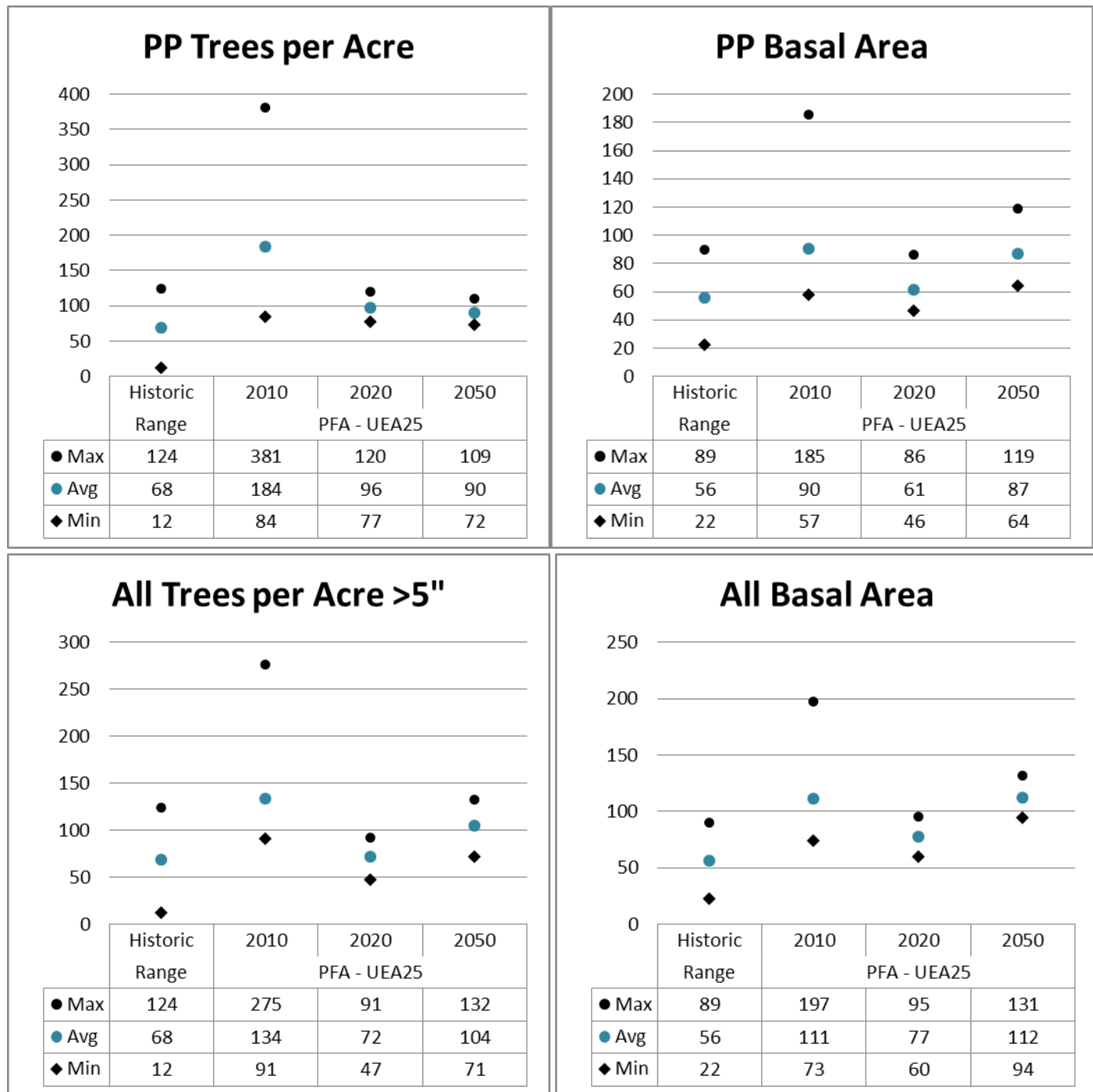
Uneven Age – 40-55%



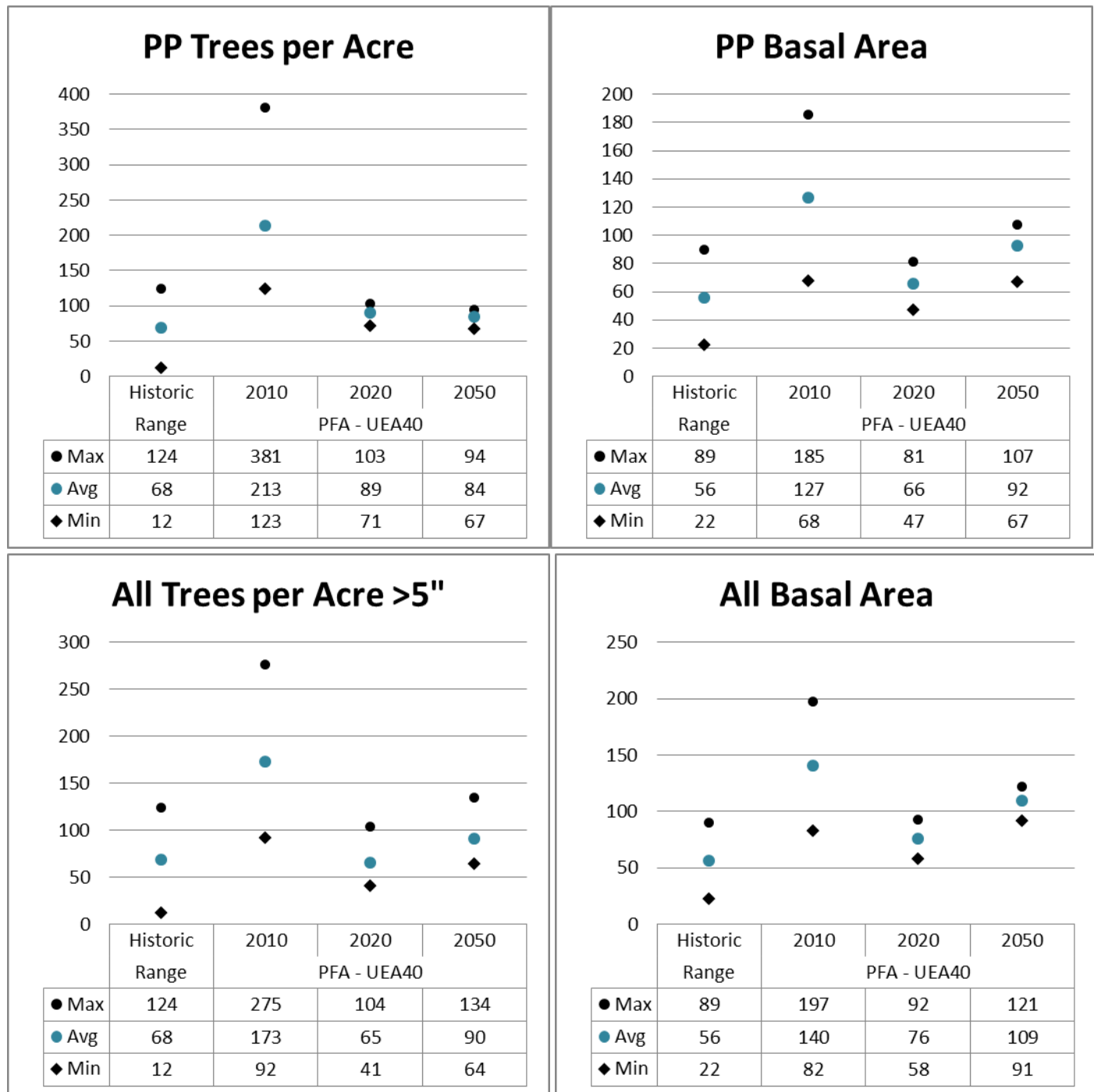
PFA Uneven Age – 10-25%



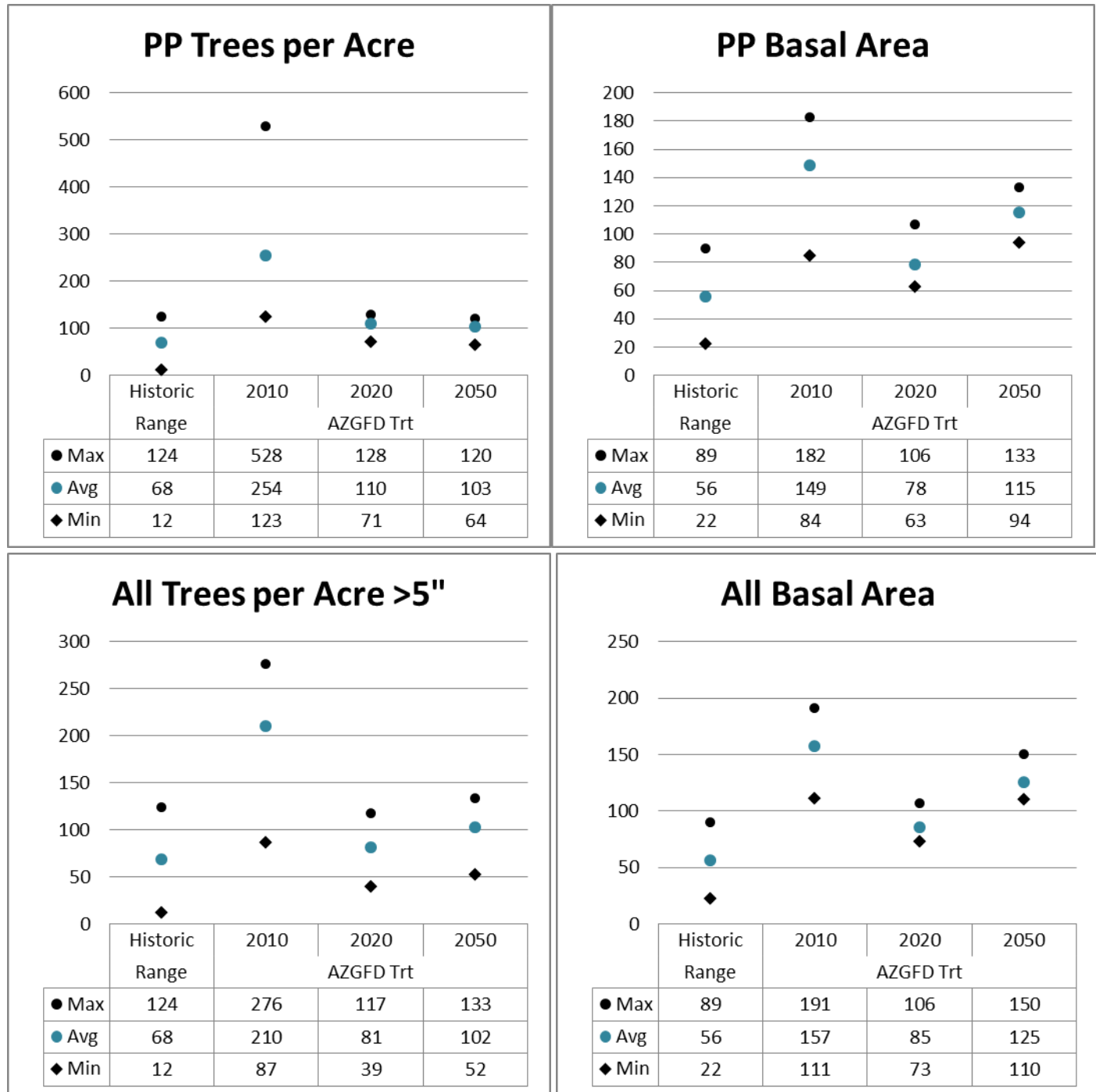
PFA Uneven Age – 25-40%



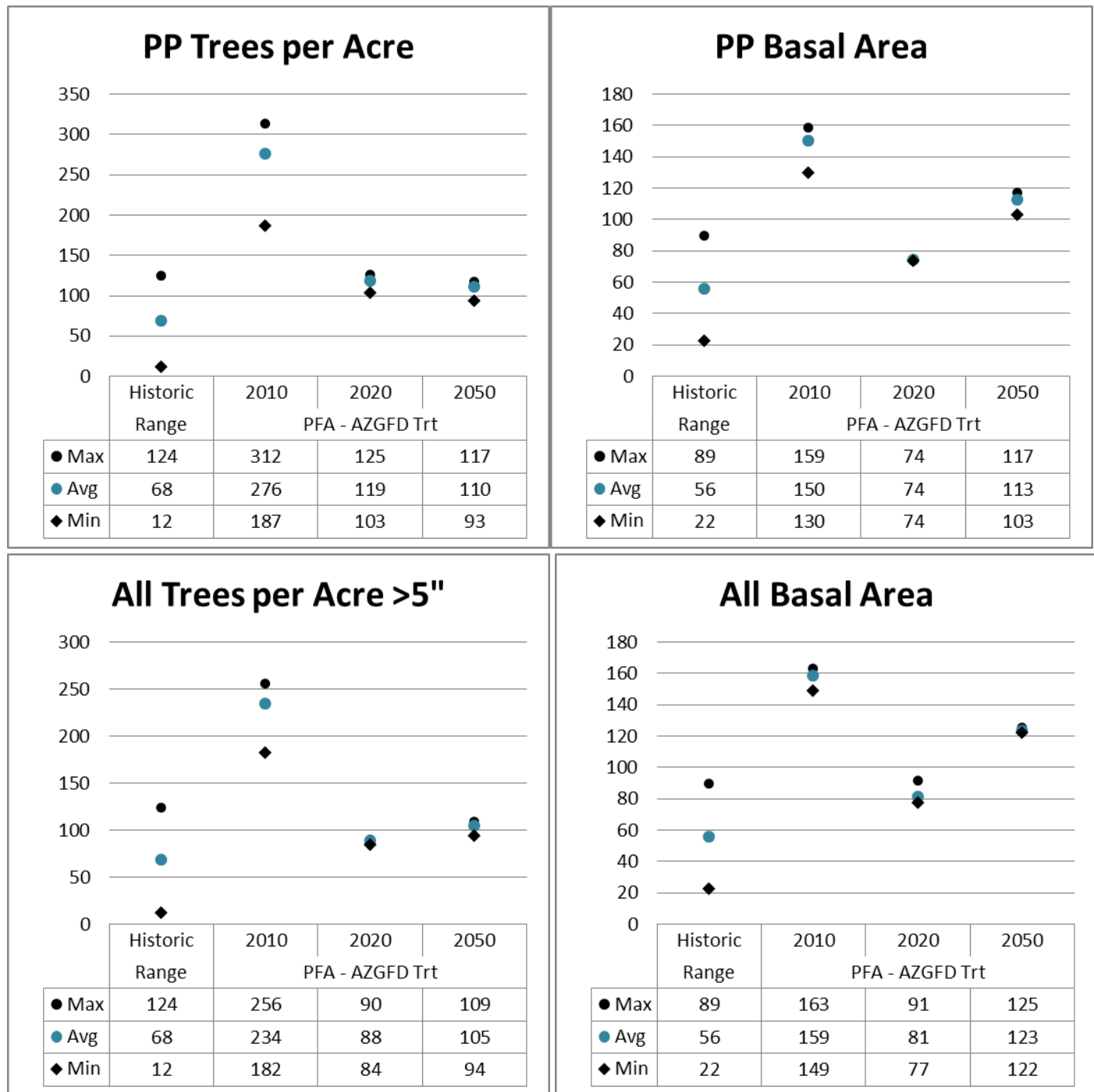
PFA Uneven Age – 40-55%



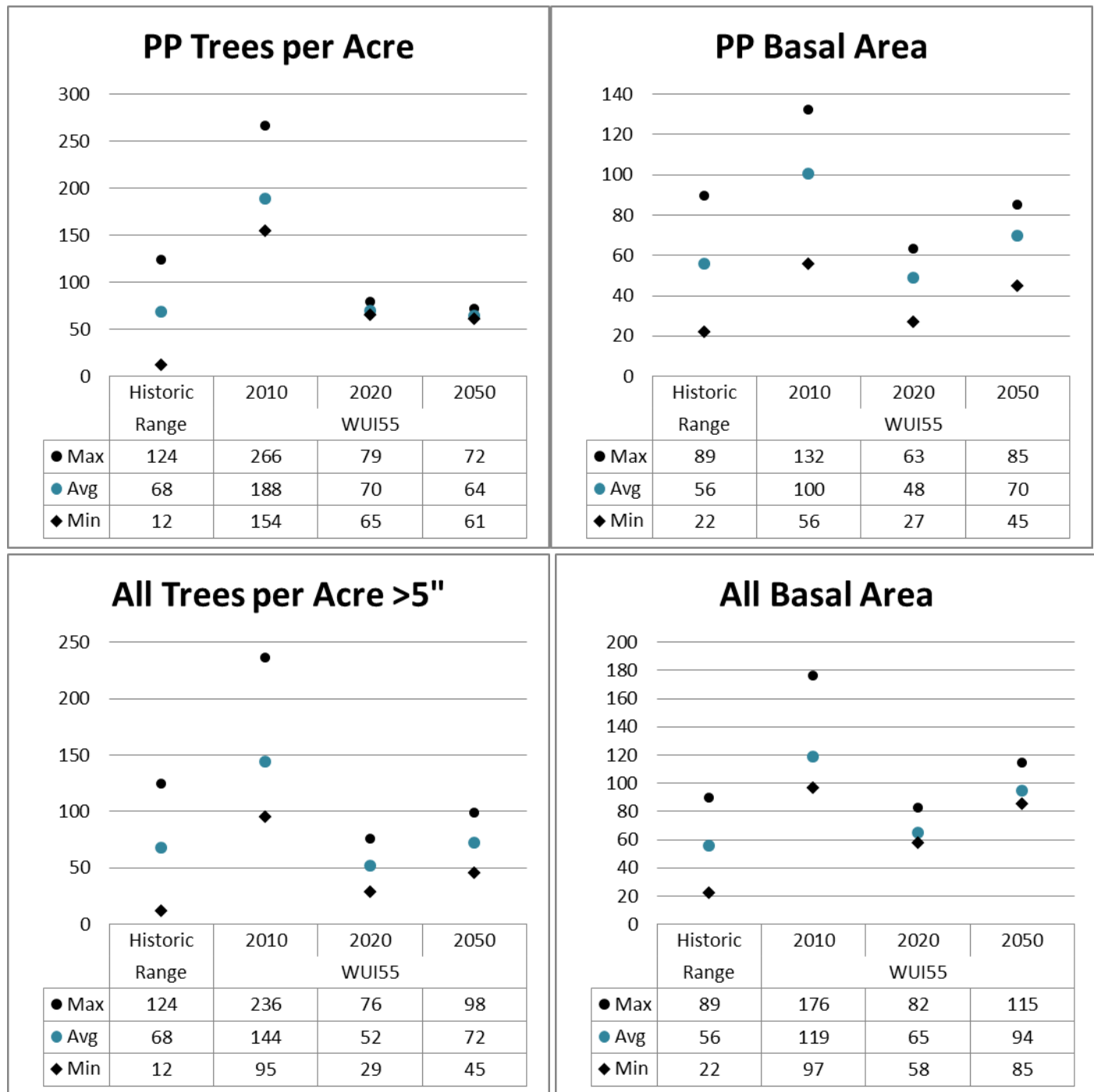
Uneven Age – Arizona Game and Fish Design



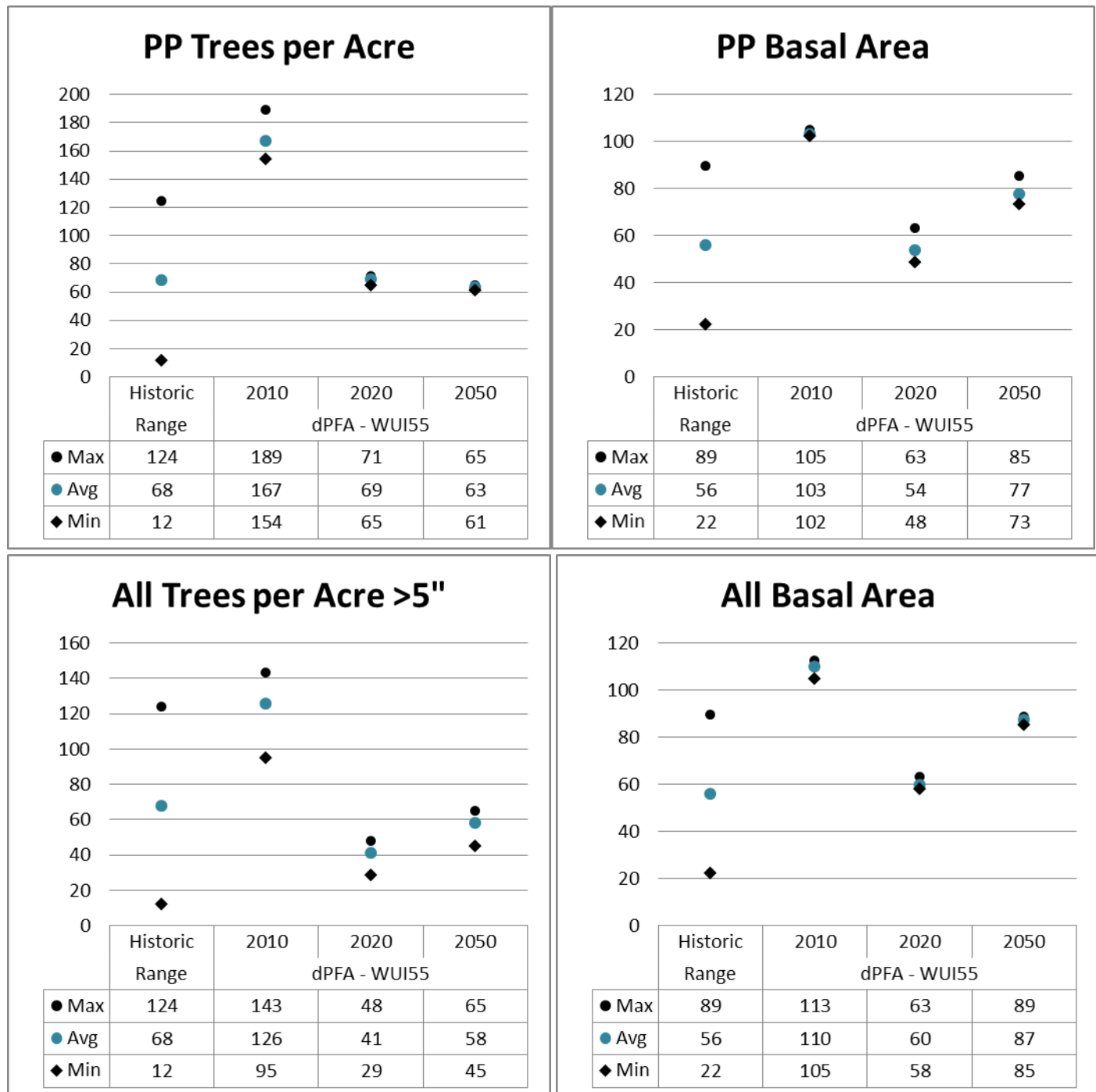
PFA Uneven Age – Arizona Game and Fish Design



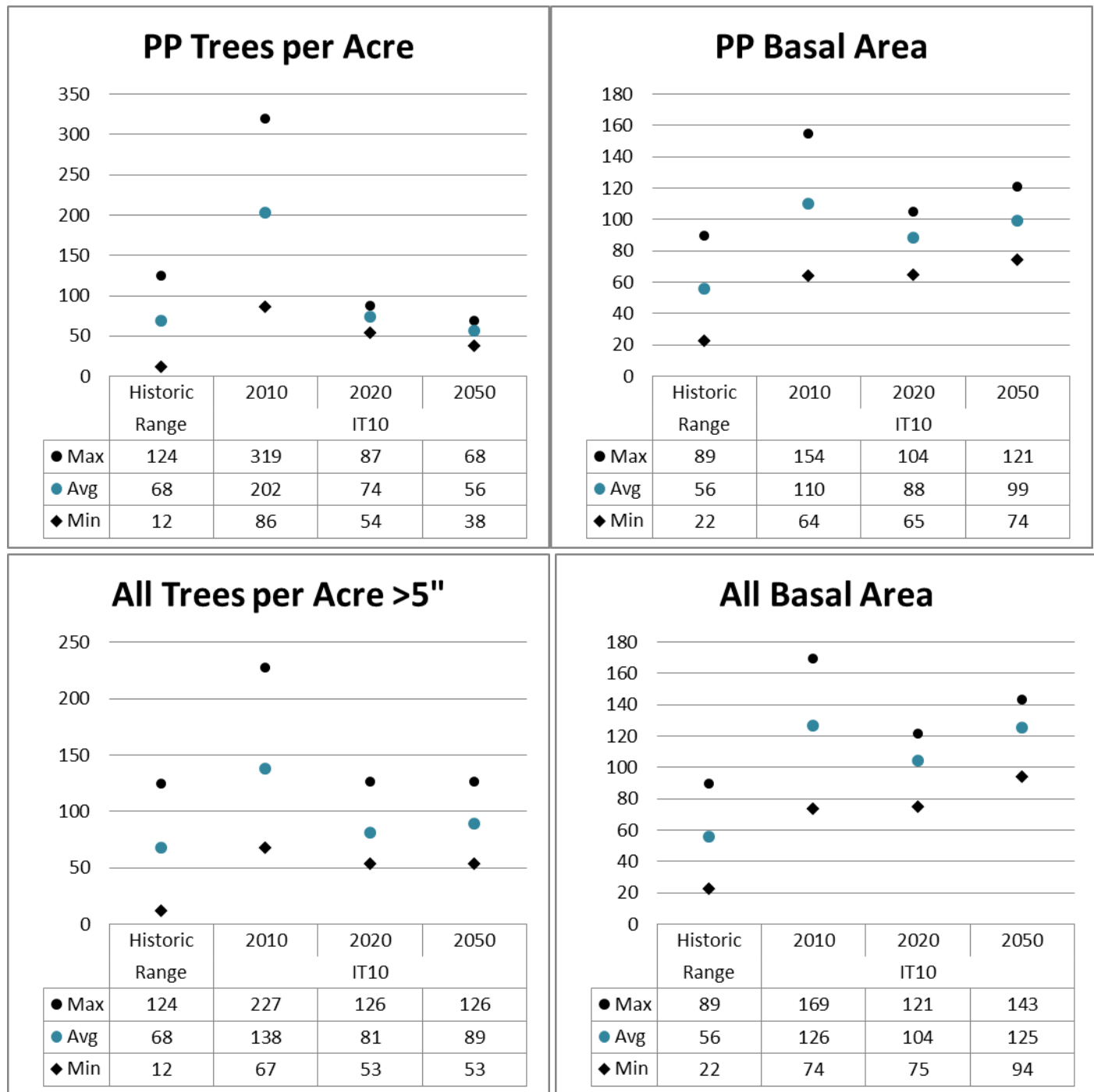
Uneven Age – Wildland Urban Interface 55%



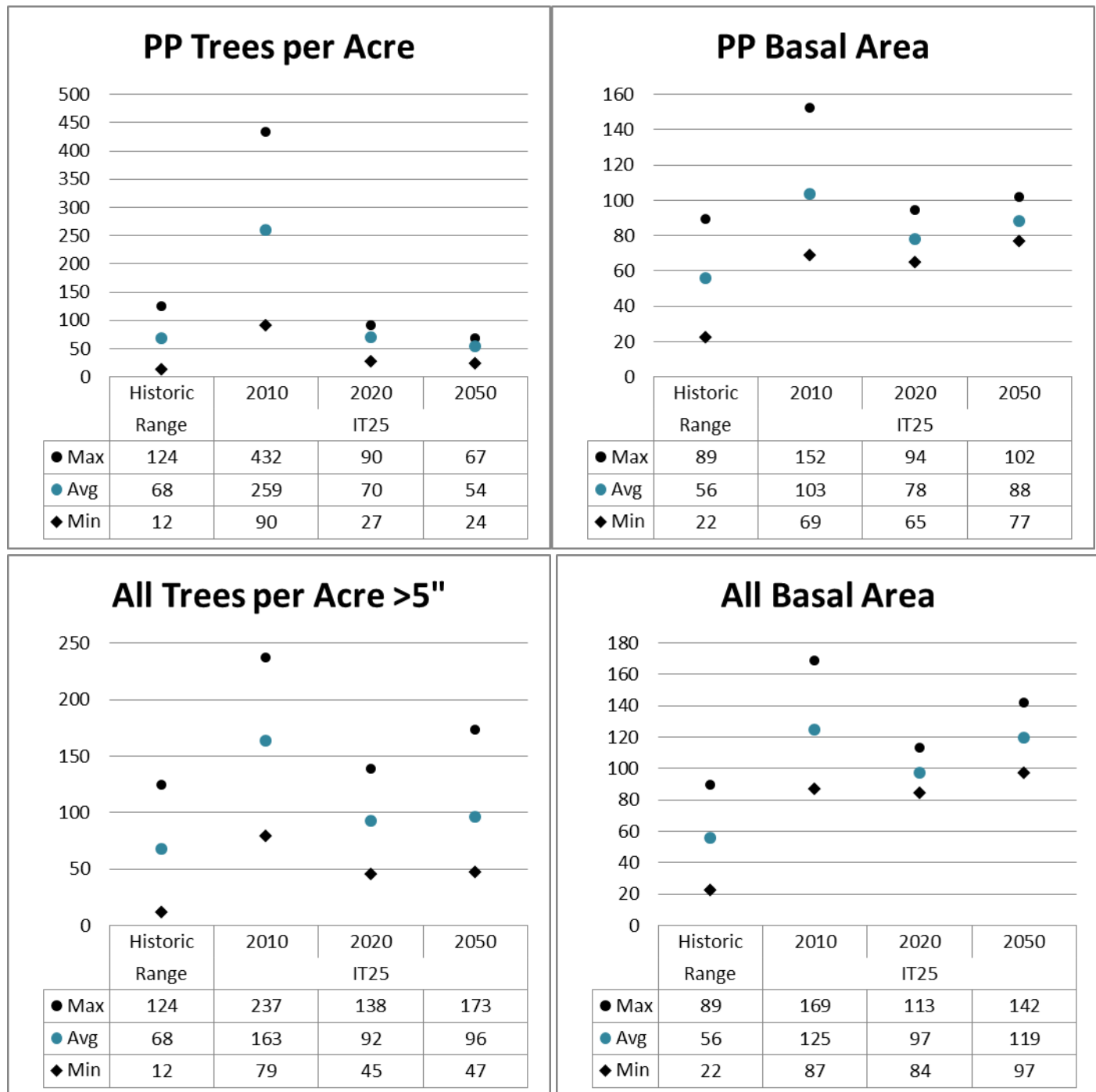
Dispersal PFA Uneven Age – Wildland Urban Interface 55%



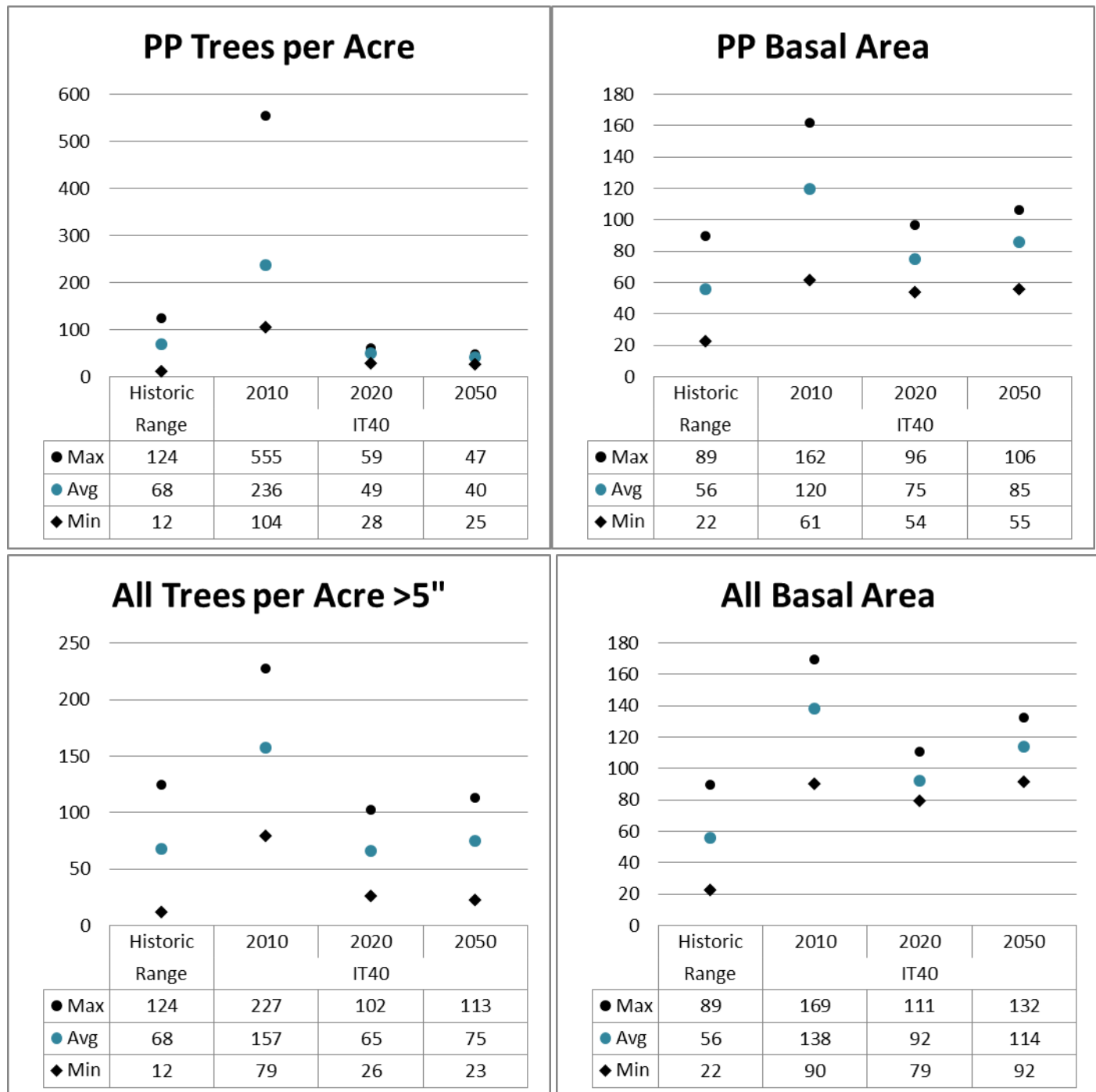
Intermediate Thin – 10-25%



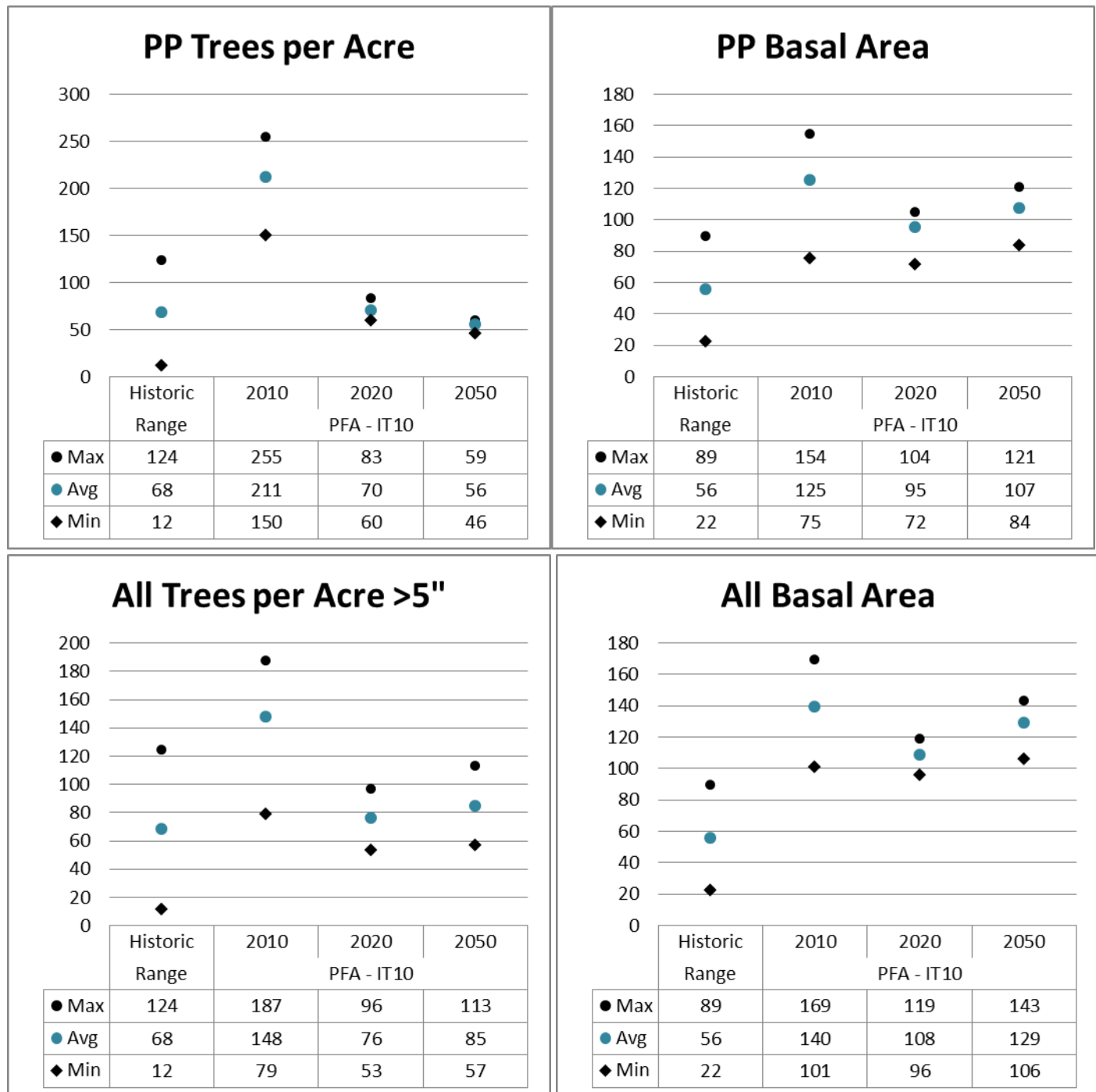
Intermediate Thin – 25-40%



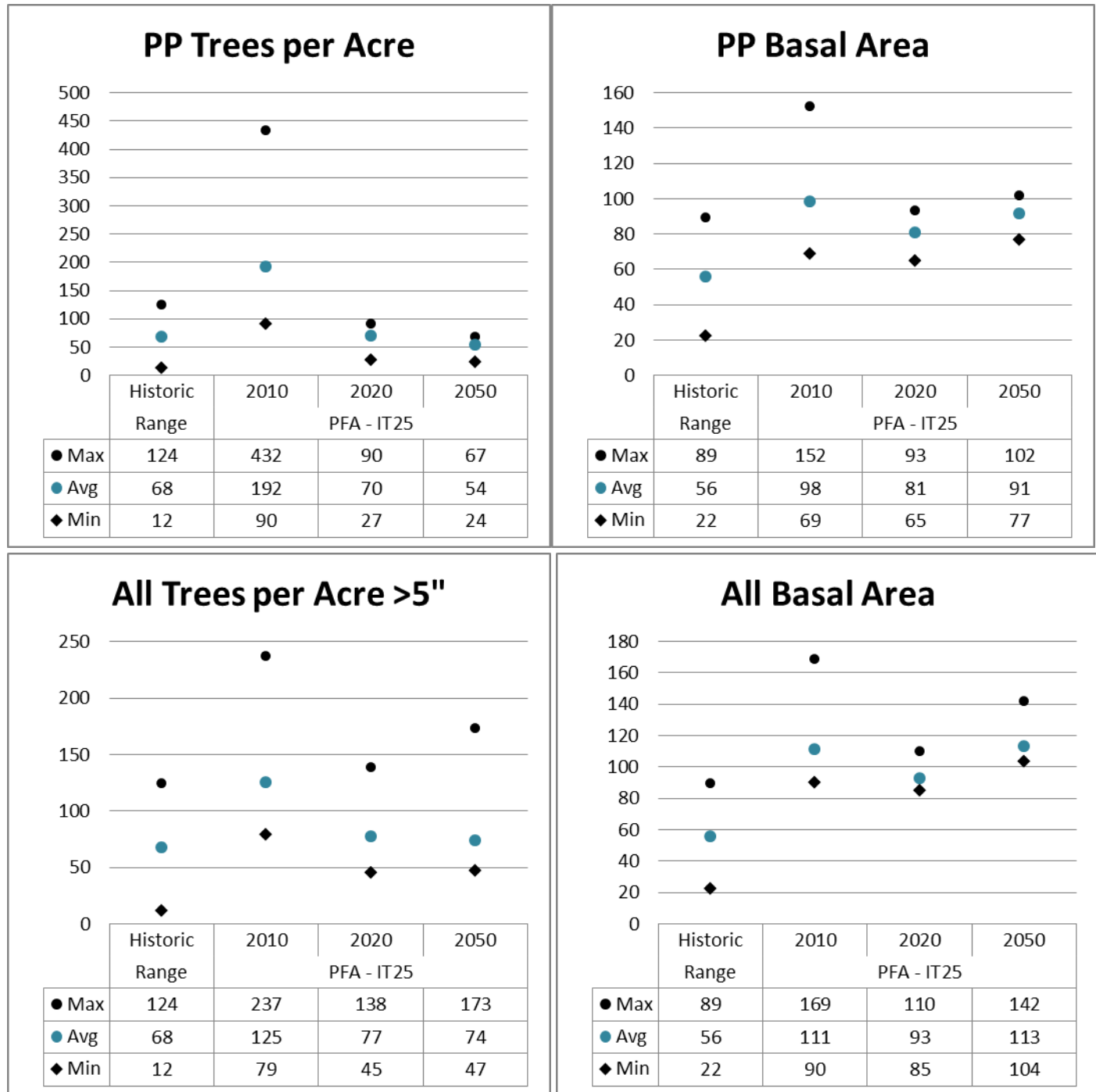
Intermediate Thin – 40-55%



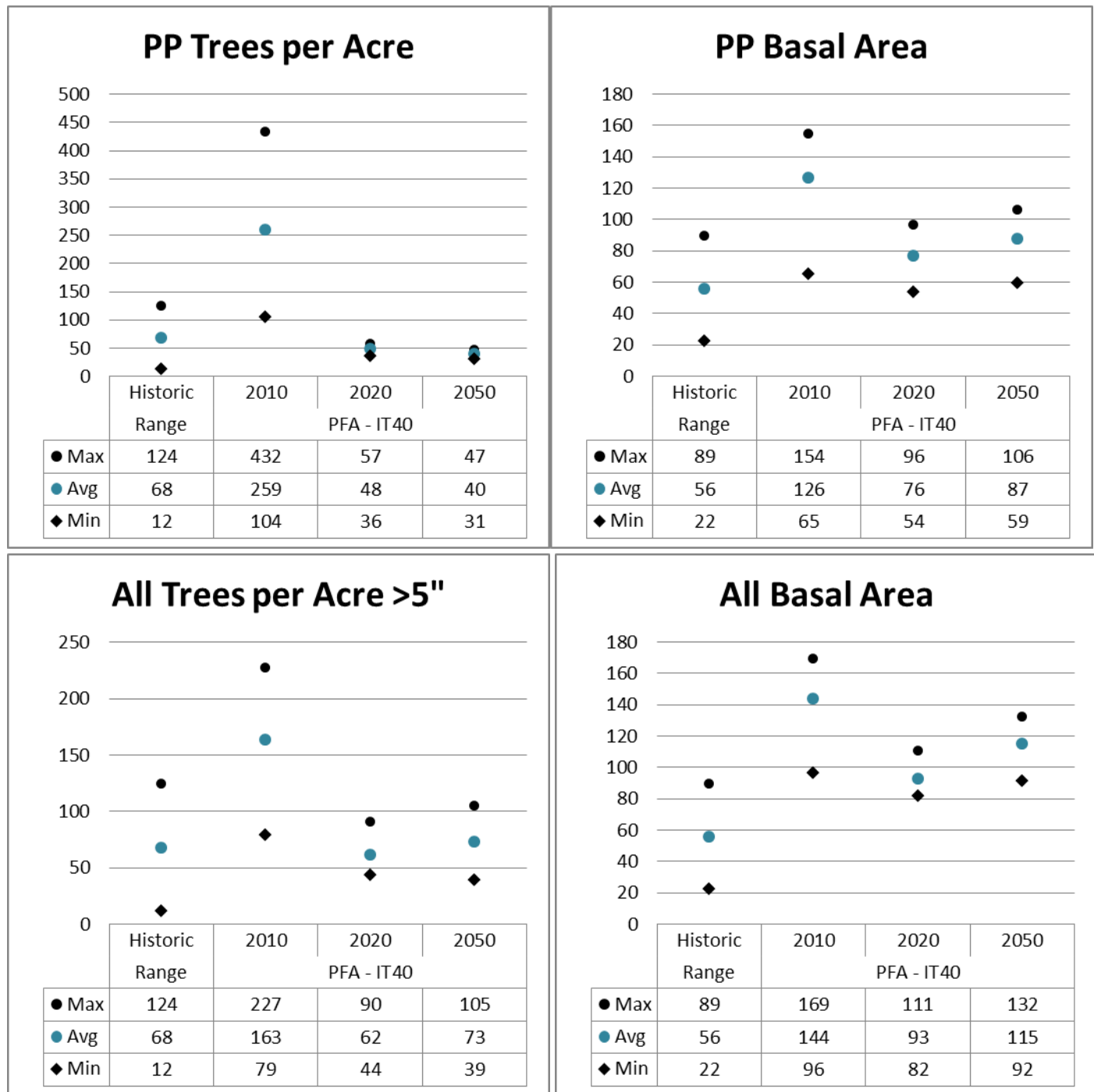
PFA Intermediate Thin – 10-25%



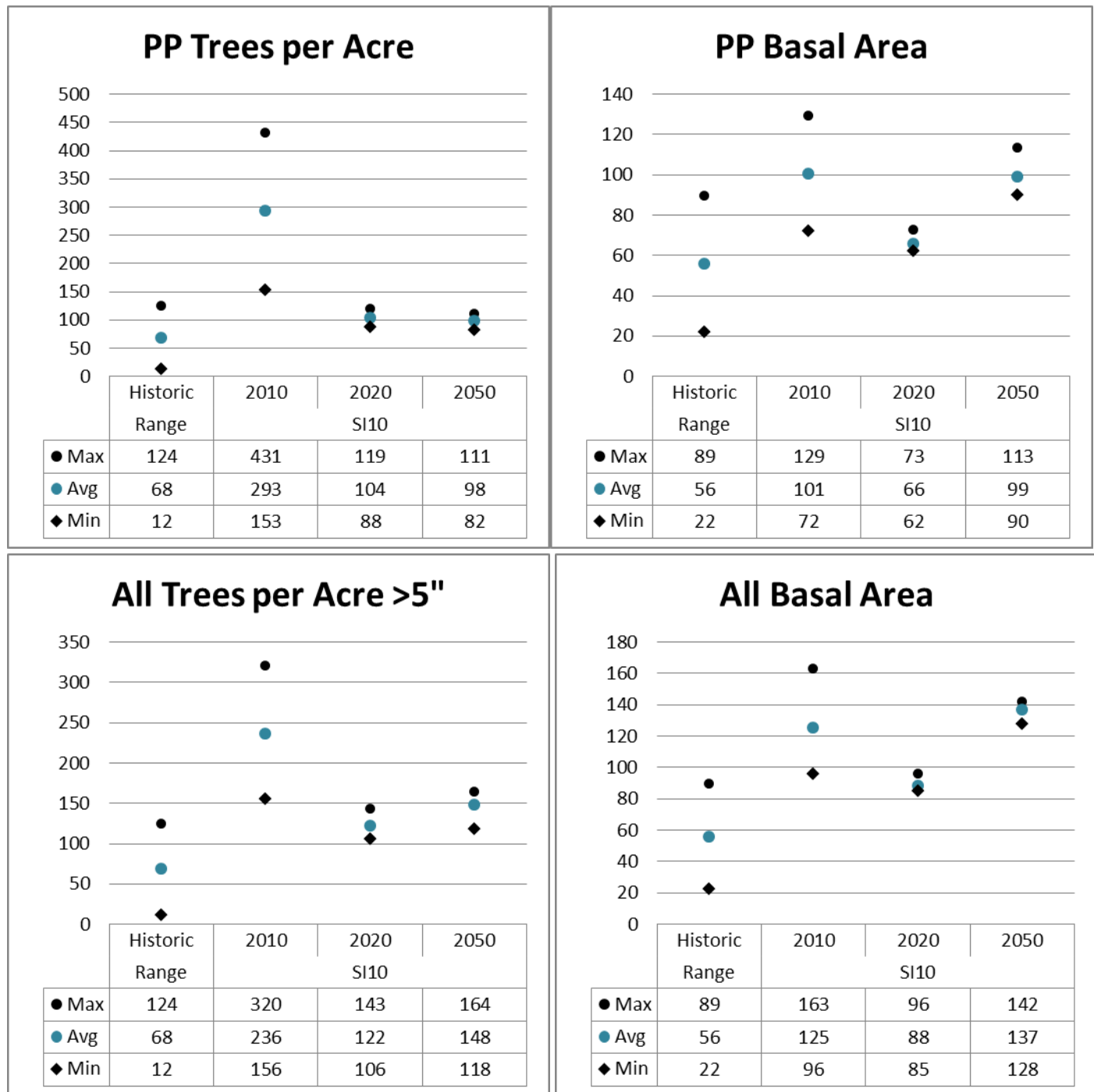
PFA Intermediate Thin – 25-40%



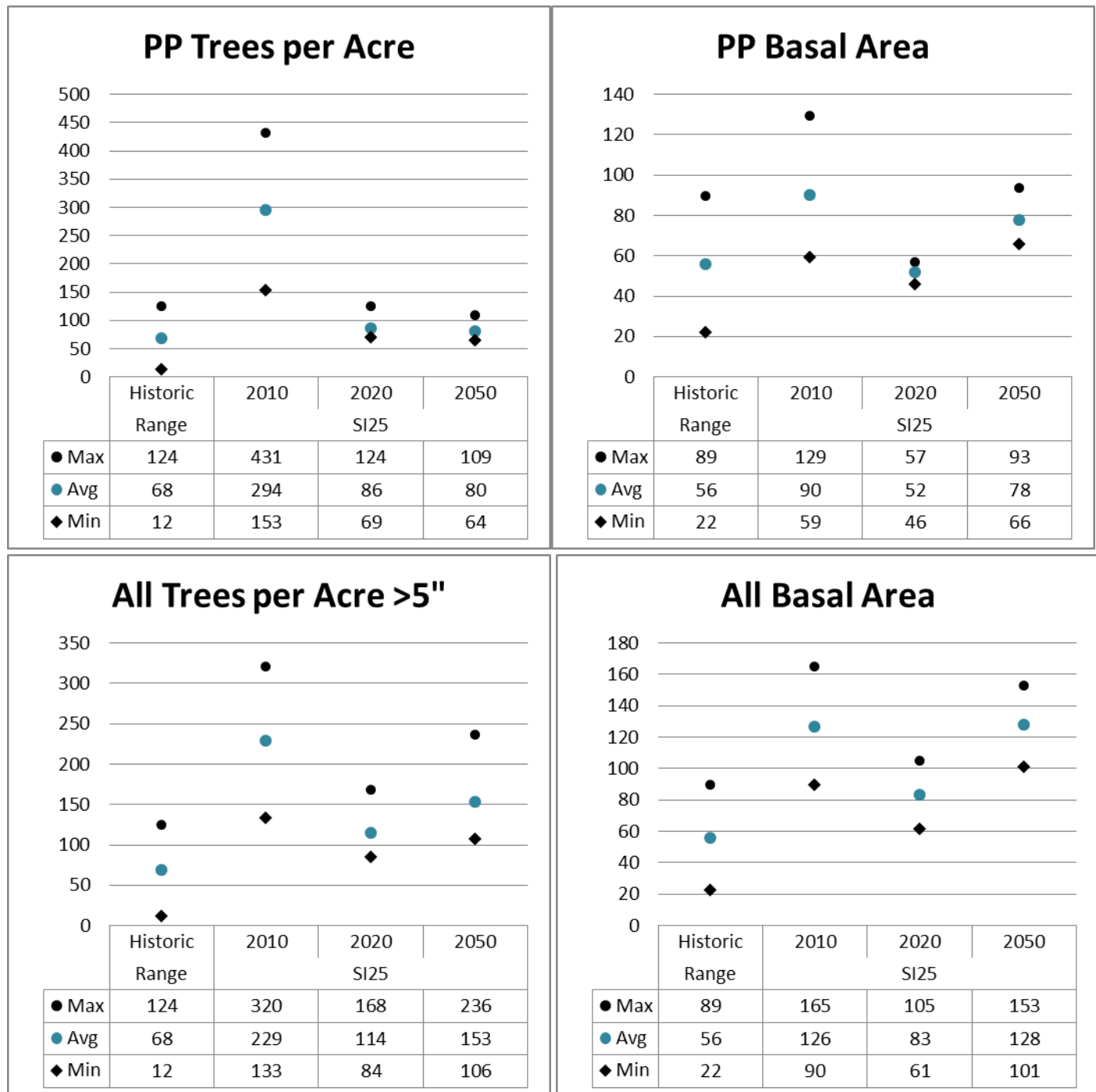
PFA Intermediate Thin – 40-55%



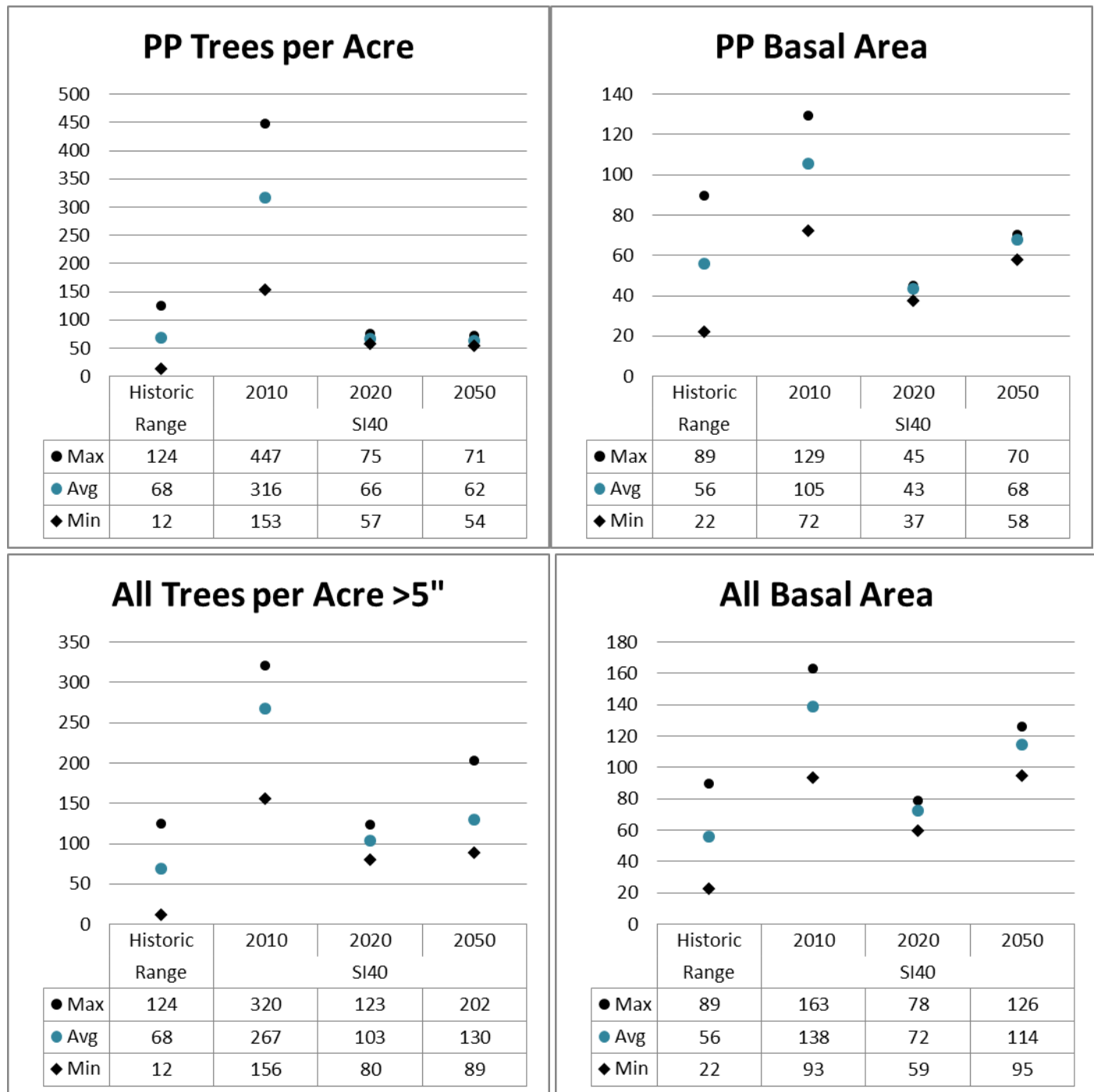
Stand Improvement – 10-25%



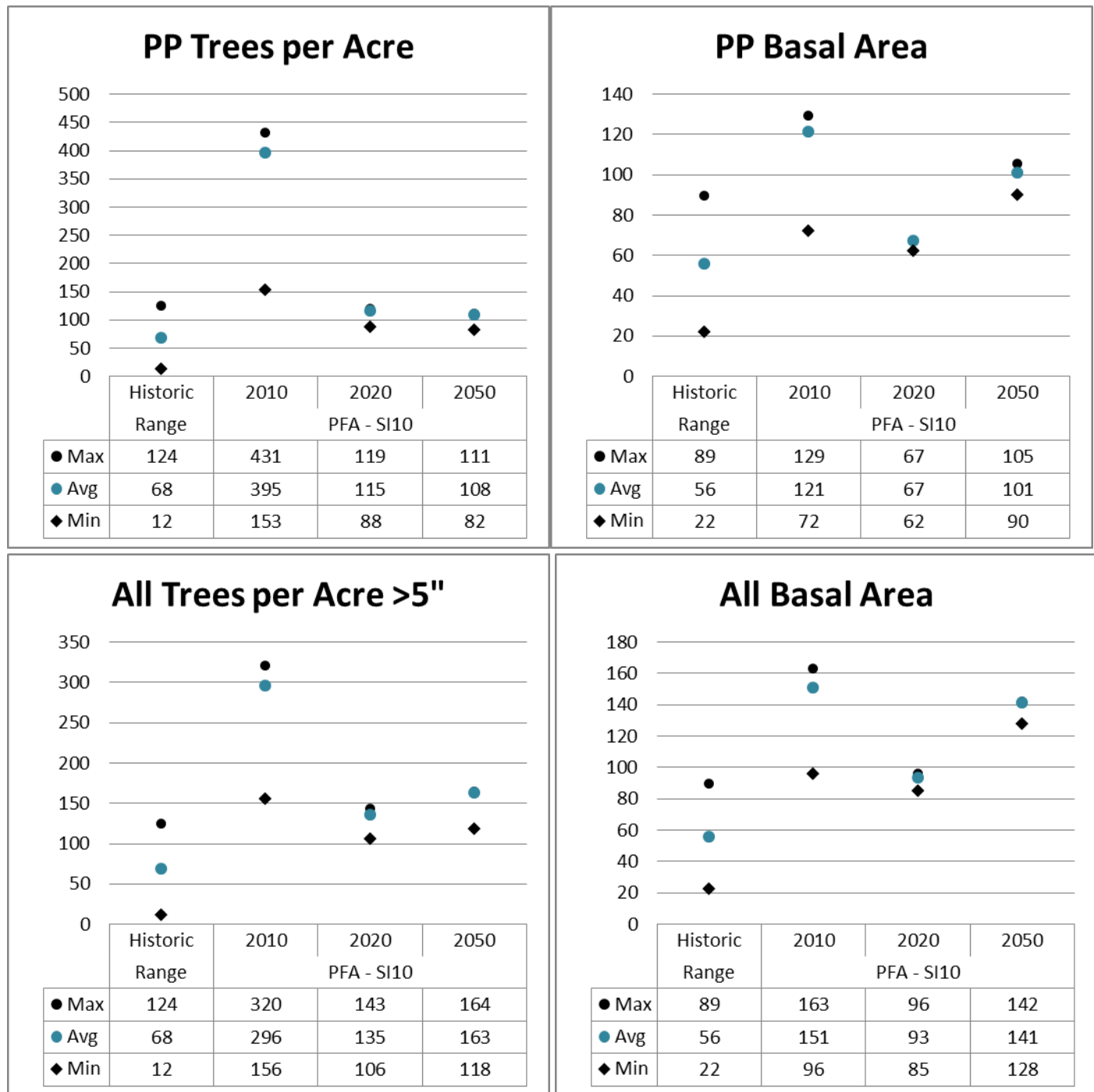
Stand Improvement – 25-40%



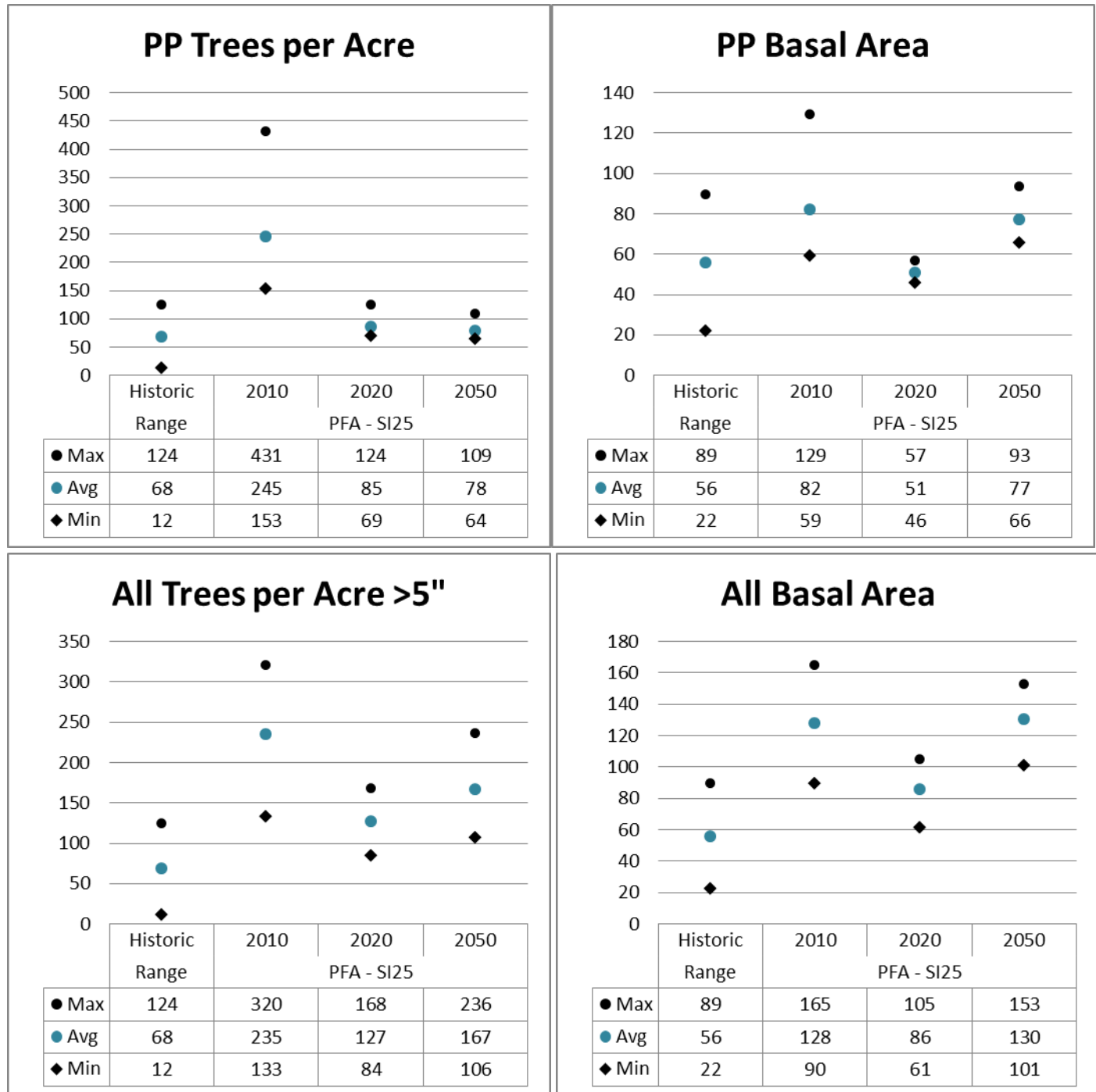
Stand Improvement – 40-55%



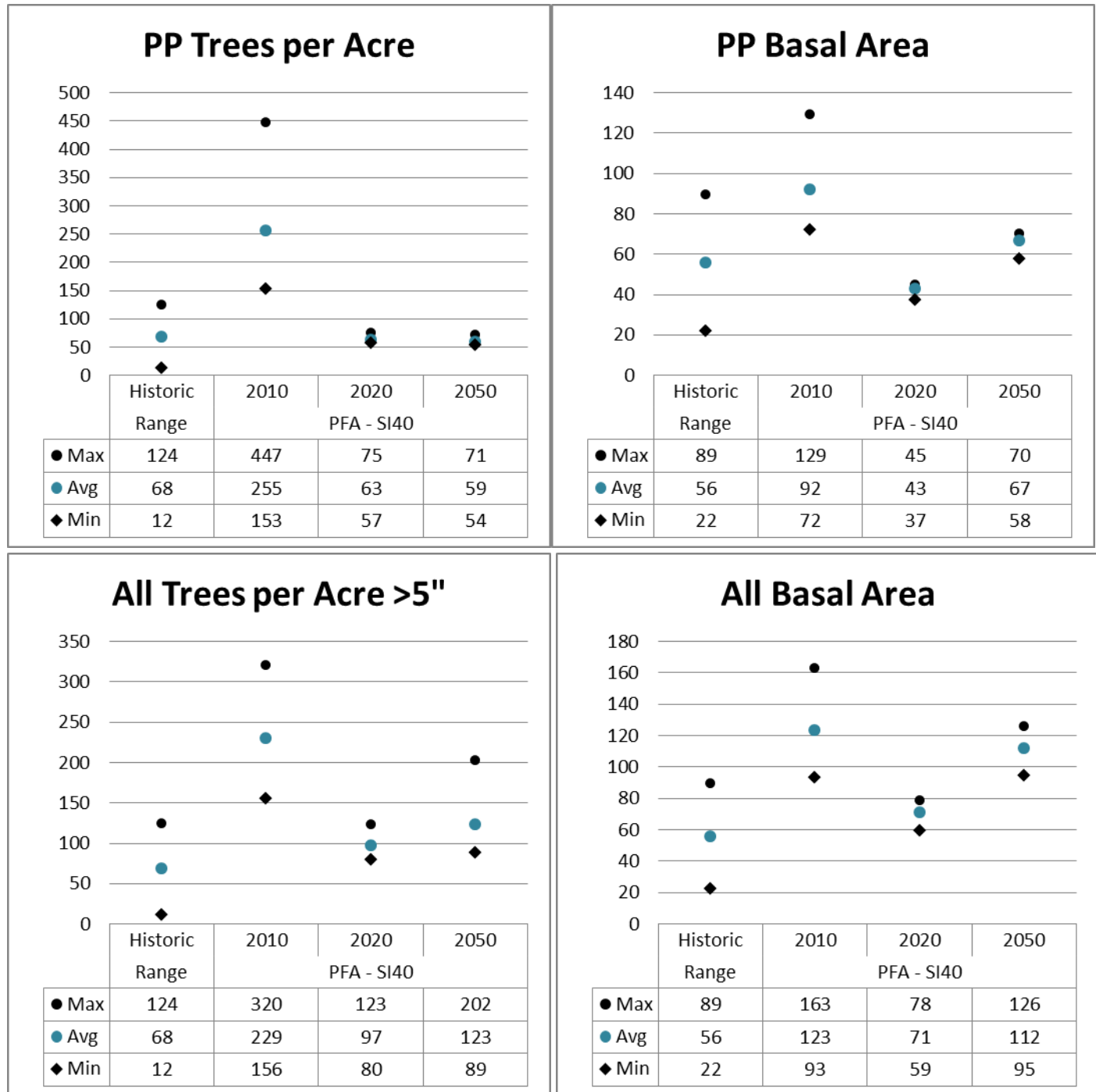
PFA Stand Improvement – 10-25%



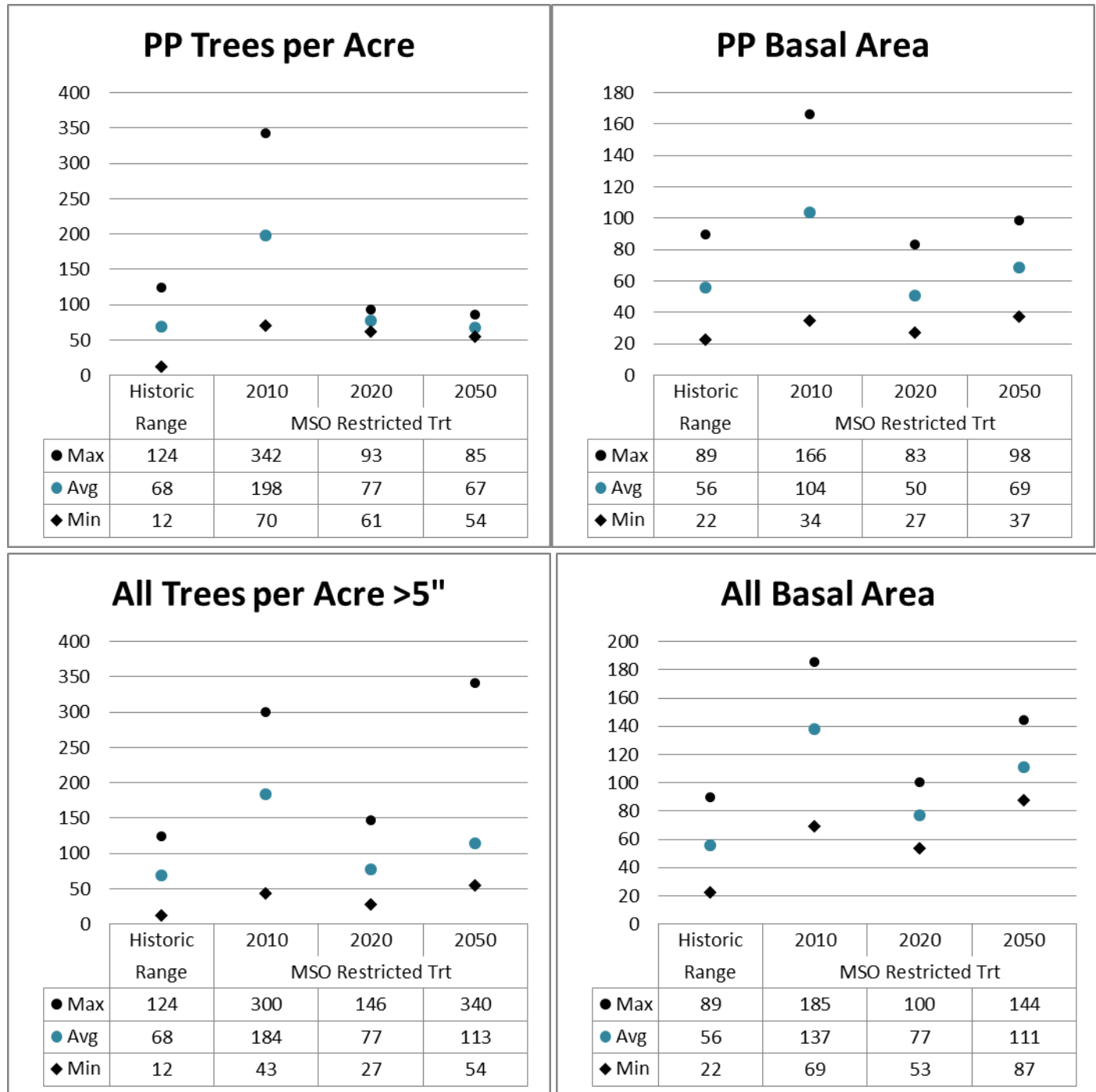
PFA Stand Improvement – 25-40%



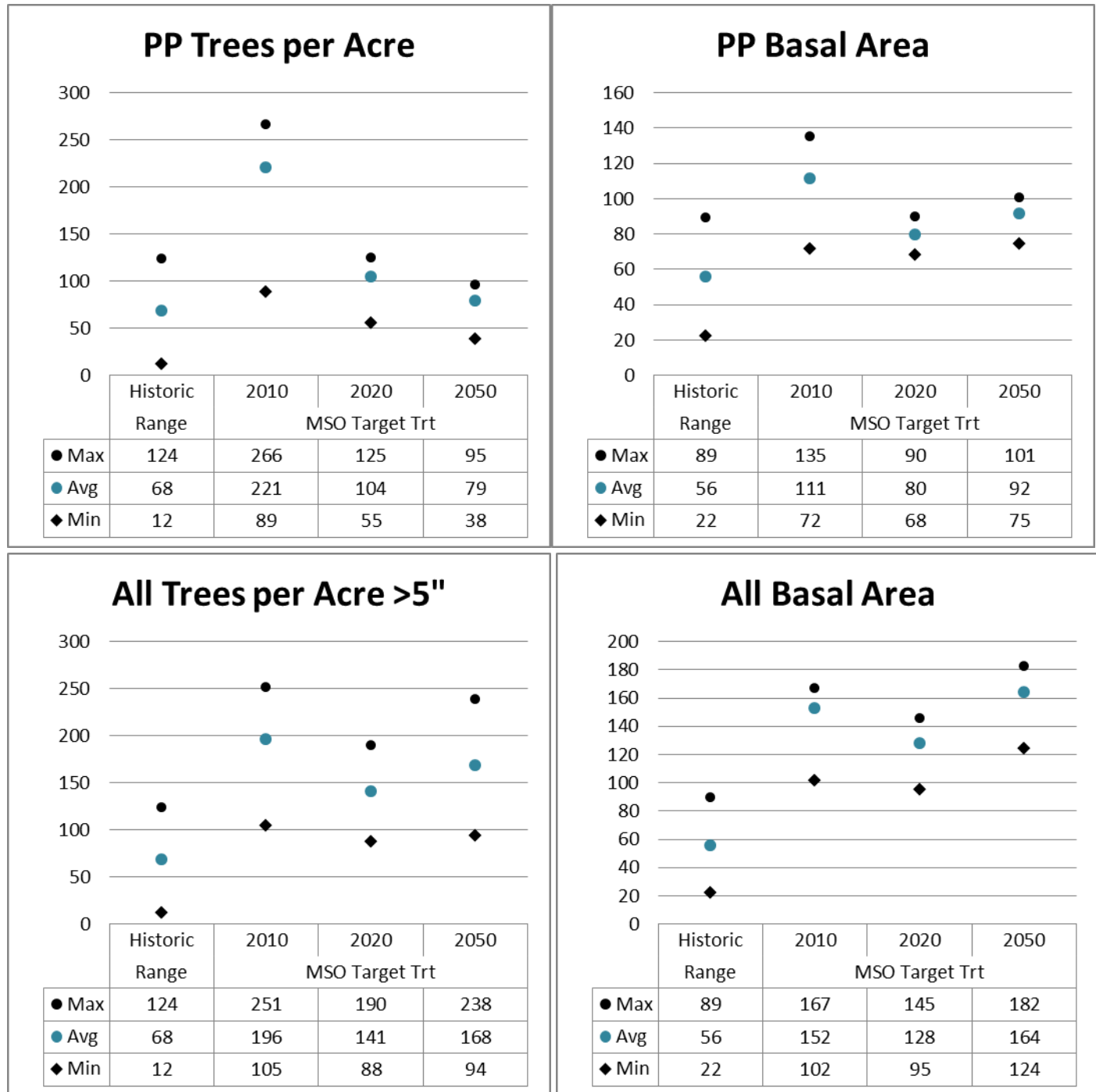
PFA Stand Improvement – 40-55%



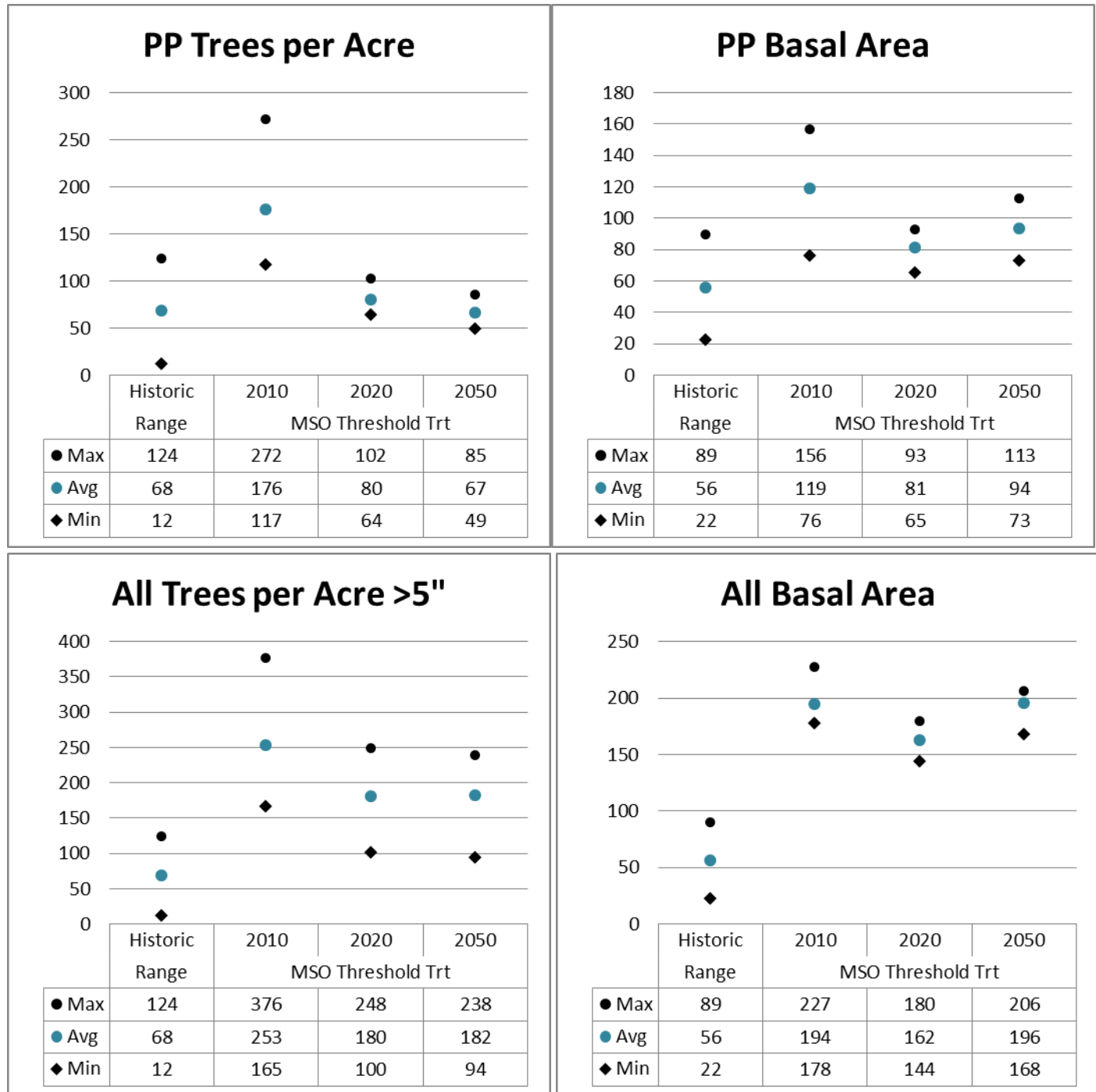
MSO Restricted Treatment



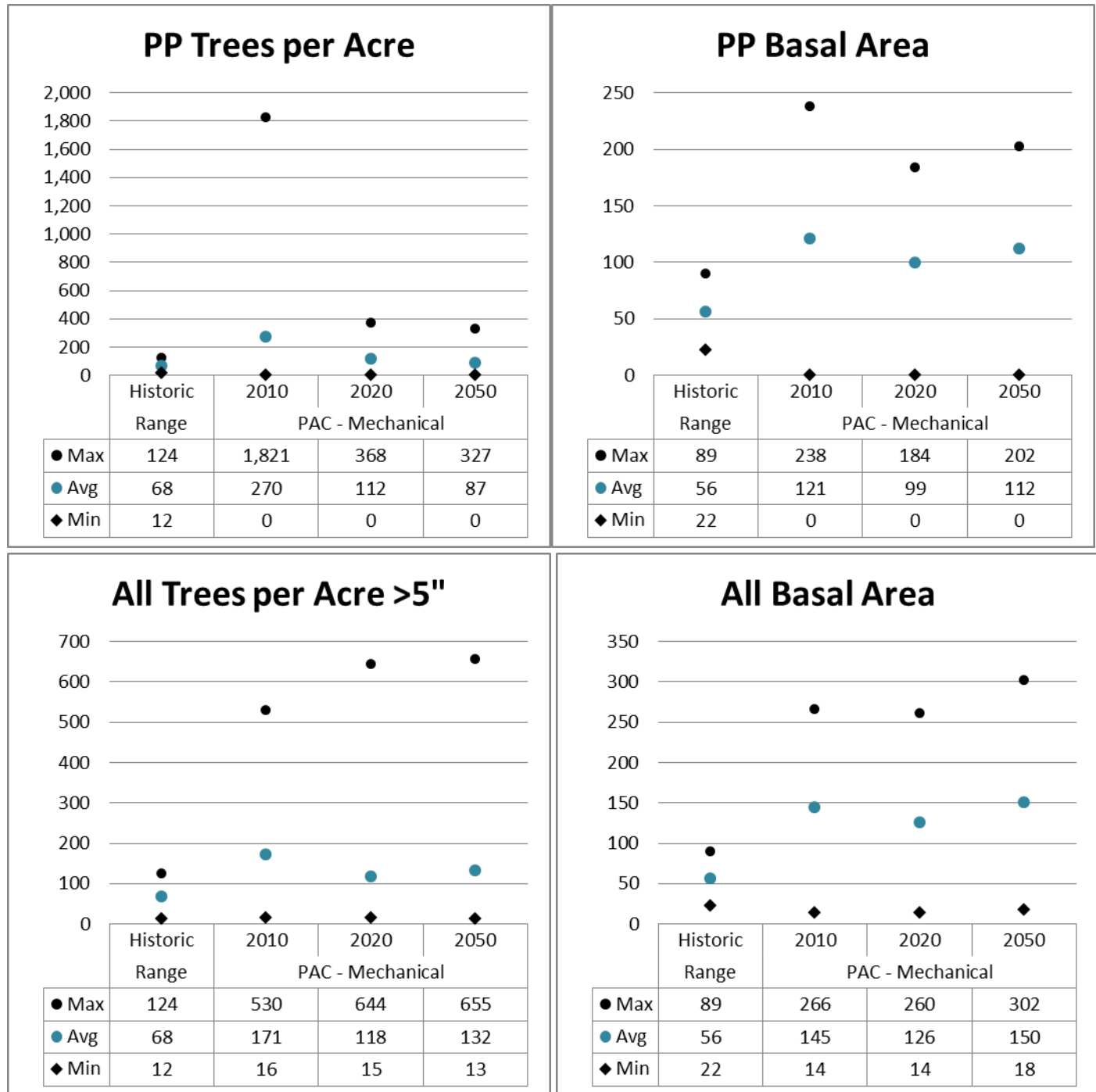
MSO Target Treatment



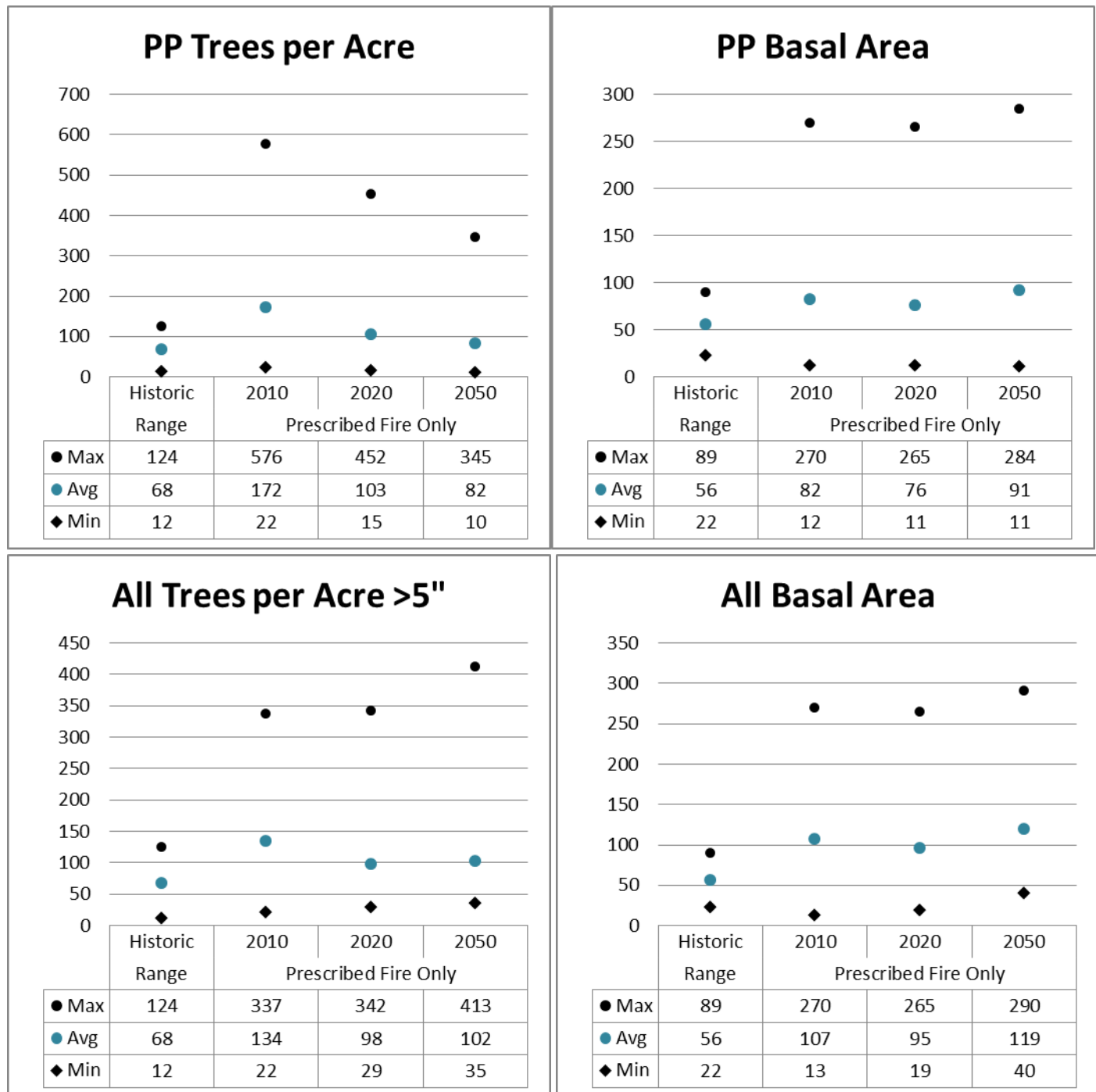
MSO Threshold Treatment



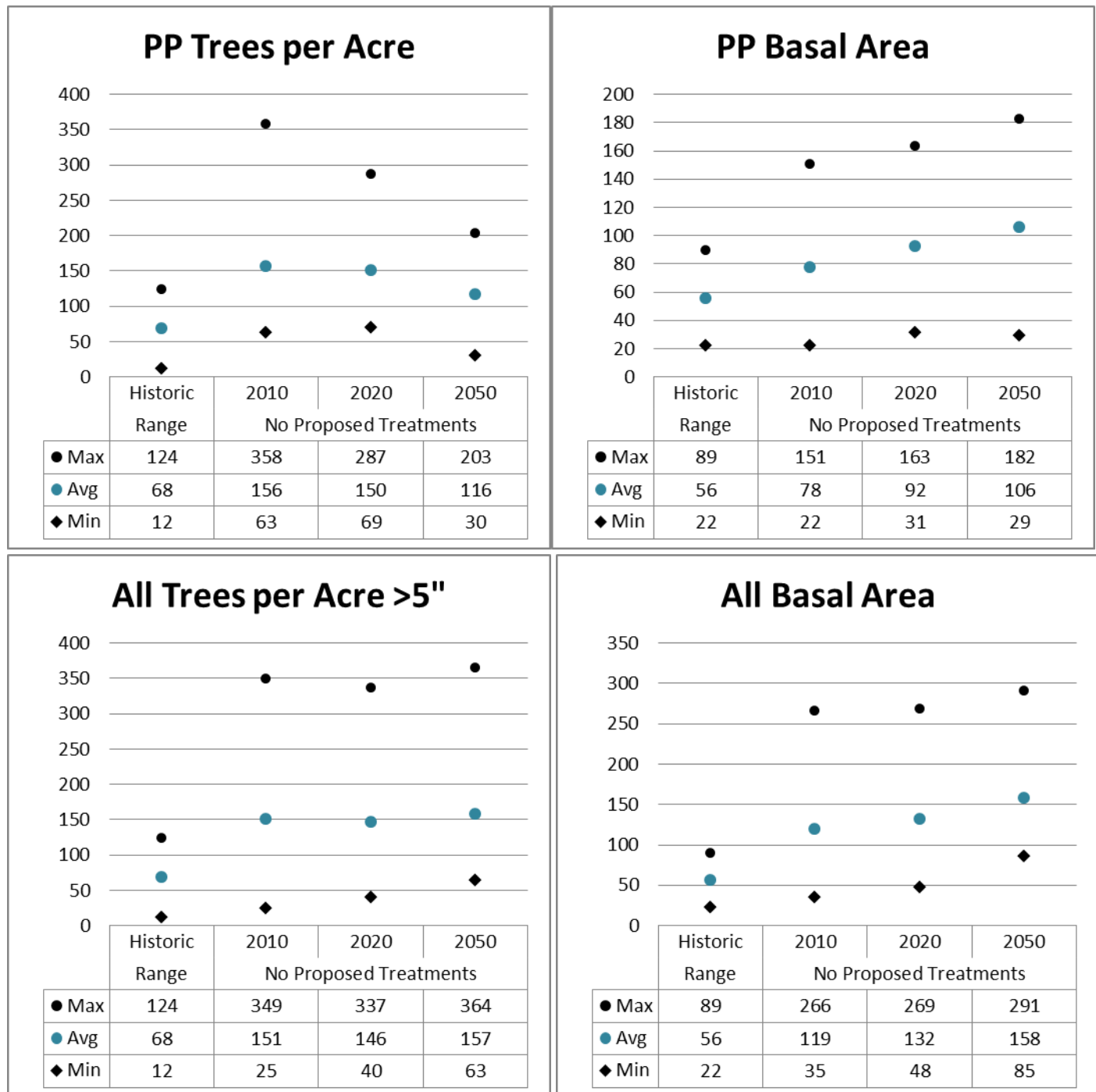
PAC – Mechanical



Prescribed Fire Only

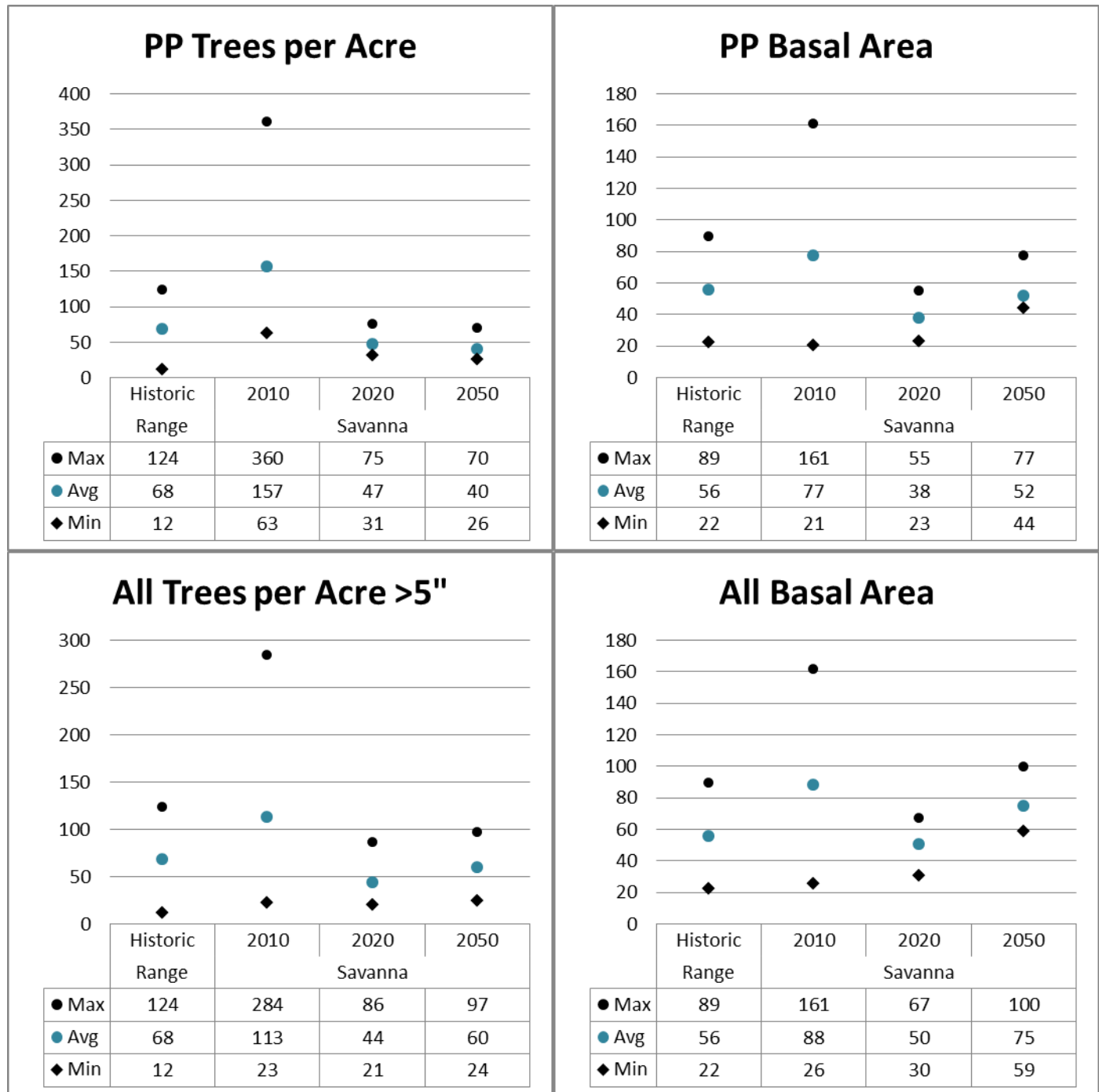


No Proposed Treatments



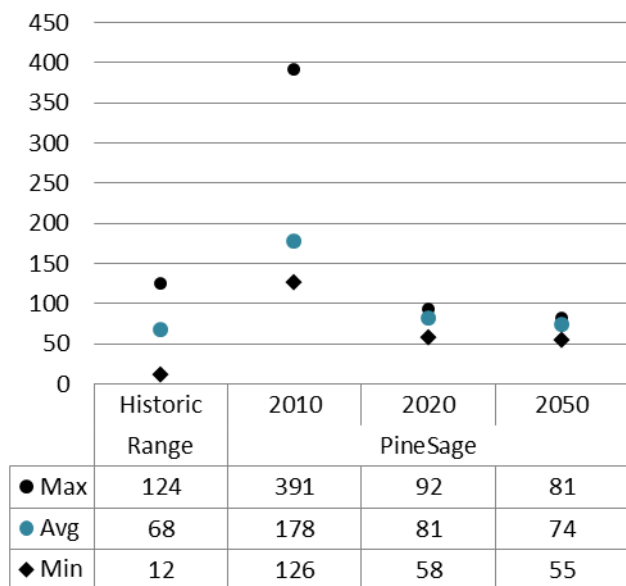
Appendix F - Natural Range of Variability Comparison by Treatment Type (Alt D)

Grassland Restoration

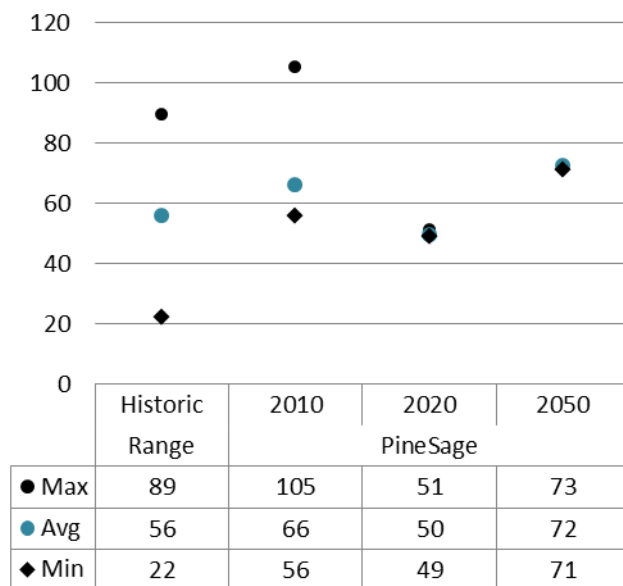


Pine Sage

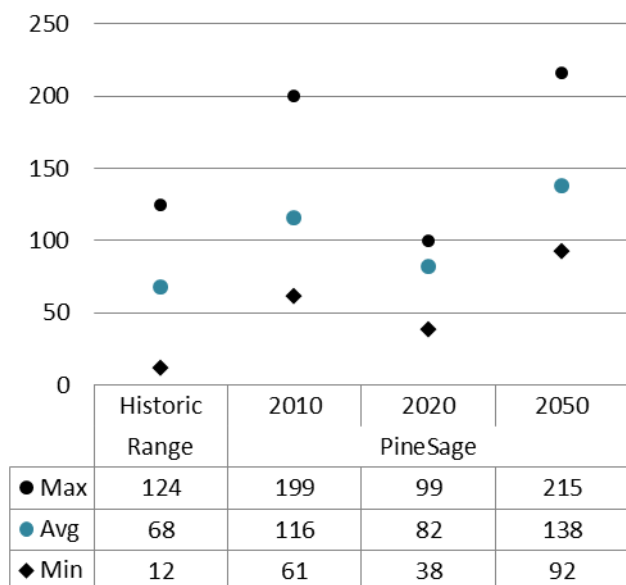
PP Trees per Acre



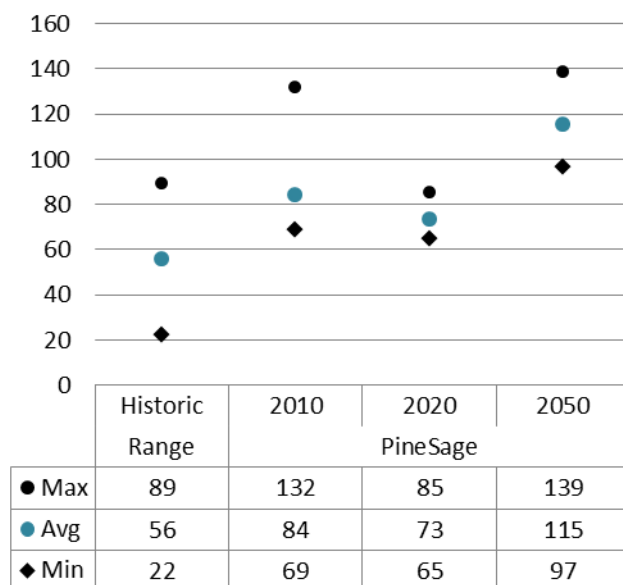
PP Basal Area



All Trees per Acre >5"

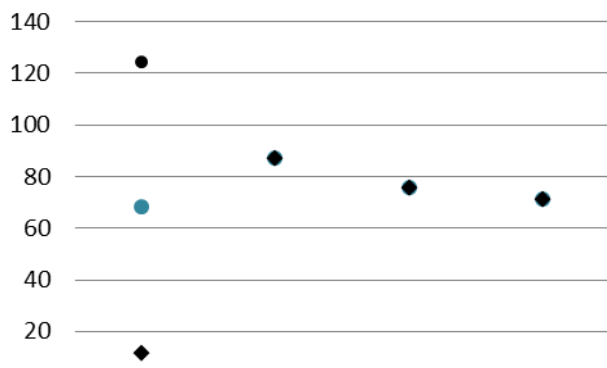


All Basal Area



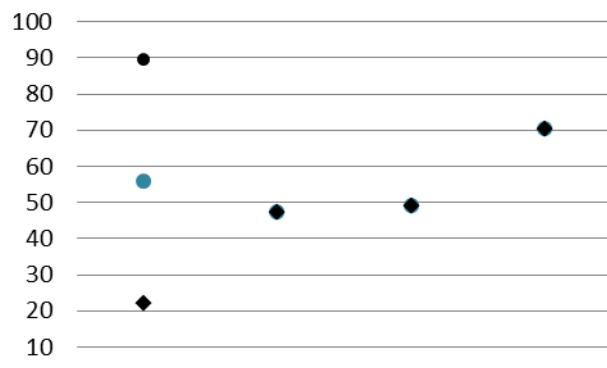
PFA Pine Sage

PP Trees per Acre



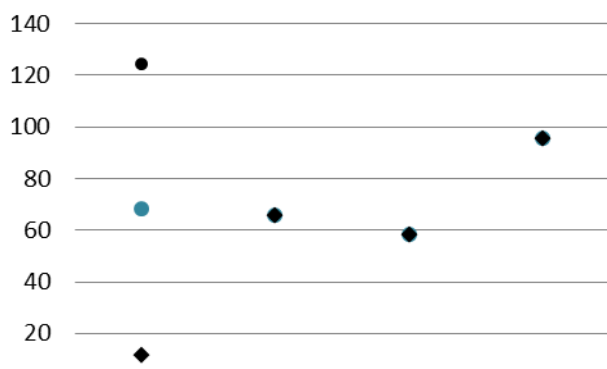
	Historic Range	PFA - PineSage		
● Max	124	87	75	71
● Avg	68	87	75	71
◆ Min	12	87	75	71

PP Basal Area



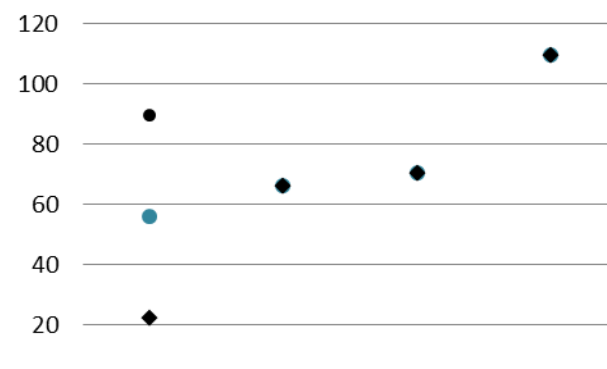
	Historic Range	PFA - PineSage		
● Max	89	47	49	70
● Avg	56	47	49	70
◆ Min	22	47	49	70

All Trees per Acre >5"



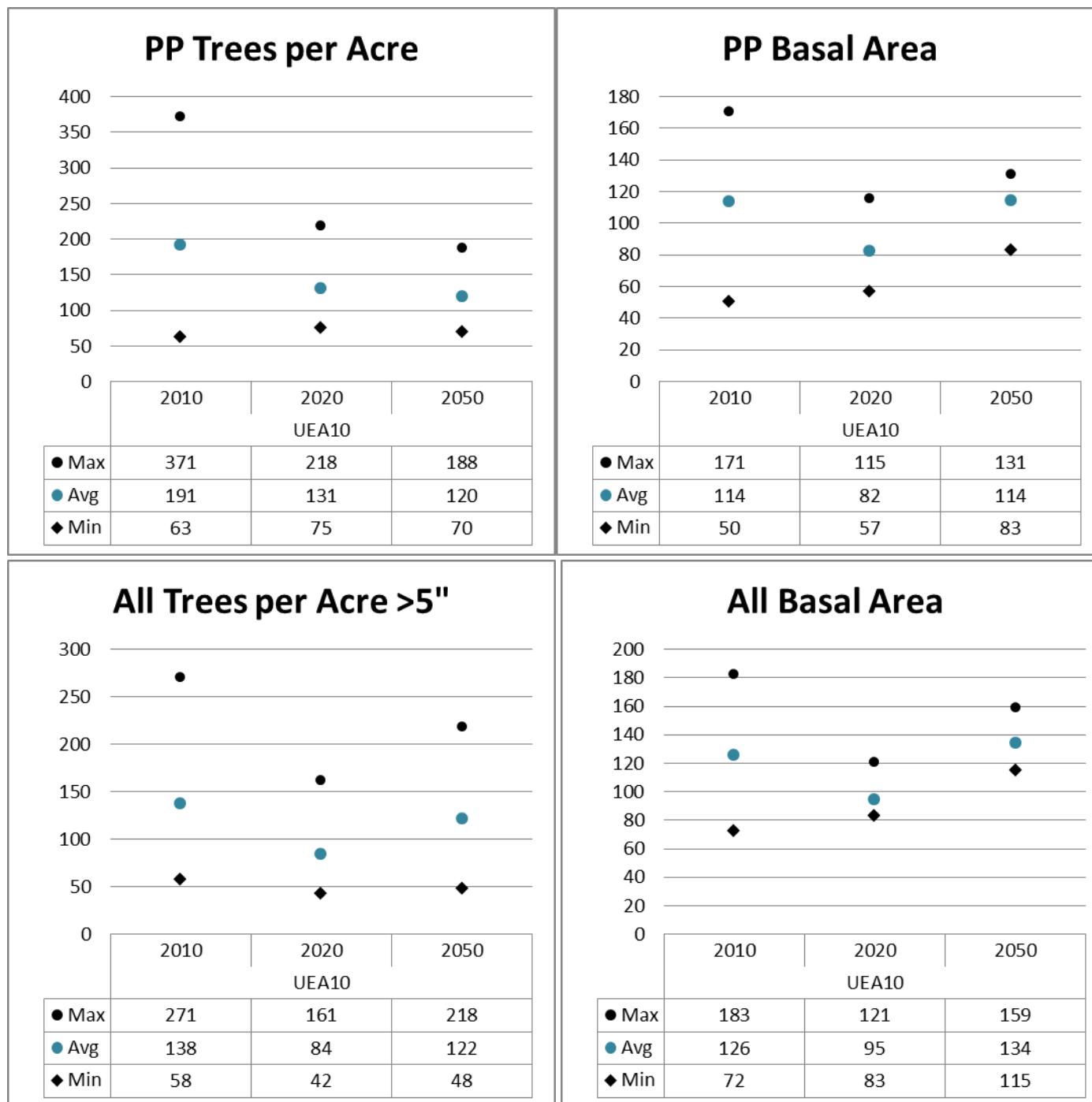
	Historic Range	PFA - PineSage		
● Max	124	66	58	95
● Avg	68	66	58	95
◆ Min	12	66	58	95

All Basal Area

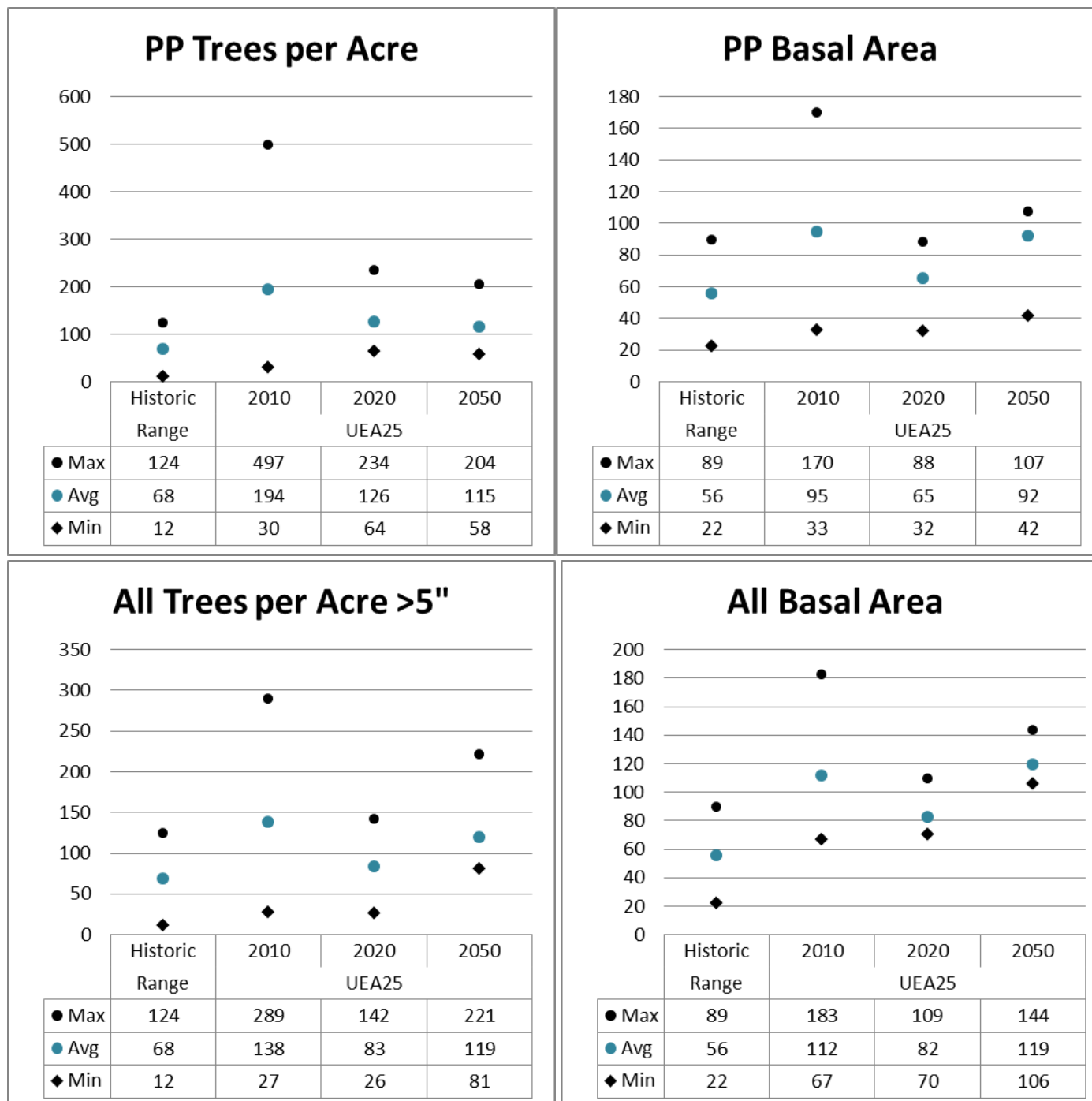


	Historic Range	PFA - PineSage		
● Max	89	66	70	110
● Avg	56	66	70	110
◆ Min	22	66	70	110

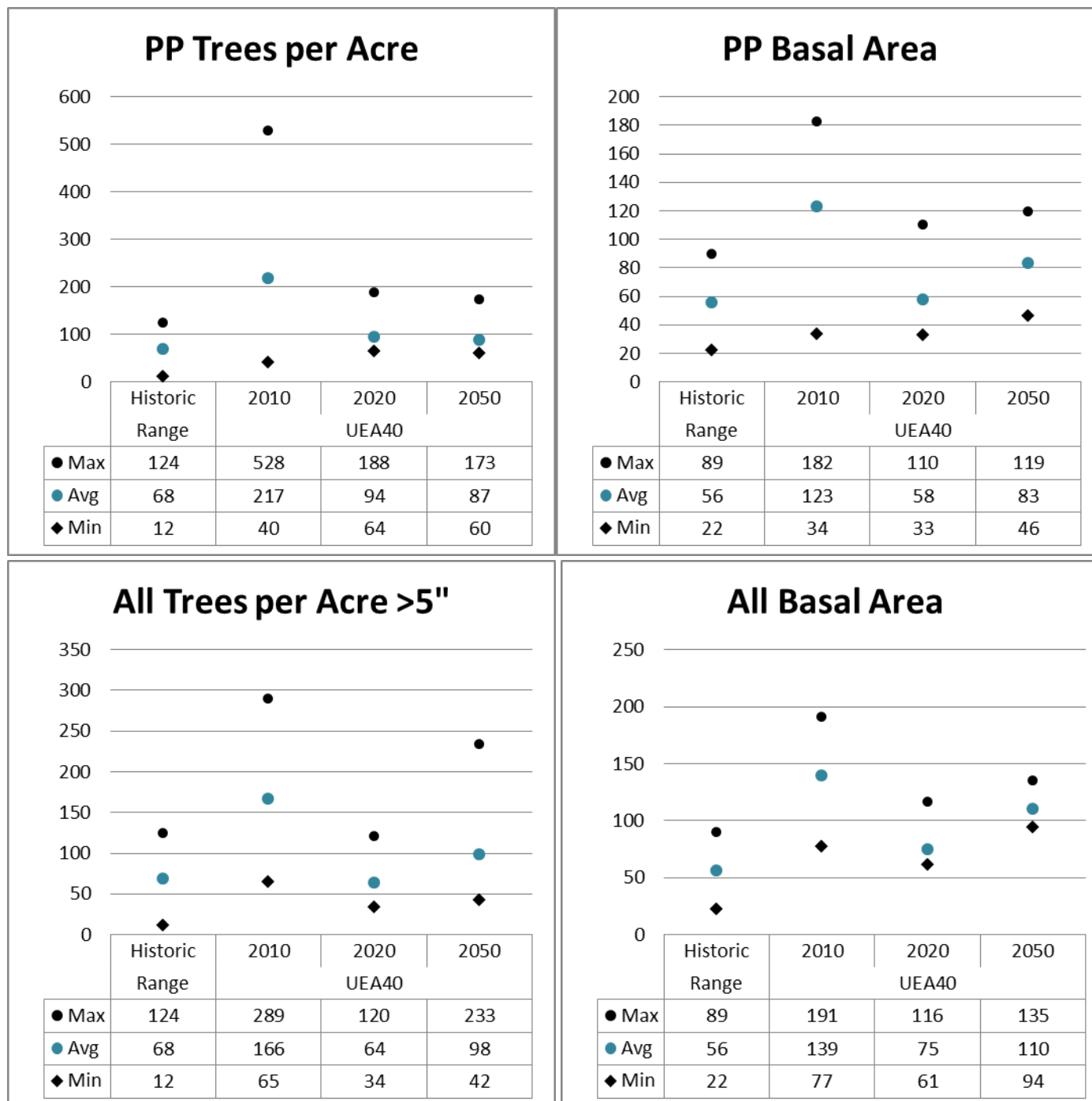
Uneven Age – 10-25%



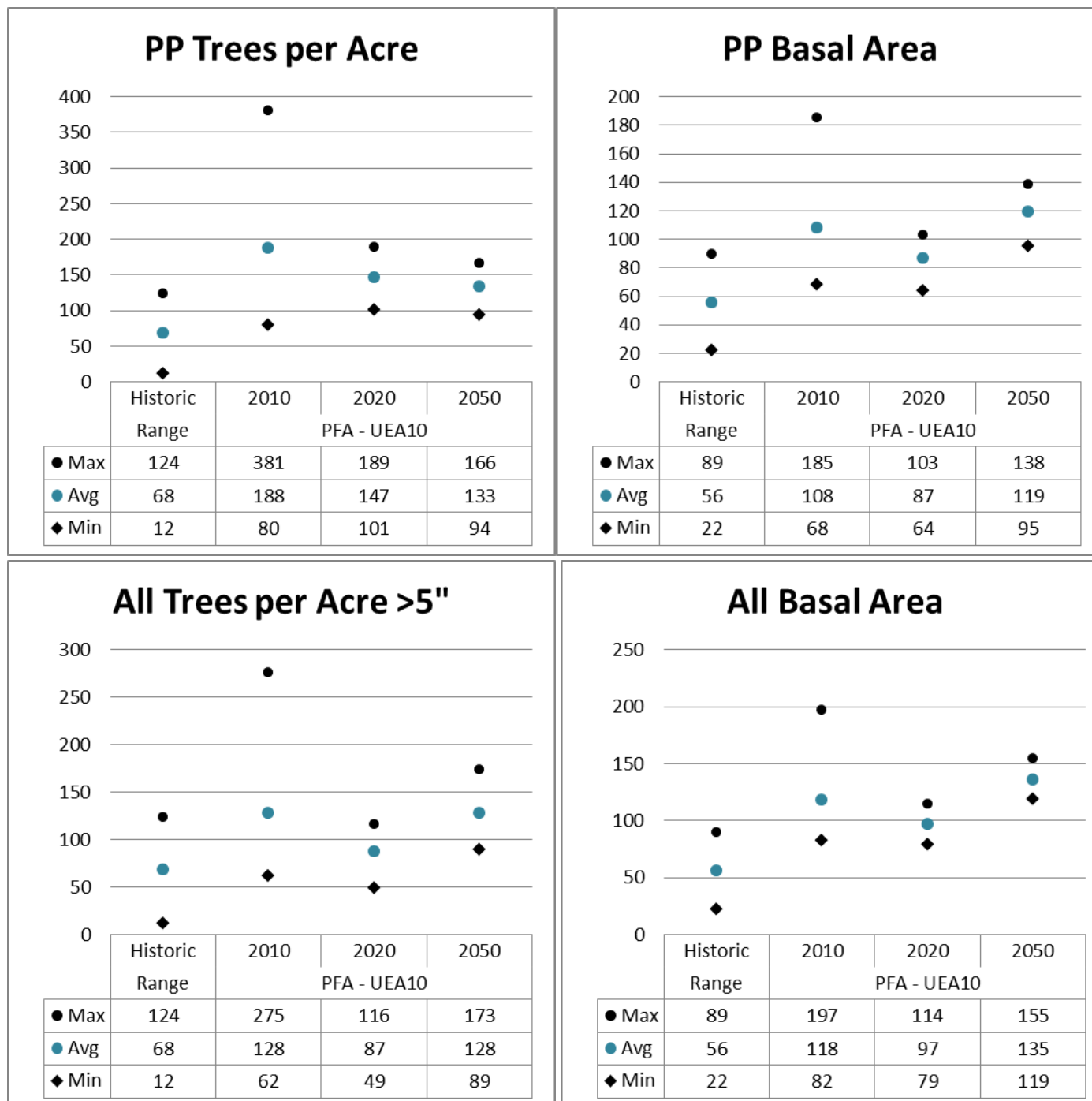
Uneven Age – 25-40%



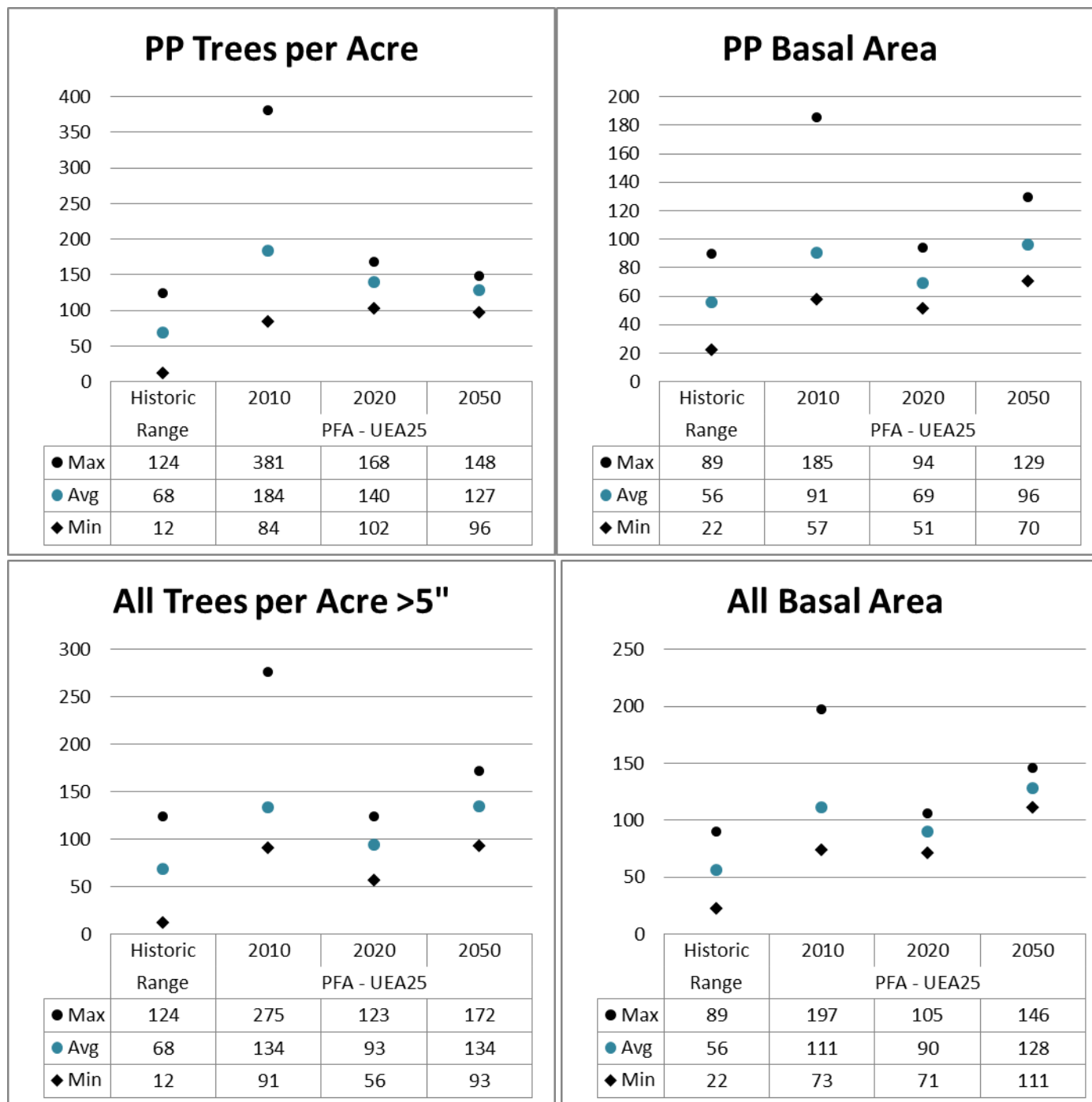
Uneven Age – 40-55%



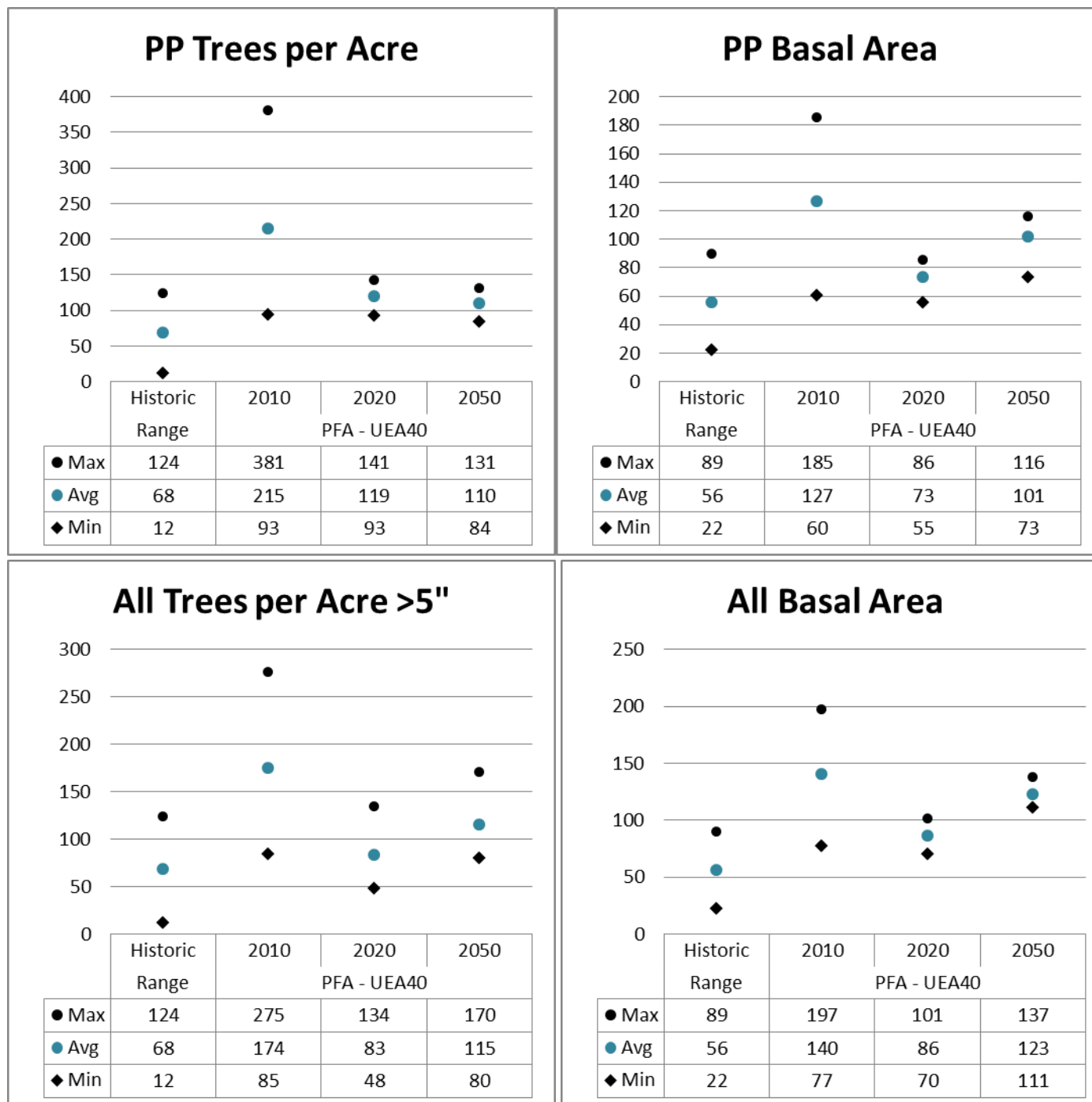
PFA Uneven Age – 10-25%



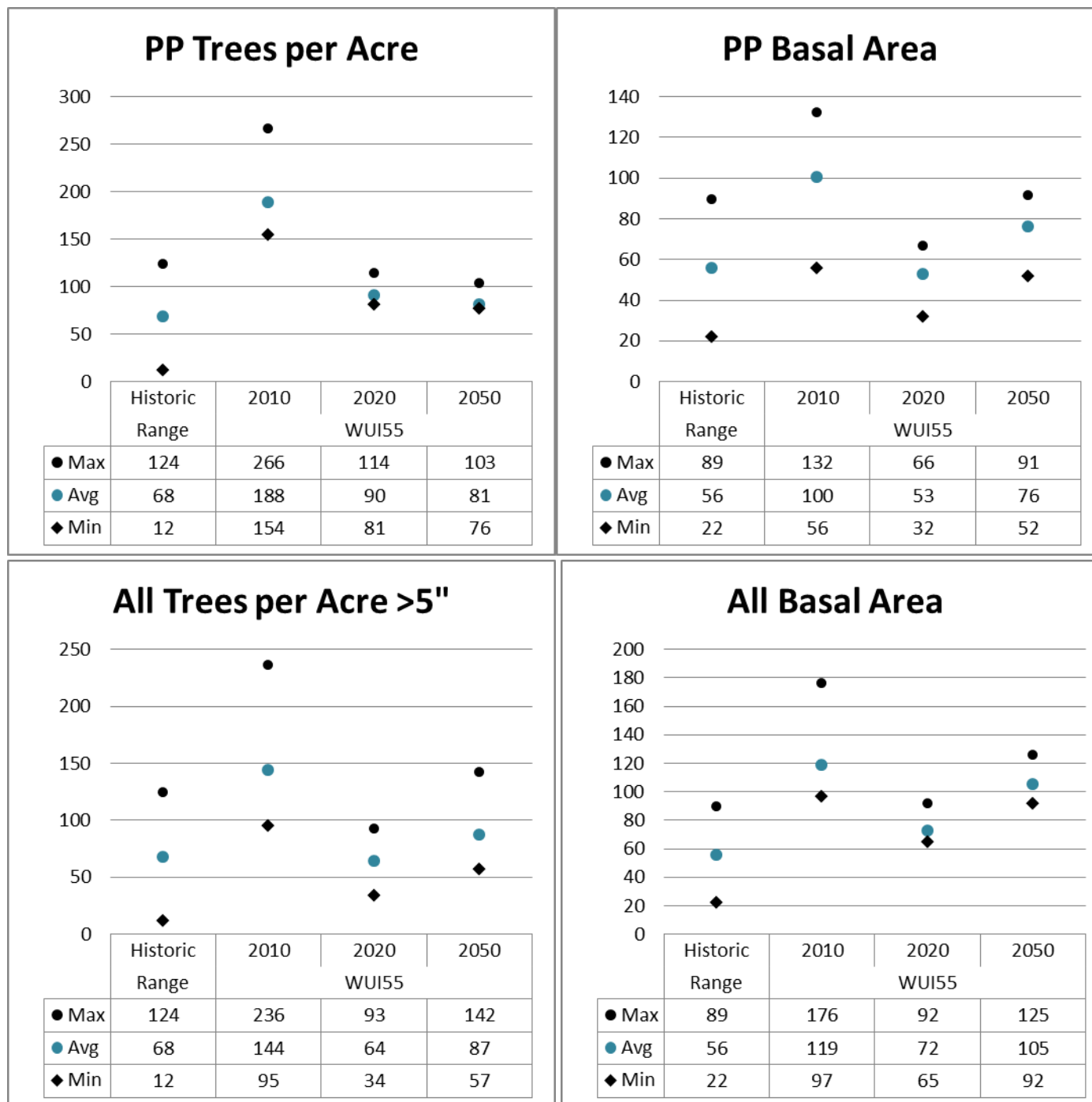
PFA Uneven Age – 25-40%



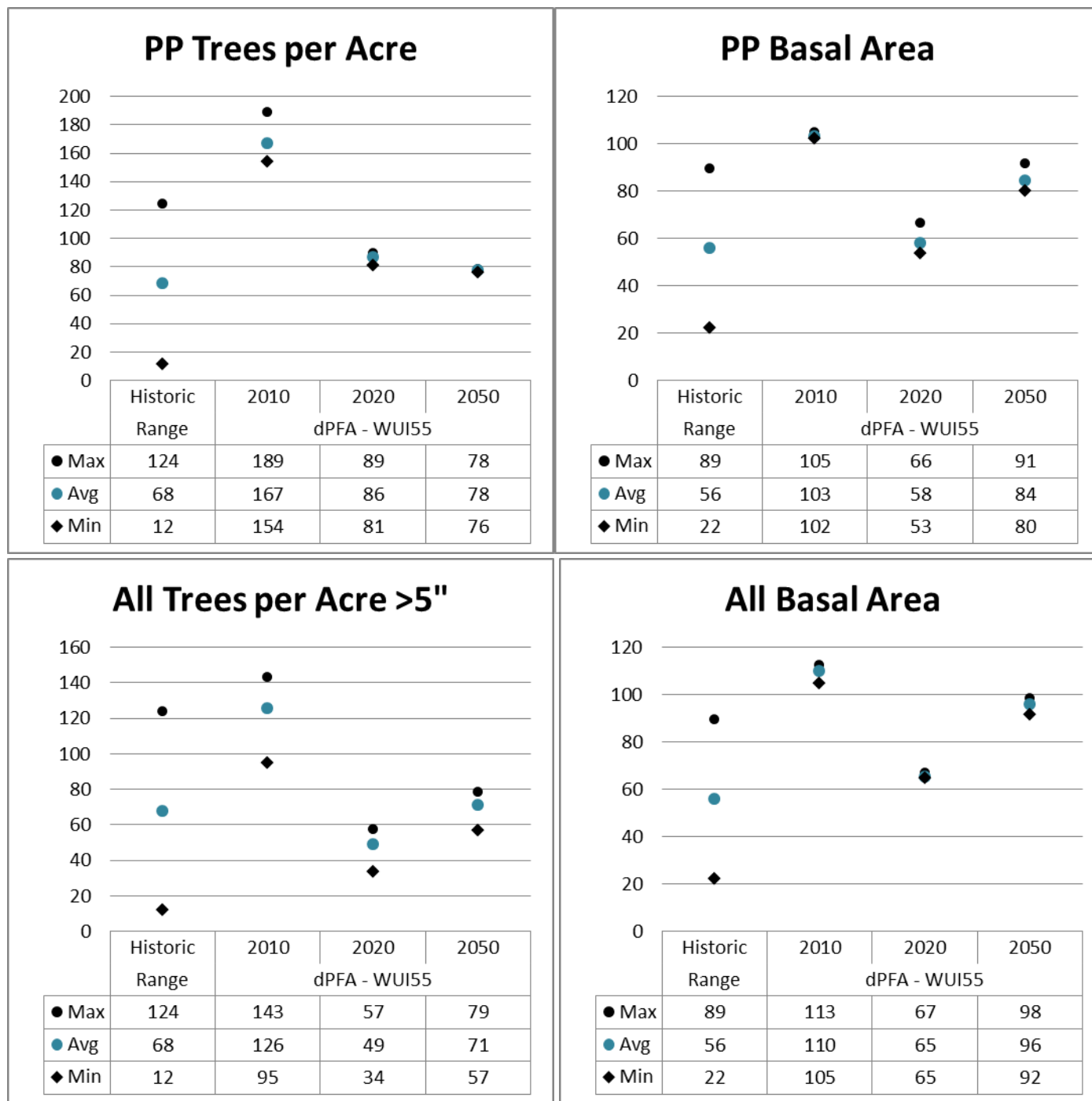
PFA Uneven Age – 40-55%



Uneven Age – Wildland Urban Interface 55%

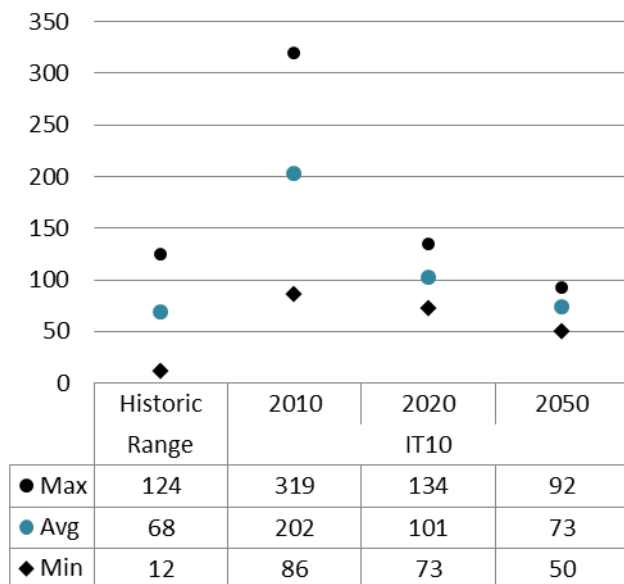


Dispersal PFA Uneven Age – Wildland Urban Interface 55%

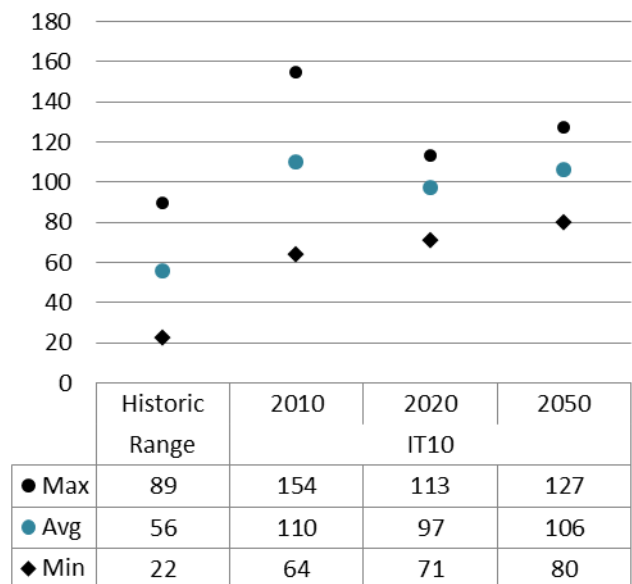


Intermediate Thin – 10-25%

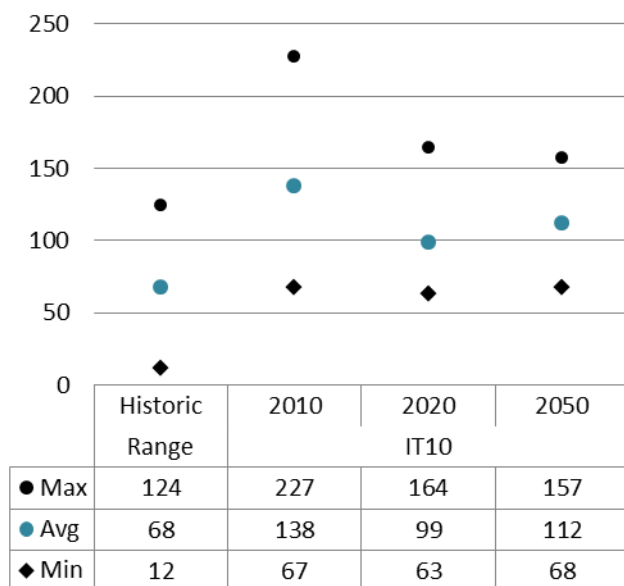
PP Trees per Acre



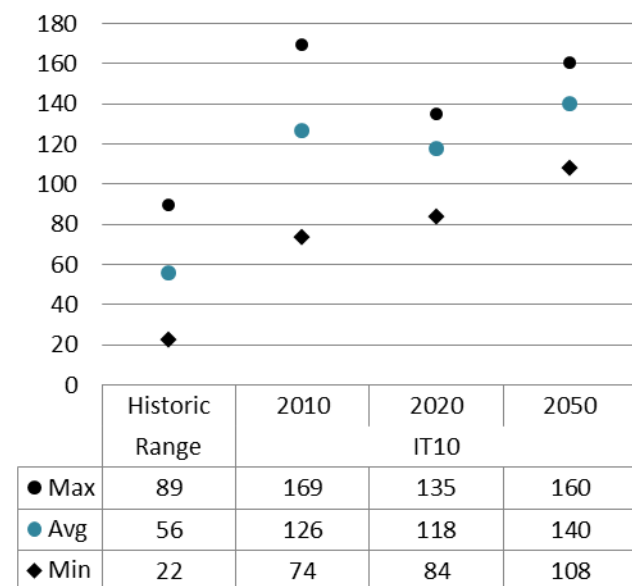
PP Basal Area



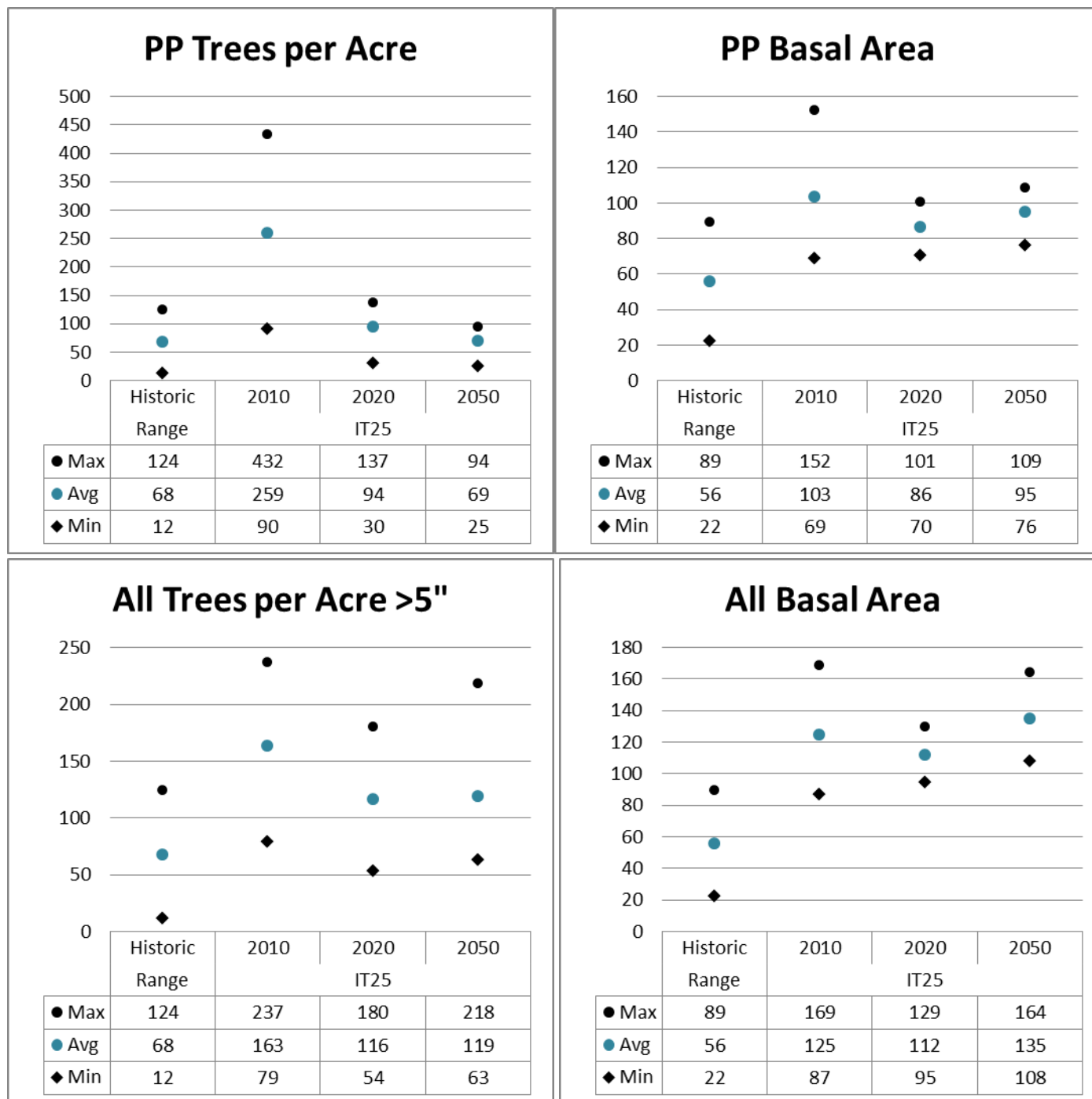
All Trees per Acre >5"



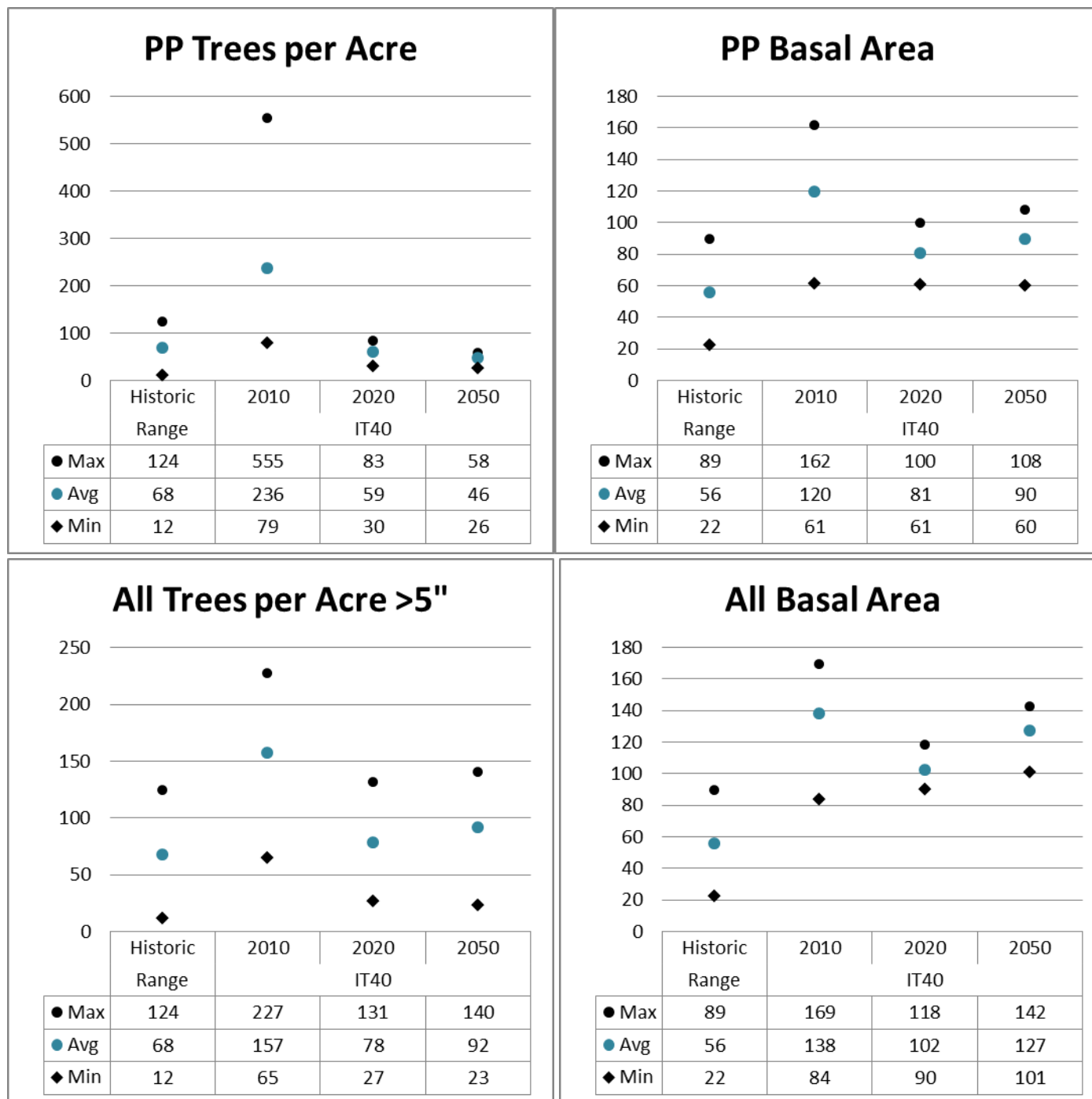
All Basal Area



Intermediate Thin – 25-40%

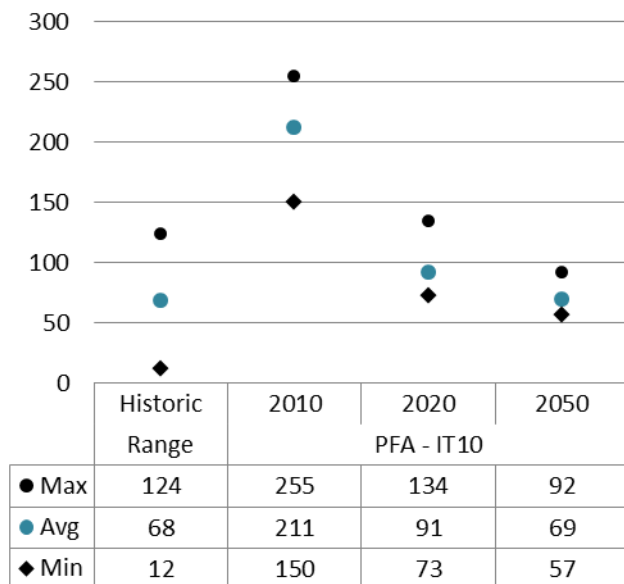


Intermediate Thin – 40-55%

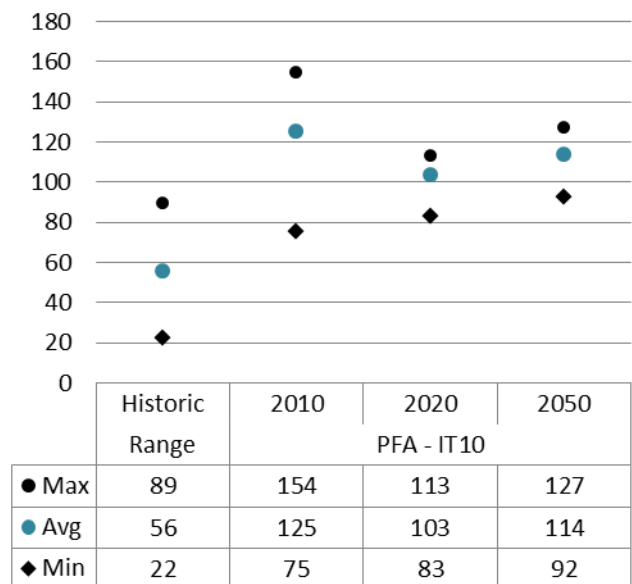


PFA Intermediate Thin – 10-25%

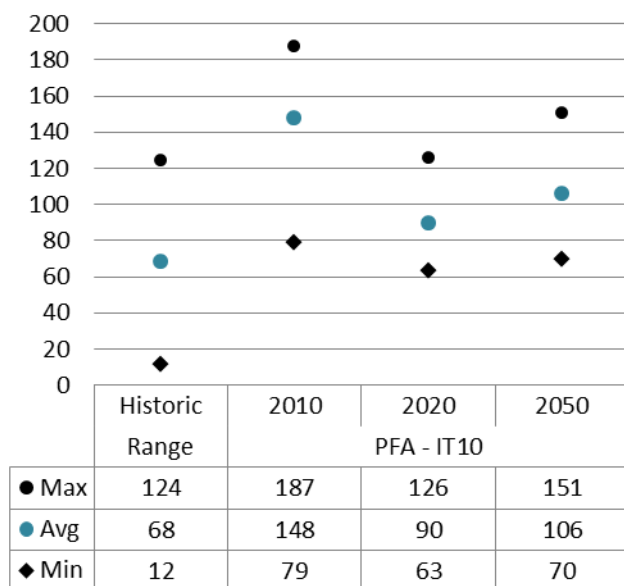
PP Trees per Acre



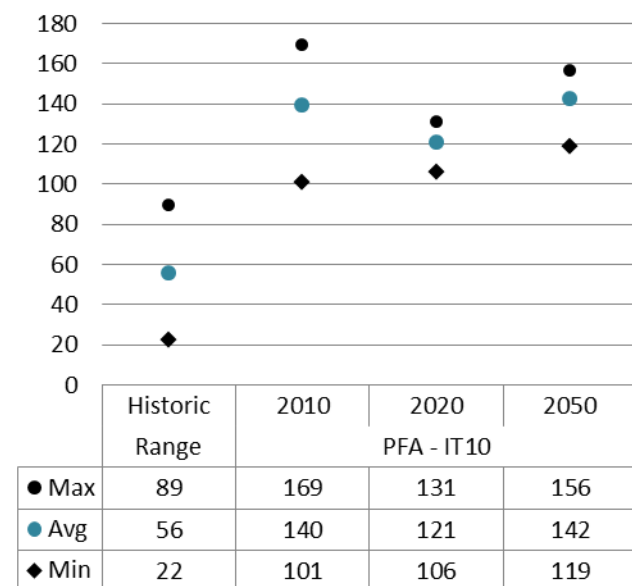
PP Basal Area



All Trees per Acre >5"

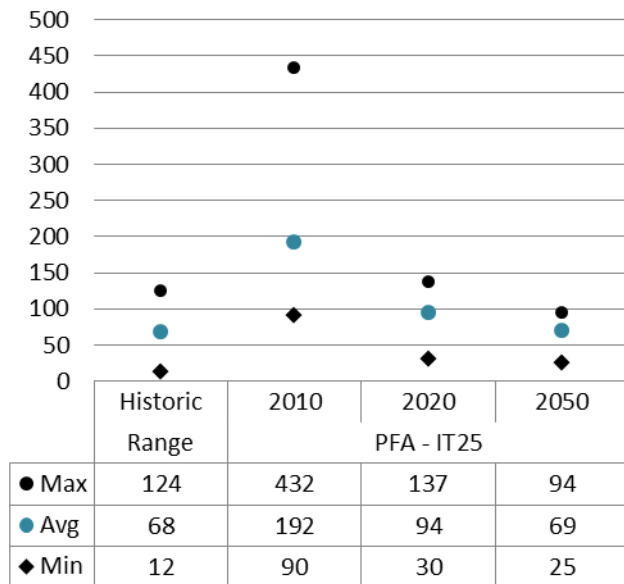


All Basal Area

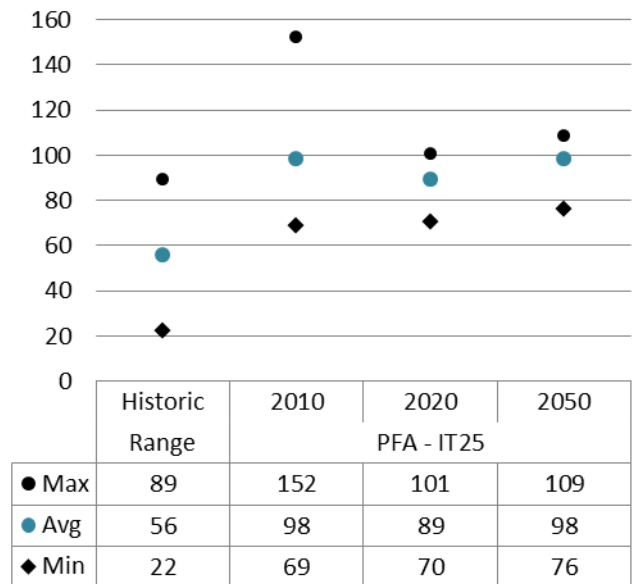


PFA Intermediate Thin – 25-40%

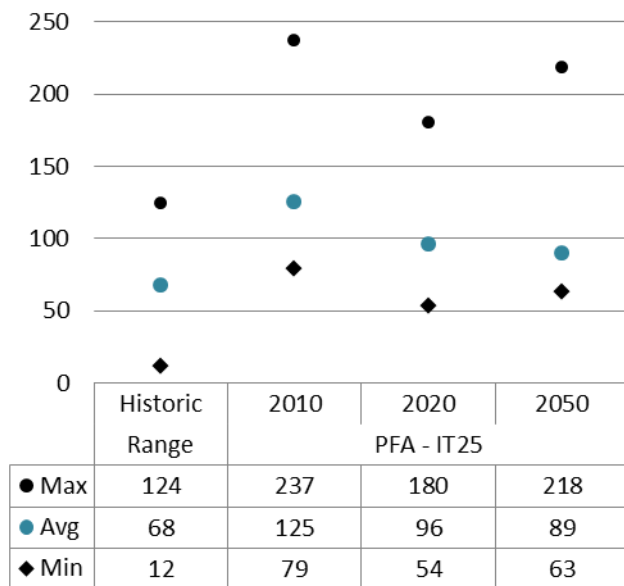
PP Trees per Acre



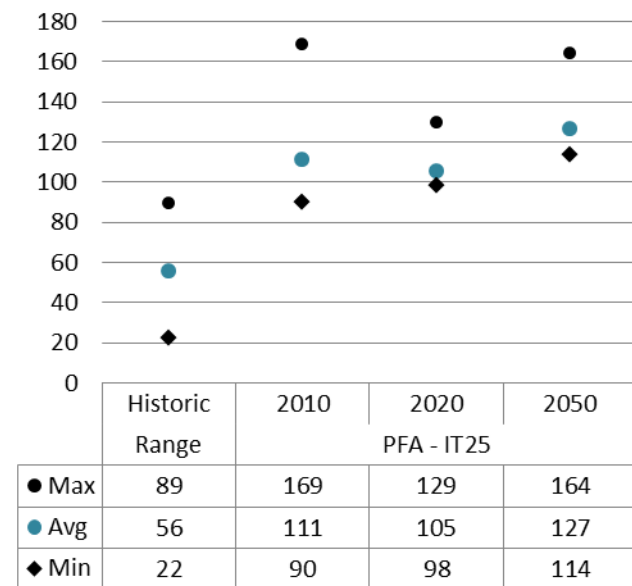
PP Basal Area



All Trees per Acre >5"

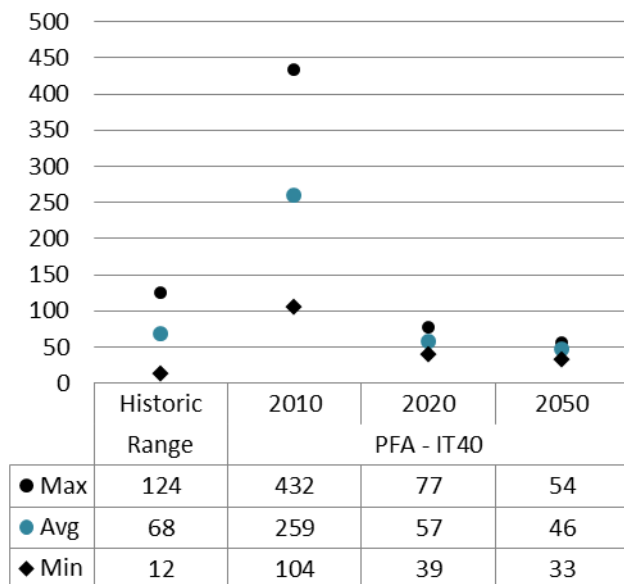


All Basal Area

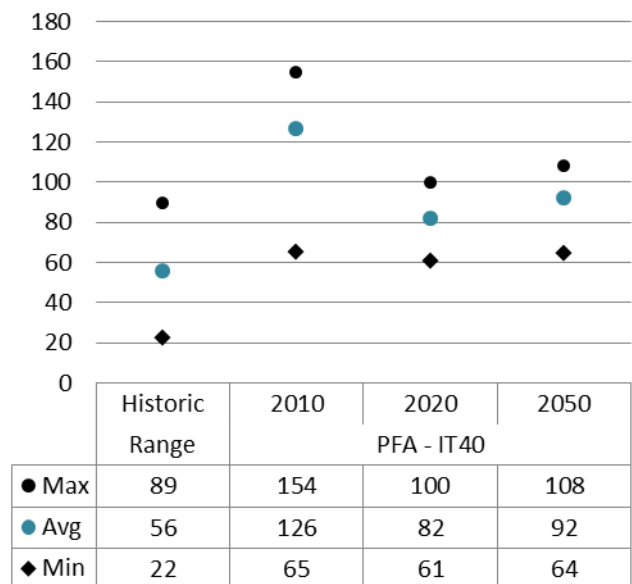


PFA Intermediate Thin – 40-55%

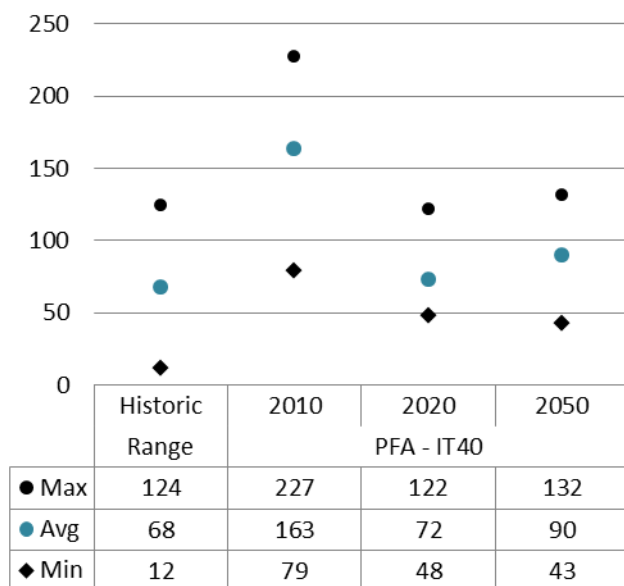
PP Trees per Acre



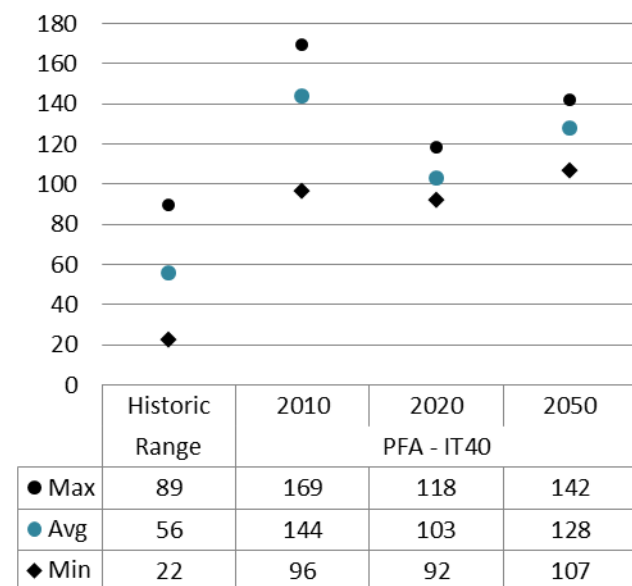
PP Basal Area



All Trees per Acre >5"

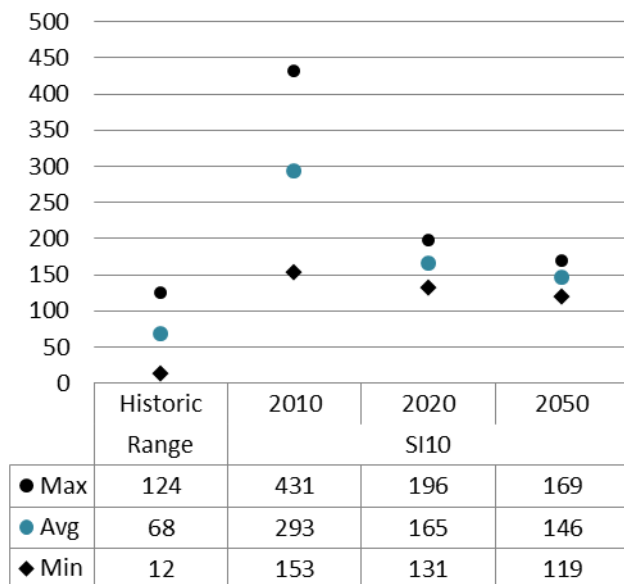


All Basal Area

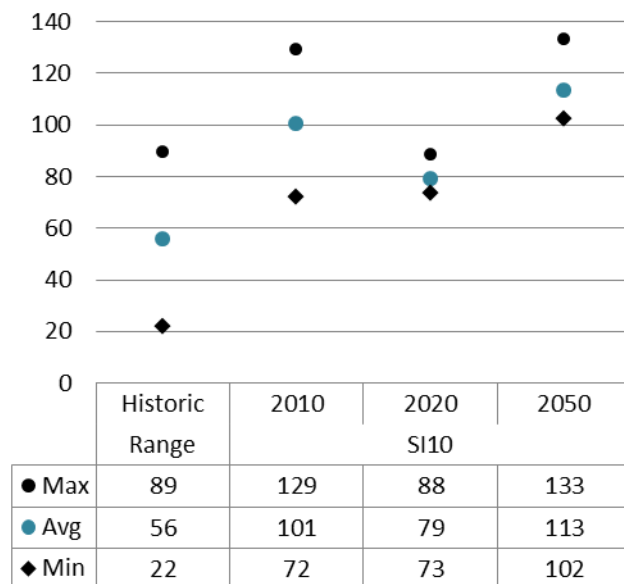


Stand Improvement – 10-25%

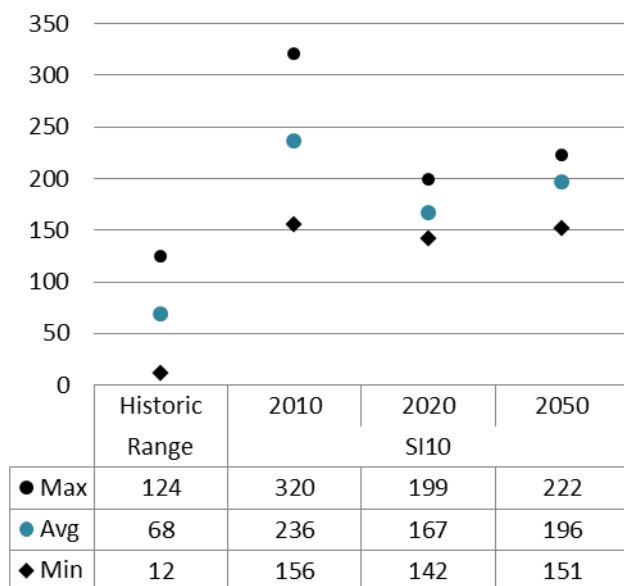
PP Trees per Acre



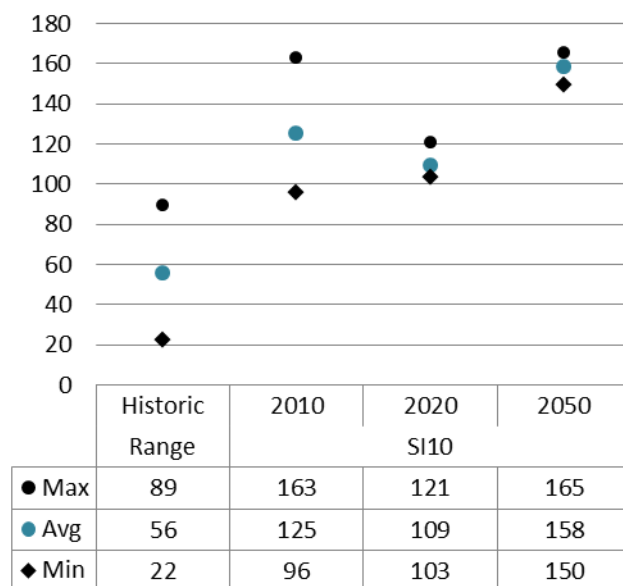
PP Basal Area



All Trees per Acre >5"

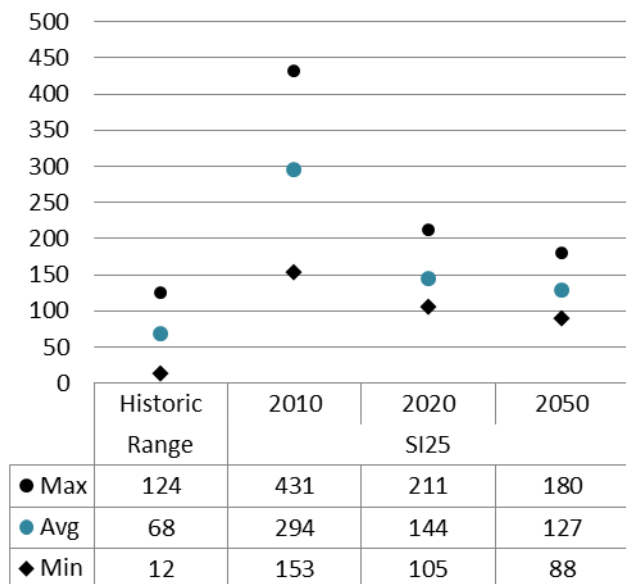


All Basal Area

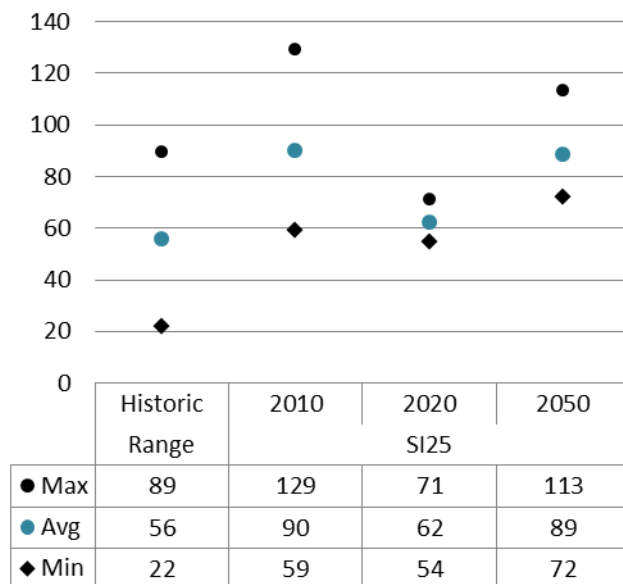


Stand Improvement – 25-40%

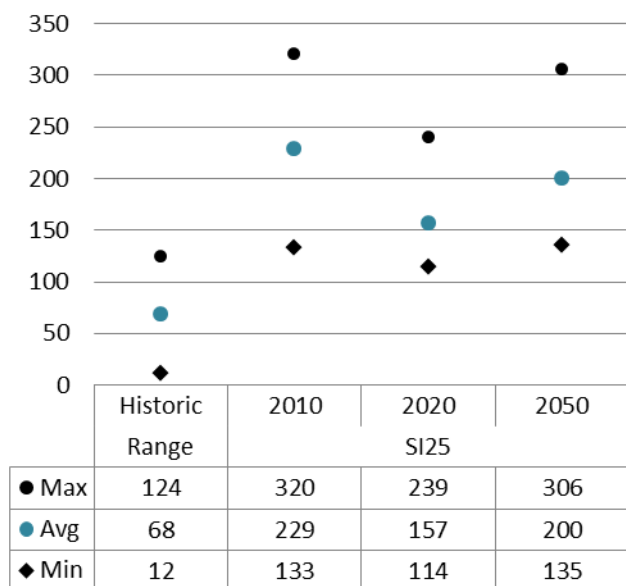
PP Trees per Acre



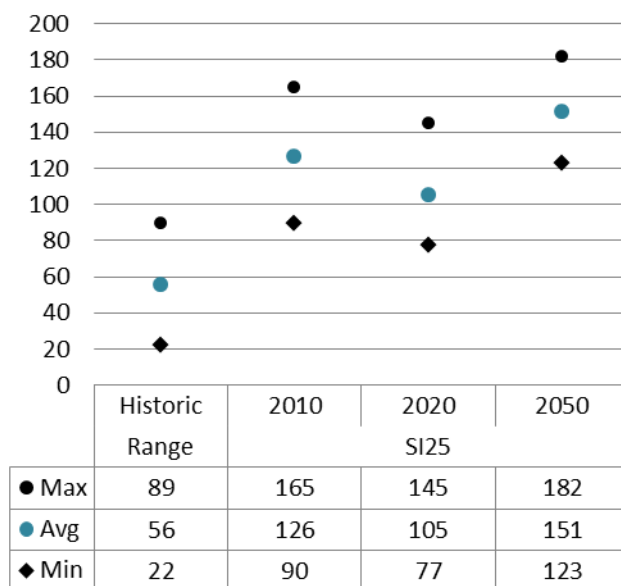
PP Basal Area



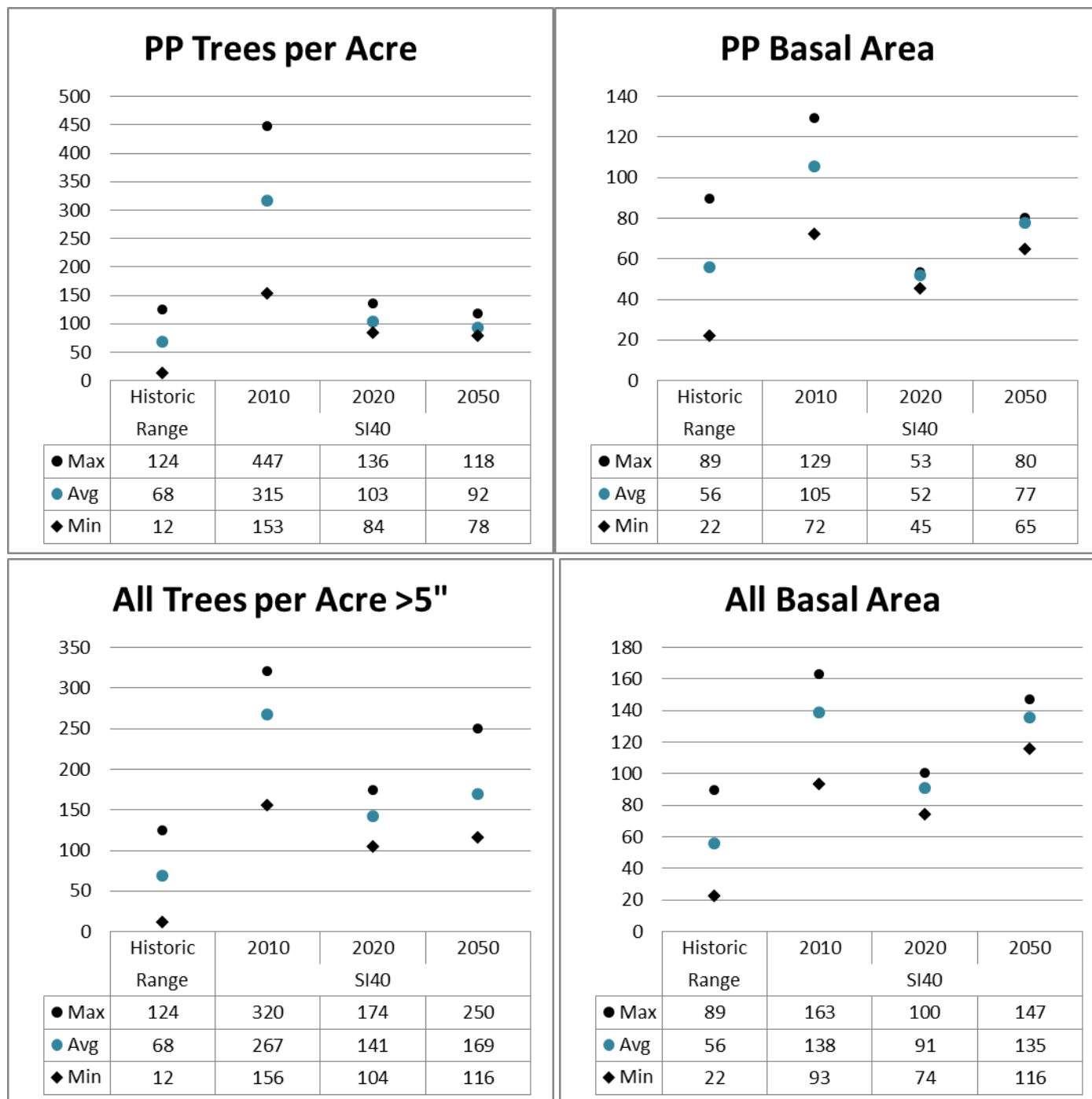
All Trees per Acre >5"



All Basal Area

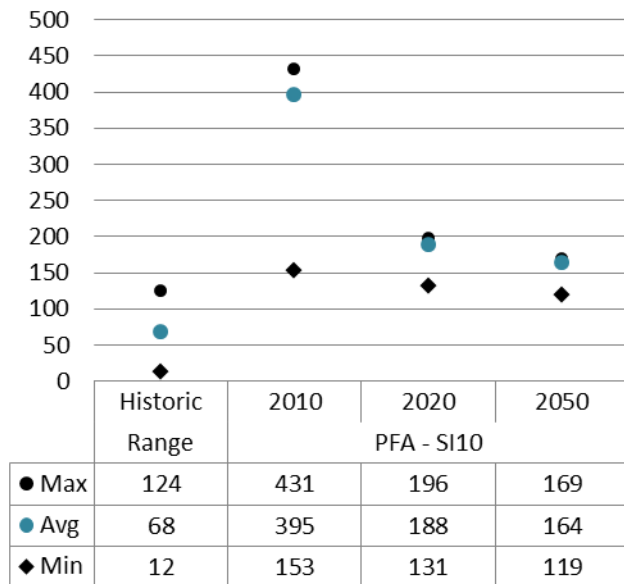


Stand Improvement – 40-55%

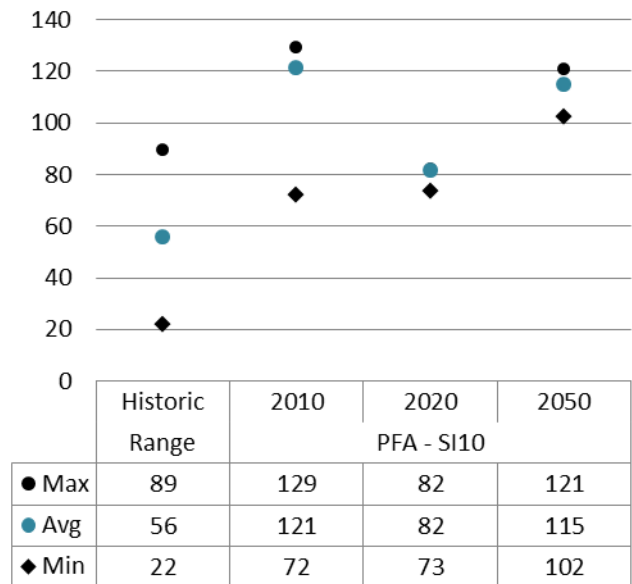


PFA Stand Improvement – 10-25%

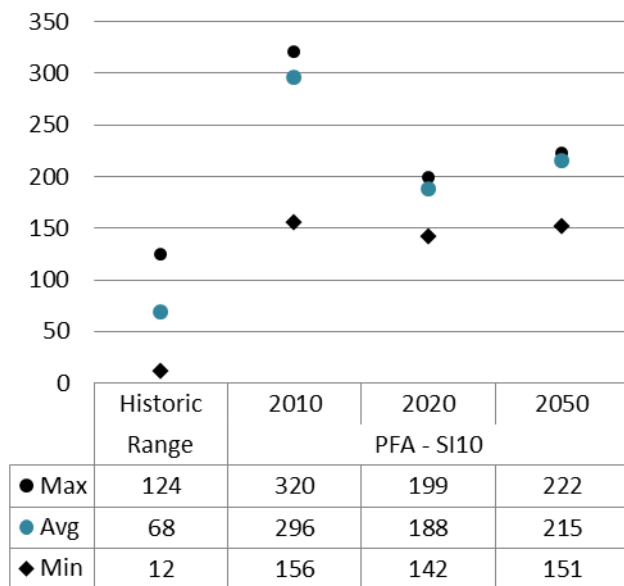
PP Trees per Acre



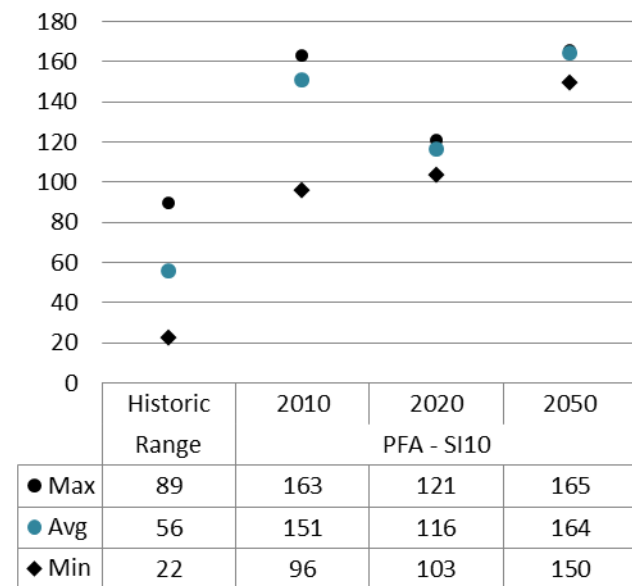
PP Basal Area



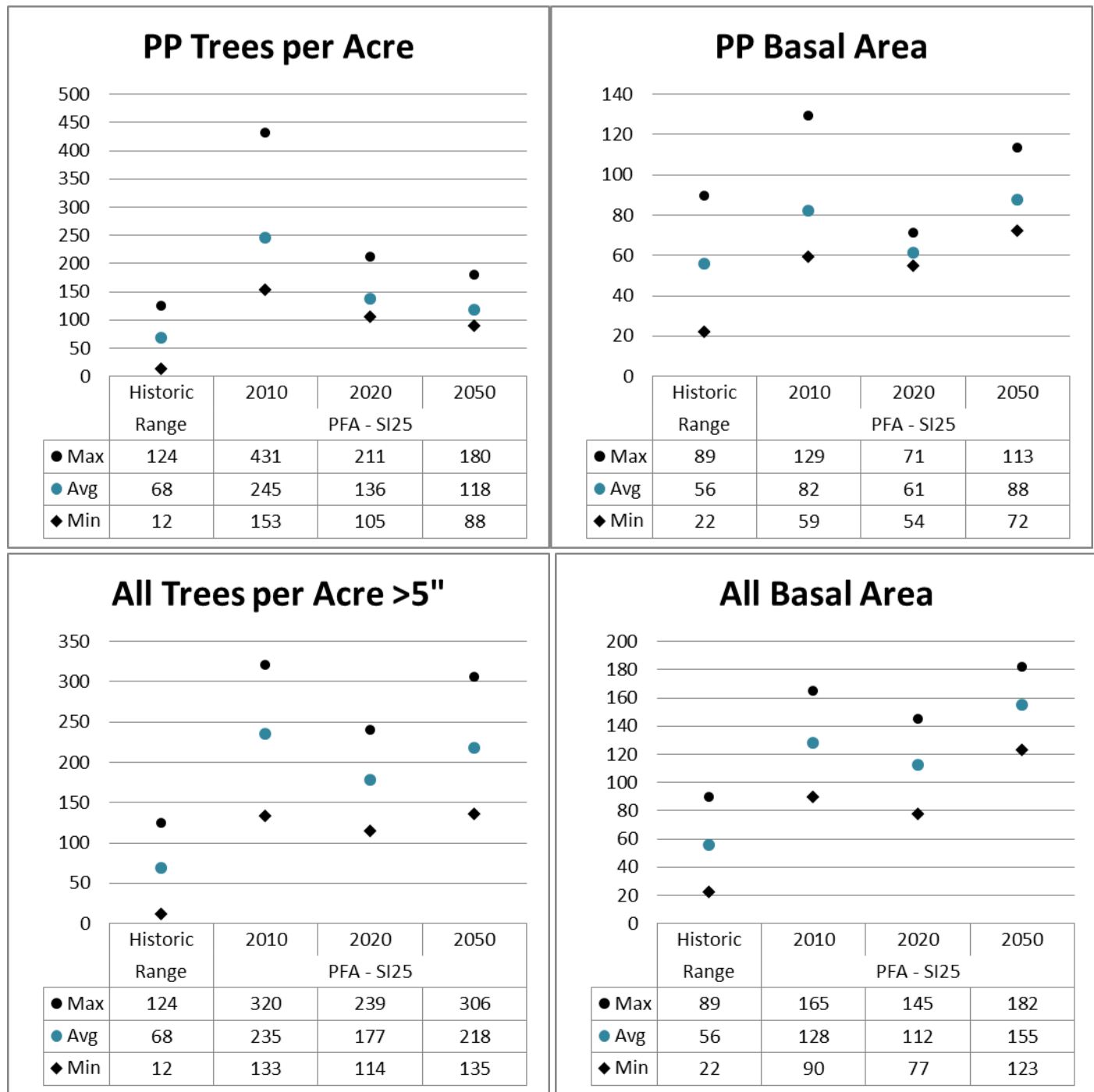
All Trees per Acre >5"



All Basal Area

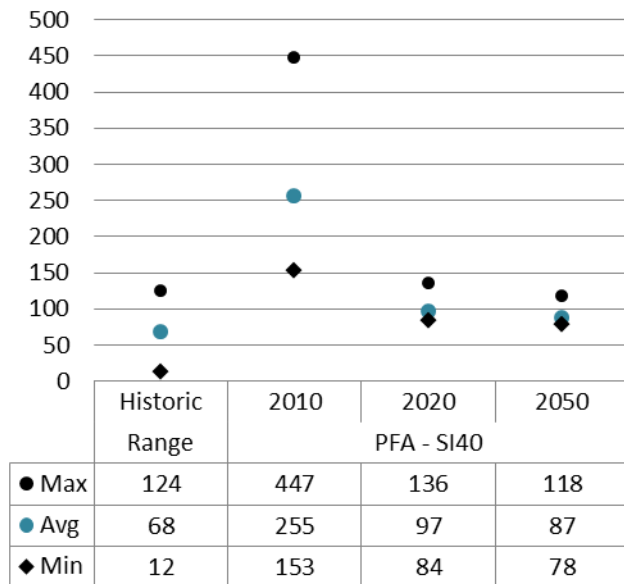


PFA Stand Improvement – 25-40%

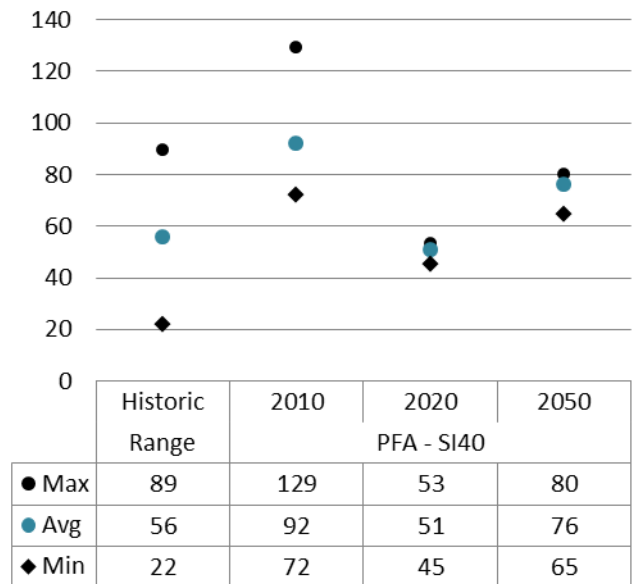


PFA Stand Improvement – 40-55%

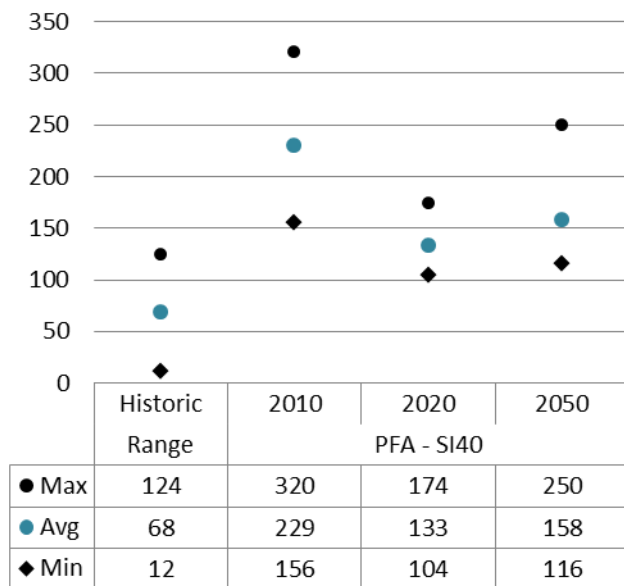
PP Trees per Acre



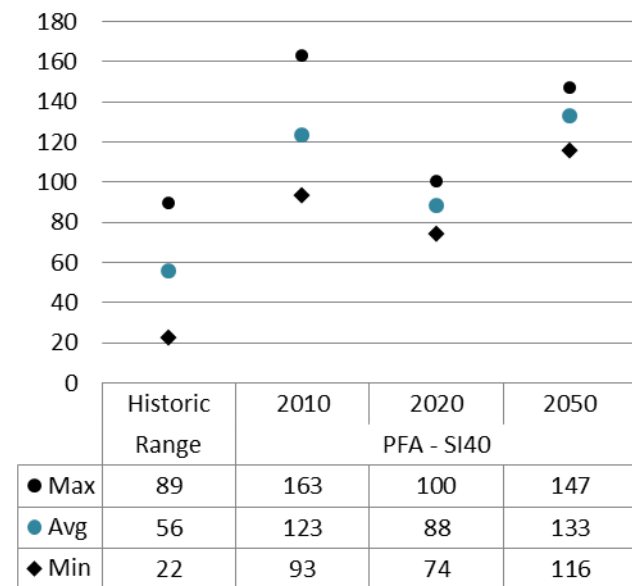
PP Basal Area



All Trees per Acre >5"

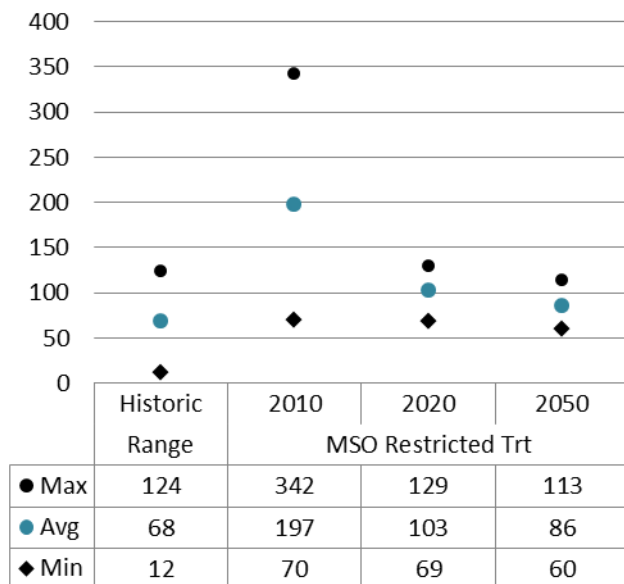


All Basal Area

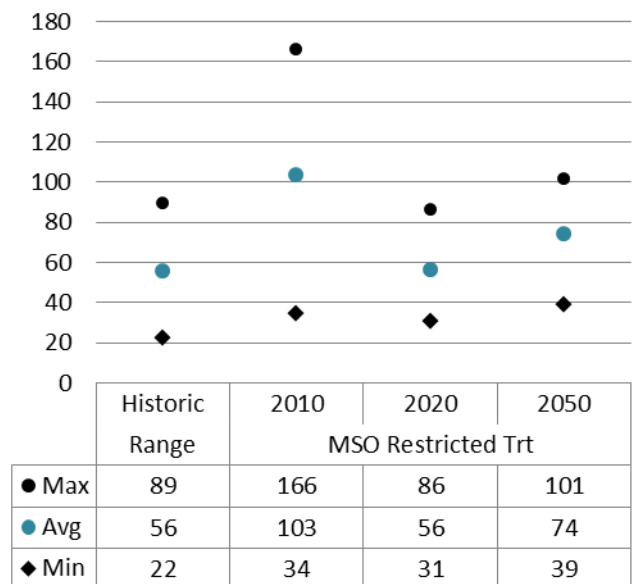


MSO Restricted

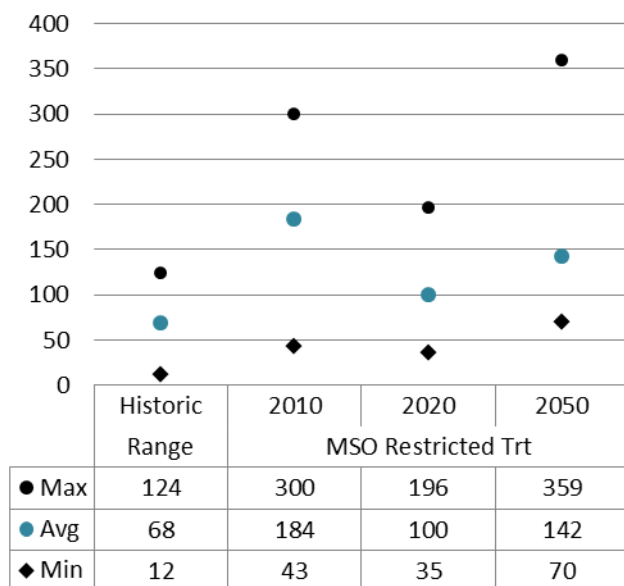
PP Trees per Acre



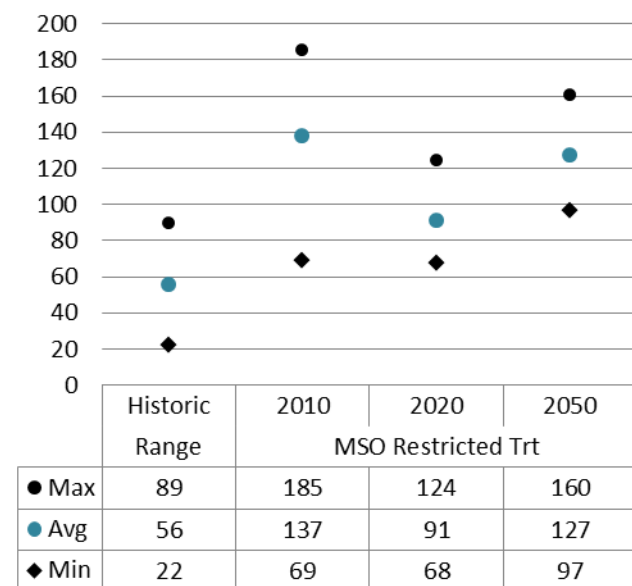
PP Basal Area



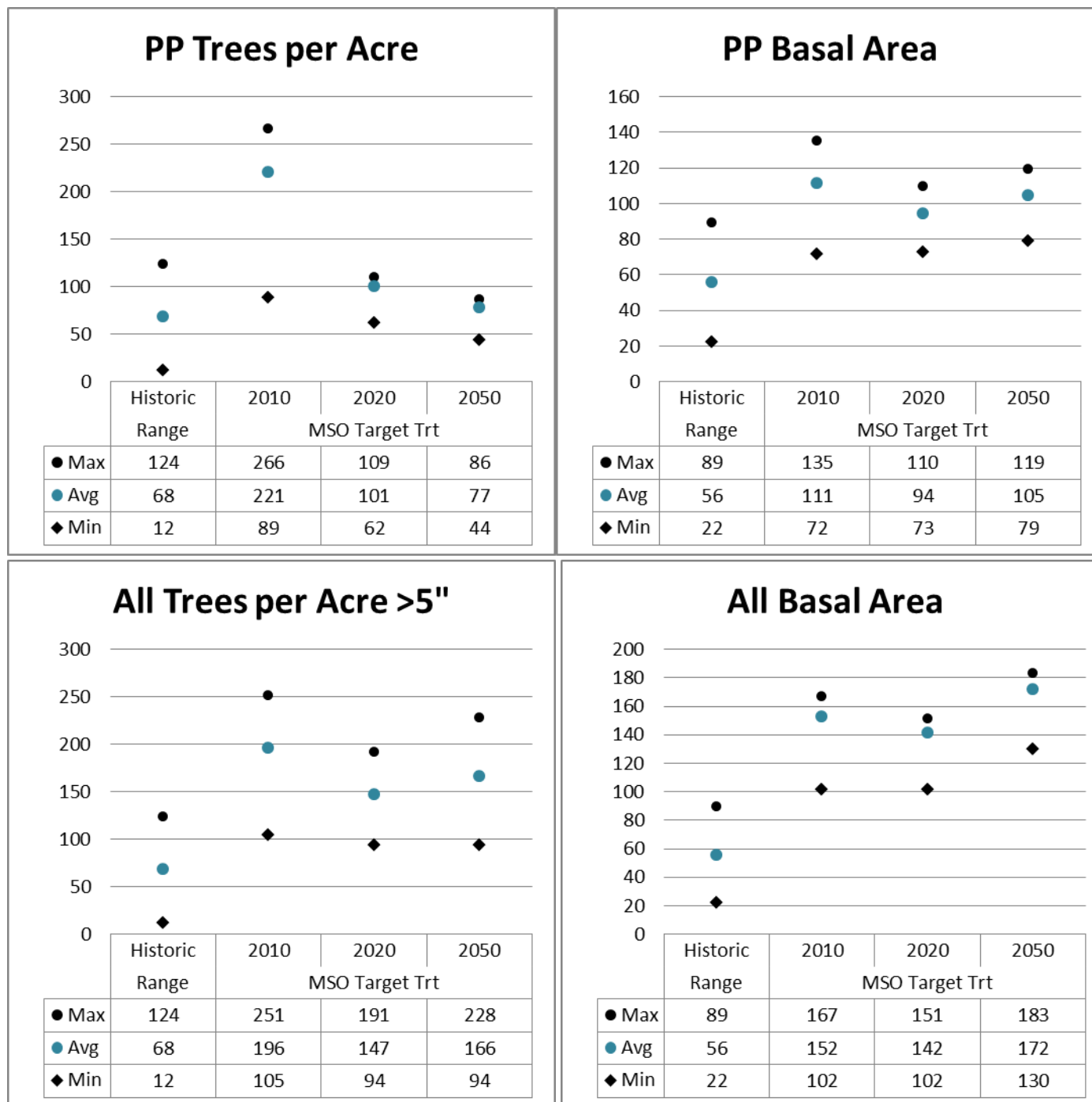
All Trees per Acre >5"



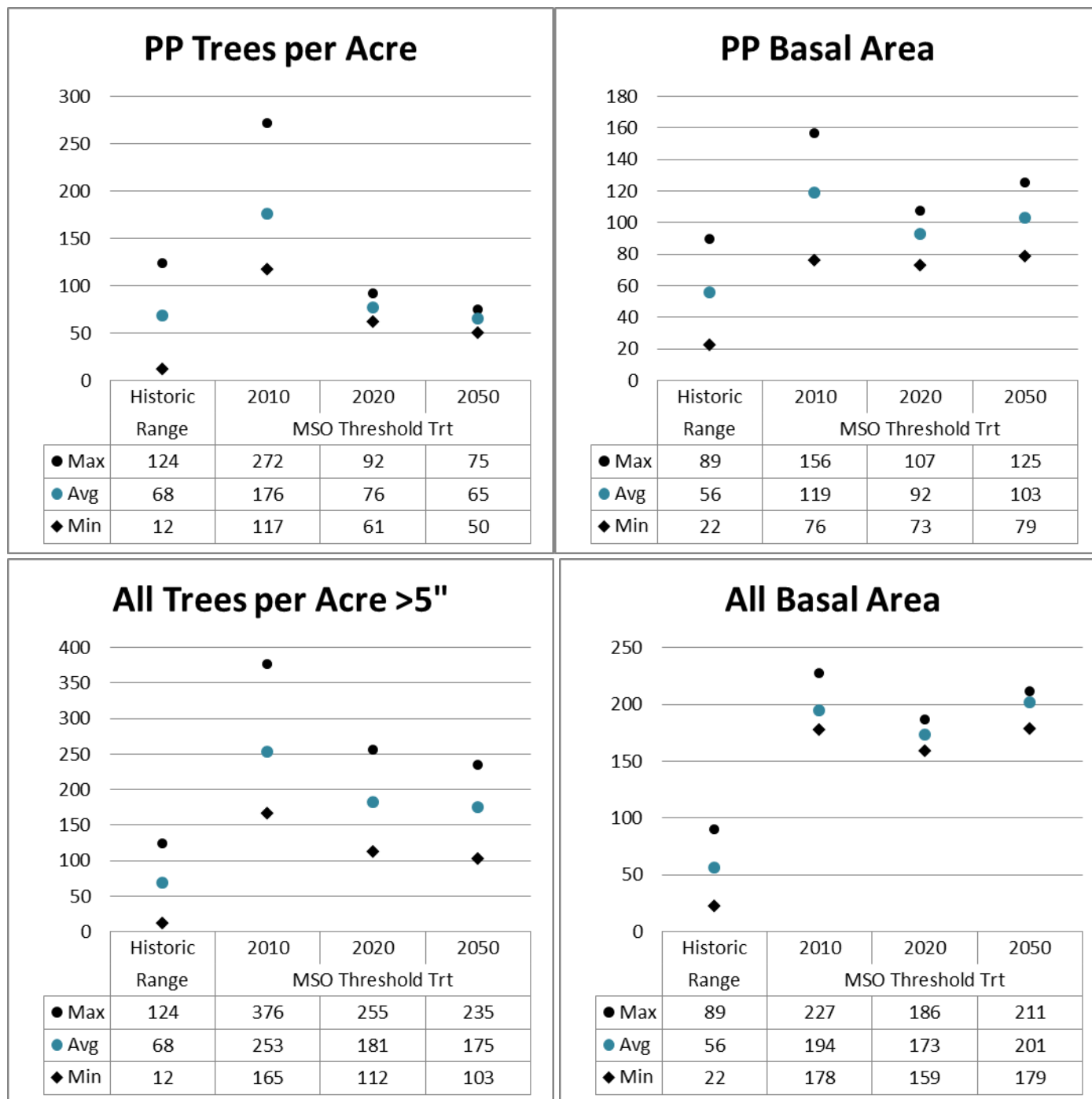
All Basal Area



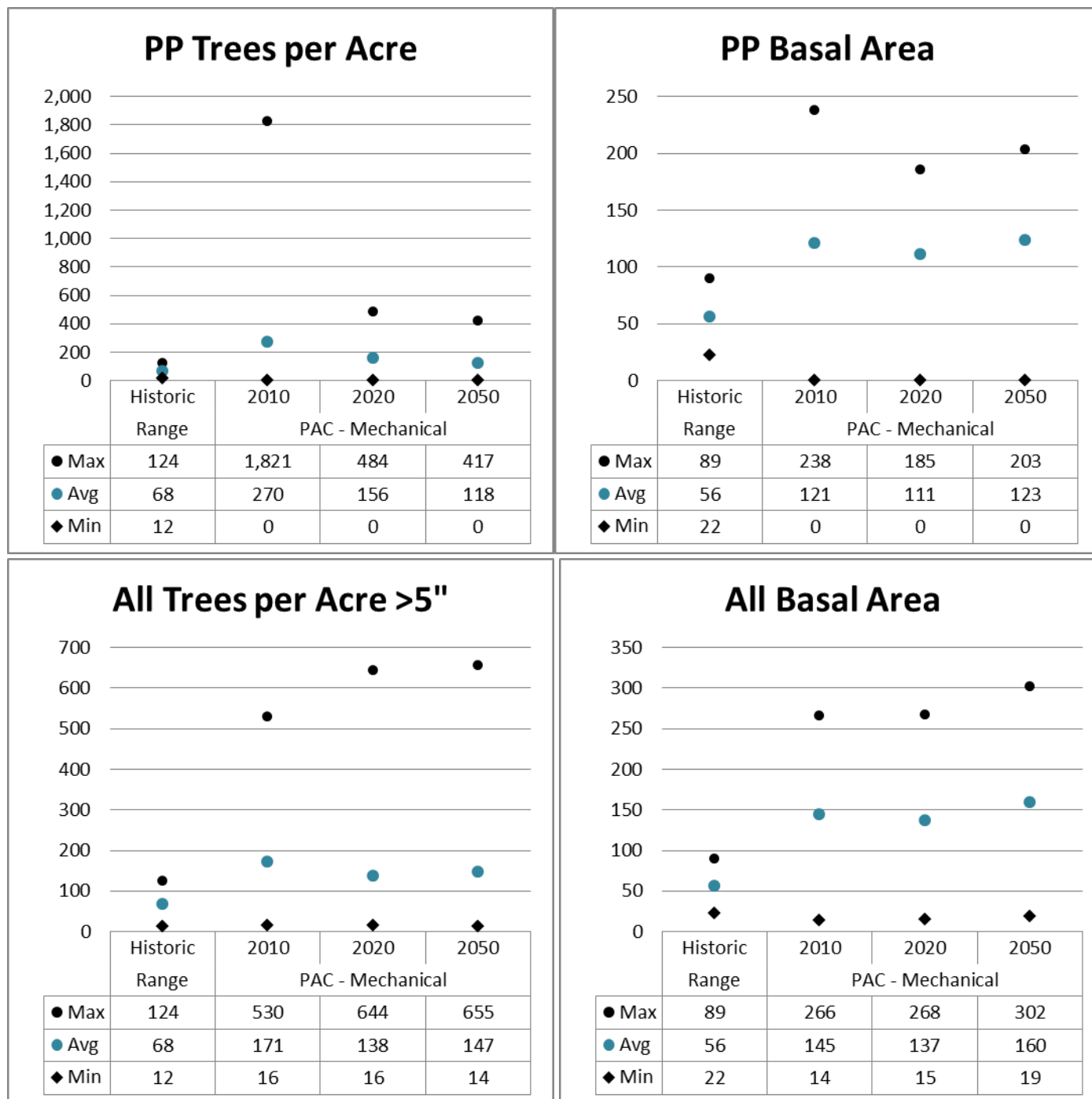
MSO Target



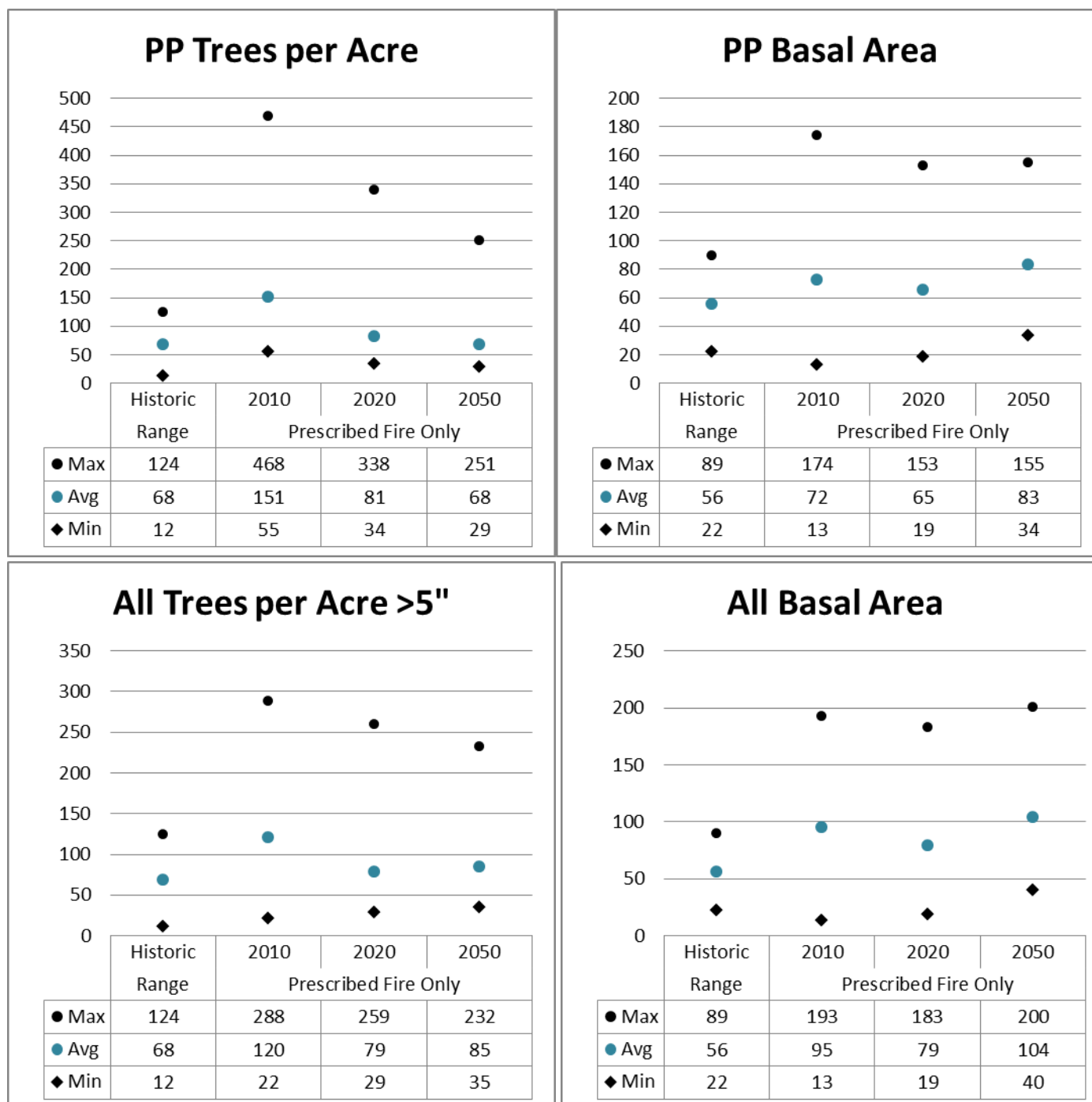
MSO Threshold



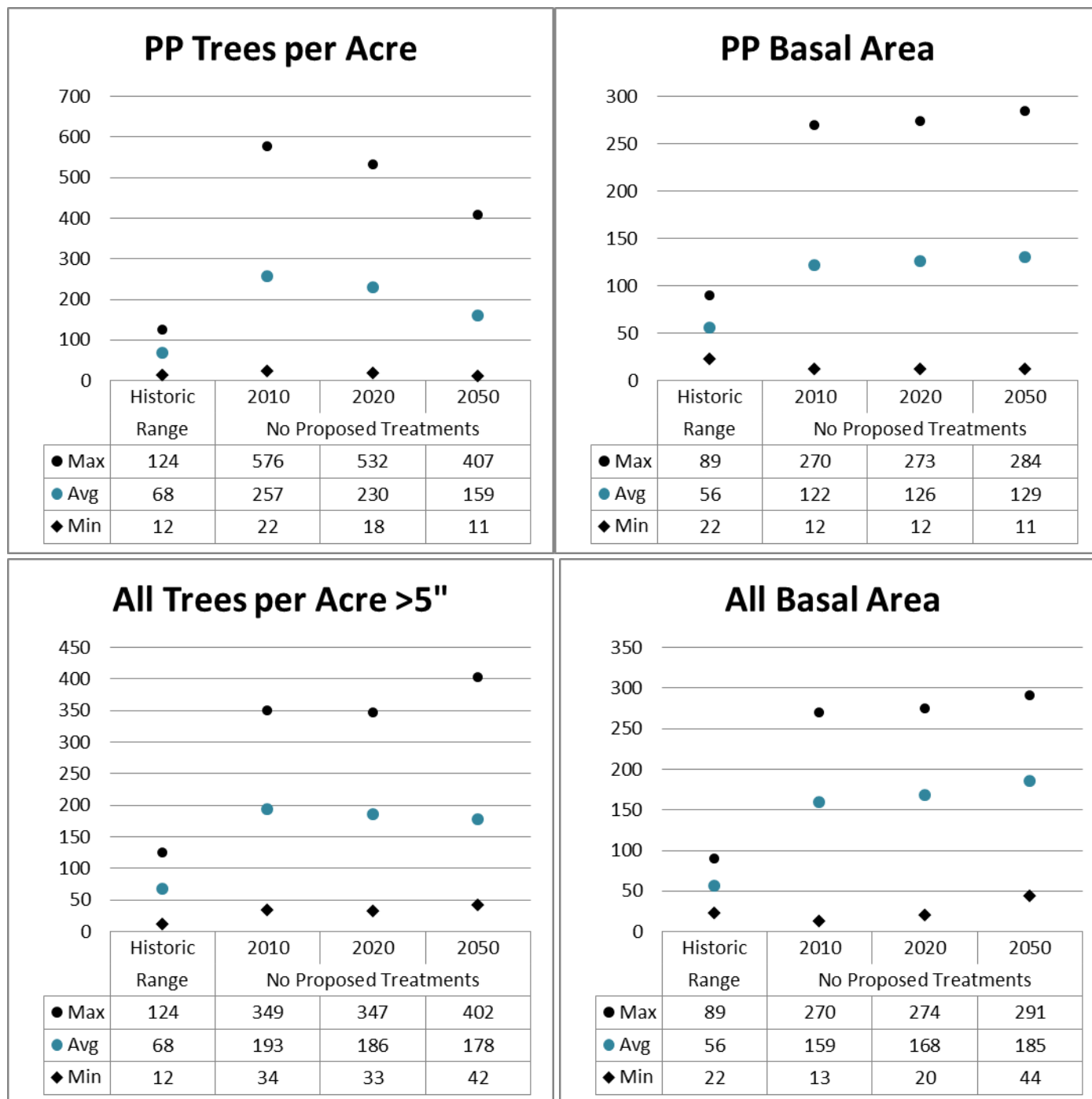
PAC – Mechanical



Prescribed Fire Only

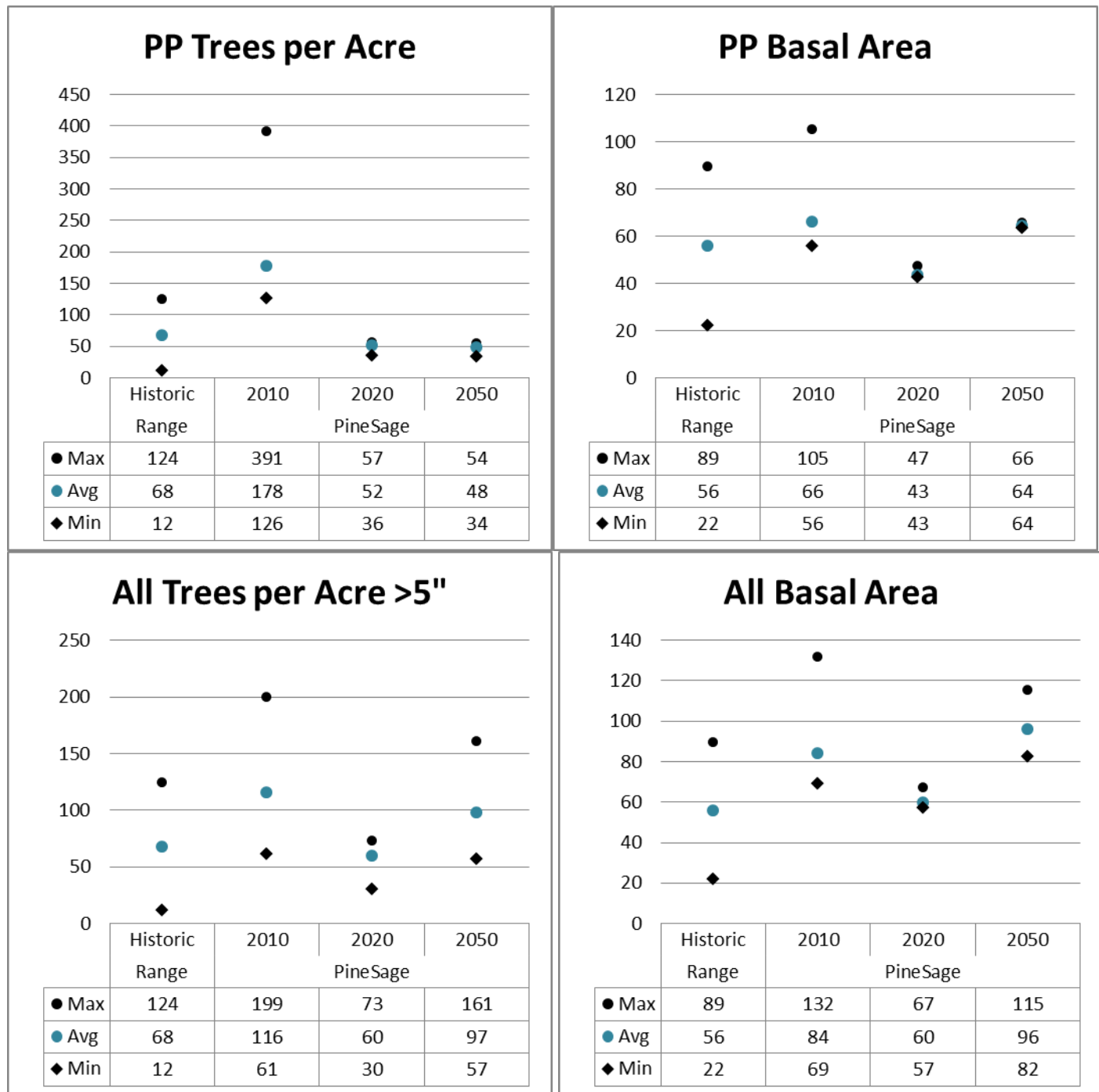


No Proposed Treatments



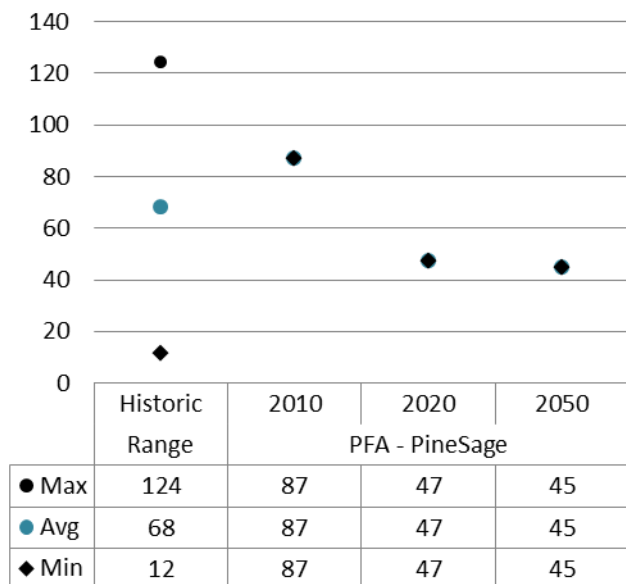
Appendix G - Natural Range of Variability Comparison by Treatment Type (Alt E)

Pine-Sage

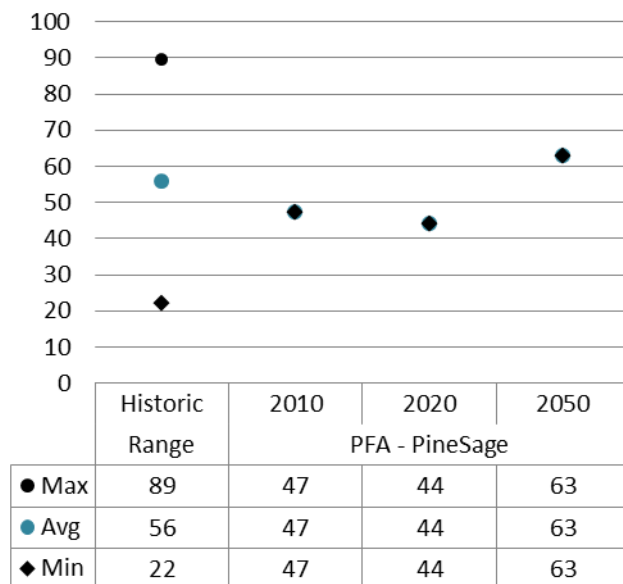


PFA Pine-Sage

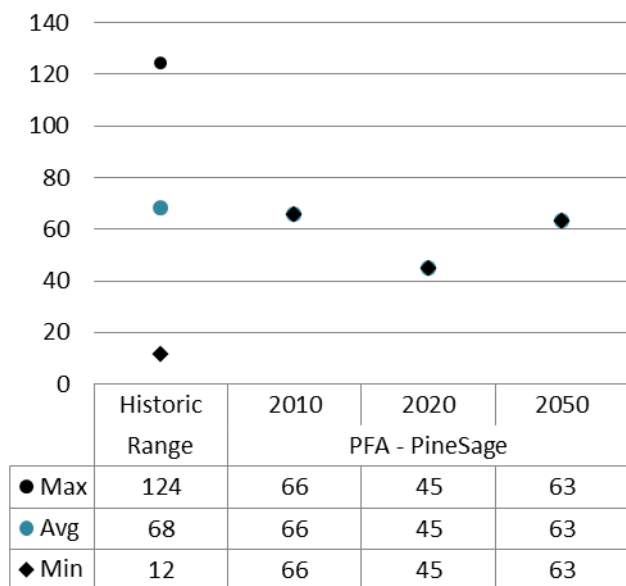
PP Trees per Acre



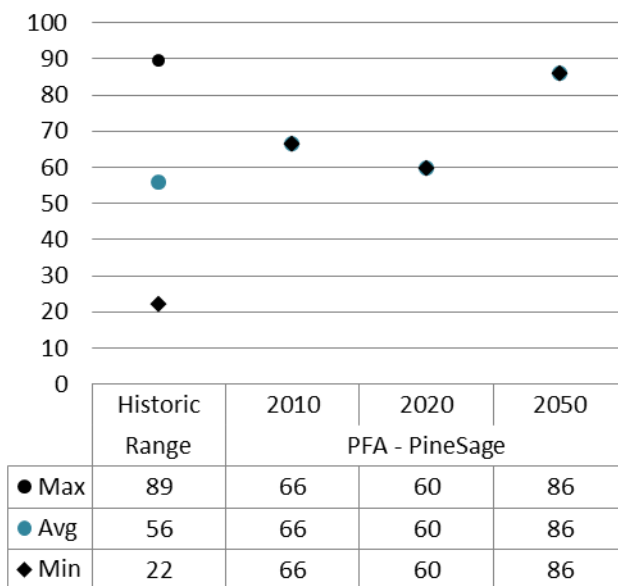
PP Basal Area



All Trees per Acre >5"

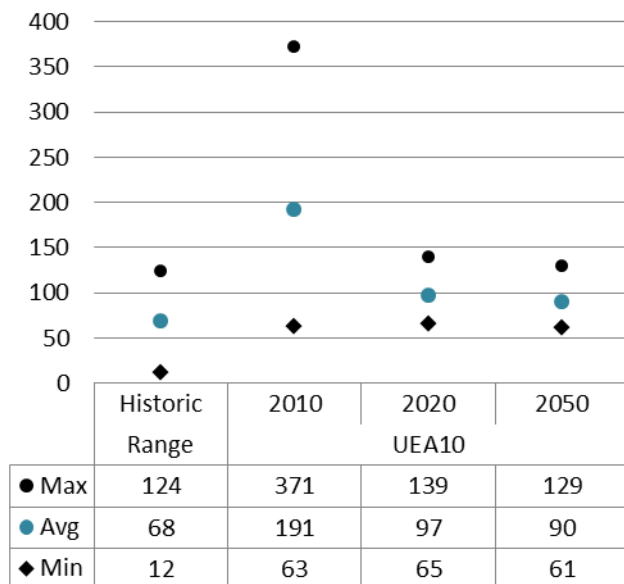


All Basal Area

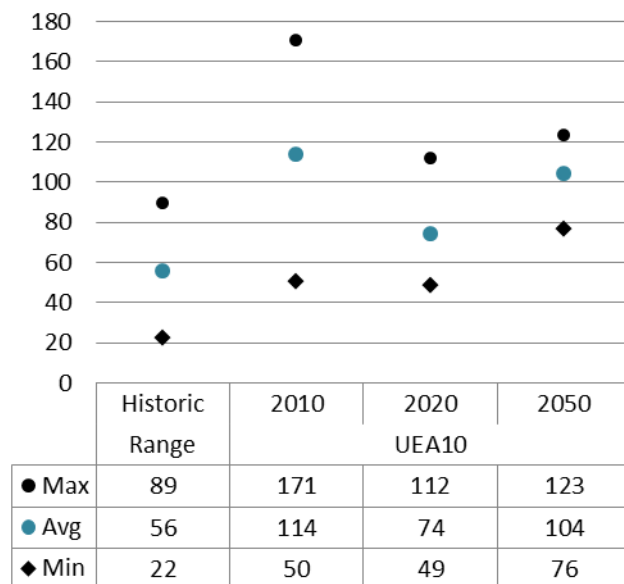


Uneven Age – 10-25%

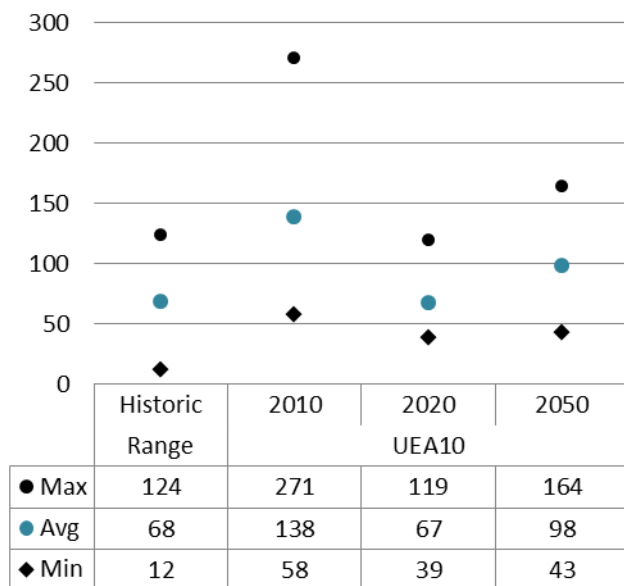
PP Trees per Acre



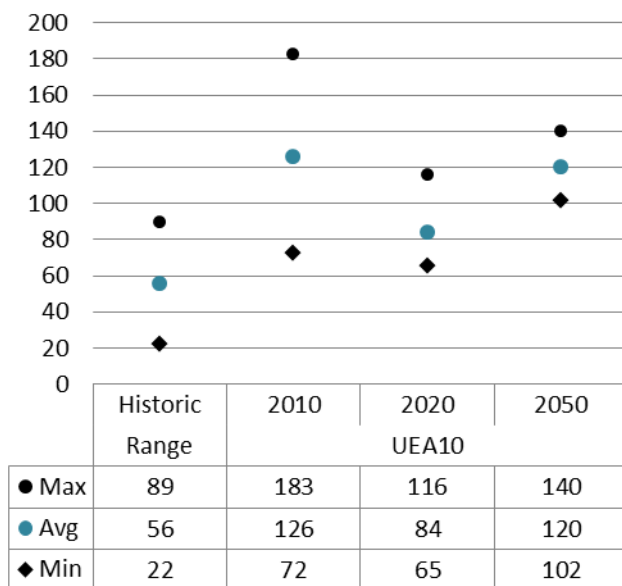
PP Basal Area



All Trees per Acre >5"

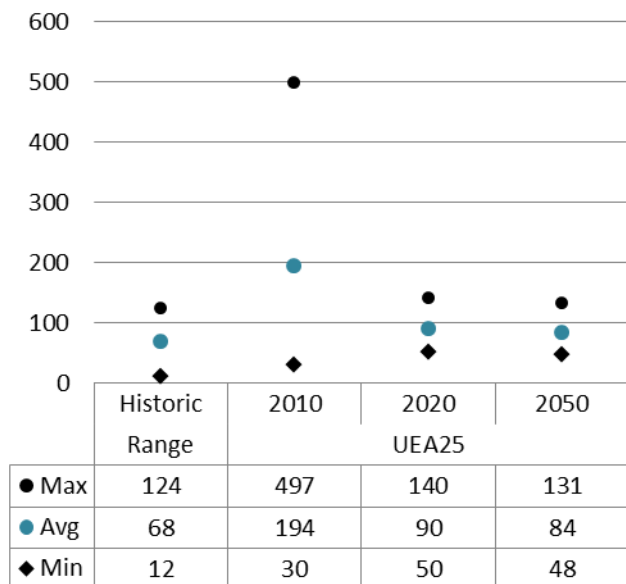


All Basal Area

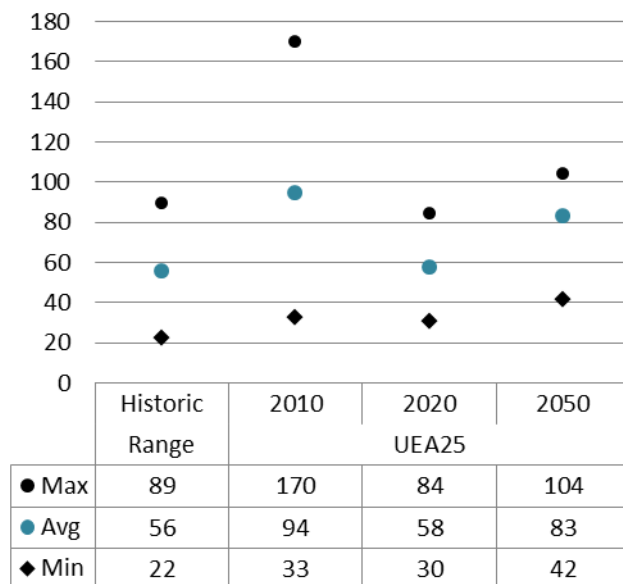


Uneven Age – 25-40%

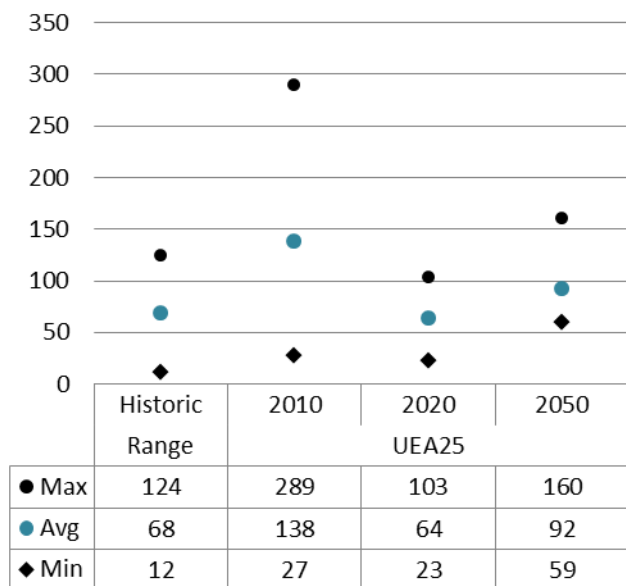
PP Trees per Acre



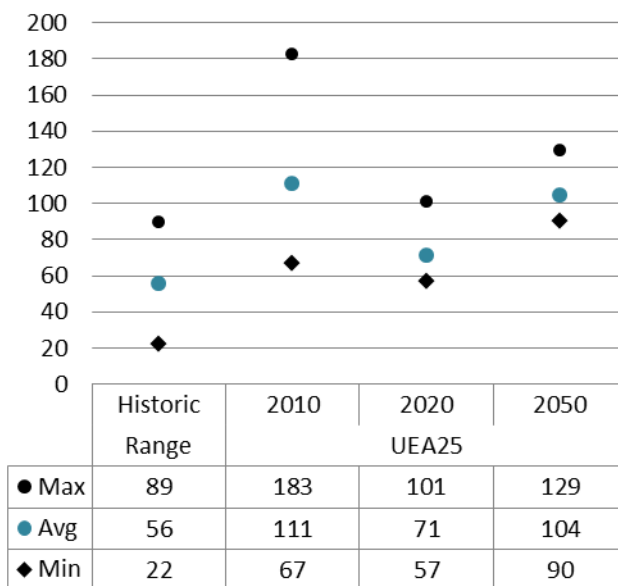
PP Basal Area



All Trees per Acre >5"

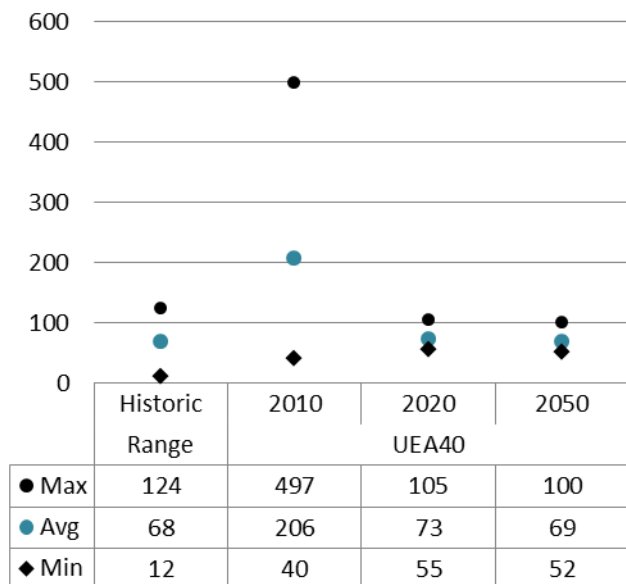


All Basal Area

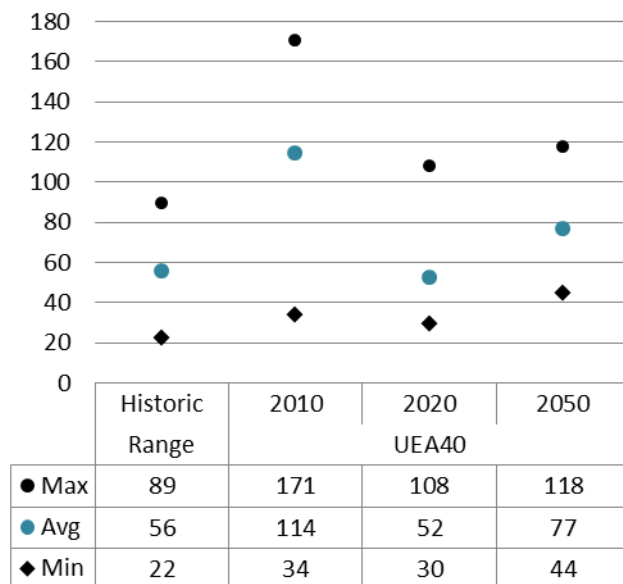


Uneven Age – 40-55%

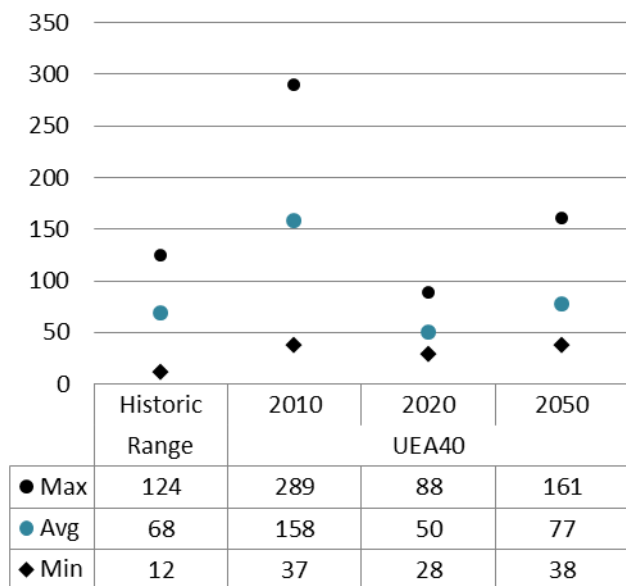
PP Trees per Acre



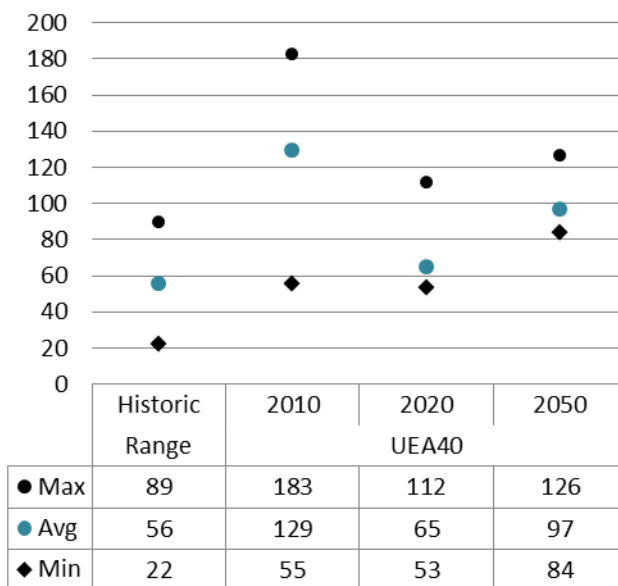
PP Basal Area



All Trees per Acre >5"

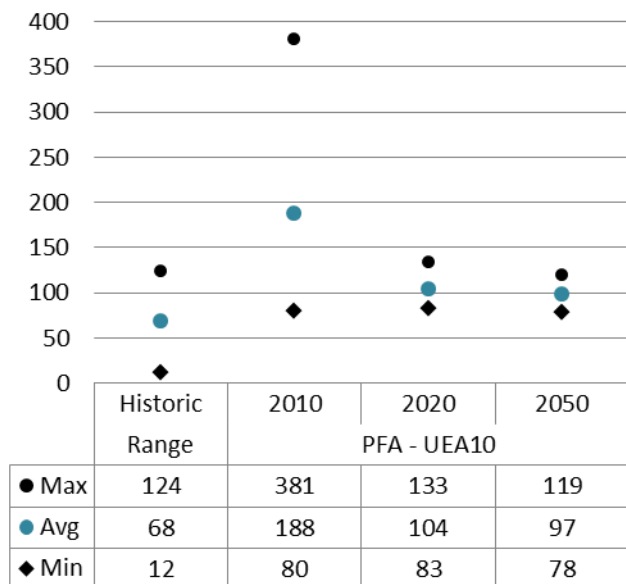


All Basal Area

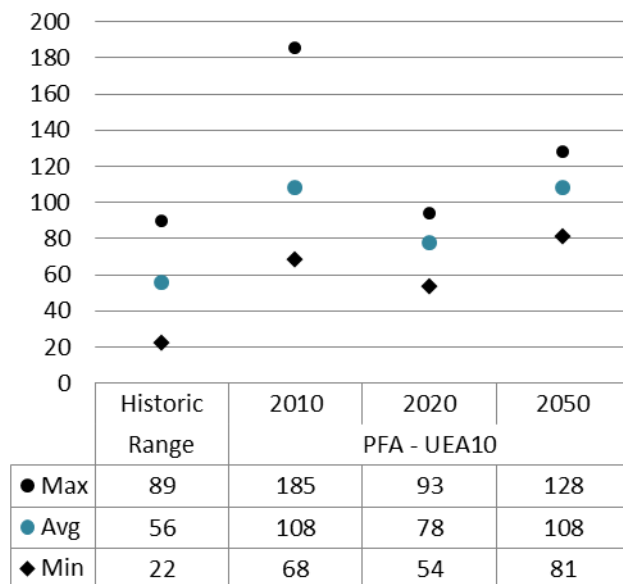


PFA Uneven Age – 10-25%

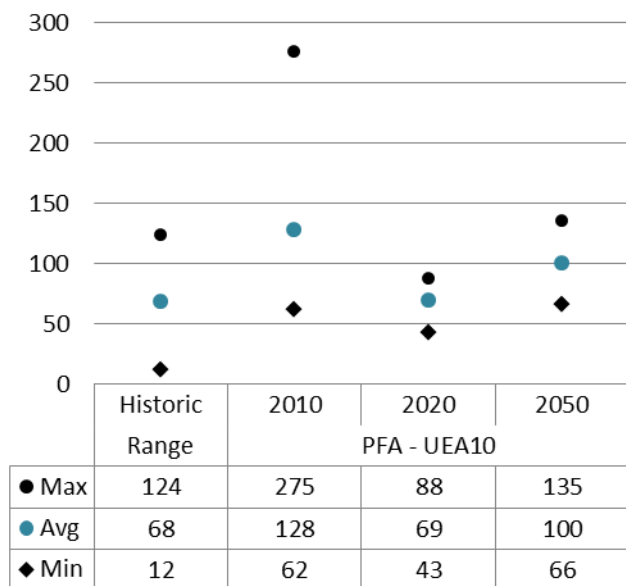
PP Trees per Acre



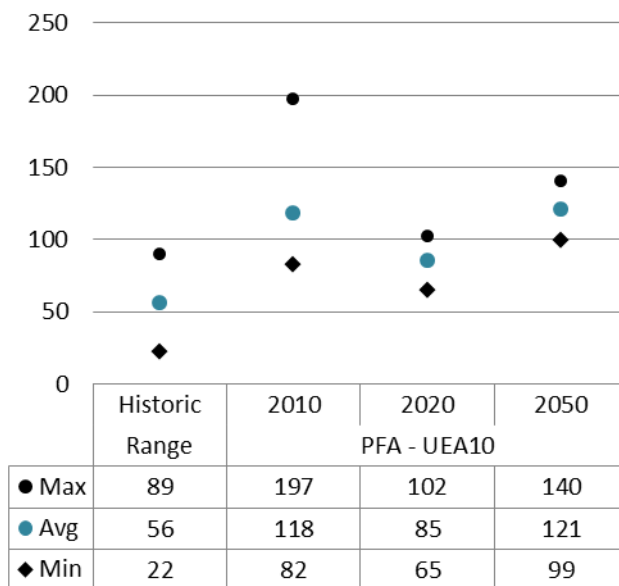
PP Basal Area



All Trees per Acre >5"

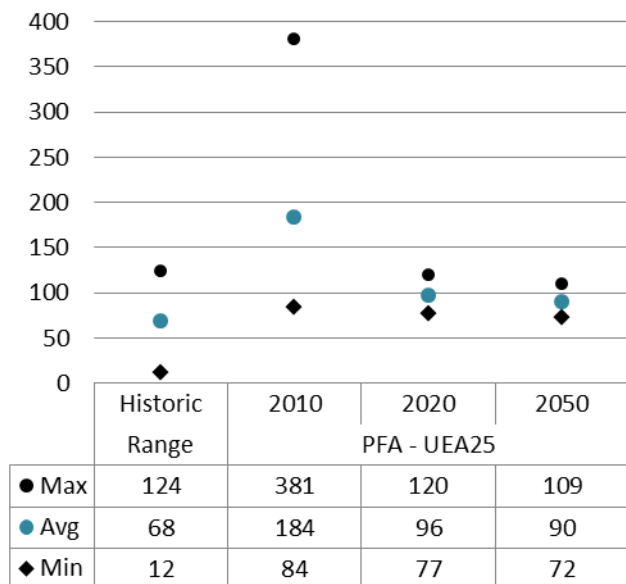


All Basal Area

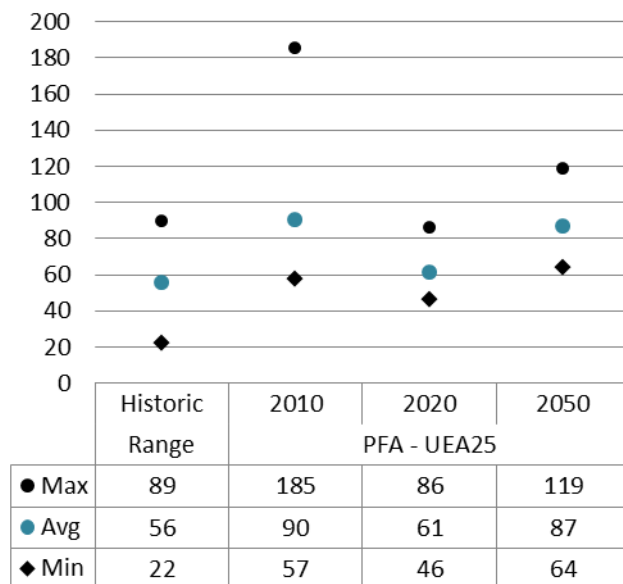


PFA Uneven Age – 25-40%

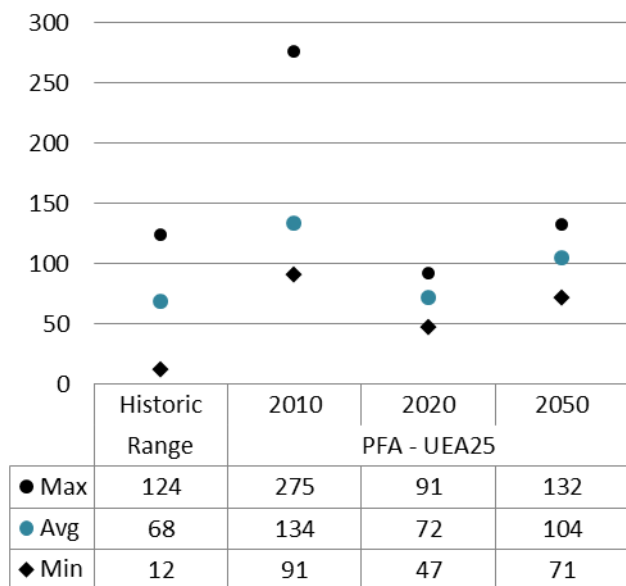
PP Trees per Acre



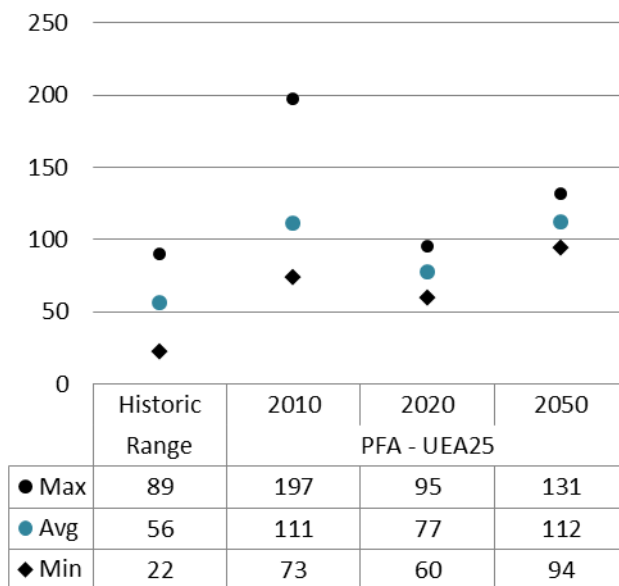
PP Basal Area



All Trees per Acre >5"

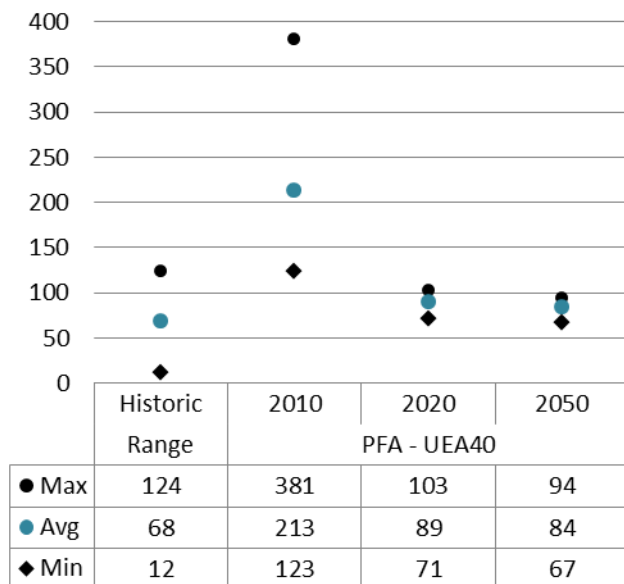


All Basal Area

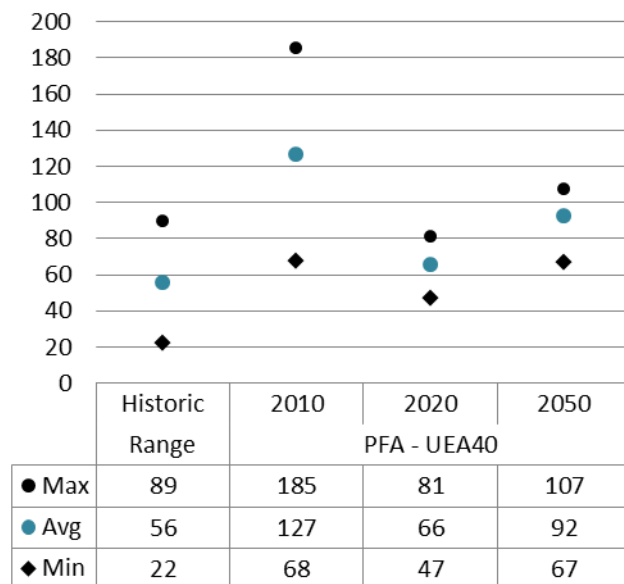


PFA Uneven Age – 40-55%

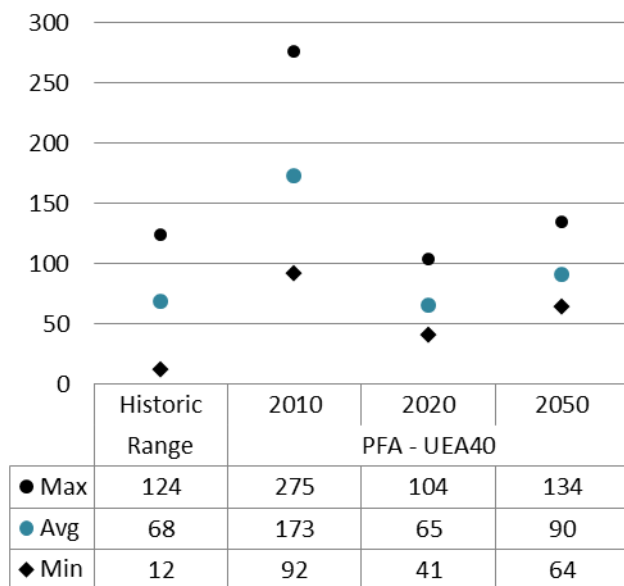
PP Trees per Acre



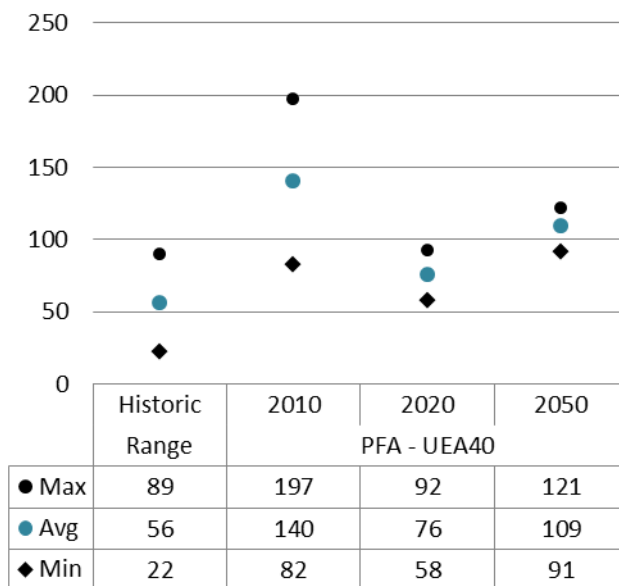
PP Basal Area



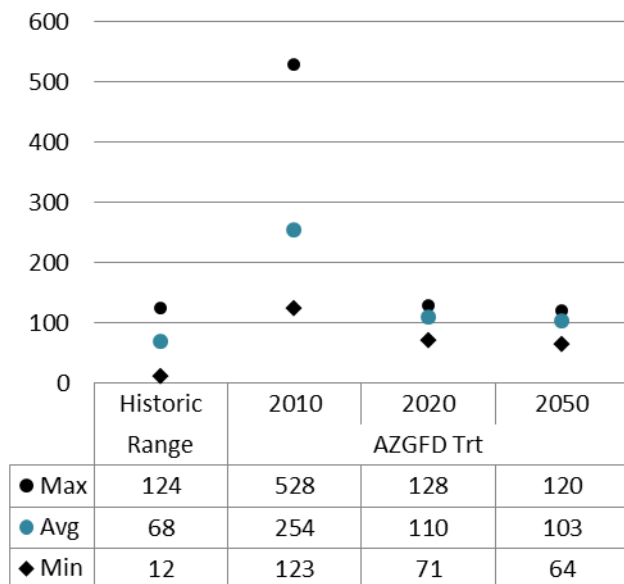
All Trees per Acre >5"



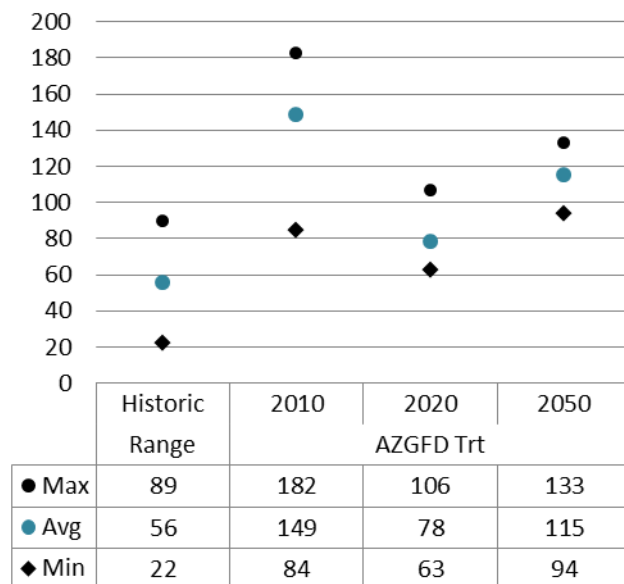
All Basal Area



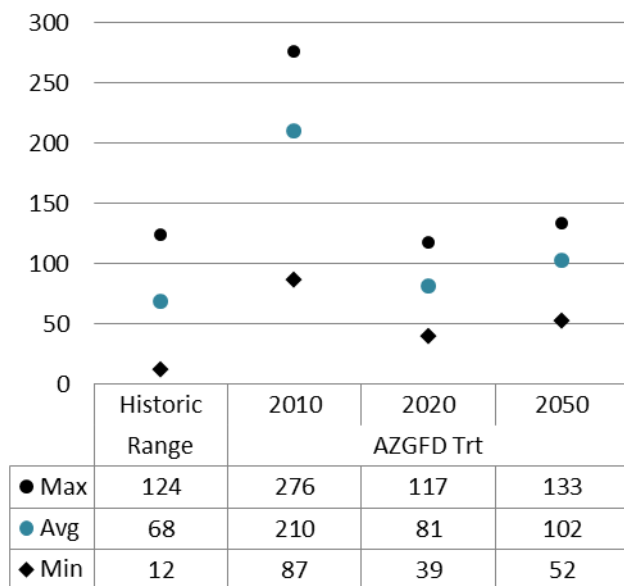
PP Trees per Acre



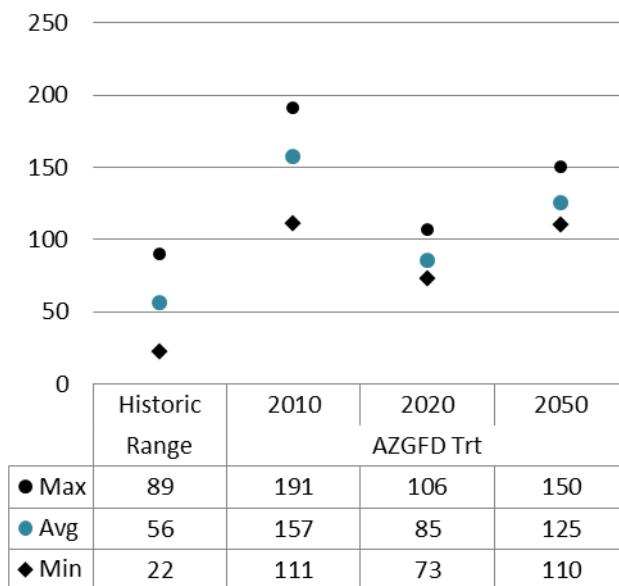
PP Basal Area



All Trees per Acre >5"

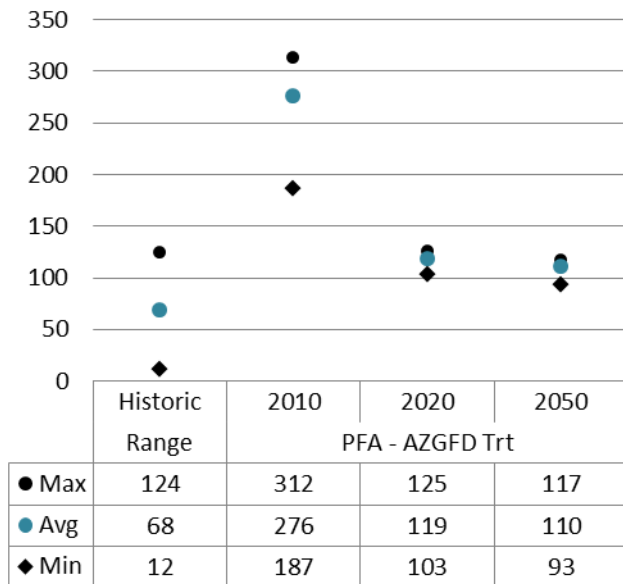


All Basal Area

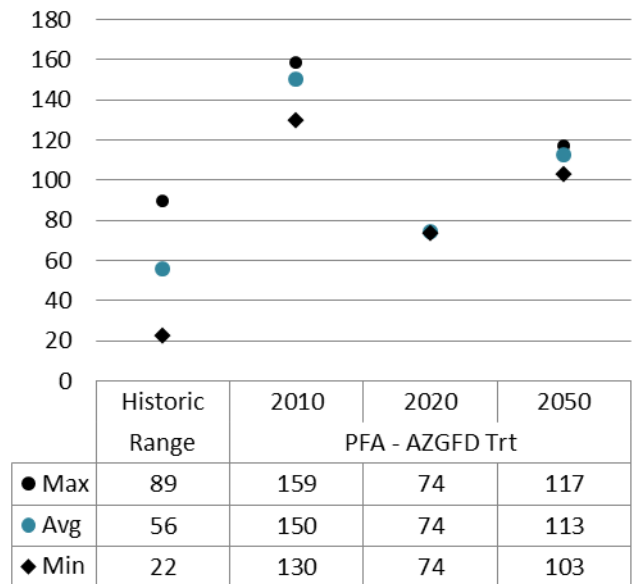


PFA Uneven Age – Arizona Game and Fish Design

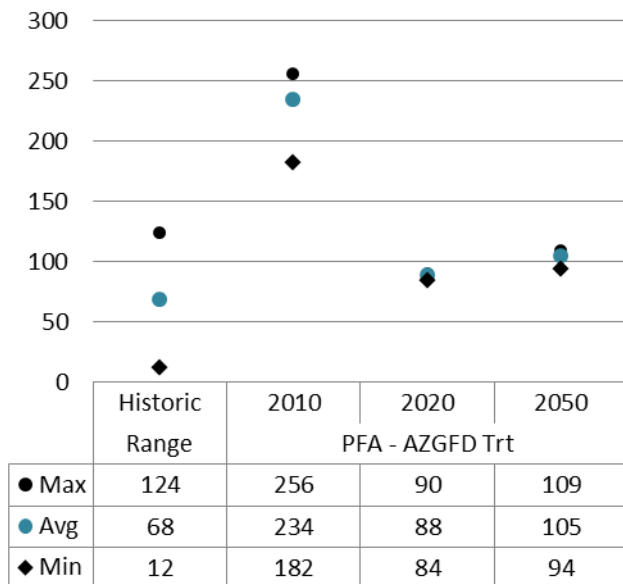
PP Trees per Acre



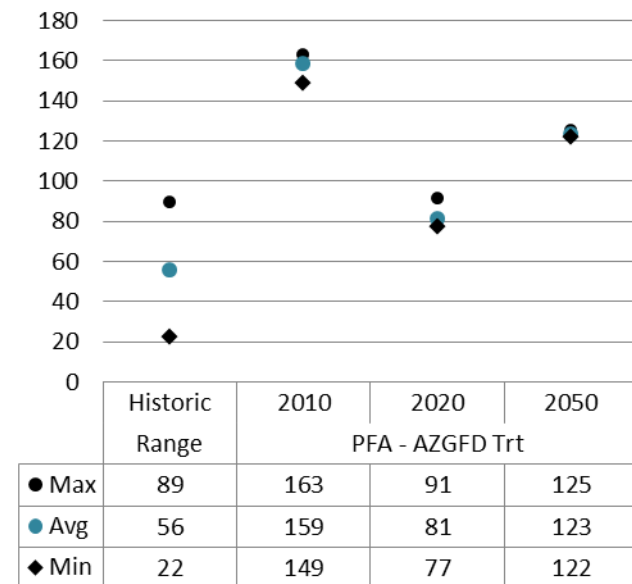
PP Basal Area



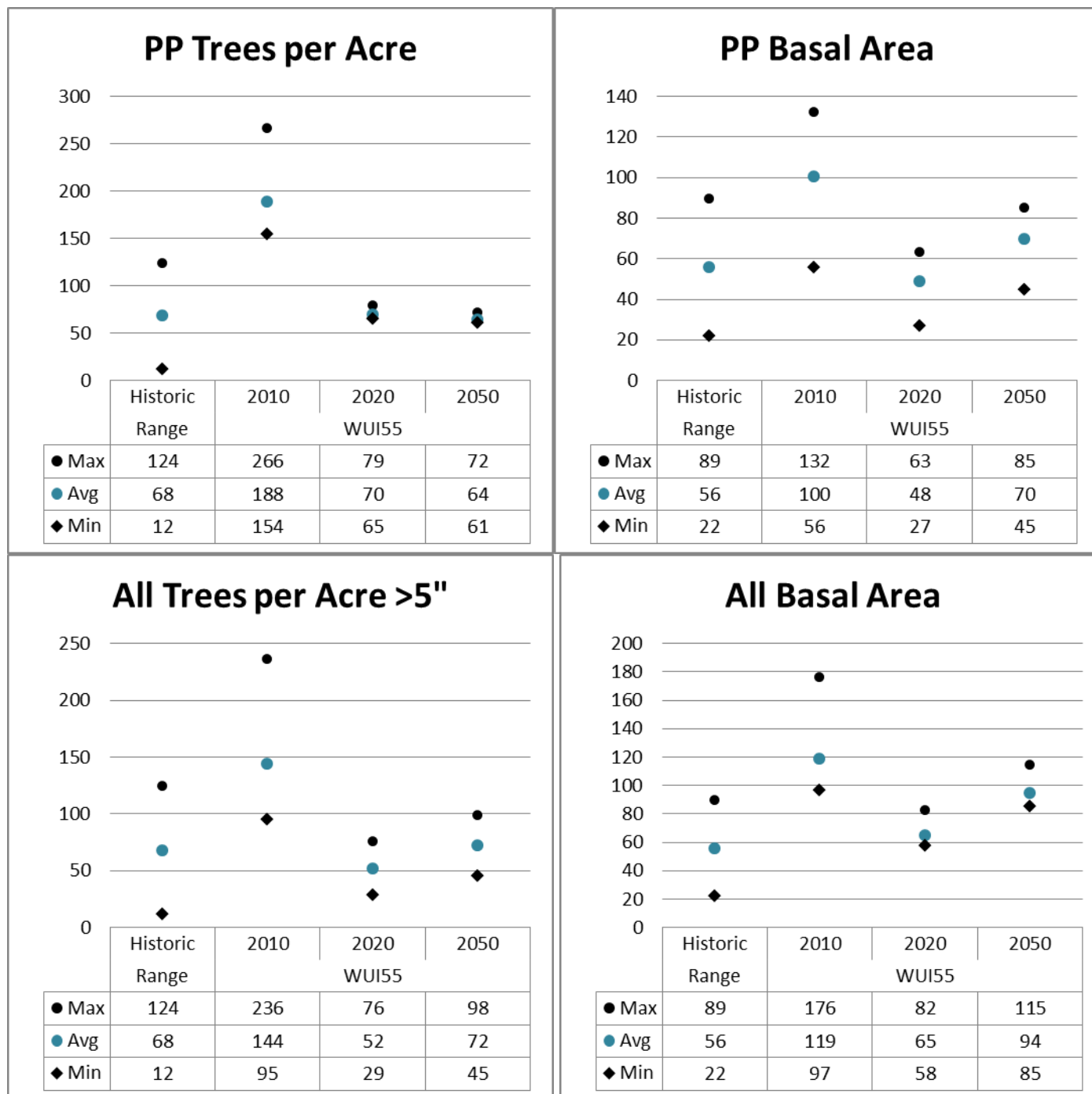
All Trees per Acre >5"



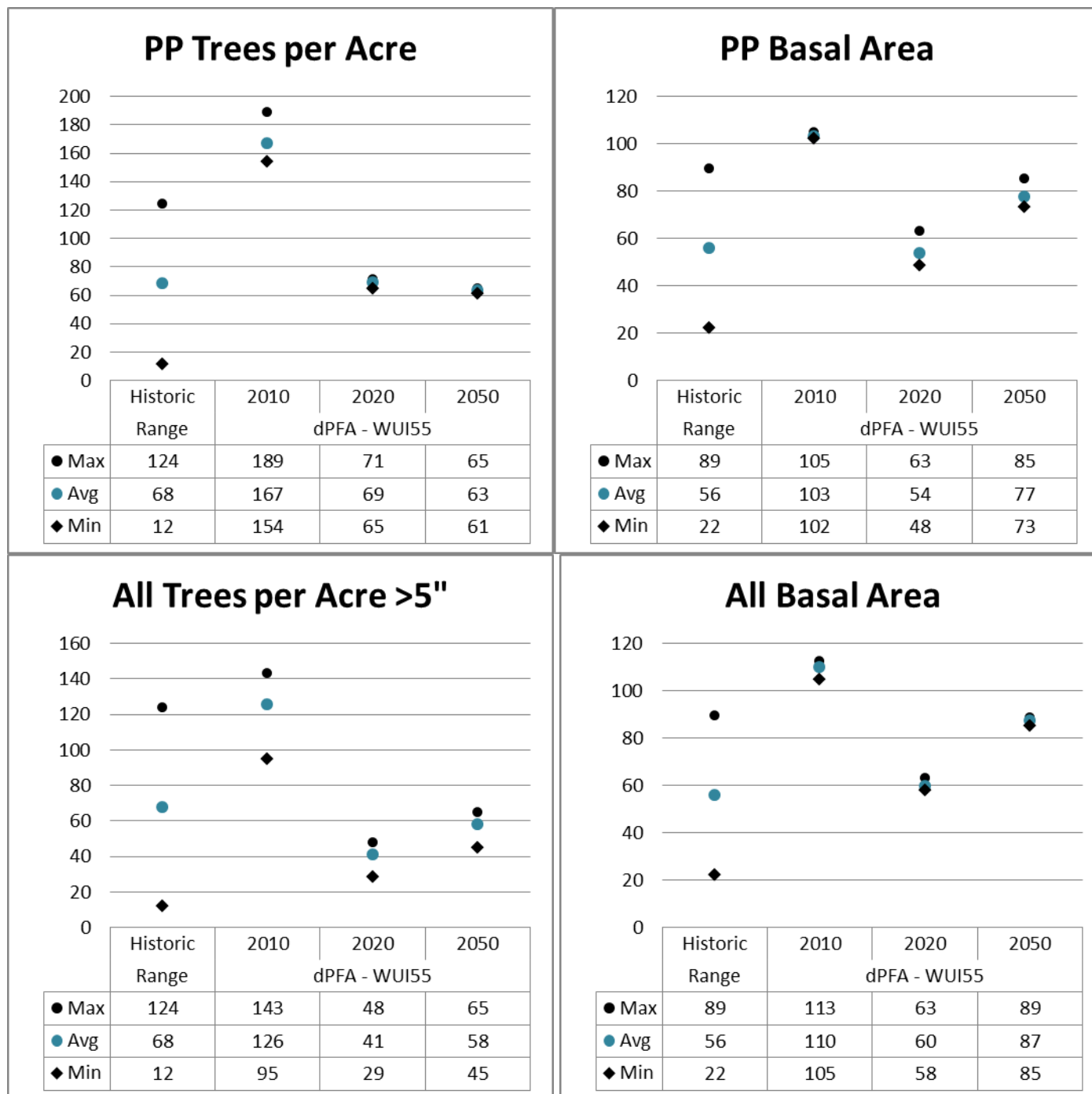
All Basal Area



Uneven Age – Wildland Urban Interface 55%

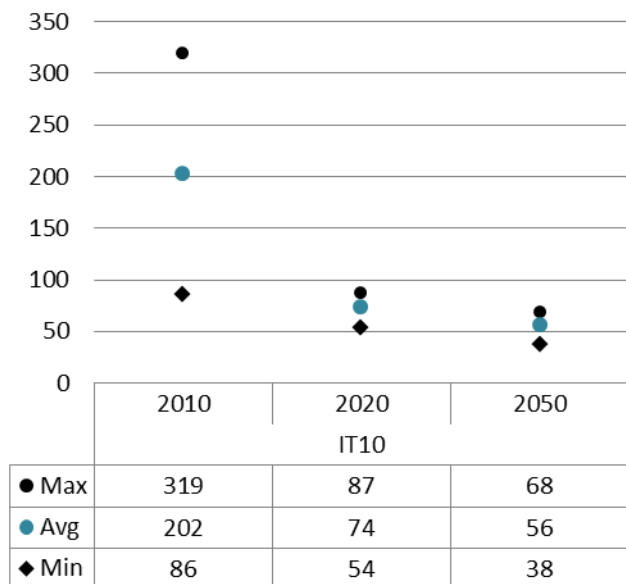


Dispersal PFA Uneven Age – Wildland Urban Interface 55%

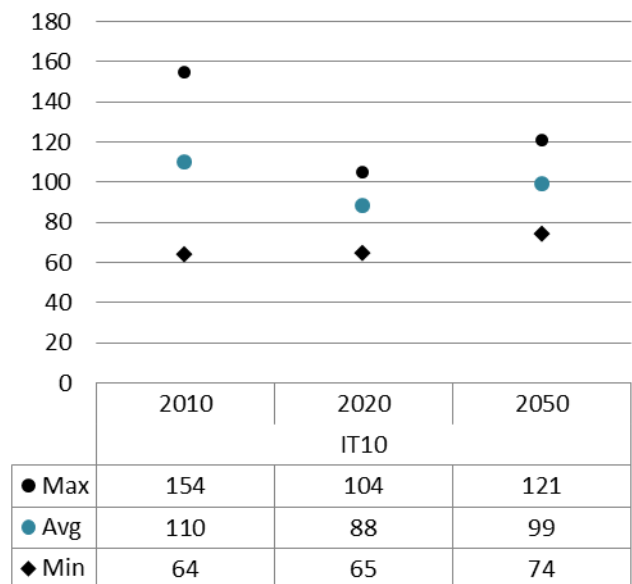


Intermediate Thin – 10-25%

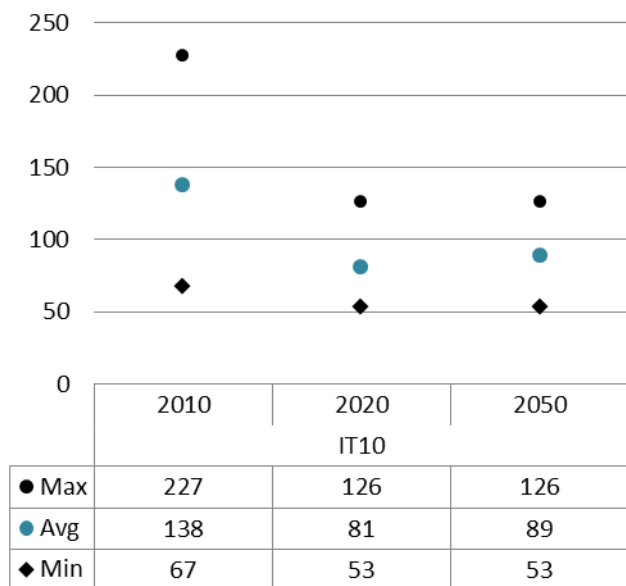
PP Trees per Acre



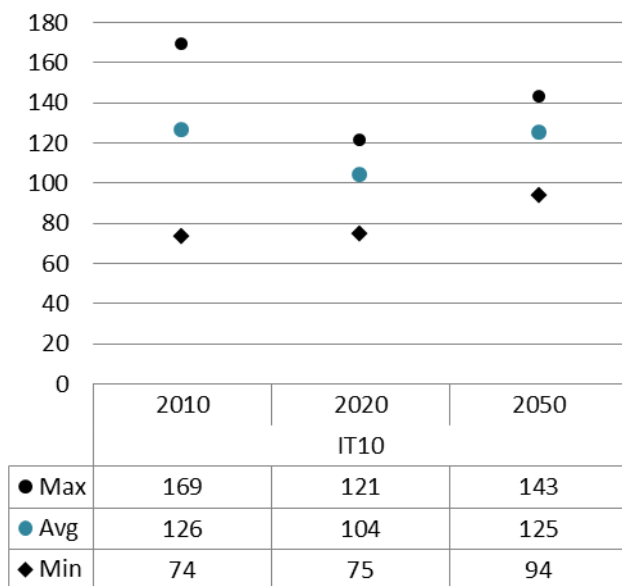
PP Basal Area



All Trees per Acre >5"

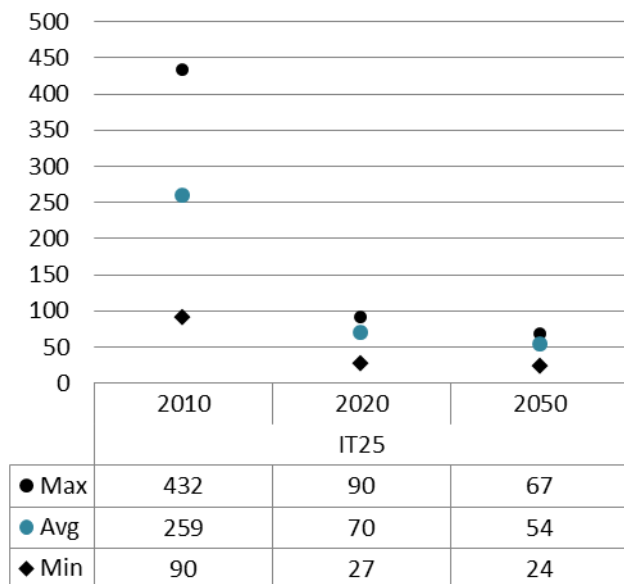


All Basal Area

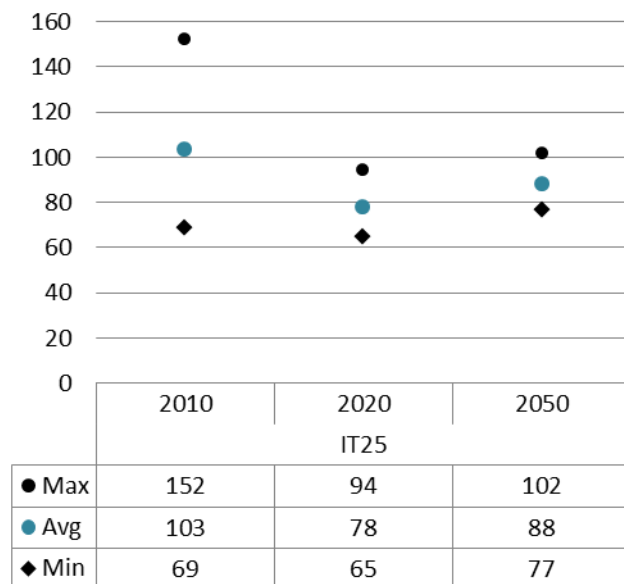


Intermediate Thin – 25-40%

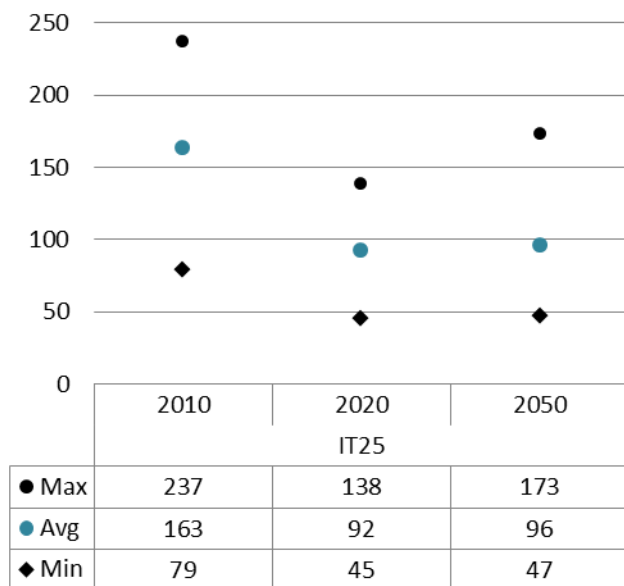
PP Trees per Acre



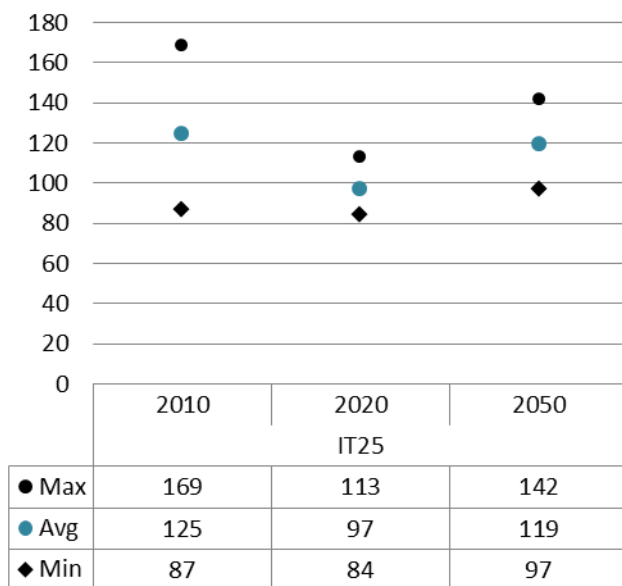
PP Basal Area



All Trees per Acre >5"

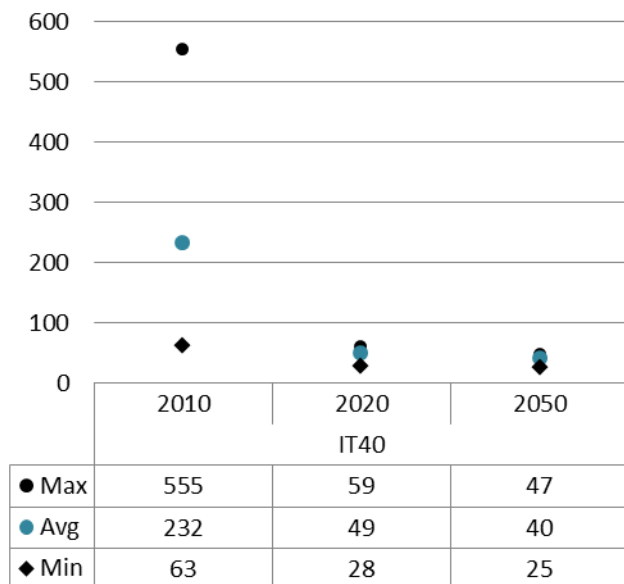


All Basal Area

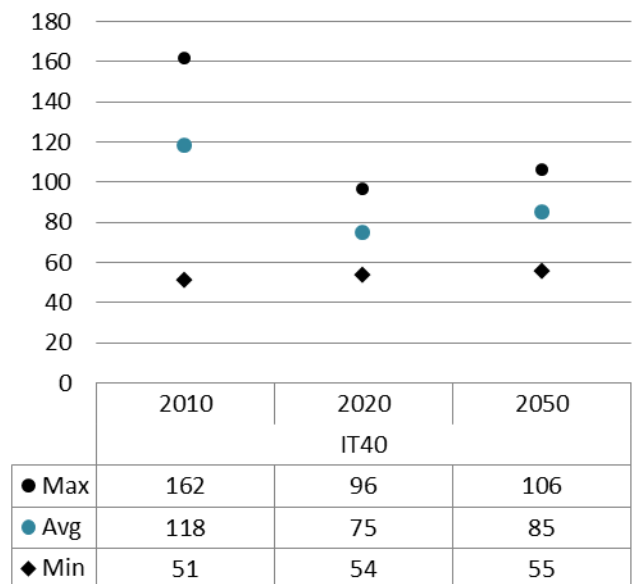


Intermediate Thin – 40-55%

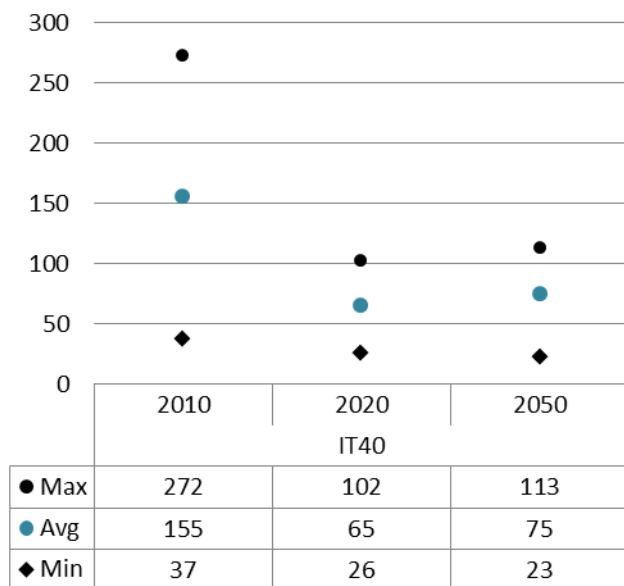
PP Trees per Acre



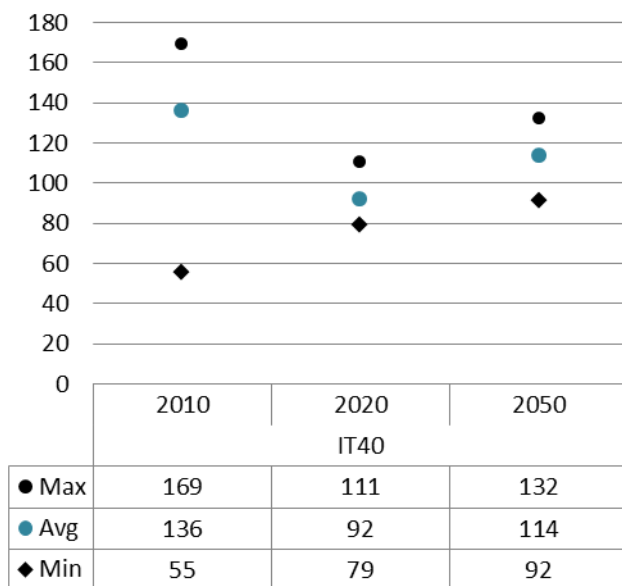
PP Basal Area



All Trees per Acre >5"

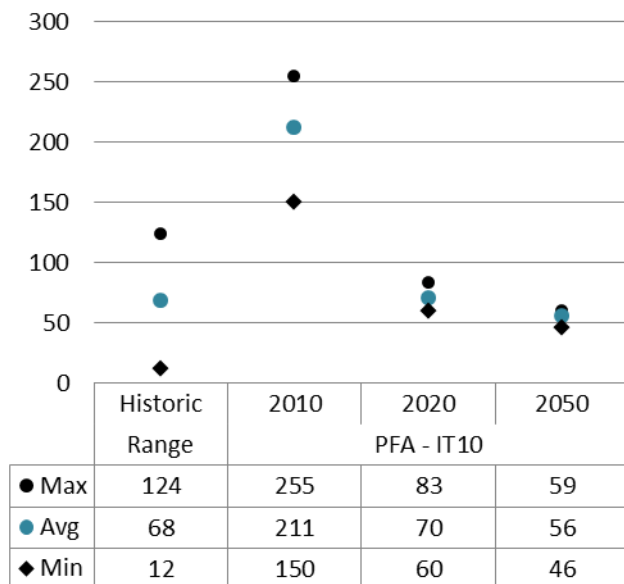


All Basal Area

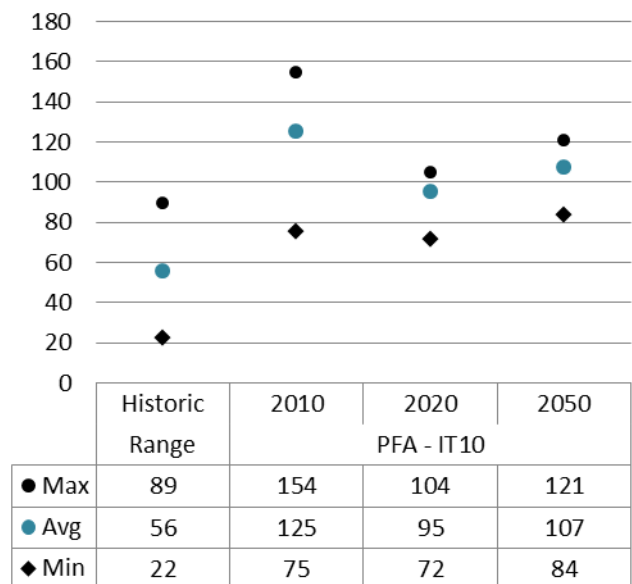


PFA Intermediate Thin – 10-25%

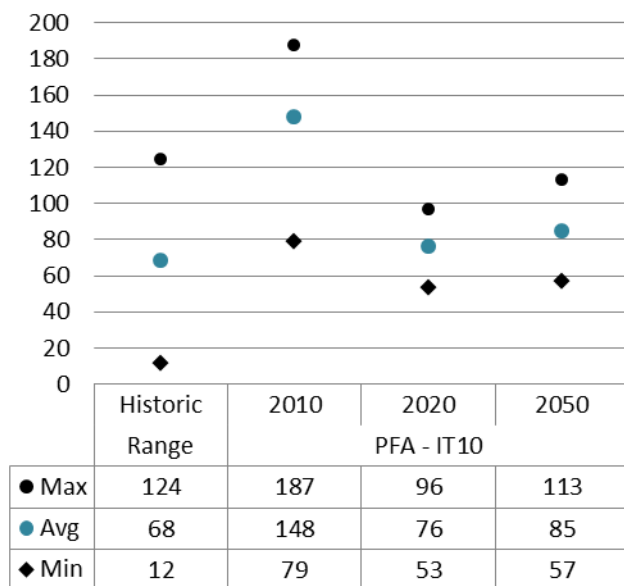
PP Trees per Acre



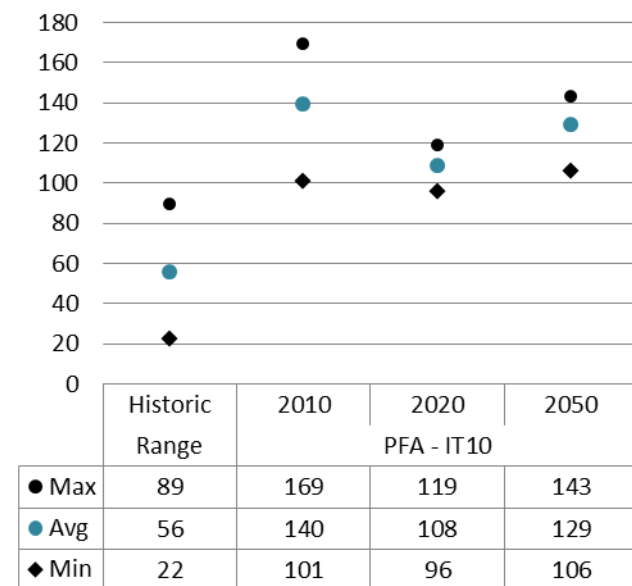
PP Basal Area



All Trees per Acre >5"

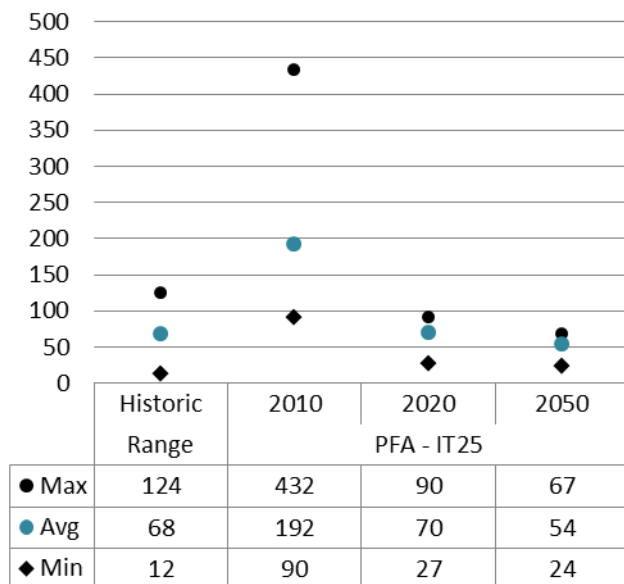


All Basal Area

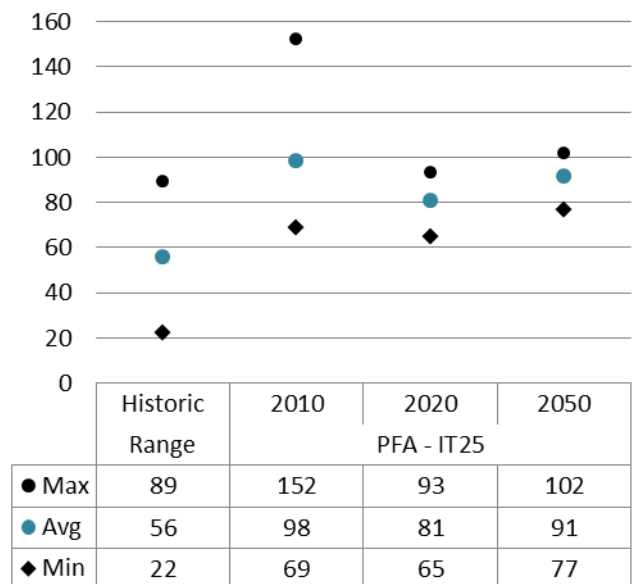


PFA Intermediate Thin – 25-40%

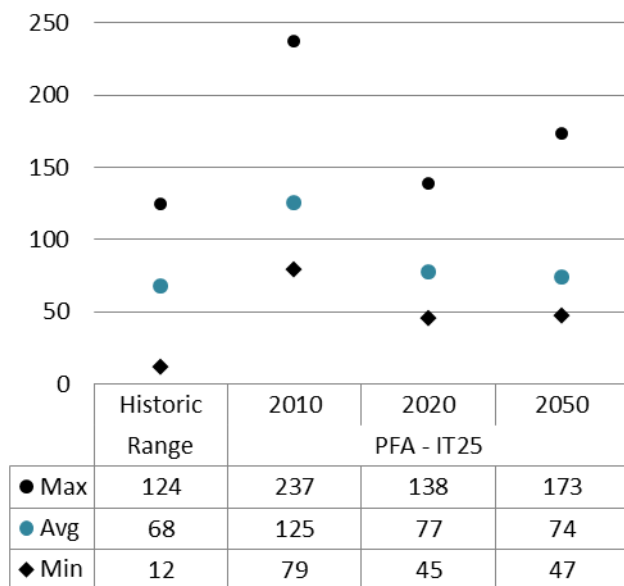
PP Trees per Acre



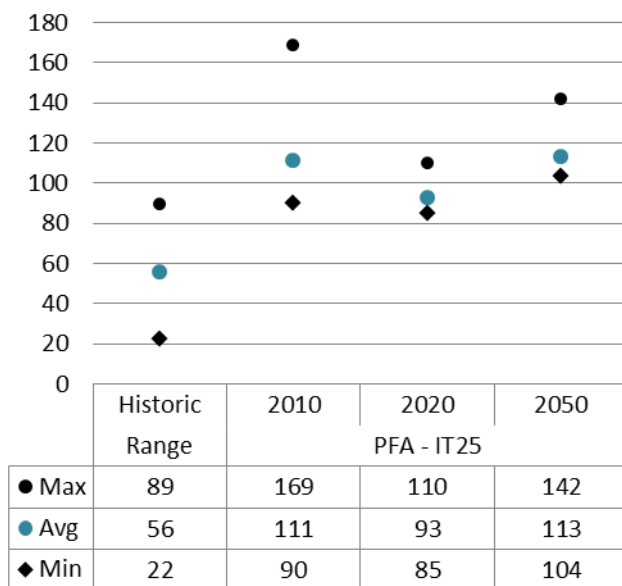
PP Basal Area



All Trees per Acre >5"

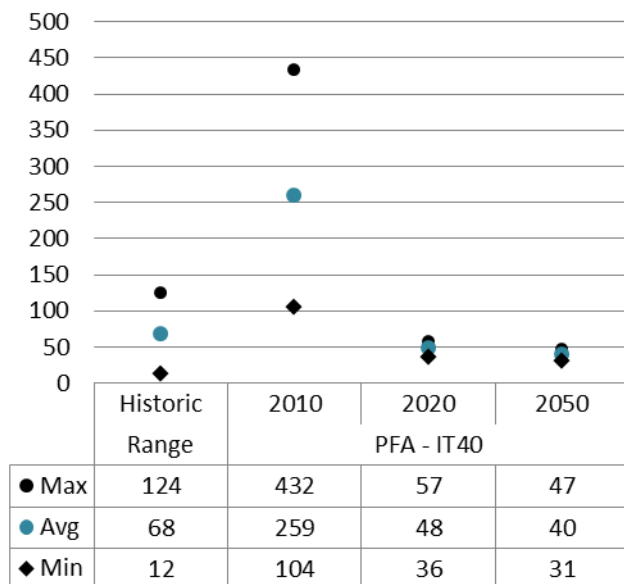


All Basal Area

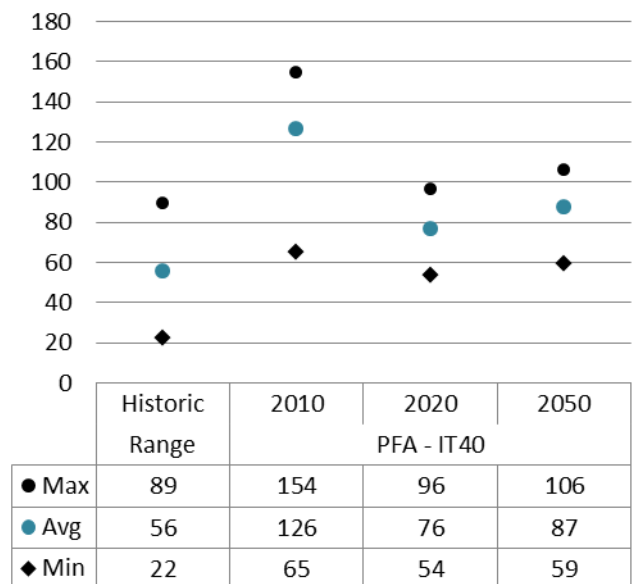


PFA Intermediate Thin – 40-55%

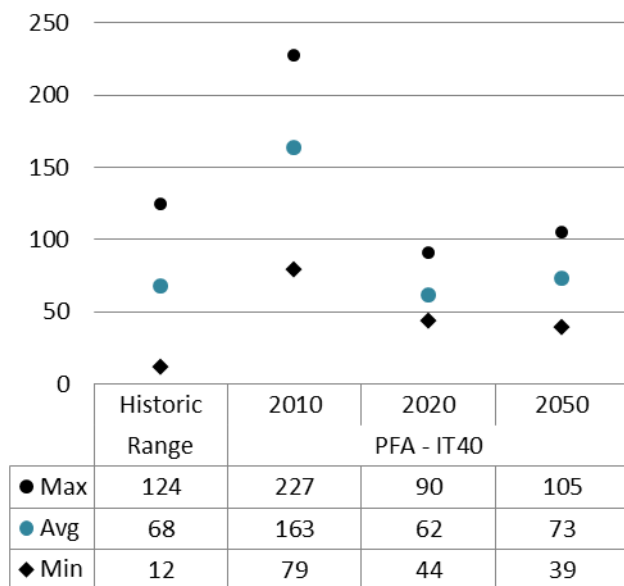
PP Trees per Acre



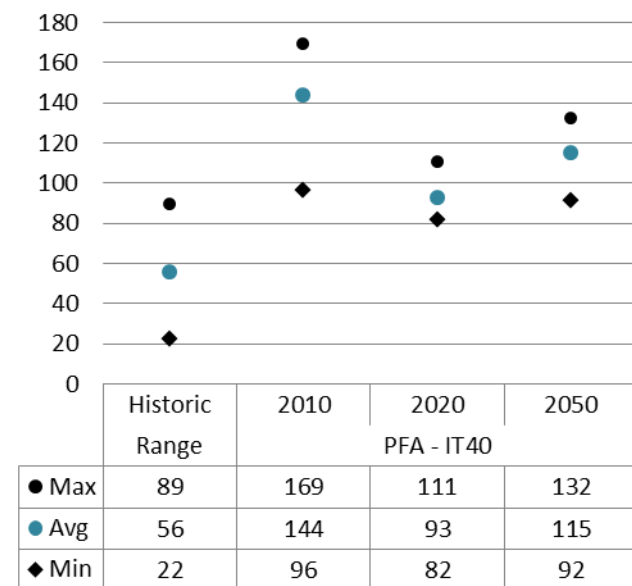
PP Basal Area



All Trees per Acre >5"

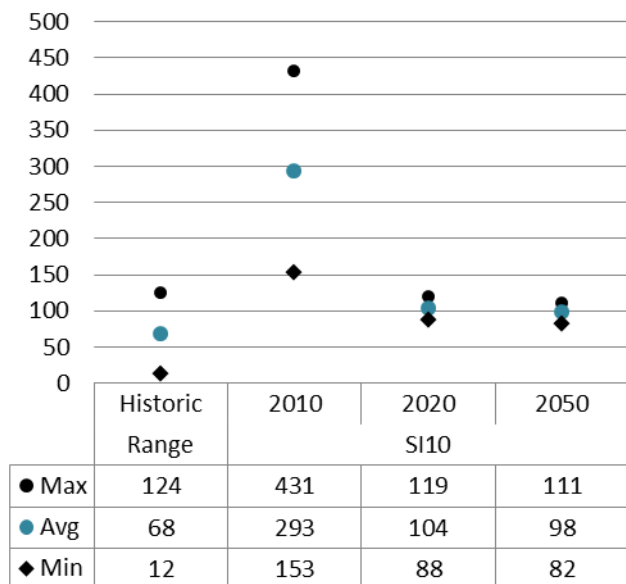


All Basal Area

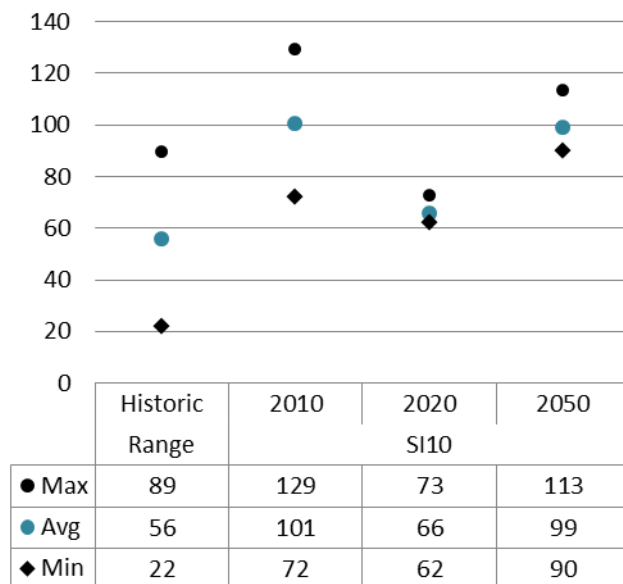


Stand Improvement – 10-25%

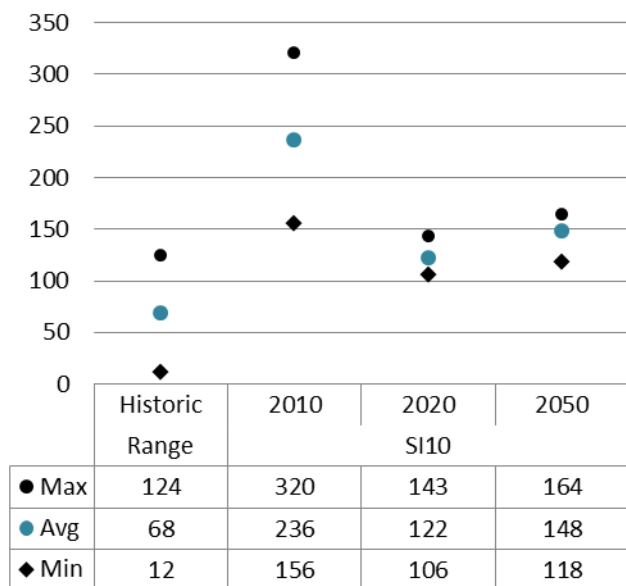
PP Trees per Acre



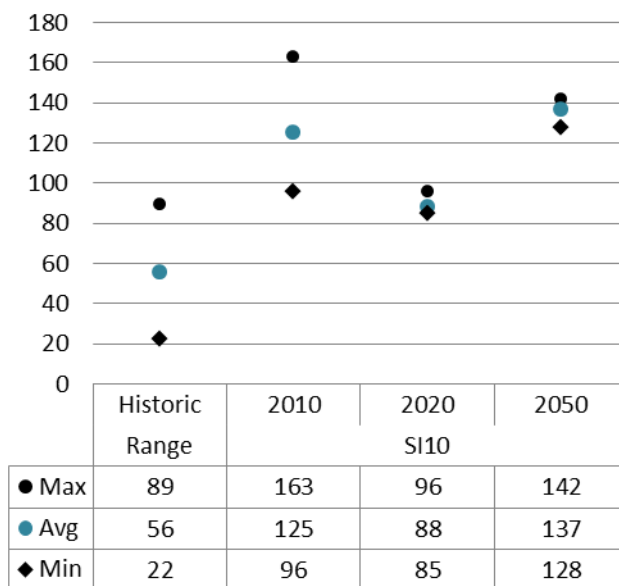
PP Basal Area



All Trees per Acre >5"

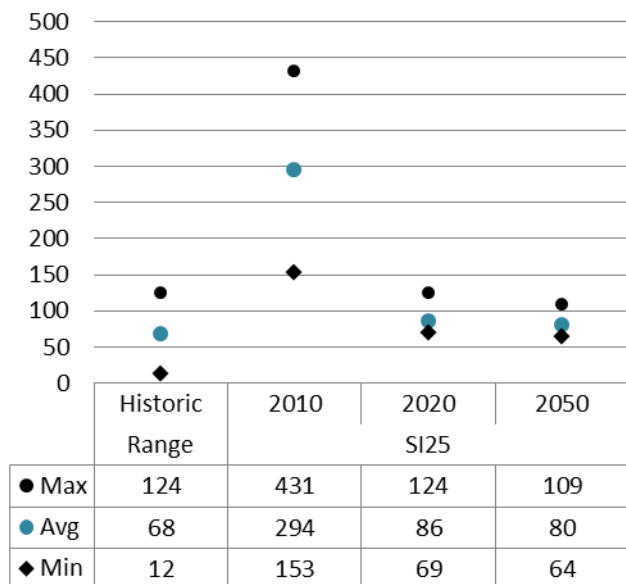


All Basal Area

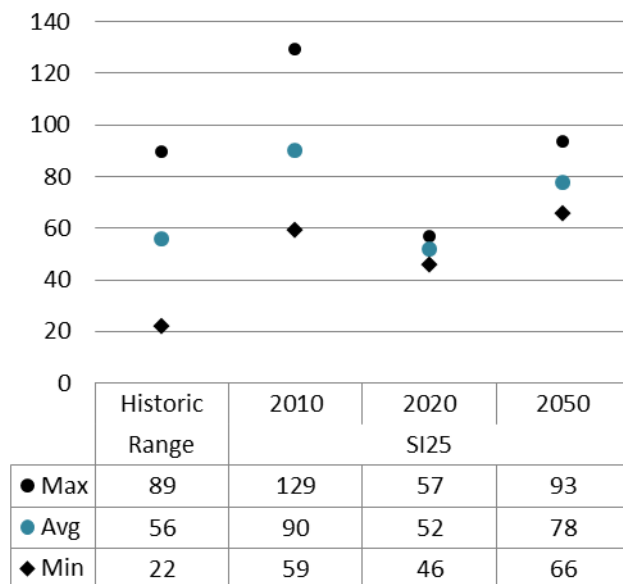


Stand Improvement – 25-40%

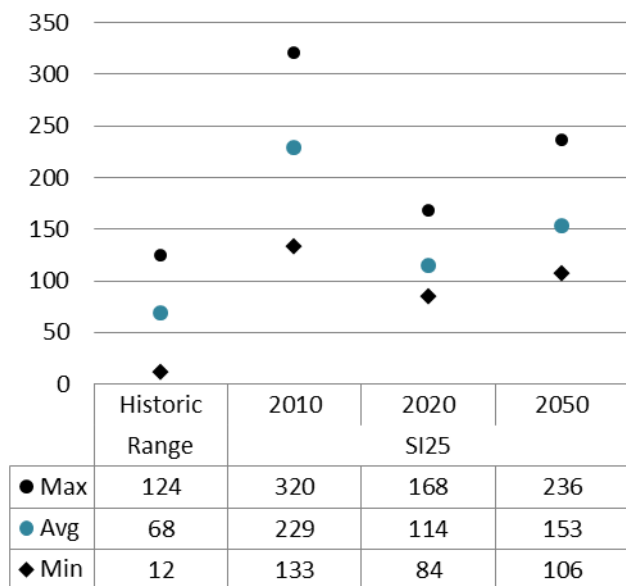
PP Trees per Acre



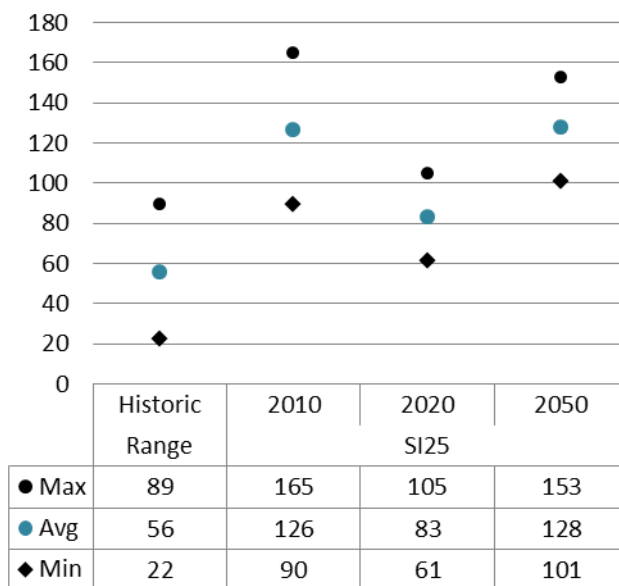
PP Basal Area



All Trees per Acre >5"

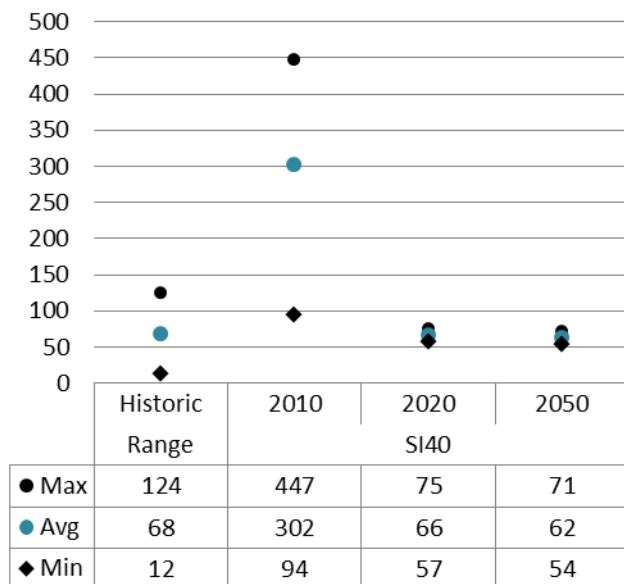


All Basal Area

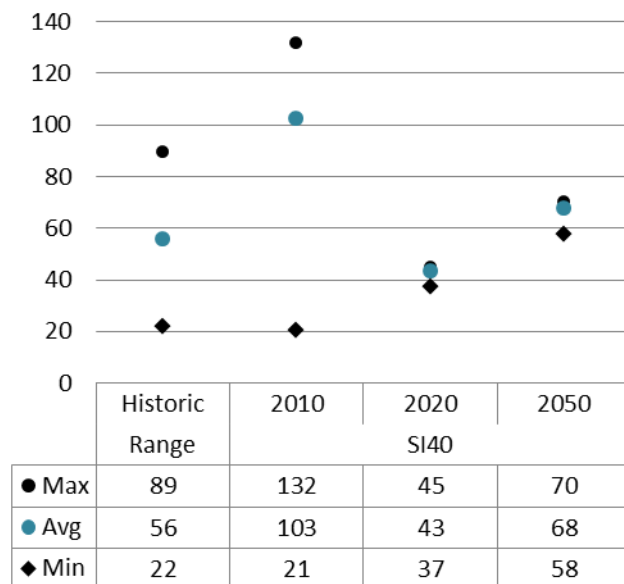


Stand Improvement – 40-55%

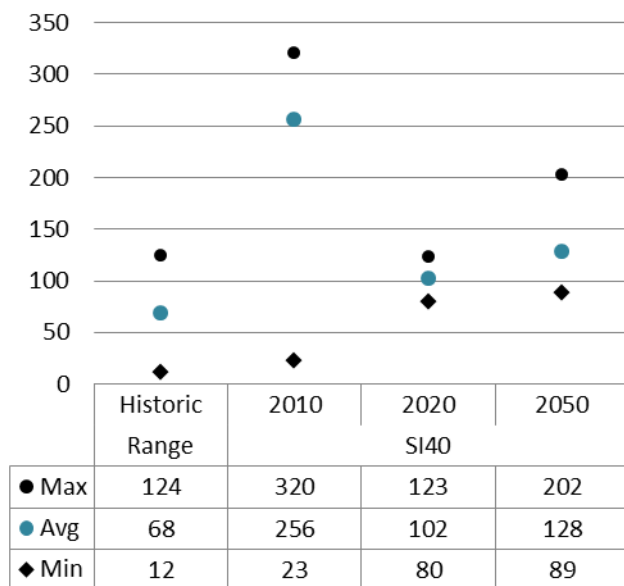
PP Trees per Acre



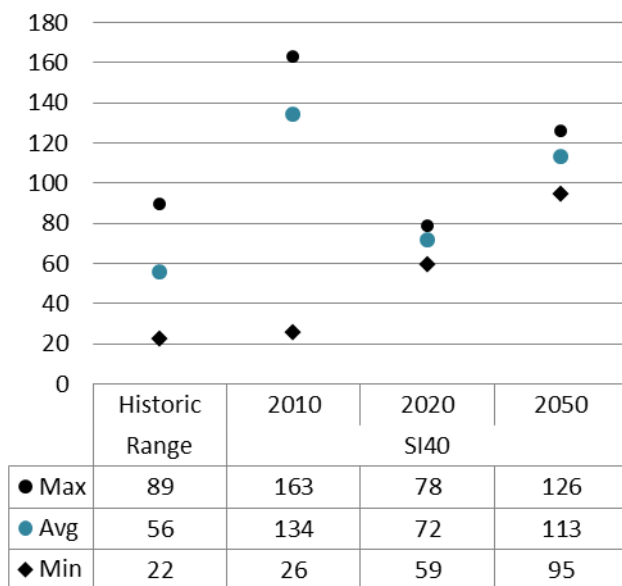
PP Basal Area



All Trees per Acre >5"

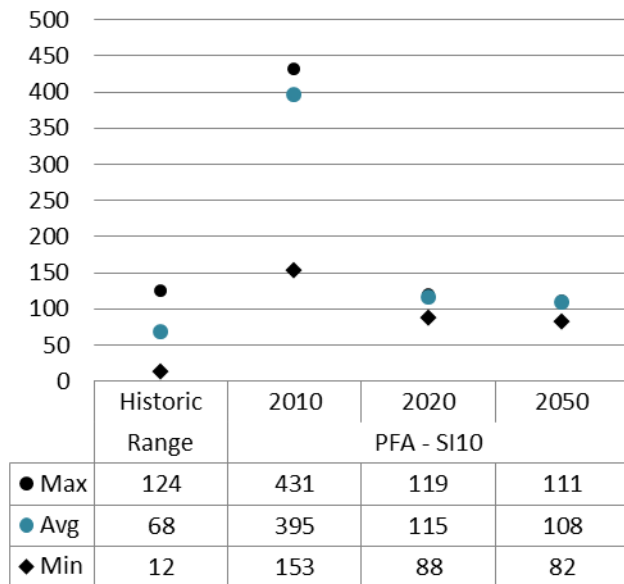


All Basal Area

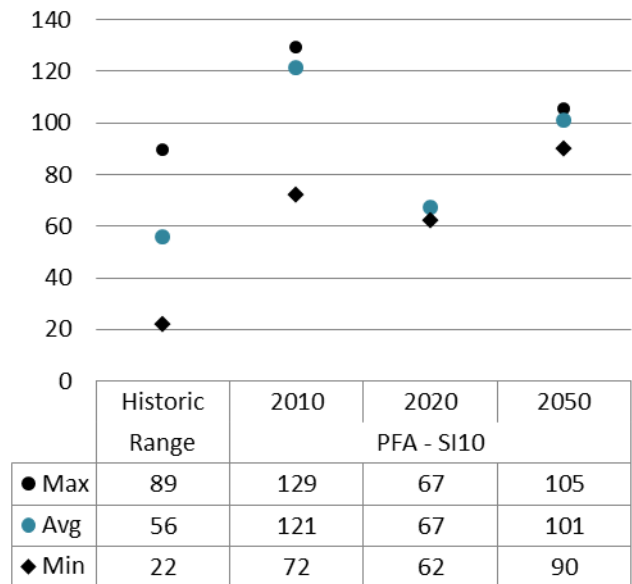


PFA Stand Improvement – 10-25%

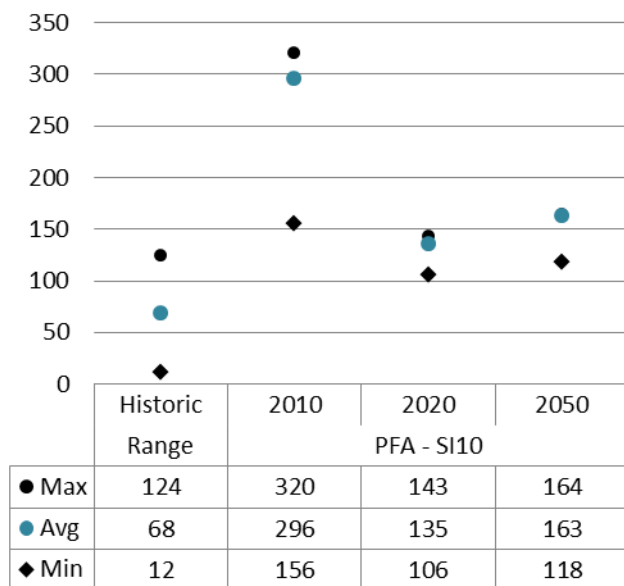
PP Trees per Acre



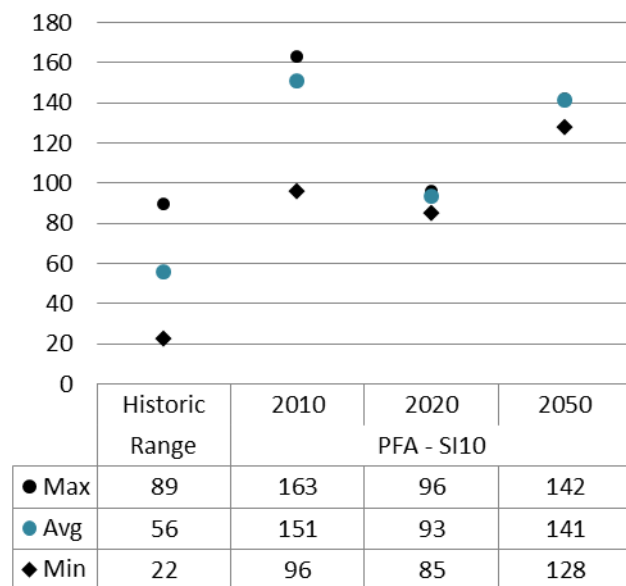
PP Basal Area



All Trees per Acre >5"

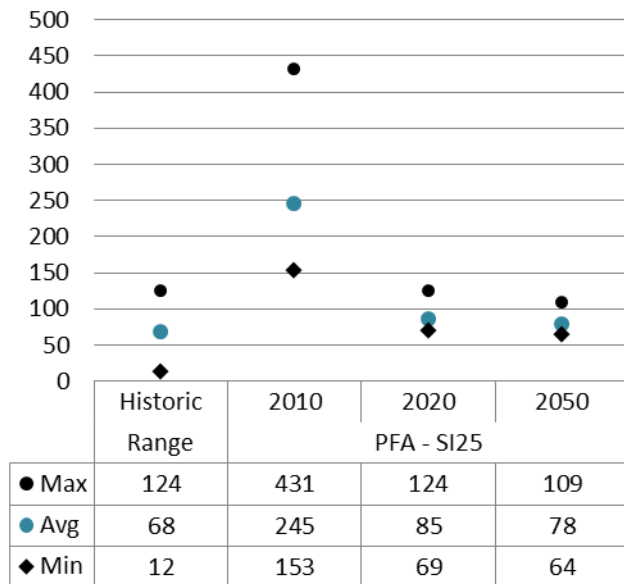


All Basal Area

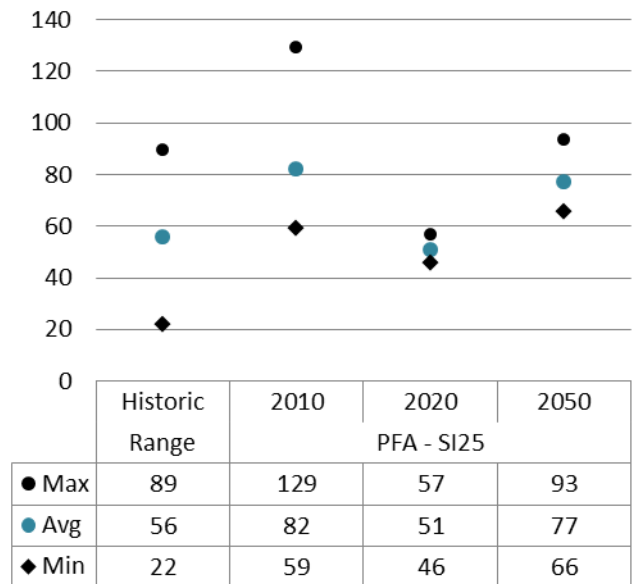


PFA Stand Improvement – 25-40%

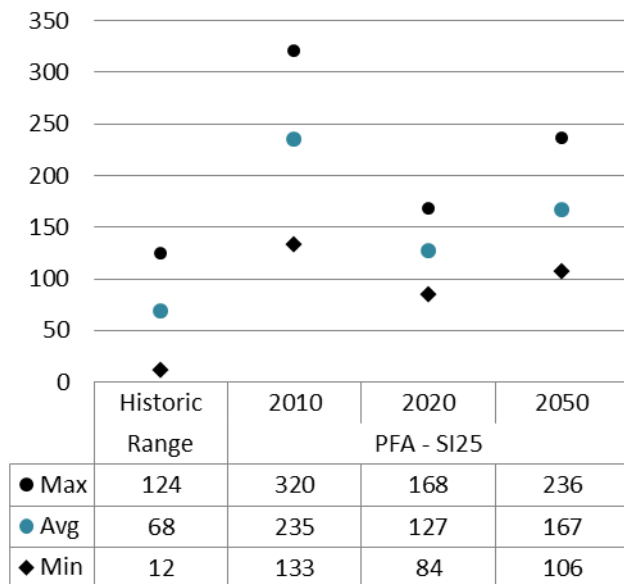
PP Trees per Acre



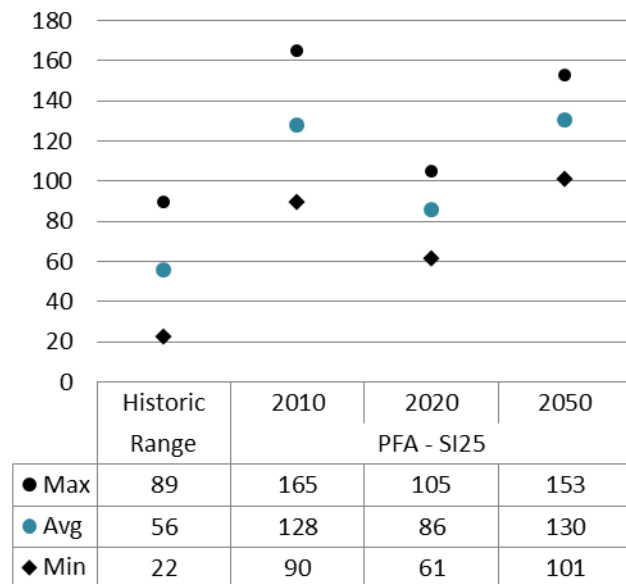
PP Basal Area



All Trees per Acre >5"

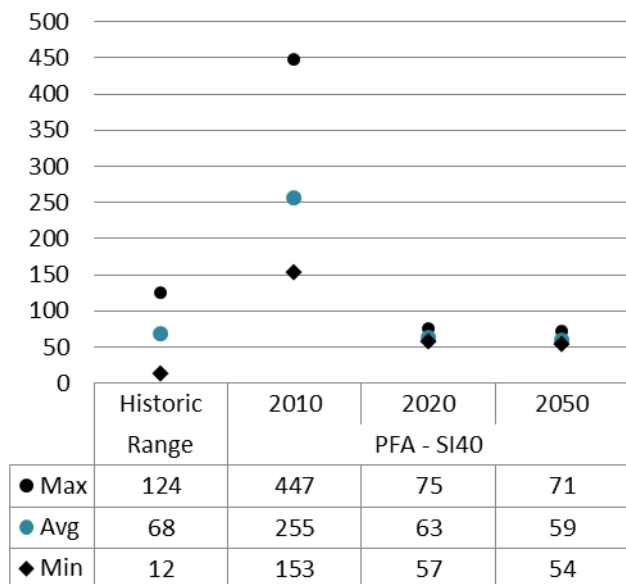


All Basal Area

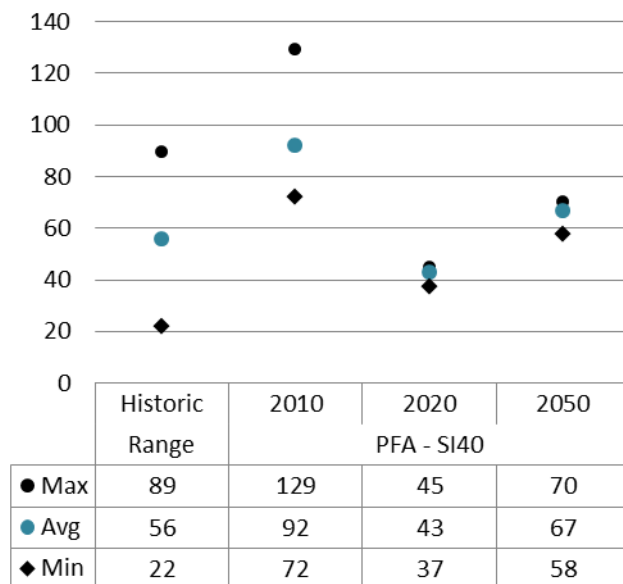


PFA Stand Improvement – 40-55%

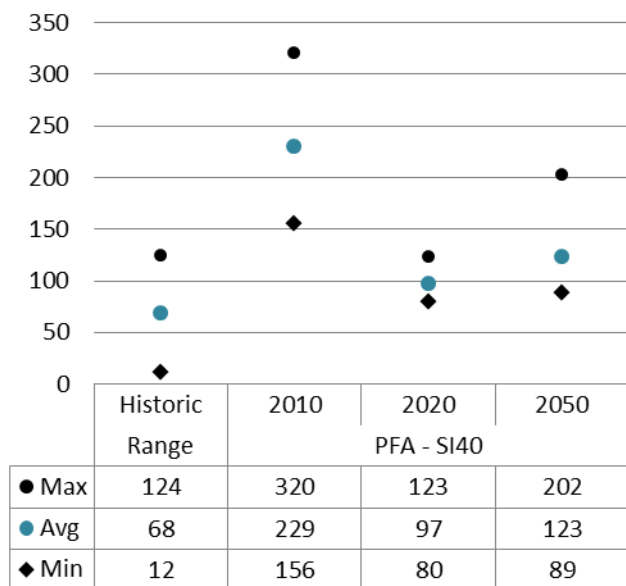
PP Trees per Acre



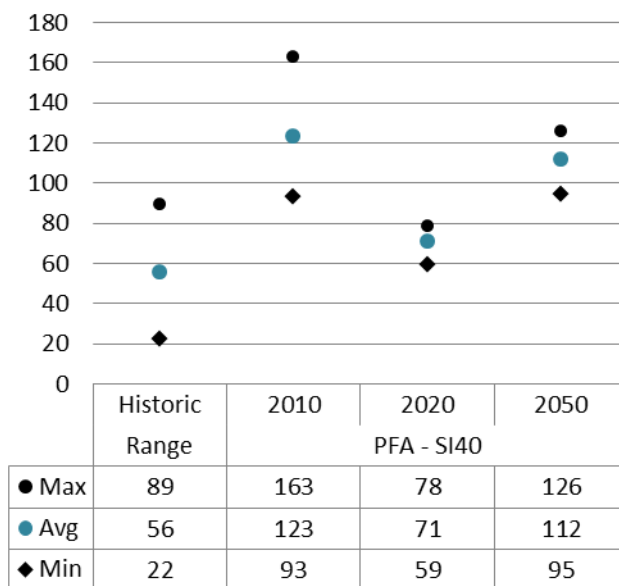
PP Basal Area



All Trees per Acre >5"

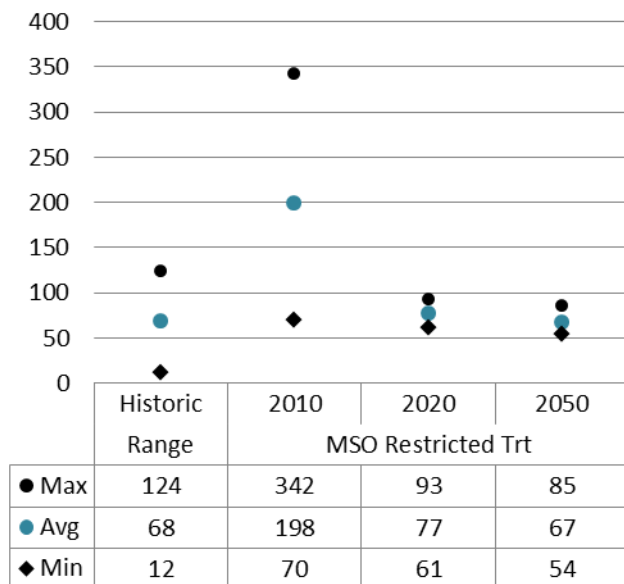


All Basal Area

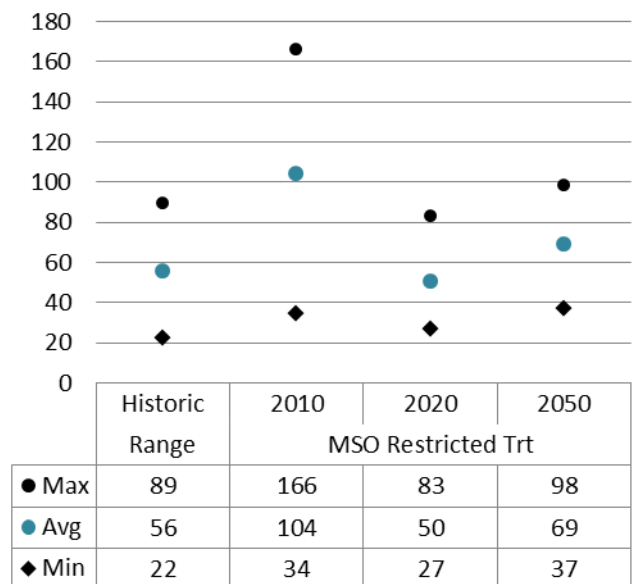


MSO Restricted Treatment

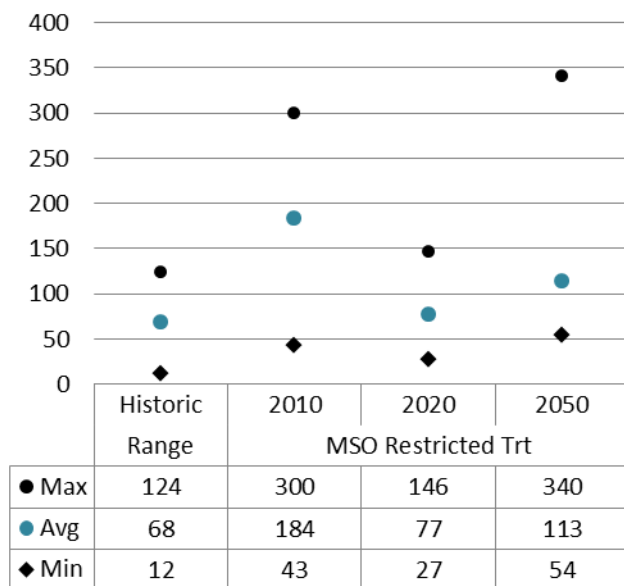
PP Trees per Acre



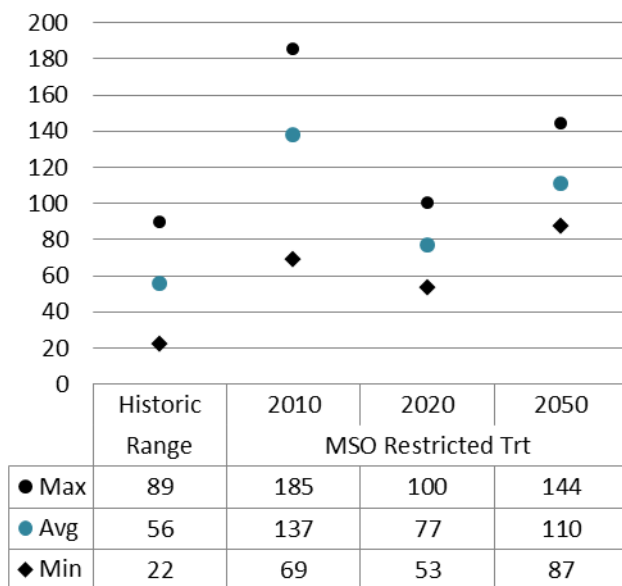
PP Basal Area



All Trees per Acre >5"

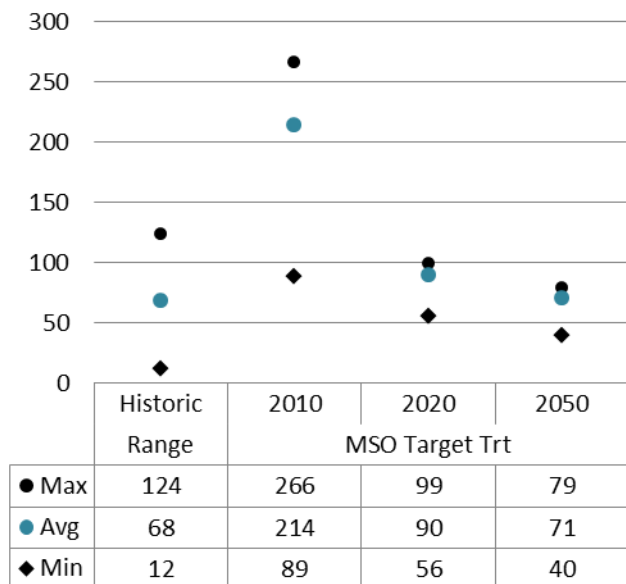


All Basal Area

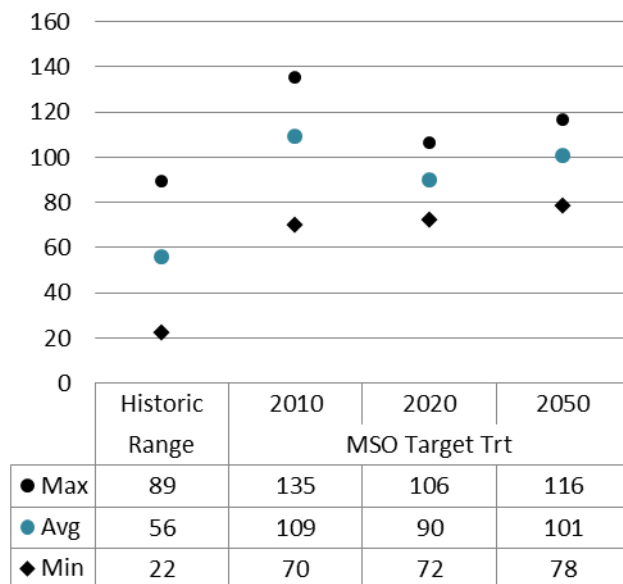


MSO Target Treatment

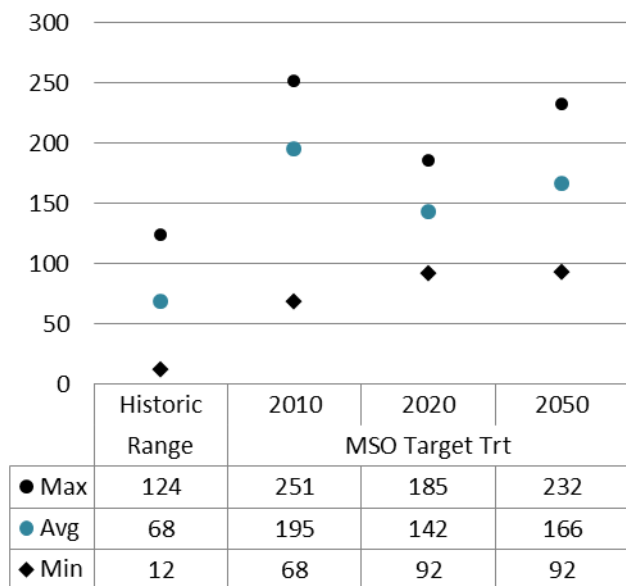
PP Trees per Acre



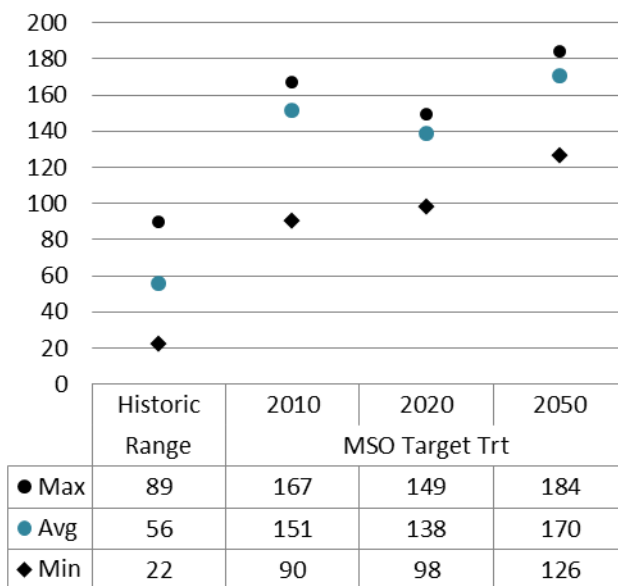
PP Basal Area



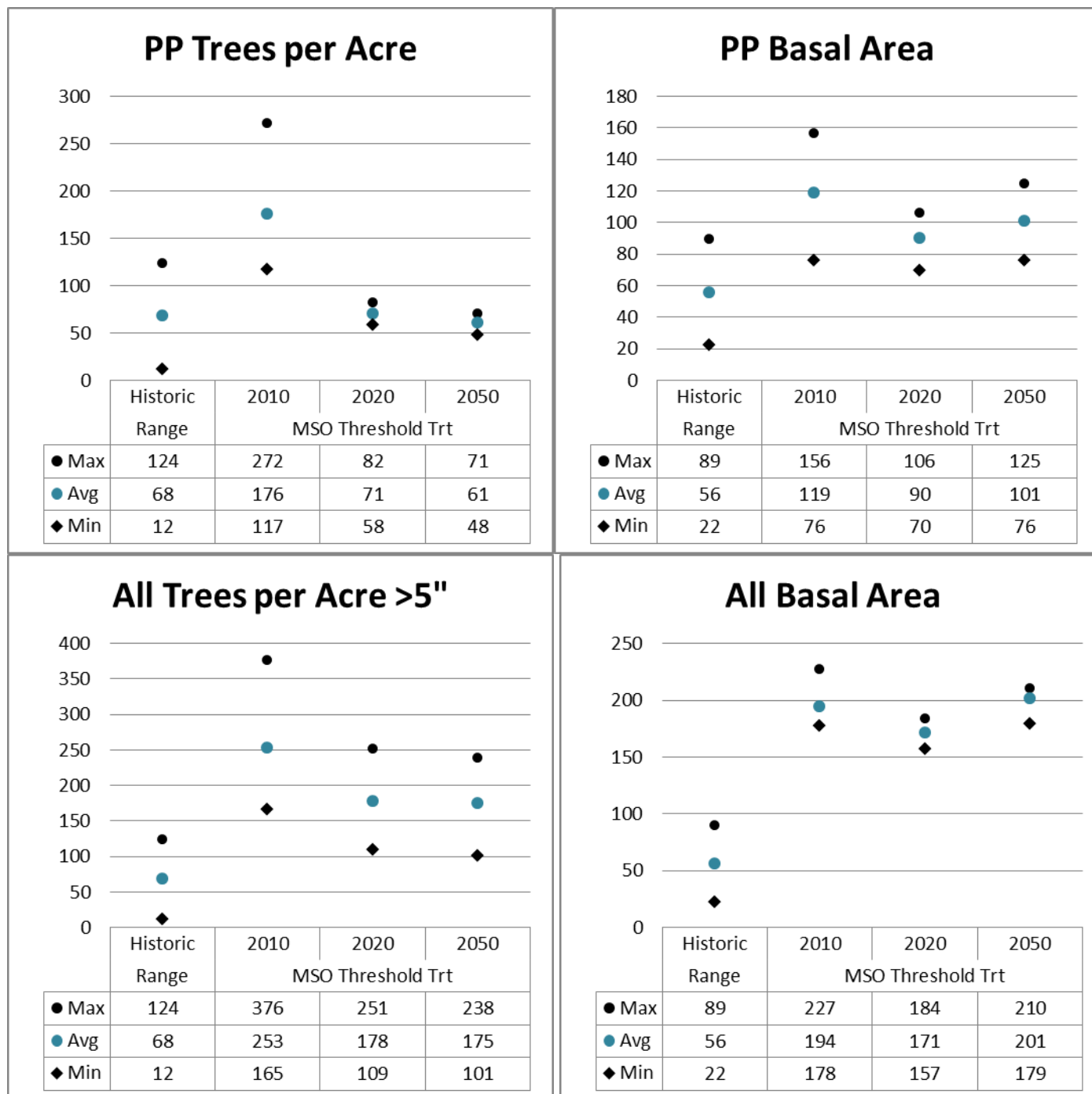
All Trees per Acre >5"



All Basal Area

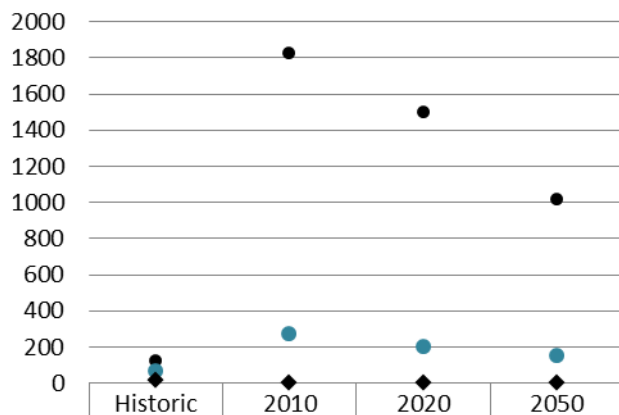


MSO Threshold Treatment



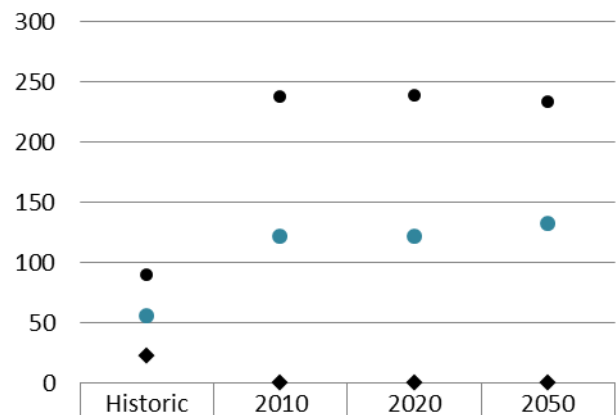
PAC – Mechanical

PP Trees per Acre



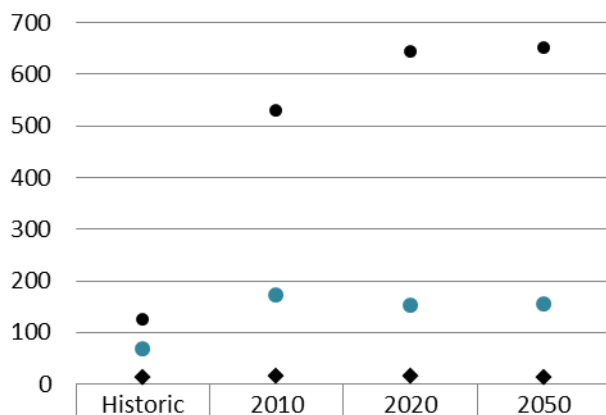
● Max	124	1821	1501	1012
● Avg	68	270	196	150
◆ Min	12	0	0	0

PP Basal Area



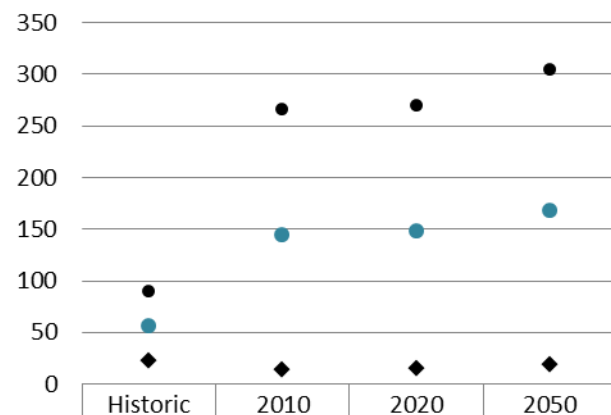
● Max	89	238	239	233
● Avg	56	121	122	133
◆ Min	22	0	0	0

All Trees per Acre >5"



● Max	124	530	642	652
● Avg	68	171	151	155
◆ Min	12	16	16	14

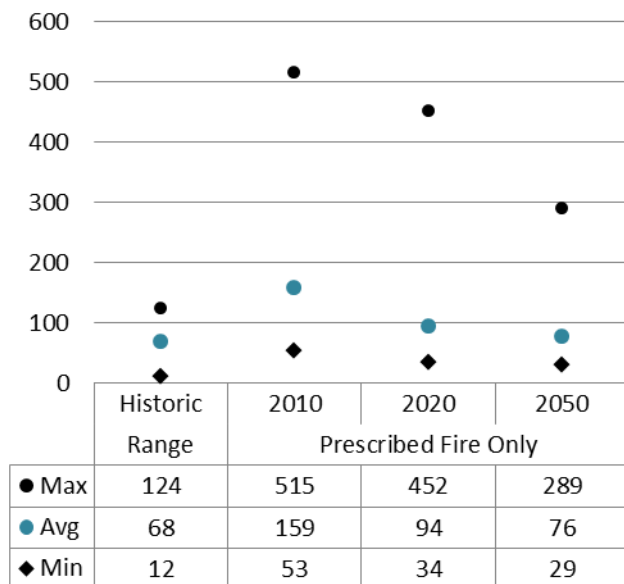
All Basal Area



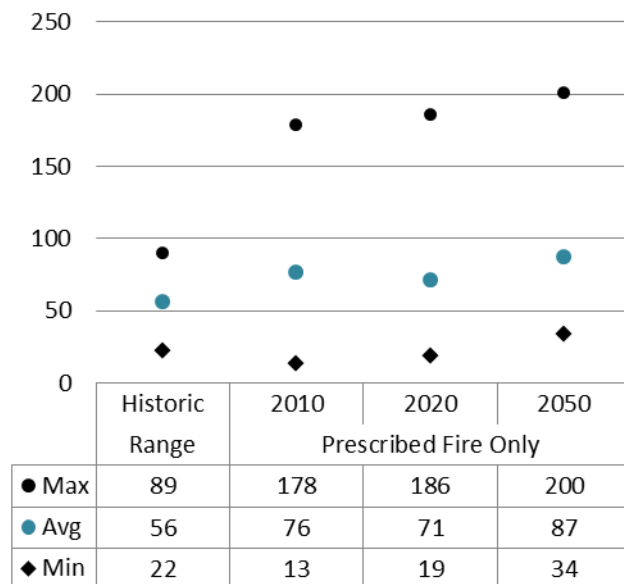
● Max	89	266	270	304
● Avg	56	145	148	168
◆ Min	22	14	15	19

Prescribed Fire Only

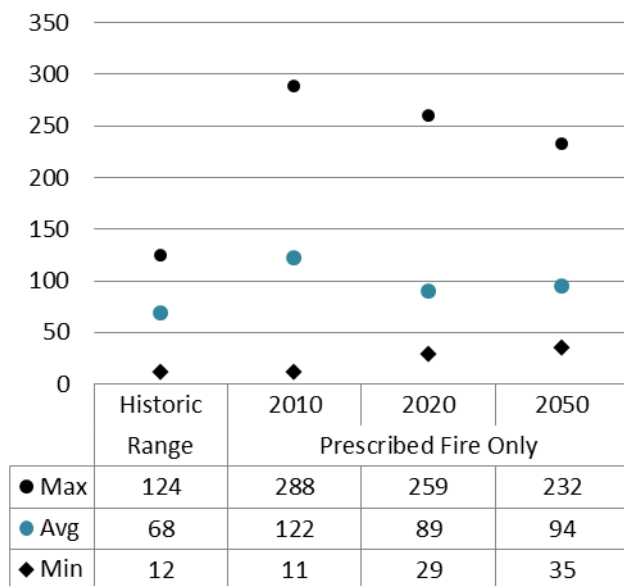
PP Trees per Acre



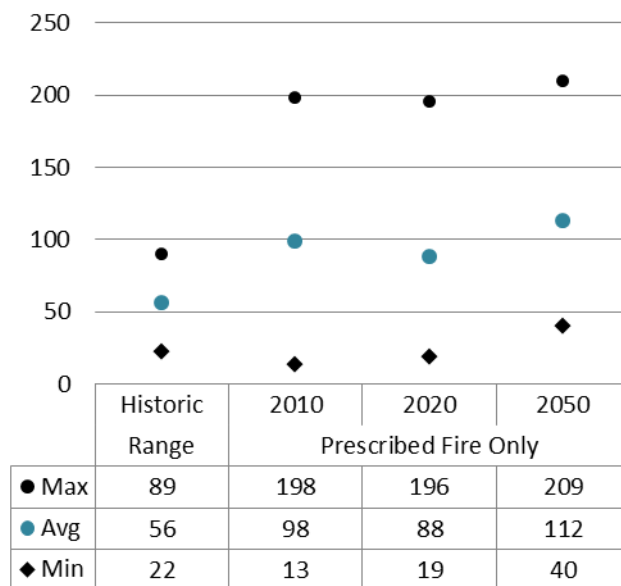
PP Basal Area



All Trees per Acre >5"

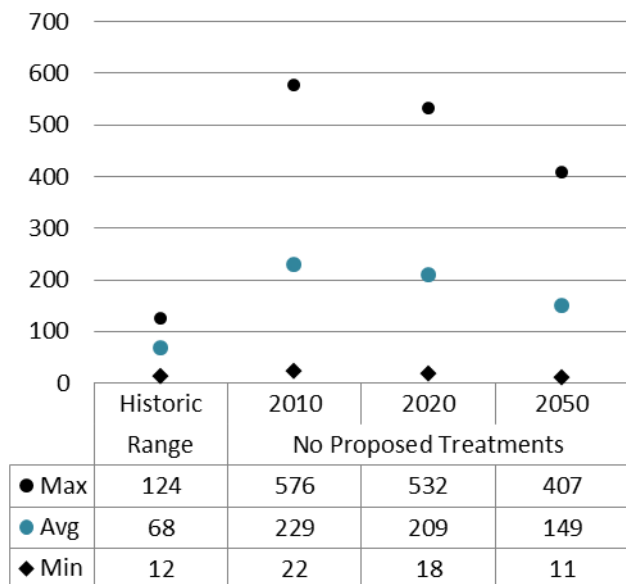


All Basal Area

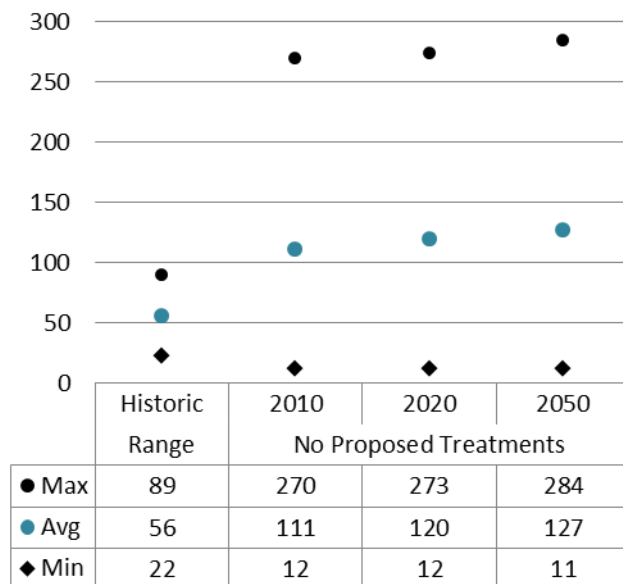


No Proposed Treatments

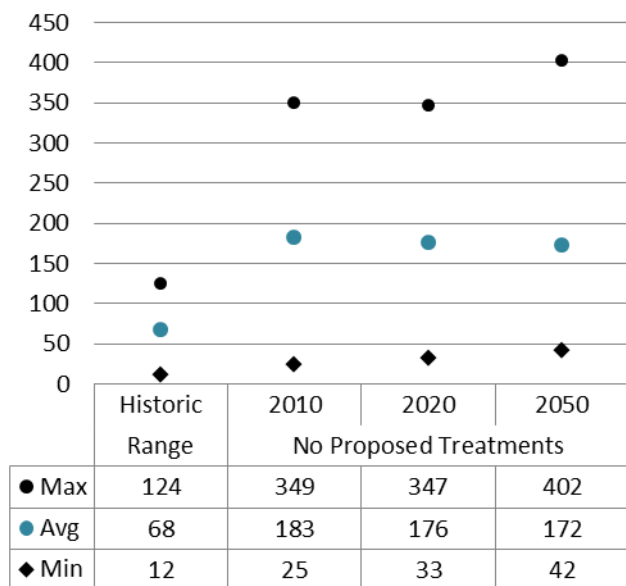
PP Trees per Acre



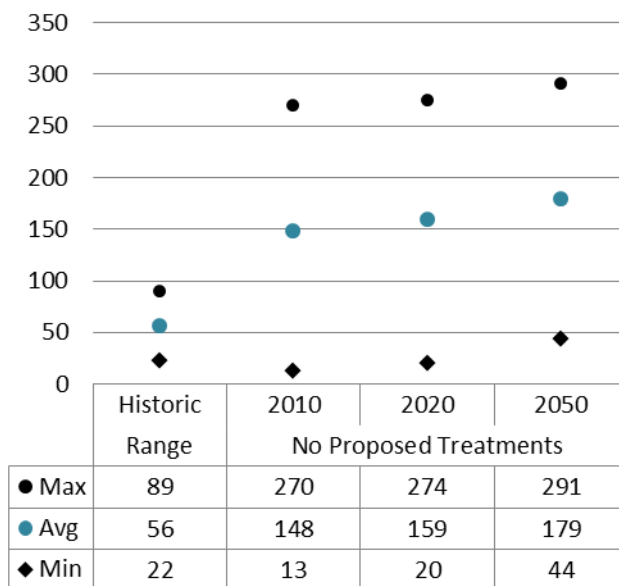
PP Basal Area



All Trees per Acre >5"



All Basal Area



Appendix H - The Slide Fire – Silviculture

The Slide fire started the afternoon of May 20, 2014, contained on June 5, and controlled on June 10 after burning 21,227 acres. The Slide fire burned 7,870 of 4FRI project area acres (Figure 23) (Table 132, using Alt C treatment acres).

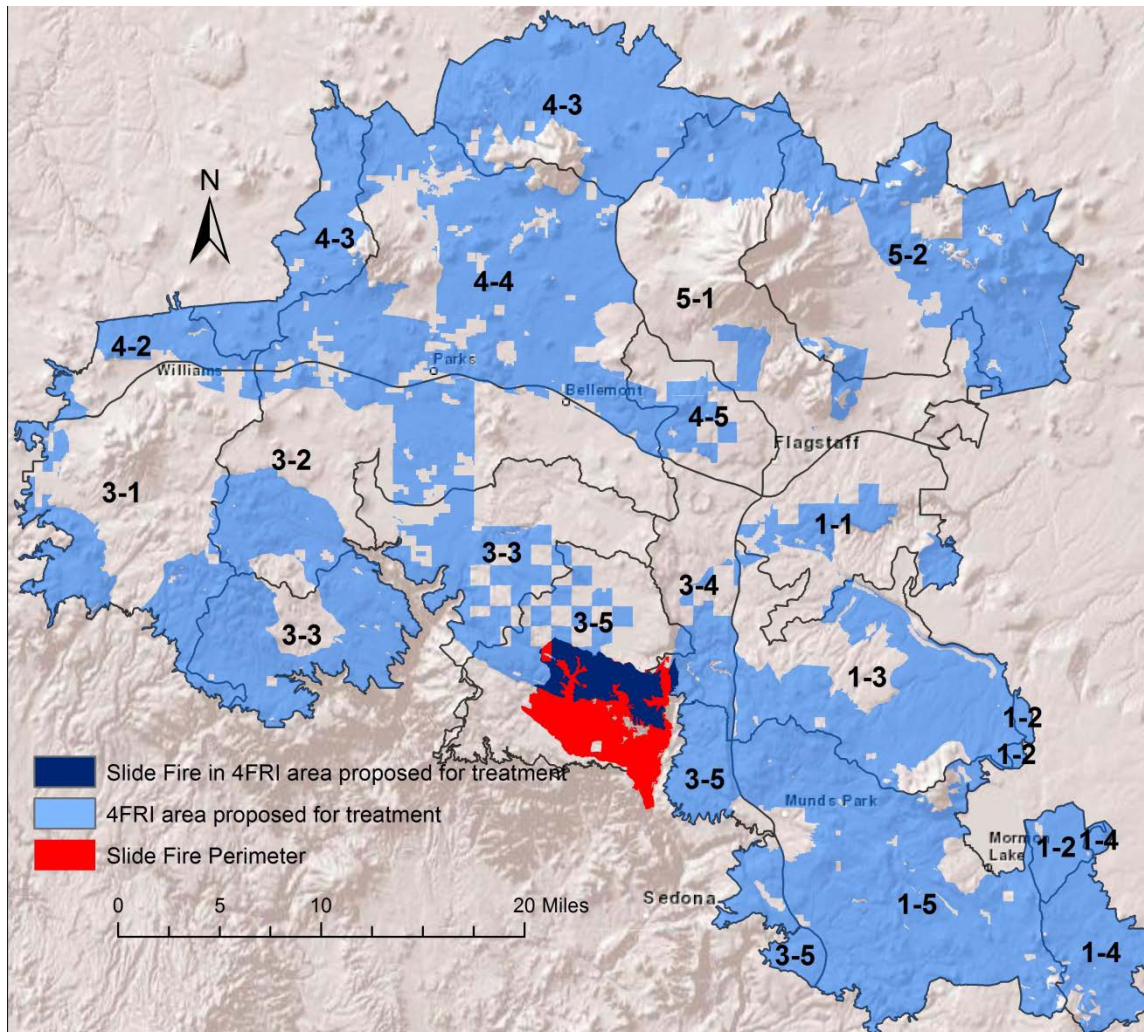


Figure 20: Overview of Southern EIS area showing relationship of Slide fire to project (Mary Lata, Slide Fire Ecology Report, 2014)

Table 129. Acres by Treatment and RAVG Class (Alt C) (Mark Nigrelli)

Proposed Treatments	Acres	Acres %	# of Stands	Outside Fire Perimeter	Basal Area Mortality (acres)						
					0%	1-10%	11-25%	26-50%	51-75%	76-90%	>91%
GL - Restoration	13	0.2%	1	0	10	2	0	0	0	0	0
IT10	28	0.4%	1	0	17	9	2	0	0	0	0
IT40	820	10.4%	8	0	239	258	104	88	54	25	50
MSO Restricted Trt	3,793	48.2%	58	1	802	1,141	601	483	305	129	332
MSO Target Trt	318	4.0%	10	0	69	86	41	40	30	13	39
MSO Threshold Trt	32	0.4%	1	0	6	7	3	3	4	4	4
No Proposed Treatments	7	0.1%	1	0	0	0	1	4	1	0	0
PFA - IT40	34	0.4%	1	0	20	11	2	1	0	0	0
PFA - UEA40	11	0.1%	1	0	2	5	3	1	0	0	0
Prescribed Fire Only	1,185	15.1%	38	0	138	270	182	182	124	52	236
Prescribed Fire Only - Operational	108	1.4%	8	2	63	27	12	3	1	0	1
Savanna	131	1.7%	7	0	45	61	14	8	2	1	0
UEA10	395	5.0%	6	0	101	156	68	49	16	3	2
UEA25	5	0.1%	2	0	3	1	0	0	0	0	0
UEA40	992	12.6%	9	0	372	401	141	63	12	2	0
Grand Total	7,870	100.0%	152	4	1,889	2,434	1,174	925	549	230	664
				0.1%	24.0%	30.9%	14.9%	11.8%	7.0%	2.9%	8.4%

Field observations were conducted June 25-6, 2014 to evaluate the extent of the damage within the project boundary and to field verify the RVAG map (Rapid assessment of Vegetation condition After Wildfire: <http://www.fs.fed.us/postfirevegcondition/whatis.shtml>) produced by RSAC (Remote Sensing Applications Center: <http://www.fs.fed.us/eng/rsac/>). RAVG produces a map of overstory vegetation affected by fire separated into seven classes of basal area loss (Table 130):

Table 130. RAVG Class of Basal Area Loss by Fire Severity

RAVG Class	% Basal Area Loss	Fire Severity
Class 0	outside fire perimeter	Unchanged
Class 1	0% basal area (BA) loss	LOW
Class 2	0% < 10% BA loss	LOW
Class 3	10% < 25% BA loss	LOW
Class 4	25% < 50% BA loss	Moderate
Class 5	50% < 75% BA loss	Moderate
Class 6	75% < 90% BA loss	High
Class 7	90% or greater BA loss	High

Field verification of the RAVG across the Slide fire demonstrated a close (anecdotal) correlation to basal area loss and overstory damage. The eastern half of the project area experience the greatest reductions in basal area where the fire burned more intensely in the valleys, drainages, ephemeral depressions, and less intense on the gradual slopes above these topographical features. RAVG data/maps are a qualitative product and make no assumptions as to the exact amount of basal area pre- or post-fire. No quantitative post-fire inventory field data was collected (Figure 24).

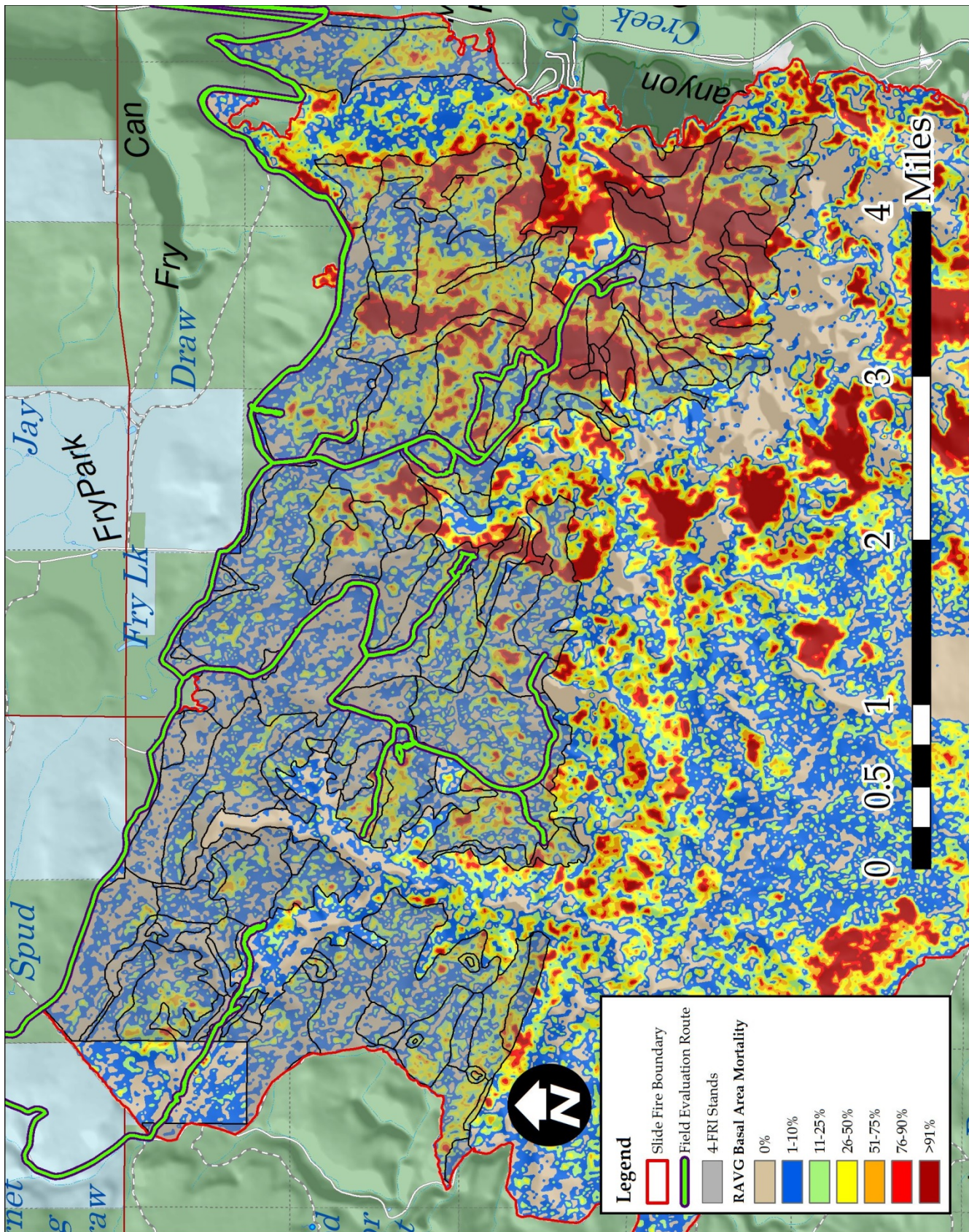


Figure 21. RVAG Map with Evaluation Route (Mark Nigrelli)

Damage Relationship to RAVG 7-Class Basal Area Loss

RAVG 0% and 10%

These two classes showed no burn activity (0%) to a low intensity underburn (1-10%) with no significant tree mortality expressed or expected.¹⁶ Scorch heights seldom exceeded 4 feet and base canopy heights were unaffected. Surface CWD and duff were partially consumed and grass had crowns scorched or consumed but a strong recovery is expected. A very strong response was already observed where western brackenfern (*Pteridium aquilinum*) was present (Figure 25). The fire effects are considered beneficial. Canopy closure and habitat composition remained essentially unchanged.



Figure 22. Low Fire Intensity Burn with Fern Response

RAVG 11-25%

This class showed variation in overstory response to the fire. On the low end there was little canopy scorch and the overstory would be expected to remain intact and fire is beneficial. Base canopy heights were raised in instances and canopy bulk densities were lowered; all reducing future potential for active crown fires. Where lower canopy scorch was observed it appears that significant green terminal buds and live upper canopy were present; and in the absence of a reburn, insects, or short monsoon season it is anticipated significant tree survival will occur. However, in this type of fire it can be expected that insect mortality will continue for the next 3 years (Breece et al., 2008) (McHugh et al. 2003). In the upper end of this zone canopy scorch in excess of 80% was observed and the majority of the overstory trees would not be expected to survive (Fowler and Sieg 2004). In this class canopy needle retention was evident and needle cast was observed on the soil. Needle retention is a major factor in lessening soil erosion by intercepting rain. The majority of the grass, forbs, and shrub components were consumed (Figure 26). There was, however, a strong sprout response from Gambel oak (*Quercus gambelli*) and New Mexican locust (*Robinia neomexicana*). Strong regrowth can be expected from the grasses (mostly *Festuca arizonica*) once monsoonal rains begin.

¹⁶ While no ponderosa pine mortality was observed there can be anticipated up to 7% mortality post-fire because of insect activity.



Figure 23. RAVG 11-25% Class with moderate severity burn (Photo by Mary Lata)

RAVG 26-50% and 51-75%

While this class shows variations in response to the fire, the entire class showed extensive canopy scorch. There was no consistent characterization of this class in terms of basal area loss. This class is a transition class from the low severity stands into the high severity stands and it displays, throughout the class, characteristics of both low and high severity vegetation response. Silviculturally, fire in this class is not considered a beneficial disturbance (Figure 27). Over 56% of the acres in this class occurred within MSO habitat. Soils in this class display hydrophobic characteristics (Slide BAER, 2014). Grass, forbs, shrubs, and trees were all consumed or mostly killed or consumed in this class. The distribution of seed source trees is non-uniform, but not totally lacking (see reforestation needs in silviculture effects). It will be a couple of years until total tree survival and distribution can be effectively evaluated and bark beetle activity subsides. Areas in this category are candidates for BAER Emergency Stabilization by Helimulch and seeding to aid in recover. Overstory recovery will be a long-term process and it will be several years before surviving overstory trees have a significant impact on regeneration and planting should be a consideration. Regeneration will not be of seed-producing age until 15-20 years; however, seeds from ponderosa pine trees aged 60 to 160 produce the most viable seeds although trees 7 years and older are potentially capable of seed production (Burns and Honkala 1990).

Slide BAER draft report states that repeated onsite tests indicated both moderate and high soil burn severity classes have hydrophobic soil tendencies that could have high hydrologic response. Soil burn severities with strong hydrophobic conditions that are connected to critical values at risk were recommended for emergency stabilization treatments (Slide BAER Report, 2014). This hydrophobic response pose risks to soil productivity from accelerated erosion above soil loss thresholds. Soil productivity is critical for forest vegetation structure, wildlife habitat including PAC's, and maintaining the ability to infiltrate water and filter sediments to protect water quality downstream. Reforestation should be conducted on 1,477 acres within these classes.



Figure 24: RAVG 26-50% (BAER, 2014)

RAVG 76-90% and >91%

From the ground observations of the 76+% RAVG and above it appears that most of the canopy is either scorched beyond reasonable recover or totally removed (RVAG 76% and above) and only bare soil remains (Figure 28). High intensity fires are more likely to damage overstory trees, which makes them more susceptible to bark beetle attack (Wallin and others 2003). This intensity of fire moves all Alternative and treatments away from desired conditions. Reforestation should be conducted on 894 acres within these RVAG classes.



Figure 25: RAVG >51% High severity fire effects (Mary Lata)

Alternative A

Under Alternative A no 4FRI treatments would be completed. Because the Slide fire occurred pre-4FRI treatments the fire burned under Alternative A conditions. The areas of moderate to high burn severity moved away from desired conditions. It is expected that insect related mortality will continue for the next three years; with most of the insect activity occurring in year one post-fire (Breece, 2008). Standing dead ponderosa pine can be expected to start falling down within 5 to 10 years adding to the dead and down fuel loadings. Ponderosa pine regeneration can be expected in areas of light burn in higher numbers than other RAVG class. Moderate and high severity areas can experience loss of soil productivity and excessive erosion which can further delay establishment of native vegetation. Areas of moderate to high burn severity will not develop functional forest conditions for decades within these conditions.

Alternatives B-E

Table 134 shows all proposed 4FRI alternatives as they relate to each other. The Slide fire has altered the opportunities to execute treatments at this time across all proposed treatments and proposed alternatives. Mechanical plus burn Alternative B-E has all been affected equally. Grassland Restoration (GL) and Savanna has affected Alternatives B-D. Grassland Mechanical has affected Alternatives C and E. And all proposed Prescribed Fire scenarios across B-D have been affected.

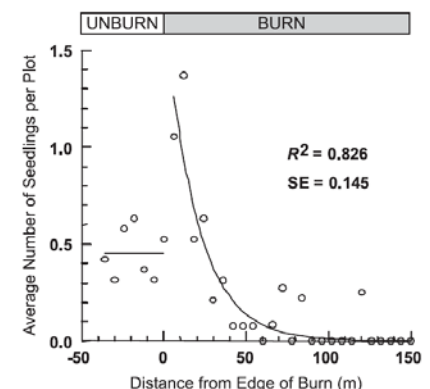
Table 131 Proposed Treatments Affected By Slide by Basal Area Mortality

Proposed Treatments	Treatment Comparison	Acres	# of Stands	Outside Fire Perimeter	Basal Area Mortality						
					0%	1-10%	11-25%	26-50%	51-75%	76-90%	>91%
GL - Restoration	B=C=D	13	1	0	10	2	0	0	0	0	0
Grassland Mechanical	C=E	108	8	2	63	27	12	3	1	0	1
IT10	B=C=D=E	28	1	0	17	9	2	0	0	0	0
IT40	B=C=D=E	820	8	0	239	258	104	88	54	25	50
MSO Restricted Trt	B=C=D=E	3,793	58	1	802	1,141	601	483	305	129	332
MSO Target Trt	B=C=D=E	318	10	0	69	86	41	40	30	13	39
MSO Threshold Trt	B=C=D=E	32	1	0	6	7	3	3	4	4	4
PFA - IT40	B=C=D=E	34	1	0	20	11	2	1	0	0	0
PFA - UEA40	B=C=D=E	11	1	0	2	5	3	1	0	0	0
Prescribed Fire Only	B=C	1,185	38	0	138	270	182	182	124	52	236
Prescribed Fire Only	D	173	4	0	40	57	30	28	14	3	1
Prescribed Fire Only	E	1,211	40	1	156	277	183	182	124	52	236
Prescribed Fire Only - Core Area	C	7	1	0	0	0	1	4	1	0	0
Prescribed Fire Only - Operational	B=D	108	8	2	63	27	12	3	1	0	1
Savanna	B=C=D	131	7	0	45	61	14	8	2	1	0
UEA10	B=C=D=E	395	6	0	101	156	68	49	16	3	2
UEA25	B=C=D=E	5	2	0	3	1	0	0	0	0	0
UEA40	B=C=D=E	992	9	0	372	401	141	63	12	2	0

Silvicultural Consequences of Slide Fire

While the understory structure has already begun its recover, the structure, composition, and function of the analysis areas that burned at moderate or high RVAG have been altered to the extent that it will take many years to begin a recover of the overstory components. In high-severity areas it is possible that the burned areas will have some live edges and some of the area is within the effective seeding distance of ponderosa pine (Lentile, 2005). In areas larger than the effective seeding distance of ponderosa pine tree regeneration will be rare, and it is likely that persistent shrub and grasslands may develop (Lentile, 2005). No tree seedlings can be expected in high-severity areas >30 m from a patch edge (Lentile, 2005). The distribution of anticipated ponderosa pine seedlings throughout

unburned and burned areas can be explained, not only by the location of seed sources, but also by the distribution of macro- and micro-environmental conditions within the burn perimeter and the strong correlation to the edge of burned/unburned areas (Bonnet et al. 2005) (Figure 29).



It is anticipated that BAER emergency stabilization operations will Helimulch and seed portions of the project area. In areas of no-burn or low burn severity understory and overstory vegetation is expected to make rapid recovery and surface fuels will continue to accumulate. There will be potential beetle populations infesting no burn/low severity areas from surrounding moderate and high severity areas as well as from the Red Rock Secret Mountain Wilderness to the south which will put stressed trees at risk (anticipated mortality is <2%). Areas that burned with moderate and high severity will have most of the overstory at risk of mortality (immediate and near term) with beetle activity putting survivor ponderosa pine at risk (estimated mortality as high as 13%). Dead trees will begin to fall within 2-3 years with <20% of the snags remaining standing after 7 years (Chambers and Mast 2014) and contributing significantly to dead down and CWD.

Because of the now altered structure and composition, and the unknown near-term mortality, all treatments within the burned area would be deferred for a minimum of five years. This would provide an opportunity for recovery of affected soils and vegetation prior to implementing any actions that may cause additional disturbance. The proposed treatments would not change; however, prior to implementation, appropriate resource specialists would evaluate the area to ensure that treatments are still appropriate and would meet resource objectives.

Reforestation Needs

The Slide Fire burned with light to no burn intensity damage up to High with varying basal area losses from zero up, and exceeding 91%. The acreage of the project within the Slide Fire was part of the Suitable timber category of the Coconino NF. The acreage burned in excess of 25% basal area loss represented by RAVG class 4 should be planted to reestablish ponderosa pine. Replanting should be conducted on 2,368 acres that represent RAVG Class 4 and higher. Priority for planting should be 1) the 664 acres of class 7, 2) 549 acres of class 6, 3) 230 acres of class 5, and 4) 925 acres of class 4.

REFERENCES

- Bonnet, V.H., A.W. Schoettle, and W.D. Shepperd. 2005. Postfire environmental conditions influence the spatial pattern of regeneration for *Pinus ponderosa*. *Can. J. For. Res.* 35: 37-47.
- Breece, C.R., Kolb, T.E.; Dickson, B.G.; McMillin, J.D.; Clancy, K.M., 2008, Prescribed fire effects on bark beetle activity and tree mortality in southwestern ponderosa pine forest. *Forest Ecology and Management*. 255: 119-128.
- Burns, Russell M., and Barbara H. Honkala, tech. coords. 1990. *Silvics of North America: 1. Conifers; 2. Hardwoods*. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC. vol.2, 877 p.
- Chambers, C.L., J.N. Mast. 2014. Snag Dynamics and Cavity Excavation after Bark Beetle Outbreaks in Southwestern Ponderosa Pine Forests. *Forest Science*. Society of American Foresters. 60(4): 713-723.
- Fowler, James F.; Sieg, Carolyn Hull. 2004. Postfire mortality of ponderosa pine and Douglas-fir: a review of methods to predict tree death. Gen. Tech. Rep. RMRS-GTR-132. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 25 p.
- Lentile, L.B., F. W. Smith, and W.D. Shepperd. 2005. Patch structure, fire-scar formation, and tree regeneration in a large mixed-severity fire in the South Dakota Black Hills, USA. *Can. J. For. Res.* 35:2875-2885
- McHugh, C.W.; Kolb, T.E.; Wilson, J.L. 2003. Bark beetle Attacks on Ponderosa Pine Following Fire in Northern Arizona. *Environmental Entomology*: 32(3): 510-522.
- Slide Fire BAER Team Report. Draft Slide Fire Burned Area Emergency Response Report, Coconino National Forest. June 2014. 211 p.
- Wallin, K.F.; Kolb, T.E.; Skov, K.R.; Wagner, M.R. 2003. Effects of crown scorch on ponderosa pine resistance to bark beetles in northern Arizona. *Environmental Entomology*. 32: 652-661.

Appendix I – MSO Consistency Evaluation

2012 MSO Recovery Plan to 1995 MSO Recovery Plan To 4FRI

MSO Consistency Evaluation

During the process of analyzing the effects of the proposed Four Forest Restoration Initiative (4FRI) that included determining project extent, data collection, data gap analysis, data analysis, FVS analysis, GIS temporal and spatial file development, development of individual specialists reports, and completion of the DEIS – the 1995 MSO Recovery Plan was the official guidance for developing management actions in MSO habitat. The first revision went into effect in 2012, shortly after the release of the DEIS. Further complicating the 4FRI analysis, the Kaibab NF revised its new forest plan (2014) that incorporated the new MSO guidelines (2012). The Kaibab NF Forest Plan is consistent with the 2012 MSO Recovery Plan (KNF page 128).

The 4FRI Project desires consistency between the project, the 1995 MSO Recovery Plan, the 2012 MSO Recovery Plan, the Kaibab NF Forest Plan, and the Coconino NF Forest Plan (Table 135).

SUMMARY

The Coconino NF Forest Plan is consistent with the 1995 MSO Recovery Plan and the Kaibab NF Forest Plan is consistent with the 2012 MSO Recovery Plan. The Four Forest Restoration Initiative (4FRI) is consistent with both the 1995 MSO Recovery Plan and the 2012 MSO Recovery Plan (as verified by completing consultation with the FWS) as well as with the Coconino and Kaibab NF's Forest Plans.

Table 132. Crosswalk 2012 to 1995 MSO Recovery Plan to 4FRI

2012 Mexican Spotted Owl Recovery Plan	1995 Revised Mexican Spotted Owl Recovery Plan	4FRI FEIS Desired Conditions
<i>Desired Conditions</i>		<i>Consistency</i>
Table C.2. (Below) Generalized description of key habitat variables comprising Desired Conditions in forest, riparian, canyon, and woodland cover types typically used by Mexican spotted owls for nesting and roosting. Desired conditions should guide management within PACs and recovery nest/roost habitats. 1. Strive for a diversity of patch sizes with minimum contiguous patch size of 1 ha (2.5 ac) with larger patches near activity center; mix of sizes towards periphery (Peery et al 1999; Grubb et al 1997; May and Gutiérrez 2002). Forest type may dictate patch size (i.e., mixed conifer forests have larger and fewer patches than pine-oak forest). Strive for between patch heterogeneity.	1. Incorporate natural variation, such as irregular tree spacing and various stand/patch sizes, into management prescriptions and attempt to mimic natural disturbance patterns (page 94).	1. Alternative B-E PAC: Management would attempt to mimic natural disturbance patterns by incorporating natural variation, such as irregular tree spacing and various patch sizes. Allow natural canopy gap processes to occur, thus producing horizontal variation in stand structure. Emphasize uneven-aged management systems. (Silviculture Report page 236) Threshold Habitat: Desired Conditions: Irregular tree spacing and various patch size. Horizontal variation in stand structure. Other key habitat components includes snags 18 inches plus, down logs >12-inch midpoint diameter, and hardwoods. (Silviculture Report page 235) Target Habitat: Desired Conditions: Irregular tree spacing and various patch size. Horizontal variation in stand structure. Other key habitat components include snags 18 inches plus, down logs greater than 12 inches midpoint diameter, and hardwoods. (Silviculture Report

2. Horizontal and vertical habitat heterogeneity within patches, including tree species composition. Patches are contiguous and consist of trees of all sizes, unevenly spaced, with interlocking crowns and high canopy cover (Ganey et al. 2003). 3. Tree species diversity, especially with a mixture of hardwoods and shade-tolerant species (Willey 1998). For example, Gambel oak provides important habitat for woodrats and brush mice (Block et al. 2005, Ward 2001) Diverse composition of vigorous native herbaceous and shrub species (Ward 2001).	2. Maintain all species of native vegetation in the landscape, including early seral species. Allow natural canopy gap processes to occur, thus producing horizontal variation in stand structure (page 94). Although our knowledge of spotted owl habitat is incomplete, nesting/roosting stands exhibit certain identifiable features, including high tree basal area, large trees, multi-storied canopy, high canopy cover, and decadence in the form of downed logs and snags (Ganey and Dick 1995) (page 91). 3. Maintain all species of native vegetation in the landscape, including early seral species. To allow for variation in existing stand structures and provide species diversity, both uneven-aged and even-aged systems may be used as appropriate. Within pine-oak types, emphasis should be placed on management that retains existing large oaks and promotes the growth of additional large oaks (page 94).	page 237) Restricted Other: Desired Conditions: Uneven-aged (3-plus size classes). Irregular tree spacing and various patch size. Horizontal variation in stand structure. Other key habitat components includes snags 18 inches plus, down logs >12-inch midpoint diameter, and hardwoods. (Silviculture Report page 238) 2. Retain key forest species such as oak; retain key habitat components such as snags and large down logs (Silviculture Report page 233e). Gambel oak, juniper, and pinyon species will not be cut as part of the treatments (DEIS page 611). Aspen treatments will occur in PACs to rejuvenate clones/clone health. Thinning will be done to reduce competition between large/old trees and small/medium-sized trees. 3. The purpose of the project is to reestablish and restore forest structure and pattern, forest health, and vegetation composition and diversity (FEIS Chapter 3 page ii).

528

7. Diversity of tree sizes with goal of having trees $\geq 16''$ DBH contributing $\geq 50\%$ of the stand BA (Willey 1998, May and Gutiérrez 2002, Ganey et al. 2003, May et al. 2004)	fuel levels, canopy cover, snag basal area, volume of large logs (>30 cm [12 inch] midpoint diameter), and live tree basal area. We assume that if the basal area and tree density levels given in Table III.B. 1 exist, adequate amounts of snags and downed logs (and other habitat elements) should be present (page 91). 7. Table III.B.1 (page 92) sets minimum percent stand density of trees greater than 12 DBH in Pine-oak forests at 45%+ of stand density of trees (page 92)	upper end of natural range of variability for ponderosa pine in the non-WUI stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes, and/or retaining additional large trees. 7. 2012 MSO Recovery Plan dictates that $>30\%$ of basal area are $>18''$ d.b.h.(KFP) The 1995 MSO Recovery Plan dictates that $>30\%$ of trees density is $> 18''$ d.b.h. (CFP)

Recommended Management Actions in Core Areas, PACs, and Recovery Habitats		
Table C.1. Summary of recommended management actions in Core Areas, PACs, and Recovery Habitats. Core 1. All activities within the core area should undergo consultation with the appropriate FWS office.	1. Site identification should be based on the best judgment of a biologist familiar with the area. Section 7 requires action agencies to assess the effects of proposed actions on listed species and their critical habitat. If, as a result of that assessment, the agency determines that an action may affect a listed species or its critical habitat, the agency must enter into	1. Consultation with the USFWS on endangered species is a requirement and was initiated on January 21, 2011 (FEIS page 10, Chapter 4).

2. All management activities should be deferred from the core during the breeding season (March 1 through August 31), except when non-breeding is confirmed or inferred that year per the accepted survey protocol. 3. Planned or unplanned fires should be allowed to enter core areas only if they are expected to burn at low intensity with low severity effects. Protected Activity Center (PAC) 4. All activities within the PAC should undergo consultation with the appropriate FWS office. 5. Conduct restoration/fuels treatments in up	consultation with the FWS (page 125) 7 2. Treatments can occur only during the nonbreeding season (1 September-28 February) no minimize any potential deleterious effects on the owl during the breeding season (page 88). 3. Light burning of ground fuels may be allowed within the 500 acres surrounding the 100-acre PAC centers, following careful review by biologists and fuels management specialists on a case-specific basis. Fires within PACs are not necessarily bad. In any cases, patchy fires will result in habitat heterogeneity and may benefit the owl and its prey (page 88) 4. Site identification should be based on the best judgment of a biologist familiar with the area. Section 7 requires action agencies to assess the effects of proposed actions on listed species and their critical habitat. If, as a result of that assessment, the agency determines that an action may affect a listed species or its critical habitat, the agency must enter into consultation with the FWS (page 125) 5. Implement a program consisting of	2. Design features would include timing restrictions so that habitat in and around PACs would not receive mechanical or prescribed fire treatments during the breeding season (March 1 to August 31) (DEIS page 184). 3. The project proposes (Alternative C) low-severity prescribed fire within 70 MSO PACs, including 54 core areas, as developed in coordination with the USFWS (DEIS page 14). 4. Consultation with the USFWS on endangered species is a requirement (FEIS page 10, Chapter 4) and will be completed before the signing of the Record of Decision.. 5. The implementation plan is designed to

to 20% of the total non-core PAC area within each EMU that exhibits high fire-risk conditions, following the guidelines in section Appendix C.	appropriate treatments to abate fire risk. The intent of this program is to assess the combined effects of thinning and fire on spotted owls and their habitat. The program should be structured as follows: a) Select up to 10% of the PACs within each RU that exhibit high fire risk conditions. Nest sites must be known within these PACs. Ideally, a paired sample of PACs should be selected to serve as control areas. b) Within each selected PAC, designate 40 ha (100 acres) centered around the nest site. This nest area should include habitat that resembles the structural and floristic characteristics of the nest site. These 40 ha (100 acres) will be deferred from the treatments described below. c) Within the remaining 203 ha (500 acres), combinations of thinning trees <22.4 cm (9 inches) d.b.h, treatment of fuels, and prescribed fire can be used to reduce fire hazard and to improve habitat conditions for owl prey. Habitat components that should be retained or enhanced include large logs (>30 cm [12 inches] midpoint diameter), grasses and forbs, and shrubs. These habitat components are strong correlates of the presence of many key prey species of the owl. Emphasis of the spatial configuration of treatments should be to mimic natural mosaic patterns (pages 86-87).	be consistent with the Revised Recovery Plan. The 4FRI is contained within the UGM EMU's. The Forest Service manages 8,699,145 acres in the UGM EMU. Total non-core PAC area within 4FRI is 29,495 acres (See Wildlife Specialist Report).
6. No mechanical or prescribed fire	6. Treatments can occur only during the	6. Limit human activity in or near nest

treatments, or road or trail maintenance should occur within PACs during the breeding season unless it has been determined that the PAC is unoccupied or the owls are not nesting that year as inferred from results of surveys conducted according to protocol. 7. 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. 8. New road or trail construction is not	nonbreeding season (1 September-28 February) to minimize any potential deleterious effects on the owl during the breeding season (page 88). 7. Within pine-oak types, emphasis should be placed on management than retains existing large oaks and promotes the growth of additional large oaks. Retain hardwoods, large down logs, large trees, and snags. Potential forms of fuelwood management include road closures, prohibiting harvest of important tree species such as oaks, prohibiting harvest of key habitat components such as snags and large downed logs (>30 cm [12 inch] midpoint diameter), and encouraging the harvest of small diameter conifers in accord with 5c below. (5c) states: Habitat components that should be retained or enhanced include large logs (>30 cm [12 inches] midpoint diameter), grasses and forbs, and shrubs (page 86). 8. Road or trail building in PACs should	sites and Post-Fledgling Family Areas (PFAs) during the breeding season (March 1 through September 30) (Silviculture Report page 13). Burning in MSO PACs is difficult as there is a need to address the high fuel loadings while maintaining many of the habitat elements that contribute to fuel loading. Burning has to be conducted in a very short timeframe to avoid the breeding season (i.e., the nonbreeding season – September 1 to February 28). (Silviculture Report page 179). 7. Retain substantive amounts of key habitat components: snags 18 inches in diameter and larger, down logs over 12 inches midpoint diameter, hardwoods for retention, recruitment, and replacement of large hardwoods (Silviculture Report page 9). Large woody debris, snags, clumps of broadleaf wood vegetation should be retained and hardwood trees larger than 10 inches at the root collar (Silviculture Report page 12, 73, 234, 235, 237, 241, 244). 8. About 6.7 miles of temporary road are

recommended in PACs 9. Monitor treatment effects as described in Appendix C. See Table C.2 for desired conditions for PACs. Recovery Nest/Roost Habitat: Forested stands identified as meeting or exceeding owl nest/roost conditions. 10. Manage for nest/roost replacement habitat.	generally be avoided but may be allowed on a case-specific basis if pressing management reasons can be demonstrated (page 86) 9. Silvicultural applications must be evaluated over time by rigorous monitoring procedures to assess their effectiveness in managing or creating owl habitat (page 84). 10. Manage mixed-conifer and pine-oak forest types to provide continuous replacement nest habitat over space and time. Treatment of a particular stand depends on its capability no attain the desired stand conditions. Treatment of a particular stand depends on its capability no attain the desired stand conditions. (page 94).	proposed in PACs. Temporary roads in PACs are expected to function for 2-3 years and would then be decommissioned. An additional 43 miles of open road would be decommissioned in PACs as part of the 4FRI project, representing about 29% of current road miles in PACs. This includes about 5 of 7.6 total road miles (67%) in core areas. 9. A monitoring plan has been developed. The plan development is deferred to the project's USFWS Biological Opinion (Silviculture Report page 174). 10. An intensive and extensive modeling effort took place in 2011, involving FS and FWS biologists, to identify the best nesting and roosting habitat. Habitat queries used a range of forest metrics. The results were evaluated in terms of patch size, location, other land uses, proximity to known owls, and movement potential. Quality control included data reviews and field verification (see Methodology in wildlife report). Manage to ensure a sustained level of owl nest/roost habitat

11. Emphasize attainment of nest/roost conditions as quickly as reasonably possible. 12. Emphasize attainment of nest/roost conditions as quickly as reasonably possible. 13. Retain large trees. Strive for spatial heterogeneity.	11. Within pine-oak types, emphasis should be placed on management that retains existing large oaks and promotes the growth of additional large oaks. Retain all trees >61 cm [24 in] d.b.h. Retain hardwoods, large down logs, large trees, and snags. 12. SEE # 11 13. SEE # 11	well distributed across the landscape (DEIS page 612). Manage to ensure a sustained level of owl nest/roost habitat well distributed across the landscape (Silviculture Report page 211). 11. Management should emphasize attainment of nest/roost conditions as quickly as reasonably possible (USDI 2012) (Silviculture Report page 212). 12. SEE #11; Modeling indicates increases in trees 18 to 23.9” d.b.h, trees >24” d.b.h, and TPA >18” d.b.h post-treatment. 13. Per CFLRA requirements, treatments in alternatives B-E are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting desired conditions of increasing VSS 5 and 6 age classes (18.0” d.b.h. +) as soon as possible. In alternatives C and E, treatments would also follow the guidance in section D, the large tree implementation plan (Silviculture Report page 216). Modeling indicates increases in trees 18 to 23.9” d.b.h,

14. Manage for species diversity. Retain key owl habitat elements (large trees, snags, large logs, hardwoods, etc.). 15. Emphasize large hardwoods, where Appropriate	14. SEE # 11 15. SEE # 11	trees >24" d.b.h, and TPA >18" d.b.h. post-treatment. 14. SEE # 13 15. SEE # 13; aspen treatments are included in MSO habitat and Gambel oak would not be targeted for removal. Conduct thinning to promote large Gambel oak.
2012 Mexican Spotted Owl Recovery Plan	1995 Revised Mexican Spotted Owl Recovery Plan	4FRI FEIS Desired Conditions
Desired Conditions		Consistency
Table C.2. (Below) Generalized description of key habitat variables comprising Desired Conditions in forest, riparian, canyon, and woodland cover types typically used by Mexican spotted owls for nesting and roosting. Desired conditions should guide management within PACs and recovery nest/roost habitats. 1. Strive for a diversity of patch sizes with minimum contiguous patch size of 1 ha (2.5 ac) with larger patches near activity center; mix of sizes towards periphery (Peery et al 1999; Grubb et al 1997; May and Gutiérrez 2002). Forest type may dictate patch size (i.e., mixed conifer forests have larger and fewer patches than pine-oak forest). Strive for between patch heterogeneity.	1. Incorporate natural variation, such as irregular tree spacing and various stand/patch sizes, into management prescriptions and attempt no mimic natural disturbance patterns (page 94).	1. Alternative B-E PAC: Management would attempt to mimic natural disturbance patterns by incorporating natural variation, such as irregular tree spacing and various patch sizes. Allow natural canopy gap processes to occur, thus producing horizontal variation in stand structure. Emphasize uneven-aged management systems. (Silviculture Report page 236) Threshold Habitat: Desired Conditions: Irregular tree spacing and various patch size. Horizontal variation in stand structure. Other key habitat components includes snags 18 inches plus, down logs >12-inch midpoint diameter, and hardwoods. (Silviculture Report

2. Horizontal and vertical habitat heterogeneity within patches, including tree species composition. Patches are contiguous and consist of trees of all sizes, unevenly spaced, with interlocking crowns and high canopy cover (Ganey et al. 2003). 3. Tree species diversity, especially with a mixture of hardwoods and shade-tolerant species	2. Maintain all species of native vegetation in the landscape, including early seral species. Allow natural canopy gap processes to occur, thus producing horizontal variation in stand structure (page 94). Although our knowledge of spotted owl habitat is incomplete, nesting/roosting stands exhibit certain identifiable features, including high tree basal area, large trees, multi-storied canopy, high canopy cover, and decadence in the form of downed logs and snags (Ganey and Dick 1995) (page 91). 3. Maintain all species of native vegetation in the landscape, including early seral	page 235) Target Habitat: Desired Conditions: Irregular tree spacing and various patch size. Horizontal variation in stand structure. Other key habitat components include snags 18 inches plus, down logs greater than 12 inches midpoint diameter, and hardwoods. (Silviculture Report page 237) Restricted Other: Desired Conditions: Uneven-aged (3-plus size classes). Irregular tree spacing and various patch size. Horizontal variation in stand structure. Other key habitat components includes snags 18 inches plus, down logs >12-inch midpoint diameter, and hardwoods. (Silviculture Report page 238) 2. Retain key forest species such as oak; retain key habitat components such as snags and large down logs (Silviculture Report page 233e). Gambel oak, juniper, and pinyon species will not be cut as part of the treatments (DEIS page 611). Aspen treatments will occur in PACs to rejuvenate clones/clone health. Thinning will be done to reduce competition between large/old trees and small/medium-sized trees. 3. The purpose of the project is to reestablish and restore forest structure and pattern, forest

(Willey 1998). For example, Gambel oak provides important habitat for woodrats and brush mice (Block et al. 2005, Ward 2001) Diverse composition of vigorous native herbaceous and shrub species (Ward 2001).	species. To allow for variation in existing stand structures and provide species diversity, both uneven-aged and even-aged systems may be used as appropriate. Within pine-oak types, emphasis should be placed on management that retains existing large oaks and promotes the growth of additional large oaks (page 94).	health, and vegetation composition and diversity (FEIS Chapter 3 page ii).
4. Diverse composition of vigorous native herbaceous and shrub species (Ward 2001).*	4. Habitat components that should be retained or enhanced include large logs (>30 cm [12 inches] midpoint diameter), grasses and forbs, and shrubs (page 88). Ultimately, monitoring should detect any change in the relative composition of herbaceous and woody plants. The intent is no maintain good to excellent range conditions in key areas while accommodating the needs of the owl and its prey (page 96).	4. The desired condition is to move even- aged stands to an uneven-aged structure and move all stands towards the forest plan's VSS percent distribution. There is a need to increase grass/forb/shrub, seedling/sapling, and mature and old forest components.
5. Opening sizes between 0.04 - 1 ha (0.1 - 2.5 ac). Openings within a forest are different than natural meadows. Small canopy gaps within forested patches provide for prey habitat diversity. Openings should be small in nest/roost patches, may be larger in rest of PAC.	5. Uneven-aged management would likely be used over large areas and does not create small stands, but rather it creates groups or clumps. Mosaic patterns resulting from timber management prescriptions such as single-tree or group selection cuts may in some ways mimic natural disturbance patterns and create canopy gaps (page 41).	5. Patches are contiguous and consist of trees of all sizes, unevenly spaced, with interlocking crowns and high canopy cover; tree species diversity, especially with a mixture of hardwoods and shade-tolerant species; diverse composition of vigorous native herbaceous and shrub species; opening sizes between 0.04 - 1 ha (0.1 - 2.5 ac) (Silviculture Report page 241).

6. Minimum canopy cover of 40% in pine-oak and 60% in mixed conifer (Ganey et al. 2003). Measure canopy cover within stands.	6. Within PACS treated no reduce fire risk, either by the use of prescribed fire alone or in conjunction with mechanical removal of stems and ground fuels, pre- and post-treatment assessments (i.e., monitoring) of habitat conditions and owl occupancy must be done. Specific habitat characteristics that should be monitored include fuel levels, canopy cover, snag basal area, volume of large logs (>30 cm [12 inch] midpoint diameter), and live tree basal area. We assume that if the basal area and tree density levels given in Table III.B. 1 exist, adequate amounts of snags and downed logs (and other habitat elements) should be present (page 91).	6. Non-WUI stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean BA greater than 70 and a mean TPA less than 100) would be managed for greater residual canopy cover and density of large trees. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-WUI stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the identified intensity range, managing for larger group sizes, and/or retaining additional large trees.
7. Diversity of tree sizes with goal of having trees $\geq 16''$ DBH contributing $\geq 50\%$ of the stand BA (Willey 1998, May and Gutiérrez 2002, Ganey et al. 2003, May et al. 2004)	7. Table III.B.1 (page 92) sets minimum percent stand density of trees greater than 12 DBH in Pine-oak forests at 45%+ of stand density of trees (page 92)	7. 2012 MSO Recovery Plan dictates that >30% of basal area are >18" d.b.h.(KFP) The 1995 MSO Recovery Plan dictates that >30% of trees density is > 18" d.b.h. (CFP)

Recommended Management Actions in Core Areas, PACs, and Recovery Habitats

Table C.1. Summary of recommended management actions in Core Areas, PACs, and Recovery Habitats.

Core

1. All activities within the core area should

1. Site identification should be based on the

1. Consultation with the USFWS on

undergo consultation with the appropriate FWS office. 2. All management activities should be deferred from the core during the breeding season (March 1 through August 31), except when non-breeding is confirmed or inferred that year per the accepted survey protocol. 3. Planned or unplanned fires should be allowed to enter core areas only if they are expected to burn at low intensity with low severity effects. Protected Activity Center (PAC) 4. All activities within the PAC should undergo consultation with the appropriate FWS office.	best judgment of a biologist familiar with the area. Section 7 requires action agencies to assess the effects of proposed actions on listed species and their critical habitat. If, as a result of that assessment, the agency determines that an action may affect a listed species or its critical habitat, the agency must enter into consultation with the FWS (page 125) 7 2. Treatments can occur only during the nonbreeding season (1 September-28 February) no minimize any potential deleterious effects on the owl during the breeding season (page 88). 3. Light burning of ground fuels may be allowed within the 500 acres surrounding the 100-acre PAC centers, following careful review by biologists and fuels management specialists on a case-specific basis. Fires within PACs are not necessarily bad. In any cases, patchy fires will result in habitat heterogeneity and may benefit the owl and its prey (page 88) 4. Site identification should be based on the best judgment of a biologist familiar with the area. Section 7 requires action agencies to assess the effects of proposed	endangered species is a requirement and was initiated on January 21, 2011 (FEIS page 10, Chapter 4). 2. Design features would include timing restrictions so that habitat in and around PACs would not receive mechanical or prescribed fire treatments during the breeding season (March 1 to August 31) (DEIS page 184). 3. The project proposes (Alternative C) low-severity prescribed fire within 70 MSO PACs, including 54 core areas, as developed in coordination with the USFWS (DEIS page 14). 4. Consultation with the USFWS on endangered species is a requirement (FEIS page 10, Chapter 4) and will be completed before the signing of the

5. Conduct restoration/fuels treatments in up to 20% of the total non-core PAC area within each EMU that exhibits high fire-risk conditions, following the guidelines in section Appendix C.	actions on listed species and their critical habitat. If, as a result of that assessment, the agency determines that an action may affect a listed species or its critical habitat, the agency must enter into consultation with the FWS (page 125) 5. Implement a program consisting of appropriate treatments to abate fire risk. The intent of this program is to assess the combined effects of thinning and fire on spotted owls and their habitat. The program should be structured as follows: a) Select up to 10% of the PACs within each RU that exhibit high fire risk conditions. Nest sites must be known within these PACs. Ideally, a paired sample of PACs should be selected to serve as control areas. b) Within each selected PAC, designate 40 ha (100 acres) centered around the nest site. This nest area should include habitat that resembles the structural and floristic characteristics of the nest site. These 40 ha (100 acres) will be deferred from the treatments described below. c) Within the remaining 203 ha (500 acres), combinations of thinning trees <22.4 cm (9 inches) d.b.h, treatment of fuels, and prescribed fire can be used to reduce fire hazard and to improve habitat conditions for owl prey. Habitat components that should be retained or enhanced include large logs (>30 cm [12 inches] midpoint diameter), grasses and forbs, and shrubs. These habitat components are strong correlates of the presence of many key prey species of the owl. Emphasis of the spatial	Record of Decision.. 5. The implementation plan is designed to be consistent with the Revised Recovery Plan. The 4FRI is contained within the UGM EMU's. The Forest Service manages 8,699,145 acres in the UGM EMU. Total non-core PAC area within 4FRI is 29,495 acres (See Wildlife Specialist Report).

6. No mechanical or prescribed fire treatments, or road or trail maintenance should occur within PACs during the breeding season unless it has been determined that the PAC is unoccupied or the owls are not nesting that year as inferred from results of surveys conducted according to protocol. 7. 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.	configuration of treatments should be no mimic natural mosaic patterns (pages 86-87). 6. Treatments can occur only during the nonbreeding season (1 September-28 February) to minimize any potential deleterious effects on the owl during the breeding season (page 88). 7. Within pine-oak types, emphasis should be placed on management that retains existing large oaks and promotes the growth of additional large oaks. Retain hardwoods, large down logs, large trees, and snags. Potential forms of fuelwood management include road closures, prohibiting harvest of important tree species such as oaks, prohibiting harvest of key habitat components such as snags and large downed logs (>30 cm [12 inch] midpoint diameter), and encouraging the harvest of small diameter conifers in accord with 5c below. (5c) states: Habitat components	6. Limit human activity in or near nest sites and Post-Fledgling Family Areas (PFAs) during the breeding season (March 1 through September 30) (Silviculture Report page 13). Burning in MSO PACs is difficult as there is a need to address the high fuel loadings while maintaining many of the habitat elements that contribute to fuel loading. Burning has to be conducted in a very short timeframe to avoid the breeding season (i.e., the nonbreeding season – September 1 to February 28). (Silviculture Report page 179). 7. Retain substantive amounts of key habitat components: snags 18 inches in diameter and larger, down logs over 12 inches midpoint diameter, hardwoods for retention, recruitment, and replacement of large hardwoods (Silviculture Report page 9). Large woody debris, snags, clumps of broadleaf wood vegetation should be retained and hardwood trees larger than 10 inches at the root collar (Silviculture Report page 12, 73, 234, 235, 237, 241, 244).

8. New road or trail construction is not recommended in PACs 9. Monitor treatment effects as described in Appendix C. See Table C.2 for desired conditions for PACs. Recovery Nest/Roost Habitat: Forested stands identified as meeting or exceeding owl nest/roost conditions. 10. Manage for nest/roost replacement habitat.	that should be retained or enhanced include large logs (>30 cm [12 inches] midpoint diameter), grasses and forbs, and shrubs (page 86). 8. Road or trail building in PACs should generally be avoided but may be allowed on a case-specific basis if pressing management reasons can be demonstrated (page 86) 9. Silvicultural applications must be evaluated over time by rigorous monitoring procedures to assess their effectiveness in managing or creating owl habitat (page 84). 10. Manage mixed-conifer and pine-oak forest types to provide continuous replacement nest habitat over space and time. Treatment of a particular stand depends on its capability no attain the	8. About 6.7 miles of temporary road are proposed in PACs. Temporary roads in PACs are expected to function for 2-3 years and would then be decommissioned. An additional 43 miles of open road would be decommissioned in PACs as part of the 4FRI project, representing about 29% of current road miles in PACs. This includes about 5 of 7.6 total road miles (67%) in core areas. 9. A monitoring plan has been developed. The plan development is deferred to the project's USFWS Biological Opinion (Silviculture Report page 174). 10. An intensive and extensive modeling effort took place in 2011, involving FS and FWS biologists, to identify the best nesting and roosting habitat. Habitat queries used a range of forest metrics.

	desired stand conditions. Treatment of a particular stand depends on its capability to attain the desired stand conditions. (page 94).	The results were evaluated in terms of patch size, location, other land uses, proximity to known owls, and movement potential. Quality control included data reviews and field verification (see Methodology in wildlife report). Manage to ensure a sustained level of owl nest/roost habitat well distributed across the landscape (DEIS page 612). Manage to ensure a sustained level of owl nest/roost habitat well distributed across the landscape (Silviculture Report page 211).
11. Emphasize attainment of nest/roost conditions as quickly as reasonably possible.	11. Within pine-oak types, emphasis should be placed on management that retains existing large oaks and promotes the growth of additional large oaks. Retain all trees >61 cm [24 in] d.b.h. Retain hardwoods, large down logs, large trees, and snags.	11. Management should emphasize attainment of nest/roost conditions as quickly as reasonably possible (USDI 2012) (Silviculture Report page 212).
12. Emphasize attainment of nest/roost conditions as quickly as reasonably possible.	12. SEE # 11	12. SEE #11; Modeling indicates increases in trees 18 to 23.9" d.b.h, trees >24" d.b.h, and TPA >18" d.b.h post-treatment.
13. Retain large trees. Strive for spatial heterogeneity.	13. SEE # 11	13. Per CFLRA requirements, treatments in alternatives B-E are designed to focus on small diameter tree thinning, with the objective of maximizing the retention of large trees – thus meeting

14. Manage for species diversity. Retain key owl habitat elements (large trees, snags, large logs, hardwoods, etc.). 15. Emphasize large hardwoods, where Appropriate	14. SEE # 11 15. SEE # 11	desired conditions of increasing VSS 5 and 6 age classes (18.0” d.b.h. +) as soon as possible. In alternatives C and E, treatments would also follow the guidance in section D, the large tree implementation plan (Silviculture Report page 216). Modeling indicates increases in trees 18 to 23.9” d.b.h, trees >24” d.b.h, and TPA >18” d.b.h. post-treatment. 14. SEE # 13 15. SEE # 13; aspen treatments are included in MSO habitat and Gambel oak would not be targeted for removal. Conduct thinning to promote large Gambel oak.

Table 133 Table III.B.1 from the 1995 MSO Recovery Plan (The Pine-oak row is of interest to this project)

Table III.B.1. Target/threshold conditions for mixed-conifer and pine-oak forests within restricted areas. Forest types are defined in II.C.

<i>Recovery Units</i>		% stand density of trees 30.5-45.7 cm dbh (12-18 in)	% stand density of trees 45.7-61 cm dbh (18-24 in)	% stand density of trees >61 cm dbh (>24 in)	Tree basal area ²	Density of large trees ³
Forest type	% of area ¹					
<i>Basin and Range - East RU</i>						
Mixed-conifer	20	10	10	10	32 (150)	49 (20)
Mixed-conifer	10	10	10	10	39 (170)	49 (20)
<i>All RUs, except Basin and Range - East RU</i>						
Mixed-conifer	25	10	10	10	32 (150)	49 (20)
Mixed-conifer	10	10	10	10	39 (170)	49 (20)
<i>Colorado Plateau, Upper Gila Mountains, Basin and Range - West RUs</i>						
Pine-oak ⁴	10	15	15	15	32 (150)	49 (20)

¹ % of area pertains to the percent of the planning area, landscape, subregion, and region that must meet target/threshold conditions. For mixed-conifer forests within Basin and Range - East and then for all other RUs, the percentage figure on the second line is a subset of the percentage figure given immediately above.

² Basal area is m²/ha (ft²/acre).

³ Trees >45.7 cm (18 inches) dbh. Density is trees/ha (trees/acre).

⁴ For pine-oak, 4.6 m²/ha (20 ft²/acre) of oak must be provided as a threshold/target condition.

Table 134 Table C3 from the 2012 MSO Recovery Plan. Of interest for this project is the Pine-oak row.

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.

²BAs in m²/ha (ft²/acre), and include all trees >1 inch dbh (i.e., any species). We emphasize that values shown are **minimums**, not targets.

³Trees > 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.

⁴Pine-oak forest type: ≥10% of the stand BA or 4.6 m²/ha (20 ft²/ac) of BA consist of Gambel oak ≥ 13 cm (5 in) drc.

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

The 1995 MSO Recovery Plan summary Table III.B.1 (Figure 1) and the analogous table for the 2012 MSO Recovery Plan Table C.3 (Figure 2) is summarized here in Table 1.

Table 135: Table C3 from the 2012 MSO Recovery Plan. Of interest for this project is the Pine-oak row.

	1995 MSO Recovery Plan (Figure 1)	2012 MSO Recovery Plan (Figure 2)	Difference
% of Area	Percent of area to be managed for Recovery nesting/roosting habitat is 10%	Percent of area to be managed for Recovery nesting/roosting habitat is 10%	Same
% BA by size class	15% in 12-18 inch	30% in 12-18 inch	Increased
	15% in 18-24 inch	30% in >18 inch	Same
	15% in >24 inch		
Minimum tree BA/acre	150	110	Decreased
Minimum # large trees >18" DBH	20	12	Decreased

Summary comparison of 1995 MSO plan to the 2012 MSO plan Table III.B1 and C3, respectively.

Differences in the two plans tables are in three areas: distribution of BA by size class, BA, and number of retained large trees. However, there is another fundamental difference in the two Tables as represented in each plan. In the 1995 MSO plan: “The values provided in Table III.B.1 represent targets in that they define the desired conditions to be achieved with time and management” (page 91 of plan). The values provided in Table C.3 in the 2012 represent “Minimum desired conditions for mixed-conifer and pine-oak forest areas managed for Recovery nesting/roosting habitat.” Therefore, if we have stand characteristics that exceed Table C.3 we are consistent with the plan.

While the percent of the planning area, landscape, subregion, and region remains at 10 percent the 2012 plan calls for an increase of 15% in the retention for 12”-18” DBH trees from 15% of total basal area up to 30% of total basal area. The desired condition retention for trees greater than 18” remains at 30% for both plans. The minimum basal area for the 2012 plan is now lowered from 150 BA/acre down to 110 BA/acre and at the same time reducing the number of large trees (>18” DBH) from 20 down to 12. The 2012 plan requires that the stands carry 60% of their basal area in trees >12” DBH while the prior 1995 plan only required that 45% of the basal area be in trees >18” DBH. This effectively will raise the QMD of the stands and lower the amount of basal area stocked in the < 12” DBH diameter classes.

The resulting shift in stocking (BA, trees >18”, and BA distribution) is displayed in Figure 30 (1995 MSO Plan) and Figure 31 (2005 MSO Plan). Of interest is the potential reduction in Stand Density Index (SDI) for the 2012 plan. This reduction in SDI, at the lower end of the minimum guide, will allow for faster ingrowth (trees growing from one diameter class up into the next diameter class), reduced completion, reduced density related mortality, and better forest health, as compared to the 1995 MSO plan.

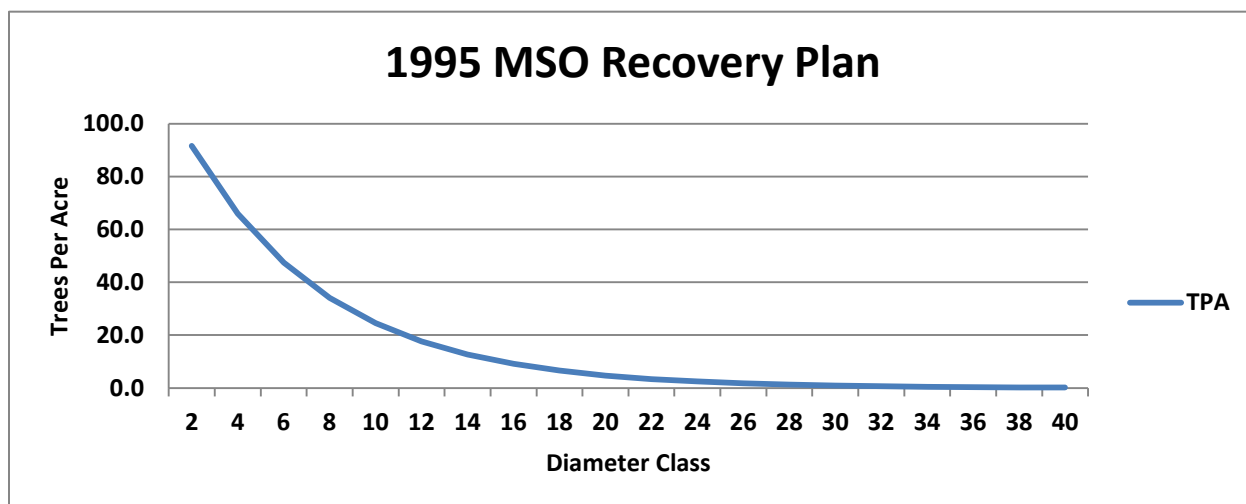


Figure 27. One, of many stand configurations meeting the 1995 MSO Recovery Plan criteria.

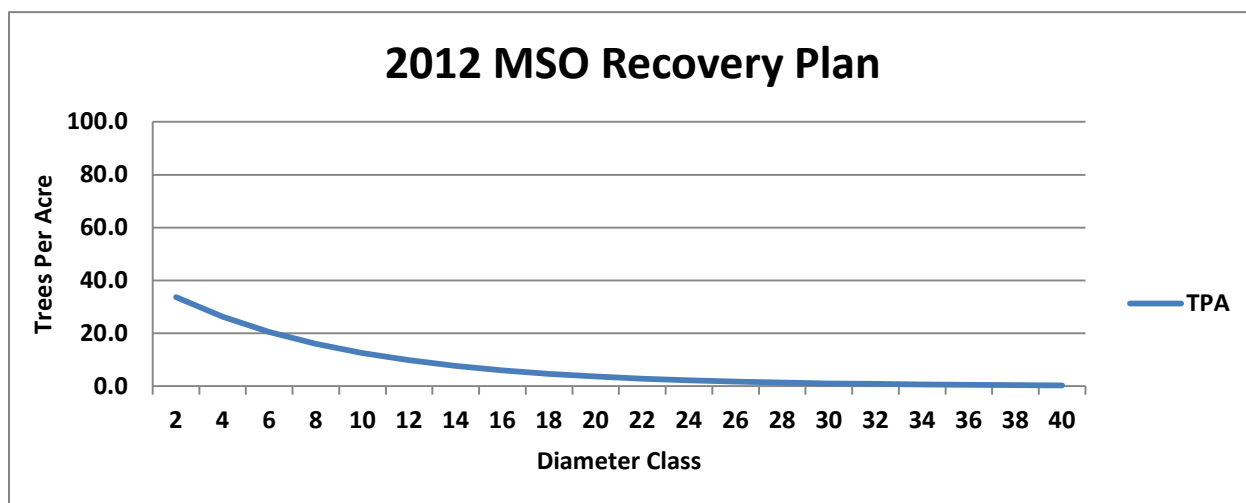


Figure 28. One, of many stand configurations meeting the 2012 MSO Recover Plan criteria.

CONSISTENCY

The 4FRI project analysis used the 1995 MSO Recovery Plan guidelines. However, after the data collection and analysis phase of the project the FWS came out with the 2012 MSO Recovery Plan. The 2012 MSO plan calls for 15% more basal area within the 12”-18” DBH class and the 4FRI project will adhere to this standard in the Implementation Guide. In most other instances, the revised version recovery plan is less restrictive than first version. The 4FRI project modeled with the higher basal area (150 vs 110) on all alternatives except for C and the higher large tree density (20 vs 12). This is consistent with the intent of the MSO recovery guidelines and with the two forest plans. The 4FRI project is consistent with the new 2012 MSO Recovery Plan guidelines because it is above the required stand minimums as confirmed by the analysis completed by the FWS. The 4FRI project treatments are consistent with the 1995 and 2012 MSO Recovery Plans.

FROM PART E: 2012 RECOVERY PLAN

Primary Differences of the 2012 Recovery Plan From the 1995 Recovery Plan

With new knowledge and experience garnered from implementation of the 1995 Recovery Plan, a number of substantive changes were made in the revision. A fundamental change underpinning the document was shift in primary threat from timber harvest and high-severity fire to simply the increased risk of stand-replacing wildfire. These include:

Part II:

- Includes an ESA five-factor threats analysis.
- Changes RUs to EMUs to conform to FWS policy.
- Restricted habitat is now “recovery habitat.”
- Target and threshold habitats are now future nesting and roosting habitats.
- Protected habitat no longer includes steep slopes that have not been harvested in over 20 years. The former steep slope protected habitat is now recovery habitat.
- Merges Southern Rocky Mountain (SRM)-Colorado and SRM-New Mexico EMUs into one (SRM).
- Revises boundary between Colorado Plateau (CP) and SRM to reflect ecological differences between the two EMUs.
- Extends boundary of Basin and Range East (BRE) EMU into Texas to incorporate verified sightings and suspected habitat.
- Reduces the size of the Basin and Range West (BRW) EMU by removing much of the western part where there are no records of owls and little, if any, known owl habitat.
- Adds descriptions of canyon cover types as they relate to the owl.
- Provides a clearer definition of riparian habitats as they relate to the owl.

Parts III-V:

- Revises delisting criteria to reflect changes in monitoring requirements (Part III).

Appendices A – G (2012 MSO Recovery Plan):

- Provides a more explicit definition of an owl site (Appendix C).
- Updates management recommendations given new information (Appendix C).
- Removes reserved lands from automatic inclusion as protected areas (Appendix C).
- Removes steep slopes from automatic inclusion as protected areas (Appendix C).
- Delineates activities that can be conducted inside of PACs and further specifies activities to occur within and outside of nest/roost core areas. Specifically, allows up to 20% of the total PAC area (external to the core) within an EMU to be treated mechanically (prescribed fire does not count in tallying PAC acres treated) to meet ecological restoration and fuels-reduction objectives if the appropriate monitoring is conducted.
- Provides guidance for removing PAC status from areas so designated.
- Renames “restricted habitat” to “recovery habitat” to more appropriately reflect the intent.
- Develops desired conditions for owls as targets to guide management.
- Provides threat-specific management recommendations for noise, recreation, energy development, land development, water development, grazing, insects and disease, fire suppression and related activities, prescribed fire and wildland fire, research, climate change, and West Nile virus (Appendix C).

- Adds emphasis to the need for monitoring and describes a new approach to monitor owl populations based on owl occupancy (Appendix E).
- Describes a new approach to monitor range-wide owl habitat using Forest Inventory Assessment (FIA) data (Part V.2 and Appendix E).
- Includes a survey protocol (Appendix D)

Appendix J - Timber Suitability

Kaibab NF Revised Forest Plan (2014) Coconino NF Forest Plan (1987 as amended)

The NFMA requires that NFS lands be classified as to their suitability for timber production. The determination of timber suitability was made in the original land management plans for both forests (forest plan) and was reevaluated on the Kaibab NF as a part of the recently revised forest plan. NFS lands were reserved with the intent of providing goods and services to satisfy public needs over the long term. These goods include the production of a sustainable supply of forest products. Timber production is the purposeful growing, tending, harvesting, and regeneration of regulated crops of trees for industrial or consumer use. Timber production activities can contribute to social, economic, or ecological sustainability. Timber production has the potential to offset some or all of the costs of thinning and other forest development or maintenance activities that lower uncharacteristic fire and insect risk, increase understory plant diversity and abundance, and create employment opportunities.

Areas unsuitable for timber production are those that are either not desirable or not feasible to manage for periodic harvests of forest products. For example, restoration of grasslands often requires cutting trees. These trees can be made available for sale, but the intent for the future is to maintain the areas as grasslands, and as a result timber production would not be desirable because it is inconsistent with the desired conditions. Where long-term resource productivity would be impaired or law, regulation, or policies prohibit it, timber production is not feasible.

In accordance with the provisions of the current planning rule, a GIS analysis was conducted on all NFS lands within the 4FRI project area managed by the Kaibab NF and the Coconino NF to derive acres of land categorized into suitable and not suitable for timber production, which varied by alternative (219.14).

Within the analysis area approximately 330,892 acres are considered in the timber suitability class (116,692 on the Kaibab NF and 214,200 acres on the Coconino NF. Unsuitable lands includes areas where prescription would preclude timber production such as critical wildlife habitat and developed recreation sites as well as areas where irreversible resource damage occur.

Table 139 shows total acres for the Kaibab & Coconino NF as reported in each Forest Plan used in the timber suitability calculation.

Table 136 Timber suitability calculation for the Kaibab & Coconino NF

Land Category	Kaibab Acres	Coconino Acres
Gross area	1,600,321*	1,821,495**
Area not administered by the Forest Service (Camp Navajo and private lands)	-57,056	
NFS lands	1,543,265	1,821,495
Non-forested†	-847,376	-325,945
Irreversible resource damage	-54,265	
Adequate restocking not assured	-21,834	
Withdrawn (219.14(a)(4))	-117,563	-101,401
Subtotal: Not-suitable for timber production	1,041,038	-427,346
Lands Tentatively Suitable for Timber production	502,227	1,394,149
Management prescriptions preclude timber production	-90,782	-593,102
Management requirements cannot be met	-16,903	-154,214

Land Category	Kaibab Acres	Coconino Acres
Not cost efficient in meeting timber objectives	-13,025	
Forested Lands not appropriate for timber harvest		-13,359
Experimental Forest		-6,148
Subtotal: Not appropriate for timber production	-120,710	-766,823
Lands suitable for timber production	381,517	627,326

* Acreages of NFS lands may vary slightly over time due to factors such as resurvey, improved mapping technology, and updates to corporate GIS layers.

** Based on 1987 Coconino Forest Plan (Appendix H)

† Includes Forest lands that are not capable of producing industrial wood, such as pinyon-juniper woodlands. (USDA 2014)

There are five Alternatives (A-E) incorporating twenty (20) various treatments across the project (See FEIS).

Tables 140 through 143 show the treatment acres by Alternative . There is no Table for Alternative A, since this alternative represents the current plans.

Table 137. Alternative B ponderosa pine treatments

Kaibab NF		Coconino NF	
Alternative B	(All)	Alternative B	(All)
Row Labels	Sum of TS_Acres	Row Labels	Sum of TS_Acres
Alt B Proposed Treatments	231,367	Alt B Proposed Treatments	276,471
Adequate Restocking Not Assured	8,141	Suitable	214,678
Irreversible Resource Damage	17,591		
Management Requirements Not Met	3,270		
Non-Forested	53,537		
Not Cost Efficient	5,130		
Rx Precludes Timber Production	25,560		
Withdrawn	185		
Suitable	117,954		

Table 138. Alternative C ponderosa pine treatments

Kaibab NF		Coconino NF	
Alternative C	(All)	Alternative C	(All)
Row Labels	Sum of TS_Acres	Row Labels	Sum of TS_Acres
Alt C Proposed Treatments	229,965	Alt C Proposed Treatments	277,875
Adequate Restocking Not Assured	8,122	Suitable	214,200
Irreversible Resource Damage	17,597		
Management Requirements Not Met	3,270		
Non-Forested	53,627		
Not Cost Efficient	5,130		
Rx Precludes Timber Production	25,342		
Withdrawn	185		
Suitable	116,692		

Table 139. Alternative D ponderosa pine treatments

Kaibab NF	(All)	Coconino NF	
Alternative D		Alternative D	(All)
Row Labels	Sum of TS_Acres	Row Labels	Sum of TS_Acres
Alt D Proposed Treatments	231,180	Alt D Proposed Treatments	276,658
Adequate Restocking Not Assured	8,141	Suitable	214,460
Irreversible Resource Damage	17,591		
Management Requirements Not Met	3,270		
Non-Forested	53,537		
Not Cost Efficient	5,130		
Rx Precludes Timber Production	25,560		
Withdrawn	185		
Suitable	117,766		

Table 140. Alternative E ponderosa pine treatments

Kaibab NF		Coconino NF	
Alternative E		Alternative E	(All)
Row Labels	Sum of TS_Acres	Row Labels	Sum of TS_Acres
Alt E Proposed Treatments	229,555	Alt E Proposed Treatments	278,284
Adequate Restocking Not Assured	8,122	Suitable	214,181
Irreversible Resource Damage	17,476		
Management Requirements Not Met	3,270		
Non-Forested	53,349		
Not Cost Efficient	5,130		
Rx Precludes Timber Production	25,342		
Withdrawn	185		
Suitable	116,680		

Table 144 shows the distribution of cover types across the analysis area (588.716 acres) by Restoration Unit (RU). To aid in the understanding in the differences of the Alternatives (for Tables 139 -142) Table 144 gives a comparison of Alternative amendments.

Table 141. Cover Type Acres by Restoration Unit

Cover Type	RU 1	RU 3	RU 4	RU 5	RU 6	Total
Unsuitable Timberlands						
Barren	120	134	129	1,301	48	1,732
Grassland	8,226	12,796	22,661	4,928	9	48,703
Pinyon-Juniper Woodland	1,428	5,884	7,283	8,845	2,219	25,658
Oak Woodland	287	1,633	926	386	30	3,262
Aspen	420	201	497	403	0	1,522
Suitable Timberlands						
Ponderosa pine (includes Pine-Oak)	144,113	129,226	134,278	59,034	41,189	507,839
Total Analysis area Acres:	154,594	149,874	165,774	74,896	43,578	588,716

Table 142. Summary of CFN forest plan amendments by alternative and theme (FEIS Appendix B)

Alternative	Mechanical Treatments in PACs	Treatments in PAC Core Areas	Restricted Habitat Management	Basal Area in Restricted Target and Threshold Habitat	Population and Habitat Monitoring	Habitat Treatment in Incremental Percentages
Forest Plan Amendment 1: Theme - Management in Mexican Spotted Owl Habitat						
A, E	N/A					
B	Amendment 1: Allows mechanical treatment up to 16- inch d.b.h. in 18 PACs	N/A: No PAC core area treatments	Amendment 1: Adds definitions for target and threshold habitat	N/A—basal area in restricted target and threshold habitat remains 150 on both forests	Amendment 1: Defers monitoring to the project’s U.S. Fish and Wildlife Service (FWS) biological opinion	Amendment 1: Defers treatment design to the project’s FWS biological opinion
C	Amendment 1: Allows mechanical treatment up to 17.9 inch d.b.h. in 18 and decreases the minimal basal area from 150 to 110 in the 18 PACs	Amendment 1: Allows prescribed fire in 54 core areas	Amendment 1: Adds definitions for target and threshold habitat	Amendment 1:Allows for managing 6,299 acres of restricted target and threshold habitat for a minimum range of 110 to 150 basal area	Amendment 1: Defers monitoring to the project’s FWS biological opinion	Amendment 1: Defers treatment design to the project’s FWS biological opinion
D	Amendment 1: Allows mechanical treatment up to 16 inch d.b.h. in 18 PACs	N/A: No PAC core area treatments	Amendment 1: Adds definitions for target and threshold habitat	N/A—basal area in restricted target and threshold habitat remains 150	Amendment 1: Defers MSO monitoring to the project’s FWS biological opinion	Amendment 1: Defers treatment design to the project’s FWS biological opinion
Forest Plan Amendment 2: Theme - Management of Canopy Cover and Ponderosa Pine with an Open Reference Condition within Goshawk Habitat						
A	N/A					
B-D	Amendment 2: (1) adds the desired percentage of interspaces within uneven-aged stands to facilitate restoration, (2) adds the interspaces distance between tree groups, (3) adds language clarifying where canopy cover is and is not measured, (4) allows 28,952 acres (alternatives B,D) and 28,653 (alternative C only) to be managed for an open reference condition (up to 90 percent open with less than 3 to 5 reserve trees), and (5) adds a definition to the forest plan glossary for the terms: interspaces, open reference condition, and stands.					
E	N/A: No desired percentage of interspaces would be added. No language clarifying where canopy cover is and is not measured would be added. Zero acres would be managed for up to 90 percent open with less than 3 to 5 reserve trees. No definition of interspace and stands would be added.					
Forest Plan Amendment 3: Theme - Effect Determination for Cultural Resources						
A	N/A					
B-D	Amendment 3: The amendment deletes the standard that would require achieving a “no effect” determination and adds the words “or no adverse effect” to the remaining standard. In effect, management strives to achieve a "no effect" or “no adverse effect” determination.					
E	N/A: Forest plan standard that would require achieving a “no effect” determination would remain in place.					

Unsuitable

Cover types are divided into three broad categories that describe vegetative state – non-vegetated, non-forest or forest. The following is a description of the cover types that occur within the analysis area. Table 143 lists the acres within the analysis area by cover type.

Non-vegetated (Barren)

These areas include mines, quarries, gravel pits and rock, talus or scree, and some rights of way.

Grasslands-Savanna

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 late 1800s 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. These conditions have been further exacerbated by soil erosion, increases in invasive, nonnative plants and low-density rural home development.

Approximately 56,372 acres (45,142 savanna and 11,230 grassland acres) within the analysis area classified as grassland and savanna cover type are proposed for treatment (Tables 3, 60 & 66 Alt C). The grassland/savanna 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. Many of the pre-settlement trees that grew along the edges of these grasslands were removed historically. These 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.

In response to comments and feedback on the DEIS, on approximately 38,256 acres (22,772 acres on the Coconino and 15,484 acres on the Kaibab NF) of UEA 40, UEA 25, and non-WUI stands with a preponderance of large trees (at a minimum all VSS 5 and 6 stands and VSS 4 stands with a mean BA greater than 70 of the VSS 4 size class and a mean TPA less than 100 of the VSS 4 size class) would be managed for greater residual canopy cover and density of large trees. After further public comments an additional 7,835 acres of IT10 and UEA 10 treatments were included for this section, for a total of 46,091 acres. Residual stand structure would be managed at the upper end of natural range of variability for ponderosa pine in the non-WUI stands that meet these conditions. This would be accomplished by focusing treatments towards the lower end of the planned prescription intensity range, managing for larger group sizes, and/or retaining additional large trees. Post treatment canopy cover in these stands would meet or exceed forest plan guidance for canopy cover, and is intended to will achieve 40 percent canopy cover at the stand scale.

The treatments proposed within the grassland and savanna types will not have a change effect of timber suitability since canopy cover and basal area will remain high enough to keep these acres in the timber suitability class.

Woodland Vegetation Community Pinyon-Juniper (PJ) - The pinyon-juniper cover type is collectively composed of the pinyon-juniper grassland, pinyon-juniper sagebrush, pinyon-juniper evergreen shrub and pinyon-juniper persistent

woodland communities. 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 sagebrush, 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 is common; as well as one-seed, Utah, Rocky Mountain, and alligator juniper. 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. The few treatments within this timber community will not change any timber suitability classification.

Oak Woodlands – This community consists of Gambel oak 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. Within this plant series this project will operate within the Pine-Oak community and will not change any of the timber suitability acres with the proposed treatments.

Forest Vegetation Community

Ponderosa Pine (PP)

The ponderosa pine forest vegetation community generally occurs at elevations ranging from 5,800 to 9,200 feet and is dominated by ponderosa pine and commonly includes other species such as oak, juniper, and pinyon. Species such as aspen, Douglas-fir, white fir, and blue spruce 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 two major sub-types: Ponderosa pine-bunchgrass and ponderosa pine-Gambel oak.

Ponderosa pine commonly grows in pure stands and currently is found in even-aged¹⁷ and uneven-aged¹⁸ structural conditions across the area. The open park-like stands characteristic of the reference conditions for ponderosa pine forests promoted greater faunal 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 (See Chapter 1) and accumulations of forest litter and woody debris are much higher than would have occurred under the historic disturbance regime. 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

¹⁷ Even-aged – pertaining to a stand composed of a single age class in which the tree ages are within + 20 percent variability based upon the mature stand age (SAF 1998).

¹⁸ Uneven-aged – pertaining to a stand with trees of three or more distinct age classes (SAF 1998).

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).

Gambel Oak Within Ponderosa Pine Forest

Gambel oak is frequently the only deciduous tree in otherwise pure ponderosa pine forests in the 4FRI analysis area, 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 1996 forest plan amendment for MSO and 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, 2008). 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 and forbs) 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. The ponderosa pine analysis area is dominated by high stand densities and closed tree canopies (see habitat specific density conditions in Table 13 through Table 19). For a more detailed discussion on tree overstory and herbaceous understory relationships, see the Wildlife Section in Chapter 3. The lack of fire disturbance has allowed ponderosa pine to encroach upon the interspace throughout these soil types resulting in a more continuous tree canopy.

Quaking Aspen (QA)

Within the project area, quaking aspen is limited to small patches within a larger forest matrix dominated by ponderosa pine or mixed conifer vegetation. These patches consist of a few overstory trees with a sapling understory component.

Aspen primarily reproduces asexually through root suckers that are a clone of the original parent tree. Fire, insect, disease, wind and human disturbances regenerate this shade-intolerant species by opening up the canopy and removing conifers from the understory. Without disturbance, conifers gradually overtop aspen, closing the canopy and eventually killing mature trees and reducing regeneration. Aspen is highly susceptible to browsing and disease causing death due to bark and root injuries. Aspen patches are regenerating successfully where livestock and wildlife are excluded (i.e., by fencing or other methods). Several aspen patches within the project area show signs of decline marked by mortality and dieback of crowns, similar to what has been observed across Arizona over the past several years (Fairweather et al. 2008).

Consistency Evaluation:

The Kaibab Forest Plan contains the following guidance that directs the management of suitable and unsuitable lands.

- Vegetation Management Guideline: On suitable timberlands, projects should retain somewhat higher frequencies of trees across broad diameter classes to allow for future tree harvest.
- Forestry and Forest Product Standard: Regulated timber harvest only occurs on suitable lands.
- Forestry and Forest Product Guidelines: On suitable timber lands, even-aged stands should have reached or surpassed 95% of the culmination of mean annual increment prior to having a regeneration harvest, unless it is

needed to reduce fire hazard within the wildland-urban interface, or would contribute toward achieving the desired uneven aged vegetation conditions over the long term.

- “On lands classified as not suited for timber production, timber harvesting should only be used for making progress toward desired conditions or for salvage, sanitation, public health, or safety.” While commercial harvesting will occur on unsuitable timberlands, the primary purpose of the treatments is to make progress toward the desired conditions. As a result, this project is consistent with this guideline for mechanical harvesting on unsuitable timber lands.
- Management Approach: On lands classified as suitable for timber production, mechanical tree removal and prescribed fire are needed to effectively make progress toward the desired conditions and are intended to retain characteristics of desired conditions for at least 20 years. In terms of prescriptions, this means that the post-treatment conditions may need to be on the more open end of the desired range to accommodate the growth that is anticipated in the interval between treatments.
- Desired Conditions PIPO: The interspaces between groups are variably shaped, are comprised of a native grass/forb/shrub mix, and may contain individual trees or snags. Regeneration openings occur as a mosaic and are similar in size to nearby groups.

The Coconino Forest Plan contains the following guidance that directs the management of suitable and unsuitable land.

- On forested lands identified as suitable for commercial timber production, design timber management activities to integrate considerations for economics, water quality, soils, wildlife habitat, recreation opportunities, visual quality, and other values.
- Evaluate timber lands adjacent to the Rim within the first decade to determine timber suitability.
- Management for the ponderosa pine/mixed conifer stands and the big tooth maple stands is the same as MA 3, foreground retention and for areas adjacent to foreground Retention lands. See MA 5 for direction for the aspen stands.
- Manage the timber resource to provide a sustained-yield of forest products through integrated stand management.
- Develop and implement a sustained-yield program for firewood and other miscellaneous forest products including posts, poles, Christmas trees, and wildings. Emphasize uneven-aged management for timber cutting areas.

Unsuitable Lands

Timber suitability for the Kaibab was based on Potential Natural Vegetation Type (PNVT). All potential grasslands on the Kaibab, regardless of whether they are currently encroached by conifers are unsuitable for timber production, within the area currently occupied by ponderosa pine, 14,640 acres are on Mollisol soils. The intent for this area for the Forest Plan is to restore them and then maintain them as grasslands. Mechanical removal of trees to below 10% canopy cover is consistent with the guideline for unsuitable land because the treatments would make progress towards the desired conditions. All lands in the woodland communities PNVT and some of the ponderosa pine PNVT on the Kaibab are unsuitable for timber production because are not capable of producing industrial wood. Unsuitable ponderosa pine includes areas with mollisols soils, nonindustrial wood (aspen, oak, etc.), as well as areas where the minimum management requirements cannot be met. The intent for this area is to restore them to their respective desired conditions and then maintain them within the desired range. Mechanical removal of trees on these unsuitable lands is consistent with the guideline in the Kaibab Forest Plan because the treatments would make progress towards the desired conditions.

Unsuitable lands within the Coconino NF are unproductive timber lands are within the ponderosa pine vegetation types.

- They are unsuitable for timber harvest because they fall in at least one of the following two categories.
- They do not meet the minimum standards for productivity which is Site Index 40 and/or 20 cubic feet per acre per year.

- There is not reasonable assurance that such lands can be adequately restocked as required by section 219.27(c)(13) of the planning regulations.

Suitable Timberland

About half of the suitable timberlands on the Kaibab occur on mollic intergrade soils. These areas were historically very open and would be on the more open end of the range of desired conditions, with a greater percentage of the land made up of interspaces and on the low end of the desired mid-scale basal area range. These areas were retained as suitable timberlands in the revised Kaibab plan because they can contribute to the goods and services available to satisfy public needs over the long term. There is recognition that these areas would be managed to reflect their more open historic condition and would therefore yield lower volumes than most areas managed for suitable timber.

Suitable lands within the Coconino NF are unproductive timber lands are within the ponderosa pine vegetation types.

- They are suitable for timber harvest because they fall in at least one of the following two categories.
- They meet the minimum standards for productivity which is Site Index 40 and/or 20 cubic feet per acre per year.
- There is reasonable assurance that such lands can be adequately restocked as required by section 219.27(c)(13) of the planning regulations.