Appendix 1. 4FRI Compliance with Forest-wide Direction from the Coconino and Kaibab Forest Plans – Wildlife and Vegetation Management

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This appendix provides forest plan direction for wildlife management on the Coconino and Kaibab National Forests. Indented below the paragraphs or bullets displaying forest plan direction are references to finding the 4FRI compliance to the forest plans. Compliance responses are indented section headings leading to the portion of the wildlife report that complies with the plan direction. The list of section headings are listed in descending order from the more general to the ("→") more specific. Page numbers are not used because they are likely to change in the final formatting of these documents for publication.

Coconino Forest Plan

Mexican Spotted Owls (Forest Plan p. 65-1)

- Provide three levels of habitat management - protected, restricted, and other forest and woodland types to achieve a diversity of habitat conditions across the landscape.
    - See Mexican Spotted Owl Habitat Definitions in the 1995 Recovery Plan and Delineating MSO Habitat in the 4FRI Treatment Area under Methodology
- Protected areas include delineated protected activity centers; mixed conifer and pine oak forests with slopes greater than 40 percent where timber harvest has not occurred in the last 20 years; and reserved lands which include wilderness, research natural areas, wild and scenic rivers, and congressionally recognized wilderness study areas.
    - **Evaluation**: Methodology → Modeling and Habitat Evaluation → MSO Habitat → Mexican Spotted Owl Habitat Definitions in the 1995 Recovery Plan and Delineating MSO Habitat in the 4FRI Treatment Area

- Restricted areas include all mixed-conifer, pine-oak, and riparian forests outside of protected areas.
    - **Evaluation**: Mexican Spotted Owl Habitat Definitions in the 1995 Recovery Plan and Delineating MSO Habitat in the 4FRI Treatment Area under Methodology
- Other forest and woodland types include all ponderosa pine, spruce-fir, woodland, and aspen forests outside protected and restricted areas.
    - **Evaluation**: Affected Environment → Ponderosa Pine Forest → Ponderosa Pine – Gambel Oak (note that the other MSO vegetation cover types are outside of the 4FRI treatment area)
- Survey all potential spotted owl areas including protected, restricted, and other forest and woodland types within an analysis area plus the area 1/2 mile beyond the perimeter of the proposed treatment area.
    - **Evaluation**: This is part of implementation and not planning, it is accounted for in Appendix C of the EIS and the table of Wildlife Design Features incorporated into 4FRI implementation planning in the wildlife report (Description of Alternatives → Design Features, Best Management Practices and Mitigation).
- Establish a protected activity center at all Mexican spotted owl sites located during surveys and all management territories established since 1989.
    - **Evaluation**: This is part of implementation and not planning, it is accounted for in Appendix C of the EIS and the table of Wildlife Design Features alternatives (see Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) → Actions Common to Alternatives B, C, D, and E → Protected Habitat)
- Allow no timber harvest except for fuelwood and fire risk abatement in established protected activity centers. For protected activity centers (PACs) destroyed by fire, windstorm, or other natural disaster, salvage timber harvest or declassification may be allowed after evaluation on a case-by-case basis in consultation with U.S. Fish and Wildlife Service (USFWS).
    - **Evaluation**: Because the intent of the 4FRI treatments was to improve MSO habitat within PACs and the forest plan does not allow mechanical thinning to benefit owls, plan amendments were developed to allow implementing the direction provided in the Revised Recovery Plan and in coordination and consultation with the USFWS (see Description of Alternatives and appendix 2 of the wildlife report).
- Allow no timber harvest except for fire risk abatement in mixed conifer and pine-oak forests on slopes greater than 40 percent where timber harvest has not occurred in the last 20 years.
    - **Evaluation**: No mechanical treatments are proposed on steep slopes in any of the alternatives (see Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) → Actions Common to Alternatives B, C, D, and E → Protected Habitat).
- Limit human activity in protected activity centers during the breeding season.
    - **Evaluation**: Numerous design features were identified to minimize human activity/disturbance in PACs (Appendix C of the EIS and Description of Alternatives → Design Features, Best Management Practices and Mitigation in the wildlife report) → Design features common to all treatment types within MSO habitat.
- In protected and restricted areas, when activities conducted in conformance with these standards and guidelines may adversely affect other threatened, endangered, or sensitive species or may conflict

with other established recovery plans or conservation agreements; consult with US Fish and Wildlife Service to resolve the conflict. Monitor changes in owl populations and habitat needed for delisting.

- **Evaluation**: This was not a factor in the development of the 4FRI.

The Forest Plan describes guidelines within Protected, Restricted Threshold and Target Threshold lands in the following forest stratified MSO habitats:

Restricted Areas (Mixed conifer, pine-oak, and riparian forests) (Forest Plan pp. 65-3 - 65-5)

- 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.
  - **Evaluation**: The status of existing nest/roost habitat was reviewed across the landscape before boundaries were even delineated for the 4FRI and existing conditions reviewed for each individual PAC. Existing habitat was factored into the evaluation of future nesting/roosting habitat. Future nesting/roosting habitat was evaluated across the landscape and delineated in coordination with the USFWS to ensure the best habitats were identified (Methodology → Modeling and Habitat Evaluation → MSO Habitat → Delineating MSO Habitat and Modeling Mechanical Treatments in PACs).
- Emphasize uneven-aged management systems. However, both even-aged and uneven-aged systems may be used where appropriate to provide variation in existing stand structure and species diversity.
  - **Evaluation**: Treatments in MSO habitat were designed to meet this and additional direction provided in the MSO recovery plan (Description of Alternatives and Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) → see Actions Common to Alternatives B, C, D, and E, Alternative B – Proposed Action, Alternative C – Preferred Action, Alternative D, and Alternative E.
- Save all trees greater than 24 inches dbh.
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices and Mitigation in the wildlife report) → Design features common to all treatment types within MSO habitat;
  - **Evaluation**: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) → see Alternative Determination of Effects for each action alternative.
  - **Evaluation**: Environmental Consequences →Forest Service Sensitive Species → Northern Goshawk → Common to Alternatives B, C, D, and E → Old and Large Trees and Direct/Indirect Effects → treatment table for each action alternative.
- In pine-oak forests, retain existing large oaks and promote growth of additional oaks.
  - **Evaluation**: Appendix C of the EIS and Description of Alternatives → Design Features, Best Management Practices and Mitigation in the wildlife report → Design features common to all treatment types within MSO habitat.
  - **Evaluation**: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) →

see Restricted Habitat → Forest Structure and Density for each action alternative and MSO Critical Habitat → Forest Structure and Density for each action alternative.

- Encourage prescribed fire and fire for resource benefits 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.
  - **Evaluation**: Methodology → Modeling and Habitat Evaluation → MSO Habitat → Smoke Effects on MSO
  - **Evaluation**: Affected Environment → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Habitat → Fire
  - **Evaluation**: Affected Environment → Forest Service Management Indicator Species → MIS for the Coconino NF → Species Indicators for Early and Late-seral Grasslands → Pronghorn
  - **Evaluation**: Description of Alternatives → individual alternative descriptions, Actions Common to Alternatives B-E, and Design Features Common to All Treatment Types in MSO Habitat.
  - **Evaluation**: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) → Restricted Habitat → MSO Prey Habitat and Fire Effects and → Other Habitat Effects → Grasslands, Savannas, and Meadows and Determination of Effects by individual alternative.
  - **Evaluation**: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) → Slide Fire → All action alternatives and Summary.
  - **Evaluation**: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) → Comparison of Alternatives
- 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.
  - **Evaluation**: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) → Restricted Habitat by individual alternative; also → Comparison of Alternatives and Critical Habitat.
- Riparian areas: Emphasize maintenance and restoration of healthy riparian ecosystems through conformance with 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.
  - **Evaluation**: Although very little true riparian habitat exists in the project area and no treatments would occur along perennial streams or other riparian ecosystems, both spring and ephemeral channel restoration would occur. Springs represent site-specific patches of habitat rather than continuous stretches of habitat. Ephemeral channels are typically too dry to qualify as "riparian." Both are addressed in Affected Environment → Vegetation Cover Types Within the Project Area → Springs and Ephemeral Channels;
  - **Evaluation**: Description of Alternatives;
  - **Evaluation**: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened)

→Actions Common to Alternatives B, C, D, and E → Restricted Habitat→ Springs and Ephemeral Channels;

- **Evaluation**: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) →[each individual action alternative effects evaluation] → Other Habitat Effects → Springs and Ephemeral Channels.

Forest Plan Vegetation Treatment Requirements by Habitat Type

- Pine-Oak Restricted MSO Habitat: Twenty percent of the pine-oak forest type (by area) provides MSO nest/roost characteristics – basal area > 150 square feet, Gambel oak basal area > 20 square feet, twenty 18inches+ trees per acre, and 45 percent of stocking in trees > 12inches diameter. All trees > 24inches diameter, substantive amounts of snags > 18inches diameter, down logs > 12inches midpoint diameter, and large hardwoods are retained following management treatments.
  - **Evaluation**: Methodology → Modeling and Habitat Evaluation → MSO Habitat → Delineating MSO Habitat in the 4FRI Treatment Area
- Pine-Oak Protected MSO Habitat: Trees greater than 9inches dbh are retained following management treatments.
  - Evaluation: Based on discussions with the USFWS, stands inside PACs proposed for mechanical thinning were individually modeled to determine the most effective diameter limit in meeting MSO Recovery Plan objectives. An amendment to the Coconino forest plan was developed to ensure the preferred alternative (alternative C) would better meet the intent of the revised MSO recovery plan (USDI 2012) that was under development at the time. See Methodology → Modeling and Habitat Evaluation → MSO Habitat →Modeling Mechanical Treatments in PACs and
  - Evaluation: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) → Amendments Supporting the Action Alternatives.

Forest Plan Target Stand Densities within Restricted Threshold and Target Threshold Lands:

- Pine-oak stands –manage for 150 square feet of basal area in mature forest structure with the following distribution; (15 percent -trees12-18inches dbh, 15 percent -trees 18-24inches dbh, 15 percent -trees > 24inches dbh)
  - **Evaluation**: While the above distribution in tree size-classes was used to develop treatments in target habitat, a forest plan amendment was developed using a minimum basal area (BA) value of 110 square feet per acre to ensure the preferred alternative (alternative C) would better meet the intent of the revised MSO Recovery Plan (USDI 2012) Description of Alternatives → Alternative C – Preferred Alternatives and Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) →Comparison of Alternatives.
  - **Evaluation**: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owls (Threatened) → Amendments Supporting the Action Alternatives.
  - **Evaluation**: The other action alternatives followed the forest plan direction: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and

Critical Habitats → Mexican Spotted Owls (Threatened) →Alternative B – Proposed Action through Alternative E

Northern Goshawk

Forest plan direction that relates to northern goshawk forest habitat applies to the forest and woodland communities described below that are outside of Mexican spotted owl protected and restricted areas (CNF Forest Plan, pp. 65-7 to 65-11):

- Manage for uneven-aged 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 such 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.
    - **Evaluation**: Affected Environment → Forest Service Sensitive Species → Northern Goshawk;
    - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices and Mitigation;
    - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species →Effects Common to All Action Alternatives;
    - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Northern Goshawk.
- Limit human activity in or near nest sites and post-fledgling family areas (PFAs) during the breeding season (March 1 through September 30).
    - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices and Mitigation;
    - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Northern Goshawk → Common to Alternatives B, C, D, and E;
    - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Northern Goshawk → see Direct/Indirect Effects for individual alternatives.
- The distribution of vegetation structural stages (VSS) for ponderosa pine, mixed conifer and spruce-fir is 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), and 20 percent old forest (VSS 6). Distribution of habitat structures should be evaluated at the ecosystem MA level, at the midscale such as drainage, and at the small scale of site.
    - **Evaluation**: Affected Environment → Forest Service Sensitive Species → Northern Goshawk → Habitat Strata and Scales of Analysis;
    - **Evaluation**: Description of Alternatives; and
    - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Northern Goshawk → see Direct/Indirect Effects for individual alternative.

Within Nesting Areas

- **General**: Provide unique nesting habitat conditions for goshawks. Important features include trees of mature to old age with high canopy cover.
    - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices and Mitigation; and

  - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Northern Goshawk → see Direct/Indirect Effects for individual alternatives.

- 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 5 of RM-217 presents attributes required for goshawks on locations with "low" and "high" site productivity.
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices and Mitigation; and
  - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Northern Goshawk → Direct/Indirect Effects for individual alternatives and appendix D of the EIS.
- Preferred treatments to maintain the desired structure are to thin from below with non-uniform spacing and use of hand tools and fire to reduce fuel loads. Lopping and scattering of thinning debris is preferred if broadcast fire cannot be used. Piling of debris should be limited. When necessary, hand piling should be used to minimize compaction within piles and to minimize displacement and destruction of the forest floor and the herbaceous layer. Do not grapple or dozer pile debris. Manage road densities at the lowest level possible to minimize disturbance in the nest area. Use small, permanent skid trails in lieu of roads for timber harvesting.
  - **Evaluation**: Appendix D of the EIS.
- **Spruce-Fir, Mixed Conifer and Ponderosa Pine Cover Types**: The nesting area contains only mature to old forest (VSS 5 and 6) having a canopy cover (measured vertically) between 50 and 70 percent with mid-aged (VSS 6) trees 200 to 300 years old. Non-uniform spacing of trees and clumpiness is desirable.
  - **Evaluation**: Methodology → Modeling and Habitat Evaluation → Goshawk Habitat and appendix D of the EIS.
- **Woodland**: Maintain existing canopy cover levels.
  - **Evaluation**: Description of Alternatives → Actions Common to Alternatives B-E and Environmental Consequences → Forest Service Management Indicator Species → Management Indicator Species for Late-seral Pinyon-Juniper and Snags in Pinyon-Juniper Habitat.

Within Post-Fledging Family Areas

- **General**: Provide for healthy sustainable forest environment for the post-fledgling family needs of goshawks. The principal difference between "within the PFA" and "outside the PFA" is the higher canopy cover within the PFA and smaller opening size within the post fledgling family area. Vegetative structural stage distribution and structural conditions are the same within and outside the PFA.
- **Ponderosa Pine**: Canopy Cover for mid-aged forest (VSS 4) should average one-third 60+ percent and two-thirds 50+ percent. Mature (VSS 5) and old forest (VSS 6) should average 50+ percent.
  - **Evaluation**: Affected Environment → Vegetation Cover Types Within the Project Area → Vegetation Structure in Goshawk and MSO Habitat
  - **Evaluation**: Affected Environment → Forest Service Sensitive Species → Northern Goshawk
  - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Northern Goshawk
- **Woodland**: Maintain existing canopy cover levels.

  - **Evaluation**: Description of Alternatives → Actions Common to Alternatives B- E and Environmental Consequences → Forest Service Management Indicator Species → Management Indicator Species for Late-seral Pinyon-Juniper and Snags in Pinyon-Juniper Habitat.

Foraging Areas - Landscapes Outside Goshawk Post-Fledgling Family Areas

- **General**: The distribution of vegetation structural stages for ponderosa pine, mixed conifer and spruce-fir forests is 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), and 20 percent old forest (VSS 6).
  - **Evaluation**: Affected Environment → Vegetation Cover Types Within the Project Area → Vegetation Structure in Goshawk and MSO Habitat
  - **Evaluation**: Affected Environment → Forest Service Sensitive Species → Northern Goshawk
  - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Northern Goshawk
- The distribution of VSS, tree density, and tree age are a product of site quality in the ecosystem MA. Use site quality to guide in the distribution of VSS, tree density and tree ages. Use site quality to identify and manage dispersal PFA and nest habitat at 2- to 2.5-mile spacing across the landscape.
  - **Evaluation**: Affected Environment → Vegetation Cover Types Within the Project Area → Vegetation Structure in Goshawk and MSO Habitat
  - **Evaluation**: Methodology → Modeling and Habitat Evaluation → Goshawk Habitat
- Snags are 18inches 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.
  - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Northern Goshawk
- The order of preferred treatment for woody debris is: (1) broadcast burning, (2) lopping and scattering, (3) hand piling or machine grapple piling, and (4) dozer piling.
  - **Evaluation**: Appendix D of the EIS
- **Canopy Cover**: 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).
  - **Evaluation**: Appendix D of the EIS
- **Ponderosa Pine**: Canopy cover for mid-aged forest (VSS 4) should average 40+ percent, mature forest (VSS 5) should average 40+ percent, and old forest (VSS 6) should average 40+ percent. Opening size is up to 4 acres with a maximum width of up to 200 feet. One group of reserve trees, three to five trees per group, would be left if the opening is greater than an acre in size. Leave at least two snags, three downed logs, and 5 to 7 tons of woody debris per acre.
  - **Evaluation**: Appendix D of the EIS
- **Woodland**: 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.

- **Evaluation**: Description of Alternatives → Actions Common to Alternatives B- E and Environmental Consequences → Forest Service Management Indicator Species → Management Indicator Species for Late-seral Pinyon-Juniper and Snags in Pinyon-Juniper Habitat.

Human Disturbance (Forest Plan p. 65-11):

- Limit human activities in or near nest sites and post-fledging family areas during the breeding season so that goshawk reproductive success is not affected by human activities.
- The breeding season extends from March 1 through September 30.
- Low-intensity ground fires are allowed at any time in all forested cover types, but high-intensity crown fires are not acceptable in the post-fledging family area or nest areas. Avoid burning the entire home range of a goshawk pair in a single year. For fires planned in the occupied nest area, a fire management plan should be prepared. The fire management plan should minimize the risk of goshawk abandonment while low-intensity ground fire burns in the nesting area. Prescribed fire within nesting areas should be planned to move with prevailing winds away from the nest tree to minimize smoke and risk of crown fire developing and driving off the adults or consuming the nest tree.
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, Mitigation

Ground Surface Layer (All forested cover types) (Forest Plan pp. 65-11 to 65-12)

- Manage road densities at the lowest level possible. Where timber harvesting has been prescribed to achieve desired forest condition, use small, skid trails in lieu of roads.
  - **Evaluation**: Methodology → Modeling and Habitat Evaluation → Roads for Hauling Forest Materials in Wildlife Habitat
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, Mitigation
- Piling of debris should be limited. When necessary, hand or grapple piling should be used to minimize soil compaction within piles and to minimize forest floor and herbaceous layer displacement and destruction.
  - **Evaluation**: Appendix D of the EIS
- Limit dozer use for piling or scattering of logging debris so that the forest floor and herbaceous layer is not displaced or destroyed.
  - **Evaluation**: Appendix D of the EIS

Note: The Coconino NF forest plan standards and guidelines do not describe desired even-aged stand conditions for goshawk non-PFA area habitat. The desired condition is to convert all foraging area even-aged stands to the uneven-aged structural conditions and convert all goshawk PFA/nest stands to the desired uneven-aged structural conditions.

Nonstructural Wildlife Habitat Improvement (Forest Plan p. 66)

- Improve vegetation conditions through seeding a mixture of species of grass, forbs, forage, and browse species desirable to wildlife.

  - **Evaluation**: Not applicable to the 4FRI. However, we expect to see substantial improvement in understory development as a result of the treatments – see appendix 6

- Improve forage conditions by using prescribed fire where environmental analysis shows beneficial effects and in line with approved burning plans.
  - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Northern Goshawk → see "Understory Development" for each alternative.

- Manage forage to increase threatened and endangered species and management indicator species (MIS) where it is determined appropriate through the integrated resource management (IRM) and National Environmental Policy Act (NEPA) process.
  - **Evaluation**: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Sensitive Species and Critical Habitat and Forest Service Management Indicator Species

T&E Nonstructural Wildlife Habitat Improvement (Forest Plan p. 66)

- Improve T&E and sensitive species habitat. Improvement projects give priority to recovery of T&E species. Conform to approved recovery plans.
  - **Evaluation**: Methodology → Modeling and Habitat Evaluation → Habitat Connectivity and appendix 8
  - **Evaluation**: Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Sensitive Species and Critical Habitat → Mexican Spotted Owls (Threatened) → see Forest Structure and Density, MSO Prey Habitat, and Other Habitat Effects under each alternative.

Insect and Disease Management (Forest Plan, p. 70)

- Habitat requirements for threatened, endangered, and sensitive species take precedence over insect and disease control.
  - **Evaluation**: This was not an issue in the 4FRI: The role of endemic insects and pathogens is recognized in the wildlife report (Affected Environment → Vegetation Cover Types Within the Project Area → Tree Density and appendix 6); silviculture treatments in MSO habitat are described in the introduction to the effects of each alternative (Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Sensitive Species and Critical Habitat → Mexican Spotted Owls (Threatened) → see alternatives B-E.

10,000-Acre Blocks (10K Blocks) (Forest Plan p. 70)

- Minimum management requirements are exceeded where it is good multiple-use management to do so, such as greater density of snags adjacent to meadows, riparian areas, and key water sources.
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices and Mitigation

- Wildlife habitat objectives for each 10K Block are evaluated on an individual stand basis as well as for the entire block.
  - **Evaluation**: Effects of proposed actions are evaluated by select habitat components relative to individual species. Each habitat component represents an average of the individual stands it

encompasses. Results are provided for multiple scales of analysis. Also see Methodology → Modeling and Habitat Evaluation → Hiding and Thermal Cover

- Evaluate the need for wildlife forage in the 10K Blocks using the Habitat Capability Index, other available data and professional judgment and, where needed, adjust prescriptions to obtain it. These areas are stands of up to 10 acres with reduced growing stock level (GSL).
  - **Evaluation**: Methodology → Modeling and Habitat Evaluation → Habitat Capability

Old-Growth (Forest Plan pp. 32-33)

- **Guideline**: 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.
  - **Evaluation**: Methodology → Modeling and Habitat Evaluation → Habitat Connectivity;
  - **Evaluation**: Affected Environment → Forest Service → Sensitive Species → Northern Goshawk → Old Growth;
  - **Evaluation**: Affected Environment → Forest Service Management Indicator Species → Late-Seral Ponderosa Pine Indicators;
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices and Mitigation;
  - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Northern Goshawk → see Old Growth and Density for each alternative;
  - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Bald Eagle → see Direct/Indirect Effects for each alternative;
  - **Evaluation**: Environmental Consequences → Forest Service Management Indicator Species → see Abert's Squirrel, Mule Deer, and Juniper Titmouse;
  - **Evaluation**: Appendix 7;
  - **Evaluation**: Appendix D of the EIS

MA 3

Manage habitat for the following indicator species through integrated stand management (p.117)

- Turkey
- Goshawk
- Pygmy nuthatch
- Elk
- Abert's squirrel
- Red squirrel
- Hairy woodpecker
- Spotted owl
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, Mitigation;

- **Evaluation**: Environmental Consequences → Forest Service Management Indicator Species;
- **Evaluation**: Appendix 10

Raptors (pp. 123-124):

Maintain a current inventory of nest locations. A nest group consists of nest tree and adjacent trees and is maintained at least as follows unless environmental analysis indicates either more or less is needed:

- Cooper's hawk – 15 acres of uncut area around active nests.
- Sharp-shinned hawk – 10 acres of uncut area around active nests.
- Other raptors – An area extending to 50 feet from active nests is left uncut.
  - **Evaluation**: Affected Environment → Migratory Birds and Important Bird Areas → Affected Environment → Important Bird Areas;
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, Mitigation;
  - **Evaluation**: Environmental Consequences → Migratory Birds and Important Bird Areas → Affected Environment → Important Bird Area
- Bald eagle winter roosts – Protect with a 300-foot radius uncut zone around the roost. Road development should avoid the roost and uncut zone.
  - **Evaluation**: Affected Environment → Forest Service Sensitive Species → Bald Eagle → Wintering;
  - **Evaluation**: Affected Environment → Migratory Birds and Important Bird Areas → Affected Environment → Important Bird Areas;
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, Mitigation (see "Nest Sites" and "Winter Roost Sites");
  - **Evaluation**: Environmental Consequences → Migratory Birds and Important Bird Areas → Affected Environment → Important Bird Area

Ospreys – At the start of Forest Plan implementation, the only known osprey nesting area is at Lake Mary. The following Standards and Guidelines apply to this nesting area. As additional nesting territories are discovered, environmental analysis is done to determine if, and to what extent, these Standards and Guidelines apply:

- Restrict all logging activities within one-fourth of a mile of active nests from March 1 through August 15.
- Provide a 20-acre nest site of uncut area around each existing (occupied or unoccupied) nest.
- Provide at least three potential nest sites in preferred nesting habitat within Designated Bald Eagle/Osprey Emphasis Area(s). This potential nest site should be at least 5 acres of mature and overmature trees with at least two snags per acre greater than or equal to 20 inches. Use of uneven-aged stands is optimal [osprey portion not relevant to 4FRI].
- Construct artificial nesting platforms as needed for habitat maintenance and improvement [not relevant to 4FRI].
- Forest-wide, during 10K Block planning, give high priority to managing for snags within potential osprey habitat. Snags and old growth managed for osprey habitat contribute to the 10K Block requirements.

- Manage for at least two snags per acre of 20inches or greater. Snags should be the height of the canopy or taller, on at least percent of the acres along the shorelines. Where necessary to provide sufficient perches and nest sites, take actions to create snags.
- Road construction or reconstruction should avoid osprey nest sites [not relevant to 4FRI].
- New roads should not be constructed within 660 feet of nests [not relevant to 4FRI].
- Where human disturbance is causing reproductive failure, evaluate the need to close the area from March 1 to at least August 15.
    - **Evaluation**: Affected Environment → Migratory Birds and Important Bird Areas → Affected Environment → Important Bird Areas;
    - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, Mitigation
    - **Evaluation**: Environmental Consequences → Migratory Birds and Important Bird Areas → Affected Environment → Important Bird Area.
- In cooperation with the Arizona Game and Fish Department, develop and implement an osprey and wintering bald eagle public education program.
    - **Evaluation**: Both the Coconino and Kaibab NFs have a Nest Watch program in cooperation with the Arizona Game and Fish Department (AGFD) separate from the 4FRI.

Wildlife Cover (pp.: 124-125)

- Manage for at least 30 percent cover in 10K Blocks. Of this total at least one-third is in thermal cover, one-third is in hiding cover, and the remaining one-third is in either thermal or hiding cover.
- Emphasize maintaining some thermal cover in known travelways and bedding areas. Emphasize maintaining some hiding cover adjacent to dependable water and key openings, along known travelways, and in pine stringers. Cover areas should be at least 200 feet wide; however, pine stringers less than this width may still be managed for hiding and thermal cover.
- Evaluate existing and potential cover on a stand-by-stand basis. Consider open road densities, topography, and non-commercial tree, shrub, and herbaceous species to determine effective cover.
- Protect and manage to include hiding and thermal cover known fawning and calving areas and defer logging activities from May 15 to June 30 in these areas.

Species Size Class Acceptable Range

Ponderosa Pine - Hiding Cover

- 1 – 5inches dbh 150 – 170 GSL
- 5 – 9inches dbh 150 – 180 GSL
- 9 – 12inches dbh 160 – 200 BA
- Area Size 15 – 25 acres

Ponderosa Pine - Thermal Cover

- 5 – 9inches dbh 180 – 200 GSL
- 9 – 12inches dbh 180 – 210 BA
- 12 – 15inches dbh 200 – 240 BA

- Area Size 30 – 40 acres
  - **Evaluation**: Methodology → Modeling and Habitat Evaluation → Hiding and Thermal Cover
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, Mitigation
  - **Evaluation**: Environmental Consequences → Forest Plan Compliance – Hiding and Thermal Cover
  - **Evaluation**: Appendix 9

Squirrel Habitat (p. 125):

- Manage for at least 20 percent of potential habitat capability for red squirrels in 10K Blocks as determined by the Forest Habitat Capability Model. As needed to meet habitat capability, protect red squirrel primary caches at a density of one cache per 2 acres. Retain all trees within a 26-foot radius from the cache (1/20th acre) (mixed conifer only).
- Manage for at least 20 percent of potential habitat capability for Abert'ssquirrels in 10K Blocks as determined by the Forest Habitat Capability Model.
  - **Evaluation**: Methodology → Modeling and Habitat Evaluation → Habitat Connectivity and Habitat Capability;
  - **Evaluation**: Environmental Consequences → Forest Service Management Indicator Species → Abert's Squirrel [Note that red squirrels are an MIS for mixed-conifer habitat and are not part of this project evaluation];
  - **Evaluation**: Appendices 7through 10

Spotted Owl and Bear Habitat (pp. 125-126):

- Whenever possible, areas managed for old-growth, bear, and spotted owls are the same. Evaluate owl and bear habitat needs as well as cover during project planning.
  - **Evaluation**: Methodology → Modeling and Habitat Evaluation → MSO habitat and Understory biomass and Habitat Connectivity and Habitat Capability and Hiding and Thermal Cover;
  - **Evaluation**: Affected Environment → Vegetation Cover Types Within the Project Area → Ponderosa Pine Forest and Grasslands, Savannas, and Meadows and Vegetation Structure in Goshawk and MSO Habitat;
  - **Evaluation**: Affected Environment →Forest Service Sensitive Species→ Northern Goshawk → Old Growth
  - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species →Northern Goshawks → see "Old Growth" under individual alternative assessments.
  - **Evaluation**: see MSO references above.

Turkey Nesting and Roosts (p. 126):

- Defer timber harvesting and slash treatment activities in turkey nesting areas from April 15 through June 30.
- Leave scattered patches of untreated slash within 1/2 mile of dependable water in actual or potential turkey nesting areas. Patches are at least 1/4 acre in size and cover at least 10 percent and not more than 20 percent of the harvested area.

- Slash is left untreated for at least 5 years, longer if it is determined that nesting is still occurring in the area. These guidelines will be evaluated and adjustments made, if necessary.
- Retain and/or develop an average of at least two turkey roost tree groups per section, in actual or potential turkey habitats.
- Retain and/or develop an average of at least four turkey roost tree groups per section in identified key turkey winter range.
    - **Evaluation**: Methodology → Modeling and Habitat Evaluation → Habitat Connectivity and Habitat Capability and Hiding and Thermal Cover.
    - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, Mitigation
    - **Evaluation**: Environmental Consequences → Forest Service Management Indicator Species → Coconino NF Late-seral Ponderosa Pine Habitat Trend and Turkey and Cumulative Effects for Management Indicator Species and Forest Plan Compliance – Hiding Cover
    - **Evaluation**: Appendices 7 through 10
    - **Evaluation**: Appendix D of the EIS

Gambel oak management direction – see silviculture

MA 4

Manage for the following indicator species:

- Turkey
- Goshawk
- Pygmy nuthatch
- Elk
- Abert'ssquirrel
- Red squirrel
- Hairy woodpecker
- Spotted owl
- Evaluation: references in MA 3 above.

Spotted Owl and Bear Habitat (p. 140):

- Whenever possible, areas managed for old-growth, bear, and spotted owls are the same. Evaluate owl and bear habitat needs during project planning.
    - **Evaluation**: references in MA 3 above and MA 12 below.

MA 5

Manage for the following indicator species (p. 141):

- Yellow-bellied sapsucker [Note this was species was split and the forest now analyzes the red-naped sapsucker instead]
    - **Evaluation**: Affected Environment → Forest Service Management Indicator Species → Species Indicators for Late-seral Aspen and Snags in Aspen;

  - **Evaluation**: Affected Environment → Migratory Birds and Important Bird Areas → Affected Environment;
  - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Northern Goshawk → see Aspen and Understory Development by alternative;
  - **Evaluation**: Environmental Consequences → Forest Service Management Indicator Species → Species Indicators for Late-seral Aspen and Snags in Aspen and Cumulative Effects for Management Indicator Species;
  - **Evaluation**: Environmental Consequences → Migratory Birds and Important Bird Areas → High-Elevation Grassland Habitat and Cumulative Effects for Migratory Birds
- Mule deer
  - **Evaluation**: Affected Environment →Vegetation Cover Types Within the Project Area → Ponderosa Pine Forest;
  - **Evaluation**: Affected Environment → Forest Service Management Indicator Species → Species Indicators for Late-seral Aspen and Snags in Aspen and Species Indicators for Early-seral Aspen and Pinyon-Juniper;
  - **Evaluation**: Environmental Consequences → Forest Service Management Indicator Species → Species Indicators for Early-seral Aspen and Pinyon-Juniper and Cumulative Effects for Management Indicator Species;
  - **Evaluation**: Appendix 10

Structural Wildlife Habitat Improvements (p. 141)

- Wildlife fence to protect aspen regeneration from grazing or wildlife where necessary
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, Mitigation
  - **Evaluation**: Environmental Consequences → Forest Service Sensitive Species → Management Indicator Species for Late-seral Aspen and Snags in Aspen and Management Indicator Species for Early-seral Aspen and Juniper
  - **Evaluation**: Appendix D of the EIS

MA 6

Manage for the following indicator species (p.145):

- Elk
- Abert'sSquirrel
- Mule Deer
- Hairy Woodpecker
  - **Evaluation**: MA 3 and 4 for species references.
- Turkey Habitat: Manage to retain and/or develop an average of at least four turkey roost tree groups per section in identified turkey winter range (p.147).
  - **Evaluation**: MA 3 for references.

MA 7 p. 148

- Wildlife habitat management emphasizes forage production on 0 to 15 percent slopes, in conjunction with firewood harvest using integrated stand management. Old-growth, cover, and snags are generally provided on slopes greater than 15 percent. However, exceptions will occur if dispersion requirements for habitat components are not met on these steep slopes. Where necessary to meet 10K Block requirements or specific habitat needs, one or more of these components can be obtained through management emphasis on the gentler slopes.
    - **Evaluation**: Treatments across nearly the entire area can be summarized as either management for MSOs or management for northern goshawks. The Environmental Consequences analysis for both species includes changes to understory production and snags. In addition, see appendix 6 for a synthesis of literature related to forest management and understory response. All action alternatives include the Old Tree Implementation Plan and alternative C has a Large Tree Implementation Plan as well. See references above for specific consideration on old-growth. Similarly, many Sensitive Species, MIS and migratory birds include cavity-nesters or other snag associates or depend on understory vegetation. Analysis of the effects of the proposed treatments on understory response and snags permeate the wildlife specialist report.

Manage for the following indicator species:

- Plain titmouse [Note this species was split and we now analyze the juniper titmouse]
    - **Evaluation**: Affected Environment → Forest Service Management Indicator Species → Species Indicators for Late-seral Pinyon-Juniper and Snags in Pinyon-Juniper
    - **Evaluation**: Environmental Consequences → Forest Service Management Indicator Species → Management Indicator Species for Late-seral Pinyon-Juniper and Snags in Pinyon-Juniper and Cumulative Effects for Management Indicator Species
    - **Evaluation**: Environmental Consequences → Migratory Birds and Important Bird Areas → High Elevation Grassland Habitat
- Mule deer
- Elk
    - **Evaluation**: MA 3 and MA 4 for species references.
- Areas needing additional forage for elk and mule deer are given first priority in scheduling firewood/wildlife habitat treatments. Treatments are usually done in areas remote from intensive development and high road densities.
    - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, Mitigation
- Evaluate bear habitat needs during project planning in dense pinyon-juniper, areas adjacent to steep pinyon-juniper, or pinyon-juniper associated with chaparral species (p. 151).
    - **Evaluation**: Outside of the Tusayan Urban Interface treatment, most treatment in pinyon-juniper habitat is prescribed fire-only. Mechanical treatments are proposed in limited areas with site-specific objectives. Overall, minor changes to structure in pinyon-juniper habitat are expected and these changes should improve foraging habitat while retaining cover for black bears – see Silviculture report for details on pinyon-juniper treatments.
- Created openings in areas that have been identified as historic big game winter range are designed so that an animal will be no more than 10 chains (660 feet) from hiding cover at any location within the

opening. Harvested areas are separated from adjacent areas by at least an 8 chain wide untreated strip (p. 152).

  - **Evaluation**: The silviculture report and appendix D of the EIS.

- Cover corridors are laid out to connect treated areas or breaks in terrain to provide interconnecting cover corridors. Known or suspected routes of game travel are used to lay out cover corridors. Corridors are managed to create at least 60 percent crown cover, and are at least 8 chains wide (p. 152).
  - **Evaluation**: Methodology → Modeling and Habitat Evaluation → Habitat Connectivity and appendix 8.
- Use steep, rocky, or otherwise unmanaged areas useable by game to satisfy wildlife cover requirements to the extent possible (MA 8). Cover requirements are considered on a 10K Block basis (p. 152).
  - Evaluation: Affected Environment → Vegetation Cover Types → Ponderosa Pine Forest → Ponderosa Pine – Gambel Oak.
- An average of three unburned piles per acre are left on areas with piled slash to provide cover for birds and small animals or leave lopped and scattered slash on 30 percent of treatment area (p. 153).
- Manage for at least 30 percent cover (p. 153).
- Emphasize cover management in travelways, bedding areas, reproductive areas, and adjacent to dependable waters and key openings (p. 153).
- Cover is managed to provide at least 60 percent crown cover and at least 8 chains wide. Manage for hiding and thermal cover in known fawning and calving areas (p. 153).
- Manage for small game and nongame by leaving an average of one slash pile per 3 acres in the woodland type and/or leave lopped and scattered slash on 30 percent of area harvested (p. 153).
- Manage pine stringers to emphasize wildlife habitat needs by maintaining turkey roosts and big game cover (p.154).
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, and Mitigation, and the silviculture and fire ecology reports.

MA 9 – p. 158

Manage for the following indicator species:

- Antelope [Note that this is a reference to pronghorn]
  - **Evaluation**: Affected Environment → Vegetation Cover Types Within the Project Area → Grasslands, Savannas, and Meadows and Forest Service Management Indicator Species → MIS for the Coconino NF and MIS for the Kaibab NF;
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, and Mitigation ;
  - **Evaluation**: Environmental Consequences → Forest Service Management Indicator Species → Management Indicator Species for Early and Late Seral Grasslands and Cumulative Effects for Management Indicator Species.
- Elk

- **Evaluation**: MA 3 above.

MA 10

Manage for the following indicator species (p. 162)

- Antelope
  - **Evaluation**: MA 9 above.
- Control invasion of undesirable plant species when necessary to improve and protect wildlife habitat values. Prescribed burning will be one specific practice used, especially where needed to improve wildlife habitat (p. 164)
  - **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, and Mitigation.

MA 12

Emphasize wildlife habitat, visual quality, fish habitat, and watershed condition on the wetlands, riparian forest, and riparian scrub (p. 172).

- **Evaluation**: These habitats are outside of the 4FRI treatments.

Manage for the following indicator species (p. 172)

- Cinnamon teal
- Lincoln's sparrow
- Yellow-breasted chat
- Lucy's warbler
  - **Evaluation**: The habitats for which these species serve as indicators are outside of the 4FRI treatment area and so were not considered as part of this analysis.
- Macroinvertebrates
  - **Evaluation**: The habitat for which this MIS was selected is outside of the 4FRI treatment area and so they were not included as habitat indicators. However, they were discussed in terms of predator-prey relationships. See Environmental Consequences → Federally Listed Threatened, Endangered, Proposed, and Sensitive Species and Critical Habitat → Narrow-headed garter snake;
  - the 4FRI aquatics report
  - and the prey/habitat discussions for fish and narrow-headed garter snakes in the 4FRI Biological Assessment (appendix 2 of the wildlife report).

Wetlands and open water containing emergent vegetation that provide nesting habitat are protected from disturbing uses that will harass nesting birds, such as activities that are noisy or would damage nests or nesting habitat from May 1 to July 15 (p.173).

- **Evaluation**: These habitats are outside of the 4FRI treatment area, however, see Description of Alternatives → Design Features, Best Management Practices, and Mitigation for a design feature retaining cover near dependable waters.

Evaluate bear habitat needs during project planning. Defer logging activities from April 15 to June 30 in known bear maternity areas (p. 176).

- **Evaluation**: Affected Environment → Other Species of Concern → Black Bears;
- Description of Alternatives → Design Features, Best Management Practices, and Mitigation.

MA 13

Management indicator species for this MA are mule deer, pygmy nuthatch, and hairy woodpecker (p. 179).

- **Evaluation**: Above references for these species.

MA 14

Support research efforts that further define the habitat requirements of native fish and bat populations. Protect and/or restore habitat conditions that may be limiting these populations (p.185)

- **Evaluation**: No native fish or bat proposals were brought forward. However, the 4FRI is supporting research on land birds and squirrels and watershed yield research projects. In addition, letters of support were written for research on caves and MSO response to fuels reduction (both projects were funded).

MA 15

Evaluate bear habitat needs during project planning (p. 190).

- **Evaluation**: See MA 12 above.

MA 18

No direction

MA 20

On-the-ground design of the recovery area and adjacent stands will include maintenance of large animal movement to and from areas on either side of the highway. Factors such as density of trees, location of right-of-way fence and topography will be considered (p.206-4)

- **Evaluation**: MA 20 occurs along Highway 180 with an emphasis on highway safety. 4FRI treatments would follow this direction.

MA 28 (p. 206-54)

Protect key elk, peregrine falcon, turkey, and deer winter habitat. Protect turkey roosts from recreational activities, especially dispersed camping and motor vehicle traffic.

- **Evaluation**: MA 28 is a travel route from I-17 to Sedona. 4FRI would implement the Travel Management Rule, addressing recreation impacts. Restoration activities incorporated within the 4FRI treatments should improve ungulate habitat and design features should ensure turkey roosts are protected. Treatment activities would not affect cliff habitats where peregrine falcons nest but could improve foraging habitat. Design features should minimize any disturbance to nest peregrine falcons.
- See Description of Alternatives → Design Features, Best Management Practices, and Mitigation

- Environmental Consequences → Management Indicator Species → Management Indicator Species for Late-Seral Ponderosa Pine and Management Indicator Species for Early-Seral Ponderosa Pine and Management Indicator Species for Early Seral Aspen and Pinyon-Juniper
- Environmental Consequences →Forest Service Sensitive Species → American Peregrine Falcon

Flagstaff/Lake Mary Ecosystem Analysis (FLEA) p. 206-67

Restrict human activities within approximately one-half (½) mile of occupied peregrine falcon nest sites March 1st through August 15th. The ½ mile protection distance may vary depending on local topography, potential for disturbance, and location of important habitat components. Monitor peregrine nesting success to determine if restrictions are effective.

Restrict human activities where active raptor nests are located. Species potentially impacted include the golden eagle, prairie falcon, Mexican spotted owl, and zone-tailed hawk. Protection distance will vary depending on the species, local topography, potential for disturbance, and breeding season for the species. Raptor surveys will be completed on site-specific areas to determine protection distance.

- **Evaluation**: Description of Alternatives → Design Features, Best Management Practices, and Mitigation.

Wildlife Habitat p. 206-72-73, 75-76

Habitats support diverse, healthy populations of native plants and animals. A natural variety of plant species, age classes, and structures are present. The impacts of non-native plant and animal species are controlled and the introduction and maintenance of undesirable non-natives is discouraged. Threatened, endangered, sensitive, and management indicator species are maintained or recovering in the majority of the habitat.

Maintain wildlife travelways to help animals travel between summer and winter ranges, feeding and nesting areas, maternity areas, and dispersal areas. Travelways help ensure genetic mixing necessary for healthy populations.

- **Evaluation**: The 4FRI is a restoration project designed to improve forest structure and increase resilience. The entire wildlife report, including appendices, addresses this guideline.

Mexican Spotted Owl Guidelines

Do not identify target threshold stands within the Urban/Rural Influence Zone. The allocation of target threshold habitat within the Lake Mary Watershed and Shultz MAs would better provide for long-term management of roost/nest habitat for the Mexican spotted owl. Approximately 26 percent of the Shultz MA and 11 percent of the Lake Mary Watershed should be managed for target-threshold conditions in the future, due to not allocating target threshold conditions in the URIZ. Within the FLEA area, survey habitat that potentially could be used for nesting, roosting, or breeding, and is within ½ mile of a proposed site-specific project boundary.

- **Evaluation**: Methodology → Modeling and Habitat Evaluation → MSO Habitat.
- Affected Environment → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owl Habitat
- Appendix D of the EIS

Northern Goshawk Guidelines

In the Urban/Rural Influence Zone, where possible, limit human activities within the 30-acre goshawk nest stand during the breeding season. In general however, do not curtail human activity such as informal dispersed recreation activities within the post-fledging family areas (PFA). Social trails are likely to occur within portions of PFAs in the urban and rural influenced areas. Locate Forest Service system trails to avoid nest sites within PFAs, within the Urban/Rural Influence Zone. Emphasize the need to control pets on Forest Service system trails through education and enforcement.

- **Evaluation**: No new trails are proposed as part of the 4FRI implementation;
- See Methodology → Modeling and Habitat Evaluation → Goshawk Habitat.

Bald Eagle Guidelines

Bald eagle winter roosts and perch habitat will be evaluated for long-term viability. Silvicultural methods that encourage regeneration and growth of desirable trees may be used near roost sites. Groves of trees may be maintained to provide screening for roost and perch areas. Silvicultural practices will result in the growth of large diameter trees with open crowns in multi-layered stands. Prescribed fires to improve and protect roost areas may be used with effective protection of large trees and snags. Human activities will be managed so that disturbance does not interfere with the eagle's ability to use the site.

- **Evaluation**: Affected Environment → Forest Service Threatened Species → Northern Goshawk
- Affected Environment → Bald and Golden Eagle Protection Act
- Description of Alternatives → Design Features, Best Management Practices, and Mitigation.
- Environmental Consequences → Forest Service Sensitive Species → Bald Eagles
- Environmental Consequences → Forest Service Sensitive Species → Bald and Golden Eagle Protection Act

Threatened and Endangered Species Guidelines

Seek opportunities to add to our base of knowledge about human disturbance to T&E species. This could be a variety of methods that could include but are not limited to, monitoring, survey of habitat, survey of recreation uses, or trail counters. Consider options to gather information when planning, or implementing, or monitoring site-specific projects, or approving special uses or outfitter guides. Consider partnership opportunities with organizations or agencies to gather information outside of site-specific project planning. A variety of methods could be used to gather information including, but not limited to: monitoring, survey of habitat, survey of recreation uses, or trail counters. Share results and data among resource personnel and line officers for consideration in future projects with wildlife biologists and recreation staff to incorporate lessons learned into the next project. If analysis shows a need, management changes that could include, but are not limited to, relocating roads or trails, limiting season of use, designating types of activities, or reducing numbers of users could result if analysis shows a need.

- **Evaluation**: A comprehensive monitoring plan has been developed in cooperation with the USFWS to evaluate effects of management activities on MSOs (see appendix 2). .

Maintain connected patches of denser vegetation that, along with topography, provide travel corridors for wildlife to move through the FLEA area. Maintain the two corridors that occur in the Urban/Rural Influence Zone. They are in the vicinity of A1 Mountain/Fort Valley, Naval Observatory, and along the Rio de Flag.

- **Evaluation**: Appendices 7 and 8 describe the array of closed canopy habitats post-treatment and the landscape corridors incorporated into project planning.

For all the MA in FLEA, management indicator species will be the same as they currently are for each original MA, which is based on vegetation type and slope. For example, lands that are covered with ponderosa pine on less than 40 percent slope will have the management indicator species described for MA 3 in the Forest Plan.

- **Evaluation**: See MA 3 above.

Within the Urban/Rural Influence Zone, and in the Wildland Urban Interface (1U) as depicted on the Fire Management Analysis Zones map, do not apply the hiding and thermal cover guideline that requires 30 percent cover within a 10K Block. Distribute wildlife cover where needed within the FMAZ 1U without accruing unacceptable wildfire threat to nearby neighborhoods. Wherever possible, projects should retain cover conditions within wildlife travelways, MSO protected activity centers (PAC's), along canyon rims, and on steeper slopes. Projects within the FMAZ 1U, should attempt to retain 15 percent cover within a given section.*

Dense stand conditions on steep slopes and within MSO PAC's contribute to the targeted 15 percent cover condition. Cover conditions might exceed 15 percent per section due to the presence of steeper slopes or MSO PACs. In the absence of steep slopes or MSO PACs, site-specific projects could retain a maximum of 15 percent cover condition to maintain a wildlife travelway through a section. Projects do not have to retain cover conditions of 15 percent, if a given section poses a high fire hazard to nearby neighborhoods

- **Evaluation**: Methodology → Modeling and Habitat Evaluation → MSO Habitat and Habitat Connectivity and Hiding and Thermal Cover
- Description of Alternatives → Design Features, Best Management Practices, and Mitigation.
- Appendices 4, 7, and 8 describe PAC conditions in this MA, the array of closed canopy habitats post-treatment, and the landscape corridors incorporated into project planning.

MA 31

MIS should be referenced by vegetation and landform type. For example, in pinyon-juniper woodland areas, MIS are those listed for MA 7 (p. 206-84)

- **Evaluation**: See MA 7 and Affected Environment → Forest Service Management Indicator Species.

MA 32

MIS should be referenced by vegetation and landform type. For example, in pinyon-juniper woodland areas, MIS are those listed for MA 7 (p. 206-88)

- **Evaluation**: See MA 7 and Affected Environment → Forest Service Management Indicator Species.

MA 33 p. 206-92

MIS should be referenced by vegetation and landform type. For example, in pinyon-juniper woodland areas, MIS are those listed for MA 7.

- **Evaluation**: See MA 7 and Affected Environment → Forest Service Management Indicator Species.

MA 34

No direction

MA 35 p. 206-98, 100

MIS should be referenced by vegetation and landform type. For example, in ponderosa pine lands less than 40 percent slope MIS are those listed for MA3.

- **Evaluation**: See MA 3 and Affected Environment → Forest Service Management Indicator Species.

MA 36

Take actions at Marshall Lake to continue use and enjoyment of Marshall Lake and to maintain important waterfowl nesting habitat. Continue maintenance of the Marshall Lake wetland in cooperation with the Arizona Game and Fish Department through such actions as matting, mowing or other actions that create waterholes in the reeds. Maintain the current boat ramp and enhance wildlife viewing opportunities. Consider making a portion of the lake and adjacent forested areas, an exclosure that prohibits dogs, people, and hunting during the waterfowl-nesting season of May 1 to July 15 to increase nesting success of upland game birds.

Refer to more recent management guidelines and conservation assessments that exist for bald eagle winter habitat management.

The designated bald eagle/osprey emphasis area should be expanded to include future perch and roost trees in key areas.

- **Evaluation**: Marshall Lake is outside of the 4FRI implementation area.

MA 37 (p. 206-111)

In the Primitive, Semi-primitive Non-motorized, and Semi-primitive Motorized ROS settings, maintain large tracts of unfragmented habitat for turkey and bear.

- **Evaluation**: See Affected Environment → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owl Habitat → Road Systems for a description of road obliteration and the scenery report for a description of implementing ROS settings.

MA 38 (p. 206-111, 116)

In the Fort Valley and A-1 Mountain areas, maintain the wildlife travelway that connects A-1 Mountain, Observatory Mesa, and the slopes of the San Francisco Mountain. Lands west of A-1 Mountain in Semi-primitive Non-motorized ROS setting maintain large tracts of unfragmented habitat for turkey and bear

Avoid or limit human disturbance to rare species such as peregrine falcon and Arizona bugbane.

- **Evaluation**: See appendices 4, 7, and 8 for evaluation/creation/maintenance of travelways;
- Affected Environment → Federally Listed Threatened, Endangered, Proposed, and Candidate Species and Critical Habitats → Mexican Spotted Owl Habitat → Road Systems for a description of road obliteration;

- Affected Environment and Environmental Consequences → Forest Service Management Indicator Species → MIS for the Coconino NF → Late-Seral Ponderosa Pine Species Indicators → Turkey
- Affected Environment → Other Species of Concern → Black Bears

Kaibab Forest Plan

Desired Conditions for Wildlife (p. 49)

- Native wildlife species are distributed throughout their potential natural range. Desirable nonnative wildlife species are present and in balance with healthy, functioning ecosystems.
- Habitat is available at the appropriate spatial, temporal, compositional, and structural levels such that it provides adequate opportunity for breeding, feeding, nesting, and carrying out other critical life cycle needs for a variety of vertebrate and invertebrate species.
- Species with specific habitat needs (e.g. snags, logs, large trees, interlocking canopy, and cavities) are provided for.
- Grasses, forbs, and shrubs provide forage, cover, fawning, and nesting sites.
- Interconnected forest and grassland habitats allow for movement of wide ranging species and promote natural predator-prey relationships, particularly for strongly interactive species (e.g., mountain lions).
- Habitat configuration and availability allow wildlife populations to adjust their movements (e.g., seasonal migration, foraging, etc.) in response to climate change and promote genetic flow between wildlife populations.
  - **Evaluation**: All action alternatives would be consistent with desired conditions for wildlife within the Kaibab National Forest portion of the project area. The project would maintain the distribution of wildlife species on the forest. Specific habitat needs are addressed though mitigations (W-1 through W-54) and with meeting the desired conditions for the different vegetation types on the forest (see Silvicultural consistency check). The development of the open and closed corridors will help maintain the interconnected forest and grassland habitat and habitat configuration to allow for wildlife movements.
  - Alternative A currently is consistent with the desired conditions. Over time, the forest could lose some of the specific habitat needs due to the high risk of uncharacteristic high-severity wildfires, overcrowding of ponderosa pine stands that will impede the growth of large trees and the development of a healthy understory, and the continual encroachment of grasslands with conifers.

Guidelines for Wildlife (p. 49)

- Project activities and special uses should be designed and implemented to maintain refugia and critical life cycle needs of wildlife, particularly for raptors.
- Potentially disturbing project-related activities should be restricted within 300 yards of active raptor nest sites between April 1 and August 15.
  - **Evaluation**: Alternative A is consistent since no activities would occur near nest sites.

Desired Conditions for Threatened, Endangered, and Sensitive Species (p. 51)

- Threatened, endangered, and sensitive species have quality habitat, stable or increasing populations, and are at low risk for extirpation.
- Goshawk nest areas are multi-aged forests dominated by large trees with interlocking crowns and are generally denser than the surrounding forest.
    - **Evaluation**: All action alternatives would be consistent with desired conditions for TES species within the Kaibab National Forest portion of the project area. The project would maintain the distribution of wildlife species on the forest. Specific habitat needs and protections are addressed though mitigations (W1-W4, W12-W18, W32-W40, W43-W45, and W54) and with meeting the desired conditions for the different vegetation types on the forest (see Silvicultural consistency check). Appendix D provides habitat design features for the Mexican spotted owl and goshawk to use during the implementation of the project on the ground.
    - Alternative A currently is consistent with the desired conditions. Over time, the forest could lose some of the specific habitat needs due to the high risk of uncharacteristic high-severity wildfires, overcrowding of ponderosa pine stands that will impede the growth of large trees and the development of a healthy understory, and the continual encroachment of grasslands with conifers.

Guidelines for Threatened, Endangered, and Sensitive Species (pp. 51-52)

- Project activities and special uses occurring within federally listed species habitat should integrate habitat management objectives and species protection measures from approved recovery plans.
- Project activities and special uses should be designed and implemented to maintain refugia and critical life cycle needs of Forest Service Sensitive Species.
- 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.
- 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.
    - **Evaluation**: All action alternatives are consistent with the guidelines for TES species. The 4FRI interdisciplinary team worked with the USFWS to develop treatments that would move toward the recovery of the species as well as protect the habitat from the potential of removal from of uncharacteristic high-severity wildfires. Mitigations have been developed for the sensitive species to maintain refugia and critical life cycle needs (see appendices C and D).
    - Alternative A currently is consistent with the desired conditions at this time. Overtime the forest could lose some of the specific habitat needs due to the high risk of uncharacteristic high-severity wildfires, overcrowding of ponderosa pine stands that will impede the growth of large trees and

the development of a healthy understory, and the continual encroachment of grasslands with conifers.

Desired Conditions for Rare and Narrow Endemic Species (p. 52)

- Habitat and refugia are present for narrow endemics or species with restricted distributions and/or declining populations.
- Location and conditions of rare and narrow endemic species are known.
    - **Evaluation**: All alternatives would be consistent with the desired conditions for rare and narrow endemics species. Mitigations have been developed for the action alternatives to maintain habitat and refugia for these species.

Guideline for Rare and Narrow Endemic Species (p. 52)

- Project design should incorporate measures to protect and provide for rare and narrow endemic species where they are likely to occur.
    - **Evaluation**: All alternatives would be consistent with the desired conditions for rare and narrow endemics species. Mitigations have been developed for the action alternatives maintain habitat and refugia for these species.

Also, see silviculture and fire sections which provide wildlife-related direction.

Appendix 2. Consultation Documents for the 4FRI: Biological Assessment and Biological Opinion

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Consultation History and Errata

The US Fish and Wildlife Service (USFWS) reviewed 2 drafts of the 4FRI Biological Assessment (BA) in 2013. A final BA was submitted on February 14th, 2014. The Forest Service then reviewed 2 drafts of the Biological Opinion (BO). During the review of the second draft BO errors were discovered in the numbers provided to the USFWS in the BA. The error was in the total number of PACs (Protected Activity Centers) "treated." The original total was based on the total number of PACs proposed for mechanical thinning and/or prescribed fire. The total number of PACs proposed for mechanical thinning and/or prescribed fire (70) represents those PACs where the biggest impacts to MSO habitat are expected. In addition, 2 PACs were proposed for site-specific, ephemeral channel restoration. Therefore, the total number of PACs with management actions was changed to 72. An errata document was prepared for the USFWS with this new number. The errata document provided opportunities to edit portions of text for better clarity, address omissions (i.e., including both PACs with proposed ephemeral channel restoration in the PAC-by-PAC discussions), provide updates on changes in the landscape (i.e., Slide Fire effects, boundary shifts to account for the Flagstaff Watershed Protection Project that led to changes in areas proposed for treatment), and changes in the method for assessing noise disturbance (a result of continued collaboration with the USFWS).

These errors/changes were sent to the USFWS on September 26, 2014. This updated information was incorporated into the final BO, received from the FWS on October 20th, 2014.

Biological Assessment

Mike Childs – Aquatic Species

Debra Crisp -- Botany

Bill Noble – Mexican spotted owls and owl habitat

Cary Thompson – Eagles and narrow-headed garter snakes

1. Background/History

Introduction

There is a need to increase forest resiliency and sustainability, protect soil productivity and improve soil and watershed function in the ponderosa pine forests across northern Arizona. The purpose of this Biological Assessment is to analyze the potential impacts to listed species from implementing the proposed 4 Forest Restoration Initiative (4FRI). The project intends to restore or move ecosystem elements toward restoration by addressing forest structure and pattern, forest health, and vegetation composition and diversity. Improved resiliency increases the ability of the ponderosa pine forest to support wildlife and fisheries habitats during stochastic events such as fire, insect and disease outbreaks, and climate change (Forest Service Manual [FSM] 2020.5). This Biological Assessment is prepared in accordance with legal requirements set forth under Section 7 of the Endangered Species Act ([ESA]16 U.S.C. 1536 (c)), and follows the standards established by the Forest Service for conducting analyses under the National Environment Policy Act (NEPA) and ESA. The 4FRI Draft Environmental Impact

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Comment [pg1]: Probably best to spell out biological assessment because BA is the acronym used for basal area later in the report

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Statement (DEIS) and associated specialist reports were developed over the course of nearly 3 years. During this whole time the Mexican Spotted Owl (MSO) Recovery Plan was in effect (USDI FWS 1995). Therefore, this Biological Assessment follows the terminology and framework established in that plan ("Recovery Plan"). The 1st Revision of the MSO Recovery Plan (USDI FWS 2012a) was released shortly after the DEIS was sent to the Government Printer. The objectives of this Biological Assessment are to

1. Analyze the potential impacts of implementing proposed actions for the 4FRI that may affect federally threatened, endangered, proposed, and candidate species, and designated or proposed critical habitats.
2. Determine the potential effects from implementing those actions on federally listed, proposed, and candidate species and designated or proposed critical habitats.

Changes have occurred in the number of protected activity centers (PACs) being treated and acres of MSO habitat types since the draft Biological Assessment was submitted for review. New PACs have been delineated (Table 1), old PACs that no longer support MSOs have been removed, and some PACs were transferred to the Flagstaff Watershed Protection Project (Table 2). Acreage changes have been minor relative to the total number of acres overall and within each habitat type.

Table 1. New PACs since the release of the DEIS

PAC Name	Area
Bridge	Treatment
Weatherford2	Treatment
Bear Tank #2	Project

Table 2. PACs no longer part of 4FRI

PACs Name	Reason for Change
Schultz Creek	Transferred to FWPP (Dry Lake Hills area)
Mt Elden	Transferred to FWPP (Dry Lake Hills area)
De Toros	Transferred to FWPP (Mormon Mtn area)
Mormon Mountain North	Transferred to FWPP (Mormon Mtn area)
Jack Smith	Combined with Pipeline
Viet	Combined with Snowbowl Road
Weatherford	Retired

2. Description of the Action and Action Area;

Location

Implementation of the 4FRI would occur on the Flagstaff and Mogollon Rim Ranger Districts of the Coconino National Forest and the Tusayan and Williams Ranger Districts of the Kaibab National Forest. Flagstaff is centrally located in the 4FRI area, which extends from the south boundary of Grand Canyon National Park to the Mogollon Rim. The 4FRI area also encompasses lands from the western extent of ponderosa pine west of Williams to the Upper Beaver Creek watershed on the Coconino National Forest. Communities in the vicinity of the proposed treatments include Flagstaff, Williams, Tusayan, Munds Park, and Mormon Lake. Legal descriptions of sections where implementation activities would occur are listed in Appendix 1.

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Due to the size of the project area, the Forest Service utilized a strategy developed by the 4FRI stakeholders to stratify the landscape into six restoration units (Figure 1). A Restoration Unit is a contiguous geographic area that ranges from about 46,000 acres to 333,000 acres in size.

Restoration Unit 1 is generally located south of I-40 and east of I-17. Restoration Unit 1 includes portions of the Flagstaff, Mogollon, and Red Rock Ranger Districts. Restoration Unit 2 is located west of I-17 and south of the Mogollon Rim. Restoration Unit 2 was removed from this analysis because the focus of the 4FRI is moving ponderosa pine forest into or toward a restored state. Ponderosa pine does not occur in large contiguous expanses in Restoration Unit 2. Restoration Unit 3 includes portions of the Williams district, Flagstaff, and Red Rock districts and is generally located south of I-40 and west of I-17. Restoration Unit 4 is primarily located north of I-40 and west of Highway 180. It includes portions of the Flagstaff district and the Williams district. Restoration Unit 5 is located north of I-40 and east of Highway 180 and includes the San Francisco Peaks. While Restoration Units 1 through 5 form a contiguous block, Restoration Unit 6 is geographically separate from the rest of the 4FRI, lying immediately south of, and adjacent to, Grand Canyon National Park. Restoration Unit 6 encompasses much of the Tusayan district.

The project area was further stratified into sub-units ranging from <4,000 to nearly 81,000 acres in size (Figure 2; Table 3). Both scales (Restoration Unit and sub-unit) are based on 6th code watershed boundaries, transportation systems, and forest administrative boundaries. Restoration Units 1 and 3 contain the majority of MSO habitat. Restoration Unit 6 does not contain any MSO habitat.

Table 3. Summary of area by restoration unit (RU) and subunit (SU)

RU 1 Subunits	Acres	RU 3 Subunits	Acres	RU 4 Subunits	Acres	RU 5 Subunits	Acres	RU 6 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

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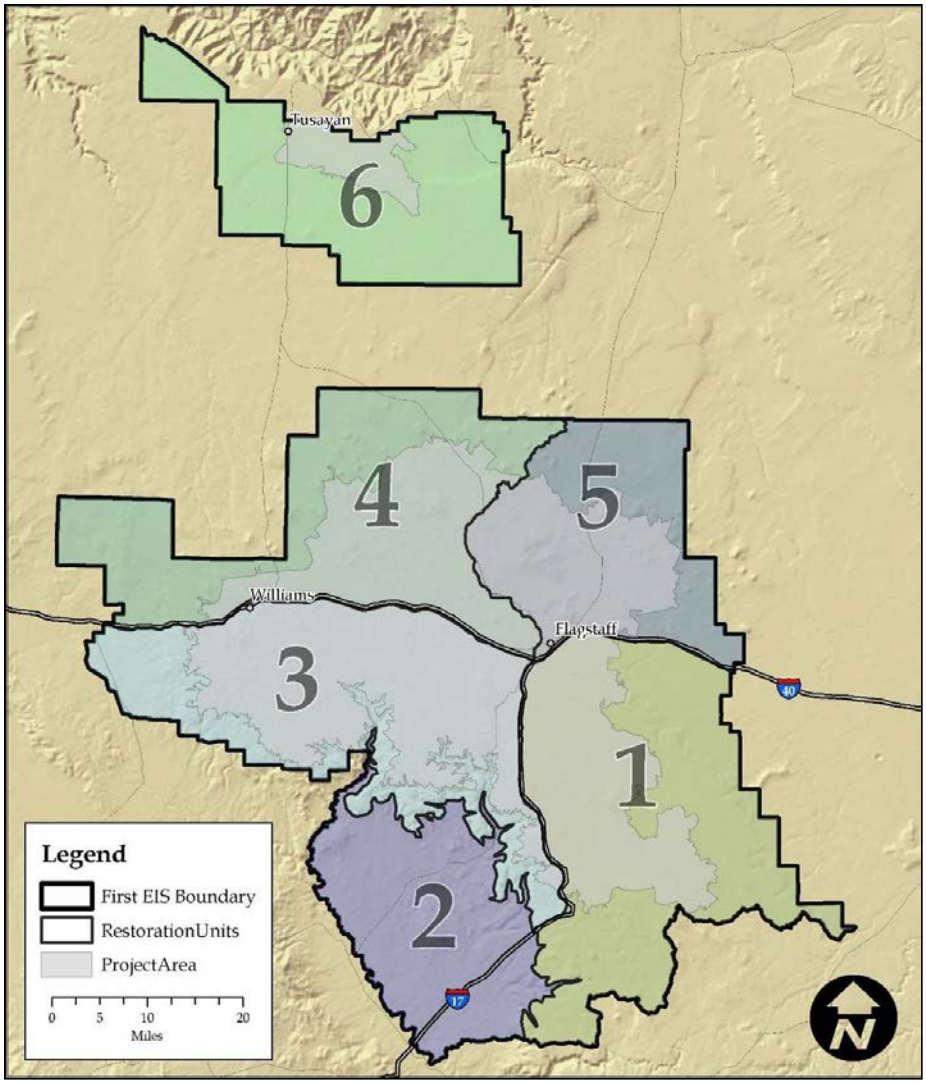


Figure 1. Restoration units within the project area

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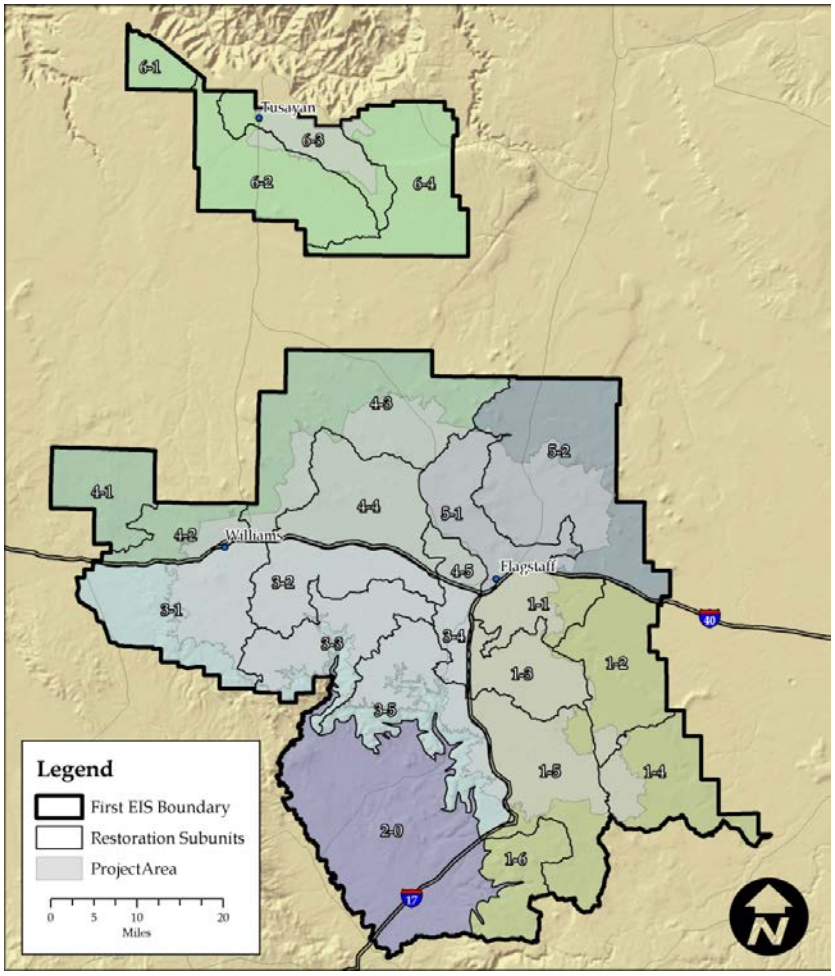


Figure 2. Restoration sub-units within the project area

Proposed Action

The 4FRI DEIS evaluated four alternatives in detail. This included the no action alternative, as required under NEPA, and three action alternatives. Alternative C is the preferred alternative and is the alternative analyzed for consultation (i.e., the proposed action). Results from the no action alternative are frequently included to provide a scale for evaluating change. While this analysis focuses on predicted effects of the proposed action, the scale of change can help inform the effects evaluation by defining how the various habitat variables would develop if no management actions were taken.

Under the Proposed Action, the 4FRI project would conduct restoration activities on approximately 586,110 acres, including about 507,839 acres of ponderosa pine forest. The 4FRI is planned as a 10-year project, but it could take up to 15 years to complete the treatment objectives. Up to 45,000 acres of vegetation would be mechanically treated annually. Averaging 40,000 acres of prescribed fire would be implemented annually across the forests. Initial and subsequent prescribed fires would be conducted on

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all acres proposed for treatment over the course of the project. All treatments in MSO PAC habitat would occur outside the nesting season. Restoration activities would:

- Mechanically cut trees on approximately 431,049 acres, including 108,846 acres of MSO habitat, with about:
  (1) 34,183 acres of PAC treatment, including mechanically thinning trees up to 18 inches diameter at breast height (dbh) within 18 MSO PACs (12,587 acres)
  (2) thin and burn 6,712 acres in target and 1,976 acres of threshold habitat,
  (3) thin, group select, and burn in other restricted habitat (65,139 acres).
- Utilize low-severity prescribed fire-only on approximately 155,061 acres, including 28,066 acres of MSO habitat (including meadows, aspen, and pinyon-juniper inclusions within MSO habitat), with:
  (1) prescribed fire on 24,575 acres of protected habitat, including 70 PAC acres (54 core areas) and 836 acres of protected habitat on slopes greater than 40%,
  (2) 217 acres of target and 84 acres of threshold habitats
  (3) 2,354 acres of restricted in other restricted habitat.
- Construct about 520 miles of temporary roads (almost 75 miles in MSO habitat although most of these roads already exist on the ground – see Effects of the Action for a details) for haul access and decommission when treatments are complete (no new permanent roads would be constructed). If an existing road is not part of the official forest system road network, it is considered a temporary road. Many of the temporary roads identified as necessary for implementing the 4FRI already exist on the landscape but would still be decommissioned at the end of the project.
- Reconstruct up to 40 miles of existing, open roads along their original alignments for safety and for resource protection; no new permanent roads would be constructed. Up to 30 miles of road would be improved to allow for hauling materials (primarily widening corners to improve turn radiuses; outside of MSO habitat) and about 10 miles of road would be relocated out of stream channels. Relocated roads would include rehabilitation of the moved road segment. See Effects of the Action for a description of miles by MSO habitat type
- Decommission about 726 miles of existing system and unauthorized roads on the Coconino National Forest (about 130.2 miles in MSO habitat – see Effects of the Action for a description of miles by MSO habitat type).
- Decommission about 134 miles of unauthorized roads on the Kaibab National Forest (23.1 miles in MSO habitat – see Effects of the Action for a description of miles by MSO habitat type).
- Restore 74 springs (17 in MSO habitat – see Effects of the Action for a description of miles by MSO habitat type) and construct up to 4 miles of protective fencing (no wire fencing would be used in MSO PACs).
- Restore about 39 miles of ephemeral channels (about 4.1 miles in MSO habitat – see Effects of the Action for a description of miles by MSO habitat type).
- Improve or restore about 1,471 acres of aspen, including 1,177 acres in MSO habitat. Construct up to 82 miles of protective fencing (no wire fencing would be used in MSO PACs). Aspen treatments would either be cut and burned or burn-only. Both techniques would be applied to aspen inclusions within portions of ponderosa pine stands, extending 100 feet beyond the visible clone boundary to

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allow for aspen expansion. Only post-settlement conifers would be cut as part of aspen treatments. Some removal of aspen within the clone as well as ground-disturbing activity or burning may occur to stimulate suckering, depending on site conditions. Prescribed burns may be used where and when feasible to treat fuels, mitigate fuel hazards, produce effects that stimulate aspen suckering and regeneration, and spur the growth of native herbaceous vegetation. Prescribed fires are designed to maintain and enhance desired aspen forest structure, tree densities, snag densities, and CWD levels.

- Improve or restore about 59,426 acres of grassland habitat, including 35 acres in PAC habitat.
- Construct up to 15 weirs, 20 weather stations, and 12 eddy covariance towers to support the paired watershed research study (Ecological Restoration Institute, Northern Arizona University). Eddy covariance towers would be taller than the forest canopy. Specific locations are yet to be determined. No towers would be erected in PAC habitat and tower design would not include guywires. Total disturbance would be < 2.5 acres.
- Designate 40% of ponderosa pine and 77% of pinyon-juniper woodland on the Coconino National Forest and 35% of ponderosa pine and 58% of pinyon-juniper woodland on the Kaibab National Forest as old growth.

The Recovery Plan recommends recovery actions concentrate on: recovery units with the highest owl populations and where significant threats exist (USDI FWS 1995). The Upper Gila Mountain Ecological Management Unit (UGM) supports over half the known population of MSOs (Ganey et al. 2011) and is at significant risk of high-severity wildfire (USDI FWS 2012a). The Recovery Plan also recommends management should emphasize alleviating the greatest threats and be tailored to the needs of the area under analysis. High-severity crown fire is recognized as the greatest threat in this recovery unit and one of the key elements lacking in MSO habitat is numbers of large trees (Ganey et al. 2011, USDI FWS 2012a). Primary objectives for 4FRI treatments in MSO habitat are to maintain existing large trees and increase tree growth rates to develop future large trees more quickly. In addition, prescribed fire would reduce surface fuels, predominantly needle cast and fine fuels, to lower the risk of future high-severity fire.

Modeling Mechanical Treatments

All tree data across the 4FRI treatment area was grown to the common year of 2010 and considered the existing condition. All tree cutting and removal was modeled in the year 2012. Two prescribed burns were modeled for the years 2015 and 2019, with the exception of aspen which was modeled for one prescribed burn in 2015. After treatment, the data was grown to the common year of 2020 to represent post-treatment conditions. Modeling assumptions aside, the reality for completion of all treatments will vary widely both spatially and temporally across the 4FRI landscape. In general, implementation of the 4FRI is expected to take 10 to 15 years to complete. Nevertheless, the modeling assumptions allow for the display of treatment effects. While actual timelines will vary by location, the effects to MSOs and their habitat were modeled on a stand-by-stand basis stratified by MSO habitat type. The model continued to grow trees between existing conditions (the year 2010) and the year 2020, so changes will occur even with no treatments. Results of proposed actions can be assessed by comparing them with both existing conditions and how the habitat variables would develop by 2020 and 2050 if no management actions were taken. Modeling assumptions are the same for tree growth and mortality between no action and proposed treatments. Model results displaying differences of a few percentages or less may not relate to real differences on the ground. However, consistent differences likely reflect real change.

MSO PAC data, expert opinion, field reviews (Appendix 2), and vegetation simulation modeling indicated mechanical treatments, including removal of trees >9 inches dbh, could better move 18 PACs toward desired conditions. The minimum basal area (BA) target for PAC treatments in the Proposed

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Action was based on recommendations from the draft Recovery Plan for the Mexican Spotted owl (*Strix occidentalis lucida*) (USDI FWS 2011a) and adopted into the final revised MSO Recovery Plan (USDI FWS 2012a) of 110 feet^2 per acre. The change is a clarification in analysis rather than an actual change in recommendations. Originally, the Recovery Team used data from plots and extrapolated that to stand values. Stand values represent a step up in spatial scale from plot data and are an average of multiple plots. Any given stand will contain dense areas (e.g., ≥150 BA) and open areas that would result in very different plot values. By using **plots** centered on areas selected by MSO to estimate the **stand** values, the original analysis inadvertently biased the stand results for BA. See Amendment C (below) and the revised MSO Recovery Plan (USDI FWS 2012a) for details.

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Modeled tree removal was intended to reduce inter-tree competition while maintaining or improving nesting and roosting habitat. All ponderosa pine stands within the 18 candidate PACs were stratified into 3 levels:

- Strata 1 – Southerly aspect with no or little oak potential; <150 total BA; outside core areas.
- Strata 2 – All other stands outside of core areas.
- Strata 3 – Core areas

Strata 1 sites were considered to have lower site potential with drier overall conditions. Part of this evaluation was based on how close the trees were to the maximum stand density index (SDImax). SDImax is the theoretical maximum density of trees possible based on tree species. Site occupancy and competition-induced mortality increase as an area approaches the SDImax (see Table 2 in Appendix 3). The team silviculturist recommended these sites be managed at the lower end of zone 3 for SDImax. Two thinning regimes were compared: SDI 160 (35% of SDImax) and SDI 180 (40% of SDImax) to determine the appropriate SDI. The selection was based on comparing average stand output in terms of how long it would take post treatment for the stand to surpass existing conditions and how long it would take to reach desired conditions. SDI 160 was selected based on this comparison.

Strata 2 sites were considered to have higher site potential. The silviculturist recommendation was to manage these sites for denser conditions (approximately 150 BA). The selected thinning regime for these sites is SDI 200 (45% of SDImax) which is the mid-range of zone 3 (Table 2 in Appendix 3).

Strata 3 was dropped from consideration for mechanical treatments and only low-severity prescribed fire was recommended for treatment in core areas.

Modeling tree removal within PACs was done at the stand level. An upper limit of 17.9 inches dbh for tree removal was chosen because trees 18 inches dbh and greater are a valuable and limited component of owl nesting and roosting habitat (USDI FWS 1995). Treating up to 17.9inches dbh also allows a greater ability to reduce competition between trees less than 18 inches dbh and large, old pine and oak trees.

All stands were modeled by strata using 5 different tree diameter caps: up to 9 inches dbh, up to 11.9 inches dbh, up to 13.9 inches dbh, up to 15.9 inches dbh, and up to 17.9 inches dbh. The respective thinning regimes (i.e., SDI 160 for strata 1 and SDI 200 for strata 2) were applied and outputs were compared by stand for each simulation. The model removed trees in the smallest size classes first, but also retained trees in each size class, i.e., the modeling was not a simple thin-from-below exercise that merely removed all small diameter components of wildlife habitat.

Evaluation criteria for model runs were net growth 10 years after thinning, the highest number of trees 18 inches dbh and greater by year 2052, and the highest percentage of trees in the mid-sized successional stage (12 to 18 inches dbh) in 2052. The latter criterion was included to ensure growing stock was available to meet Recovery Plan guidelines for recruitment into larger tree size classes in the long term.

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The diameter limit that best met the combined criteria was selected from among the five model runs for each individual stand. This approach retained current owl habitat characteristics while reducing the time required to achieve improving potential future habitat.

Forest Plan Amendments

The proposed actions would require amendments to the forest plans that include changes to the standards and guidelines for MSO. A non-significant forest plan amendment would be required on the Coconino National Forest to implement the proposed actions in MSO habitat:

Amendment 1 would add language to allow mechanical treatments up to 18 inches dbh to improve nesting and roosting habitat structure in 18 MSO PACs. This would allow low-severity prescribed fire within 54 MSO PAC core areas and remove language that limits PAC treatments in the recovery unit to 10% and requires the selection of an equal number of untreated PACs as controls. Replacement language would defer to the USFWS biological opinion for the project. The amendment would remove language referencing monitoring (pre- and post-treatment population and habitat monitoring) and replace it with language that defers MSO monitoring to the U.S. Fish and Wildlife Service (USFWS) biological opinion for the project. In restricted pine-oak habitat, this would allow 6,444 acres of restricted target and threshold habitat to be managed for a minimum range of 110 to 150 BA. A definition of target and threshold habitat would be included.

Design Features Incorporated Into Project Implementation

Vegetation design features common to all treatment types within MSO habitat

The following design features were incorporated into the proposed action:

- Manage for 15% or more of the SDI in ponderosa pine trees between 12 and 18 inches dbh, 15% or more of the SDI in ponderosa pine trees between 18 and 24 inches dbh, 15% or more of the SDI in ponderosa pine trees ≥24 inches dbh, and ≥20 trees per acre (TPA) ≥18 inches dbh.
- No trees 24 inches dbh or larger would be removed.
- Manage for snags ≥12 inches dbh and down logs ≥12 inches with an emphasis on snags ≥18 inches dbh.
- Gambel oak, juniper and pinyon species would not be cut as part of the treatments. These species may only be cut as necessary to facilitate logging operations (skid trails and landings).

Outside core areas, trees may be thinned in selected PACs. Treatments in PAC habitat were designed to maintain and develop key elements of MSO habitat. Core areas are 100 acres or greater and encompass known nest or roost sites or the best nesting and roosting habitat available within PACs. Core areas would not receive mechanical treatments. The following vegetation design features would apply to PACs:

- Thinning objectives would include releasing large pine and Gambel oak from competition with uncharacteristic densities of young pine trees. This would reduce density-related mortality that is common when large, old trees are unable to compete with encroaching young trees.
- Reduce fuels and mitigate fuel hazards where feasible; release young oak from encroaching and/or over-topping young to mid-aged ponderosa pine; move stands toward uneven-aged conditions; and improve prey habitat.
- In stands where thinning has been identified as potentially improving MSO habitat, each stand within each PAC treated would have an upper diameter limit ranging from 9 to 17.9 inches dbh, depending

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on site-specific conditions within the individual stand. Trees would be retained in each size-class and all trees above the stated limit would be retained.

- Treatments are designed to increase residual tree health and vigor and maintain greater than or equal to 110 BA where present.
- Irregular tree spacing would be used to create canopy gaps to move toward or facilitate stand conditions that improve forest resiliency and create conditions more conducive to low-severity prescribed fire treatment. Canopy gaps would enhance understory development, enhance prey habitat, and allow for regeneration to create multi-story conditions.
- Low-severity prescribed fire would treat fuels and mitigate fuel hazards where feasible. The objectives of prescribed burns in PACs are to reduce surface fuels (primarily litter and duff) and raise crown base height. Results would include reducing future surface fire intensity and flame length, thereby reducing the potential for future surface fires to transition into high-severity crown fire. Prescribed fire would reduce coarse woody debris, total oak BA, and snags, but these losses would be mitigated through burn prescriptions, ignition techniques, or other techniques.

Treatments in target and threshold habitat are designed to maintain existing elements of MSO habitat where they exist and move forests toward those habitat features where they are lacking. Treatments are designed to be in accord with Recovery Plan objectives by retaining oak and large trees, increasing tree growth rates, increasing stand resiliency, improving prey habitat, and reducing risk of undesirable fire behavior and effects. Specifically, treatments in target and threshold habitats are designed to achieve the following:

- Increase residual tree health and vigor and reduce fire hazard through intermediate thinning;
- Maintain, where present, BA greater than or equal to 110;
- Irregular tree spacing would be used to create canopy gaps to move toward or facilitate stand conditions that may be more conducive to low-severity prescribed fire treatment and to provide food and cover for prey species;
- At least 20 trees or more per acre measuring 18 inches dbh or greater would be retained or moved toward that goal in shorter timeframes than if left untreated.

Treatments in MSO restricted "other" habitat (outside of target and threshold habitats) are designed to achieve the following:

- Develop uneven-aged forest structure, irregular tree spacing and variable patch size by thinning tree groups and establishing interspace openings adjacent to tree groups to improve forest resiliency. These actions would move forest structure toward the historical range of variation and move toward or create stand conditions more conducive to low-severity prescribed fire treatments;
- Crown spacing between tree groups (interspace) would average 25 to 60 feet distance, providing for forest health, prey habitat development, and to move toward or facilitate stand conditions more conducive to low-severity prescribed fire treatments;
- On average, tree groups would range from 0.1 to 1 acre in size; tree group size would be smaller on southerly aspects and larger on northerly aspects to take advantage of microsite variability and provide habitat heterogeneity;
- Tree thinning would target 60 to 80 BA on southerly aspects and 80 to 100 BA on northerly aspects with the goal of managing a sustainable range of density and structural characteristics;

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- In order to recruit new age classes and move toward or maintain uneven-aged conditions, regeneration openings would be created on 10 to 20% of the area; openings would average 0.3 to 0.8 acres in size. However, in specific areas where ponderosa pine mistletoe infections are heavy, openings may extend up to 4 acres;
- Manage for uneven-aged conditions by retaining individual trees and clumps of vigorous ponderosa pine seedlings, saplings, and poles within larger mid-aged, mature, or old tree groups;
- Manage to retain current habitat diversity through time in moderate to heavy dwarf mistletoe infection centers that are not intended for regeneration openings: improve tree vigor and growth by retaining the best growing dominant and co-dominant trees containing the least amount of mistletoe;
- No trees greater than 24 inches dbh would be cut and existing old growth attributes would be retained;
- To maintain and develop large Gambel oak trees, conifers up to 17.9 inches dbh that do not meet the "old tree" definition would be removed within 30 feet of oak ≥10 inches diameter at root crown (drc) to reduce competition with ponderosa pine trees for moisture, nutrients, and sunlight; only post-settlement trees (established after wildfire was limited or eliminated from the landscape) would be removed, allowing large oak to develop and be more sustainable through time;
- Low-severity prescribed fire to treat fuels and mitigate fuel hazards would be conducted where feasible. The objectives of prescribed burns in PACs are to reduce surface fuels and raise crown base height.

The goal of these measures is to follow the ecological approach outlined for restricted habitat in the fine filter approach for managers, included in the overall and specific guidelines described on page 94 of the 1995 Recovery Plan and page 269 of the revised Recovery Plan.

Other vegetation design features that can benefit MSO

The following design elements would either directly or indirectly benefit MSOs (Table 4). They are intended to further detail management actions, mitigate environmental consequences, and establish priorities for implementation. Environmental consequences have been evaluated with all features, practices, and mitigation considered.

Table 4. A subset of wildlife design features incorporated into 4FRI implementation planning that are expected to benefit MSOs

Species	Location	Description	Benefits to MSO
Mexican Spotted Owl	Restricted habitat	Trees greater than 24" dbh would not be harvested	Retains a component of MSO habitat limited on the landscape
Mexican Spotted Owl	Restricted and protected habitat	MSO surveys in the project area during the year of implementation or one year prior to determine owl occupancy in new and established areas	Minimizes the risk of impacting unknown owls
Mexican Spotted Owl	Restricted and protected habitat	Pre- and post-treatment habitat monitoring would occur as specified by the USFWS	Part of the 4FRI commitment to adaptive management and monitoring effects of treatments on MSO
Mexican Spotted Owl	Protected Activity Centers	Mechanical and fire treatments would not occur during the breeding season in PACs	Minimizes the risk of disturbance to MSOs

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Species	Location	Description	Benefits to MSO
Mexican Spotted Owl	Protected Activity Centers	Spring restoration will not occur during the breeding season (March 1 to August 31), if PAC is occupied, in Rocktop, Sawmill Spring, Red Raspberry and Weimer Spring PACs (i.e., 5 out of 74 proposed spring restoration sites would be affected).	Improves prey habitat without disturbing owls
Mexican Spotted Owl	Protected Activity Centers	Ephemeral stream restoration will not occur during the breeding season (March 1 to August 31), if occupied, in Bear Seep, Clark, Holdup, Coulter Ridge and Meadow Tank MSO PACs	Improves prey habitat without disturbing owls
Mexican Spotted Owl	Protected Activity Centers	Road construction, obliteration, relocation, and maintenance would not occur during the breeding season (March 1 to August 31) if PAC is occupied.	Minimizes risk of disturbance to owls and can improve prey habitat
Mexican Spotted Owl	Protected Activity Centers	No mechanical treatments or prescribed burning would occur in PACs during the breeding season (March 1 to August 31) if occupied.	Minimizes risk of disturbance to owls while improving MSO habitat
Mexican Spotted Owl	Protected Activity Centers	Hauling will not occur within PACs during the breeding season (March 1 to August 31) unless monitoring confirms the territory is unoccuppied during the year of implementation. Exceptions would occur in Dairy Springs and Clark PACs where haul routes are <1/4 from core areas. Review of site conditions indicates that topography would minimize noise disturbance. In addition, haul trucks will not exceed 25 mph in PACs and hauling through PACs would occur in daylight hours. See PAC by PAC descriptions for more detail.	Allows landscape restoration to proceed without disturbing nesting and roosting owls
Mexican Spotted Owl	Protected Activity Centers	No new wire fencing will be constructed in PACs. Other alternatives will be used for aspen, springs, and ephemeral drainage restoration exclosures within PACs. Alternatives will be coordinated with other specialists and the USFWS. Restoration work will not be done if suitable alternatives cannot be identified.	Minimizes the risk of injury or mortality from owls colliding with new structures within areas of focused owl activity
Mexican Spotted Owl	Protected Activity Centers	Coordinate burning spatially and temporally to limit smoke impacts to nesting owls, particularly for PACs identified in low-lying areas (Effective March 1 to August 31).	Limits smoke disturbance to owls
Mexican Spotted Owl	Protected Activity Centers	All stands included in the proposed mechanical PAC treatments would be marked for harvest by hand and marking would be coordinated with the US Fish and Wildlife Service	Ensures resutls meet the intent of the treatment
Mexican Spotted Owl	Protected Activity Centers	Fireline associated with preventing fire from entering PACs and/or core areas will be constructed outside the nesting season.	Minimizes disturbance to owls
Mexican Spotted Owl	Core Areas	Known nest trees will be protected in the design and implementation of prescribed burn plans.	Protect key habitat element while implementing habitat improvement treatment
Mexican Spotted Owl	MSO Habitats	Burn plans will be designed and implemented to minimize smoke impacts to nesting birds.	Minimizes disturbance, to owls
Mexican Spotted Owl	MSO Habitats	Implementation would be phased in across the landscape so that impacts to MSO habitat would be limited both spatially and temporally	Minimizes the number of owls exposed to potential disturbance in a given year

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Species	Location	Description	Benefits to MSO
General	Dependable waters	Do not create interspaces or openings where hiding cover exists near dependable waters identified by the Arizona Game and Fish Department (e.g. stock tanks, lakes, and riparian stream reaches).	Provides habitat diversity for MSOs and their prey
General	Snags & logs	Protect snags and logs wherever possible by placing landings in existing openings or in areas where snags and/or logs, and old trees would be minimally impacted.	Protects key habitat elements for MSOs and their prey
General	Snags & logs	Protect/provide snags and logs wherever possible through site prep, implementation planning, green tree selection, and ignition techniques to retain >2 snags/ac. ≥30' high and ≥18" dbh + ≥3 logs ≥8' long and ≥12" mid-point diam. + 5-7 tons of CWD (>3" diam)/ac. in pine and pine-oak habitat.	Protects key habitat elements for MSOs and their prey
General	Snags	Retain trees ≥18" dbh with dead tops, cavities, and lightning strikes (i.e., the living dead) wherever possible to provide cavity nesting/foraging habitat in ponderosa pine habitat.	Protects key habitat elements for MSOs and their prey
General	Snags	Emphasize retention of snags exhibiting loose bark to provide habitat for roosting bats.	Protects key habitat elements for MSO prey
Bald Eagles	Bald eagle winter concentration areas	Retain the tallest snags >18 "dbh	Protects key habitat elements for MSOs and their prey
Bald Eagles	Winter Roost sites	No mechanical treatments will occur around confirmed bald eagle roost sites (300' radius around roosts on the Coconino National Forest and a 10 chain radius on the Kaibab National Forest).	Provides habitat diversity for MSOs where these species overlap
Bats	Caves and sink holes	A 300-ft no mechanical treatment buffer would be designated around 34 cave entrances and around sink holes to protect cave and karst systems from siltation, protect human health and safety, and reduce potential disturbance to roosting bats. Existing roads could be used for mechanical harvest but no new skid trails would be created. Ignition and other prescribed fire techniques would maintain existing vegetation patterns and forest plan guidance for snags and logs while reducing fuels.	Provides habitat diversity for MSOs and their prey where their habitat overlaps with these geologic features

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Species	Location	Description	Benefits to MSO
Other raptors	Nest sites	Known nest trees for any raptor species would be prepped prior to prescribed burning. Forest Plan buffers will be provided per current plan direction if nests are active: Sharp-shinned hawk: no mechanical treatment buffer of 10 acres around occupied nests; Cooper's hawk: no mechanical treatment buffer of 15 acres around occupied nests; Osprey: no mechanical treatment buffer of 20 acres (or use site specific analysis to determine no-treatment zone) around occupied or unoccupied nest sites and all logging activities will be restricted within ¼ mile of active nests from March 1 to August 15 Other raptors: 50 ft no-treatment zone around occupied nests.	Provides habitat diversity for MSOs and their prey where these species overlap
Miscellaneous	VSS 4s, 5s, & 6s	Within Group Density: Manage mid-aged tree groups for a range of density and structural characteristics by thinning about 50% of the mid-aged groups to the lower range of desired stocking conditions, about 20% each to the middle and upper range of desired stocking conditions and about 10% remain unthinned.	Provides habitat diversity for MSOs prey species and dispersing MSOs
Miscellaneous	VSS 4s, 5s, & 6s	Within Group Structure - Enhance and maintain mid-aged, mature or old group structure by retaining individual and clumps of vigorous ponderosa pine seedlings, sapling and pole-sized trees within the larger group	Provides habitat diversity for MSOs prey species and dispersing MSOs
Miscellaneous	Wildlife canopy, cover, and stand heterogeneity in ponderosa pine cover type	Gambel oak, juniper and pinyon species would not be cut with the following exceptions: seedling/sapling, young and mid-aged pinyon and juniper up to 11" drc may be cut within a 50' 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). Manage for large Gambel oak trees: remove conifers within 30‘ of oak ≥10” drc if conifers are <18” dbh, do not meet the “old tree” definition, and do not have interlocking crowns with oaks	Protects key habitat elements for resident and dispersing MSOs
Miscellaneous	Burn Plans	Coordinate burning between administrative units and between wildlife and fire management to minimize potential disturbance and ensure the potential cumulative effects of multiple fires do not inadvertently produce negative effects to local wildlife	Minimizes smoke and noise disturbance to MSOs

3. Listed Species and Critical Habitat in the Action Area

All species that are federally listed, proposed or candidates for listing, and designated and proposed critical habitats for those species occurring in the action area were reviewed for the 4FRI project. Federally listed species for which proposed activities could lead to “may effect, but are not likely to adversely affect” or “may effect and are likely to adversely affect” determinations were brought forward for this consultation (Table 5). Arizona bugbane is a sensitive species but is included here per a

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conservation agreement with the USFWS in an effort to avoid potential future listing under the ESA. In addition, the Forest Service requests technical assistance for avoiding adverse effects to bald and golden eagles during or as a result of implementation of this project.

Table 5. Federally listed threatened, endangered, and candidate species and designated critical habitat within the 4FRI project area, Coconino and Kaibab National Forests (Coconino National Forest and Coconino National Forest)

Common Name	Scientific Name	Federal Status	Critical Habitat	Occurrence
Arizona bugbane	*Actaea (Cimicifuga) arizonica*	Candidate	No	Coconino National Forest & Kaibab National Forest
Mexican spotted owl	*Strix occidentalis lucida*	Threatened	Yes	Coconino National Forest & Kaibab National Forest
Spikedace (critical habitat Only)	*Meda fulgida*	Endangered	Yes	Coconino National Forest
Loach minnow (critical habitat Only)	*Tiaroga cobitis*	Endangered	Yes	Coconino National Forest
Roundtail chub	*Gila robusta*	Candidate	No	Coconino National Forest
Narrow-headed Garter Snake	*Thamnophis rufipunctatus*	Proposed for Listing	Yes	Coconino National Forest

Federally listed, proposed or candidates for listing, and designated and proposed critical habitats for which no effect determinations were made are identified in Table 6. Complete rationales supporting the no effect calls are presented in the 4FRI wildlife specialist report.

Table 6. Federally listed threatened, endangered, and candidate species for which a "No Effect" determination was made for implementation of the 4FRI project, Coconino and Kaibab National Forests

Common Name	Scientific Name	Federal Status	Rationale
Black-footed Ferret	*Mustela nigripes*	Endangered	Not present in the treatment area and prairie dog surveys will be done to assess potential for ferret habitat
California Condor	*Gymnogyps californianus*	Experimental/Non-essential	Rarely present in the treatment area and mitigations are in place if one appears
Spikedace	*Meda fulgida*	Endangered	Not present in the treatment area and appear to be extirpated from the Verde River (also not in the treatment area)
Loach minnow	*Tiaroga cobitis*	Endangered	Not present in the treatment area

This project was developed under the original MSO recovery plan (USDI FWS 1995). Elements of the draft plan were incorporated into project planning after the draft revision was released (USDI FWS 2011a), but the final revision was not available until project documents were already sent to the

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government printing office. Therefore, consultation for this project follows the terminology of the 1995 recovery plan.

Bald and Golden Eagle Protection Act

The final rule to remove the bald eagle from the Federal List of Threatened and Endangered Species was published in the Federal Register on July 9, 2007, and took effect on August 8, 2007. However, all golden and bald eagles, regardless of status, are protected under the Bald and Golden Eagle Protection Act (Eagle Act). This analysis determines if take is likely to occur with implementation of the action alternatives. Take is defined as to "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb". Disturb is further defined "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." We request technical assistance from the USFWS in ensuring we meet the intent of the Bald and Golden Eagle Protection Act while implementing the actions associated with the 4FRI EIS.

For our analysis, we have reviewed the above guidance for the Bald and Golden Eagle in Arizona and our determination is that take would not occur from implementation of this project. These guidelines were incorporated into the 4FRI as either design features or mitigation. The Forest Service has worked closely with the USFWS biologist, Shaula Hedwall, to modify the proposed action to reduce impacts to bald and golden eagles. The USFWS recommends using Conservation Assessment and Strategy for Bald eagles in Arizona (Driscoll et al. 2006) in conjunction with the Bald Eagle National Guidelines (USDI FWS 2007) to protect bald eagles in Arizona. For golden eagles, the USFWS has issued a report titled "Interim Golden Eagle Technical Guidance: Inventory and Monitoring Protocols; and Other Recommendations in Support of Golden Eagle Management and Permit Issuance" (Pagel et al. 2010).

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4. Environmental Baseline Conditions

Projects before 1996 are incorporated into existing conditions. Aspects of existing conditions that are a result of these early projects include a deficit in large trees and snags and even-aged conditions. Pre-1996 projects also had heavy selection pressure for preferred tree genetics to provide healthy trees with good form. The effect from this selection pressure was harvest areas regenerated from planting stock or from the selected reserve trees left in seed tree harvest units (Bruce Higgins, pers comm. 2012). Wildlife habitat in the form of nesting, feeding, and loafing sites was reduced by selecting for disease-free trees with symmetric shapes, eliminating fork-top trees, trees with unusual branching patterns, and replanting with nursery stock.

The project area is dominated by ponderosa pine forest, including ponderosa pine and Gambel oak (pine-oak) communities. Inclusions of aspen, grassland, savanna, meadows, ephemeral drainages, and scattered springs occur across the landscape and represent wildlife habitat diversity. Because this is a fire adapted ecosystem with frequent fire return intervals dominated by low-severity surface fire, conditions that existed before Euro-settlement (pre-settlement) are considered sustainable. Management since Euro-settlement (post-settlement) altered the fundamental forest structure, pattern, and composition of this area to the point where current conditions are no longer sustainable. Ponderosa pine forests in northern Arizona are now deficient in large and old trees, understory grasses, forbs, and shrubs, and large snags. Uncharacteristic densities of mid-aged trees create continuous canopy connectedness, outcompete the less vigorous large and old trees, shade out aspen and oak trees, and limits understory development. Tree growth rates have slowed or stagnated, preventing or delaying development of old forest conditions while promoting tree density-related mortality and supporting uncharacteristic levels of forest pathogens.

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Wildlife habitat, and specifically MSO habitat, is at risk from forest health issues and landscape-scaled high-severity fire (see Appendix 3 for more background and status of forest health in the 4FRI area). More information can be found in the 4FRI silviculture, fire ecology, soils, and wildlife reports. The information provided in these documents is incorporated here by reference.

Pine-oak habitat currently has an abundance of trees 5 – 18 inches dbh and trees ≥18 inches dbh are under-represented. This is particularly true for trees >24 inches dbh (see USDI USFWS 1995 and the 4FRI silviculture report for more detail). Fast-growing, younger ponderosa pine have overtopped and is outcompeting much of the large diameter Gambel oak (Abella and Fulé 2008, Appendix 3). The deficit in large trees limits the distribution of potential nesting and roosting habitat. The preponderance of dense, single-storied young and mid-aged trees limits development of future nesting habitat. The dominance of closed forest conditions in young to mid-aged trees also limits food and cover development for MSO prey species by shading out understory growth. More information on forest structure and understory vegetation can be found in Appendix 8 of the 4FRI wildlife specialist report.

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Arizona bugbane

Endangered Species Act Status: Consultation Agreement (1995)

Forest Occurrence: Coconino and Kaibab National Forests

Recovery Plan: No

Critical Habitat: No

Status of the Species

Arizona bugbane is an endemic species that was first collected on the slopes of Bill Williams Mountain on the Kaibab National Forest in 1883. In 1993, a petition for listing Arizona bugbane as a Threatened or Endangered species was published in the Federal Register (58 Federal Register 51144; September 30 1993) and the species was assigned Category 1 Status, indicating there was enough information to support listing under the Act. The USFWS and Arizona Rare Plant Recovery Team determined that the implementation of a Conservation Strategy by the Forest Service with a Memorandum of Understanding (MOU) was sufficient to preclude the listing of Arizona Bugbane. The forests prepared the Arizona Bugbane Conservation Assessment and Strategy for Coconino and Kaibab National Forests in 1995. This document was accepted and approved by the District Rangers and Forest Supervisors for Coconino and Kaibab National Forests. As a result of this effort, the species has remained a Region 3 sensitive species. Although these documents have expired, both agencies continue to coordinate on actions affecting Arizona bugbane.

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There is no designated critical habitat for Arizona bugbane. It may co-occur with MSOs in some locations.

Distribution

Arizona bugbane is endemic to northern and central Arizona. It requires deep shade from forest or riparian overstory. Arizona bugbane occurs in mesic habitats, typically along the bottoms and lower slopes of steep, narrow canyons, where the dense overstory often includes a combination of coniferous and deciduous tree species. Important overstory species include Douglas fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), big tooth maple (*Acer saccharum ssp. grandidentatum*), Arizona alder (*Alnus oblongifolia*) and red osier dogwood (*Cornus stolonifera*). This special combination of environmental features that contribute to Arizona bugbane habitat also supports a high diversity of other species of plants

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and animals (USFWS 1998). It is confined to various tributaries of Oak Creek Canyon, and West Clear Creek on the Coconino National Forest (Figure 4 - Figure 6) and the slopes of Bill Williams Mountain on the Kaibab National Forest, and in Workman Creek and Cold Springs Canyon in the Sierra Ancha Mountains (Tonto National Forest), (Arizona Game and Fish Department 2012). The populations of Arizona bugbane in this analysis are confined to Restoration unit 3.

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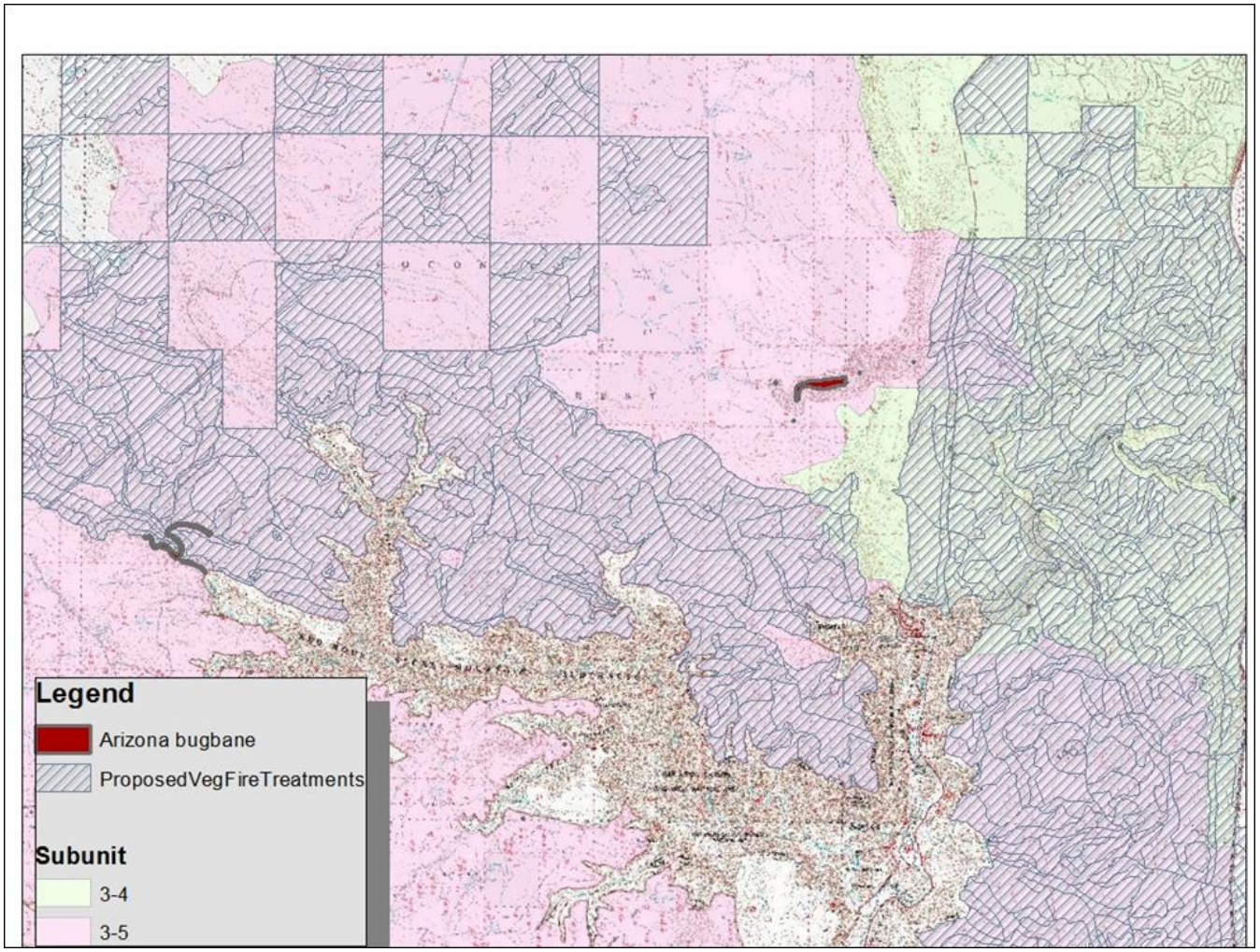


Figure 3. Arizona Bugbane in the West Fork of Oak Creek and Fry Canyon Areas

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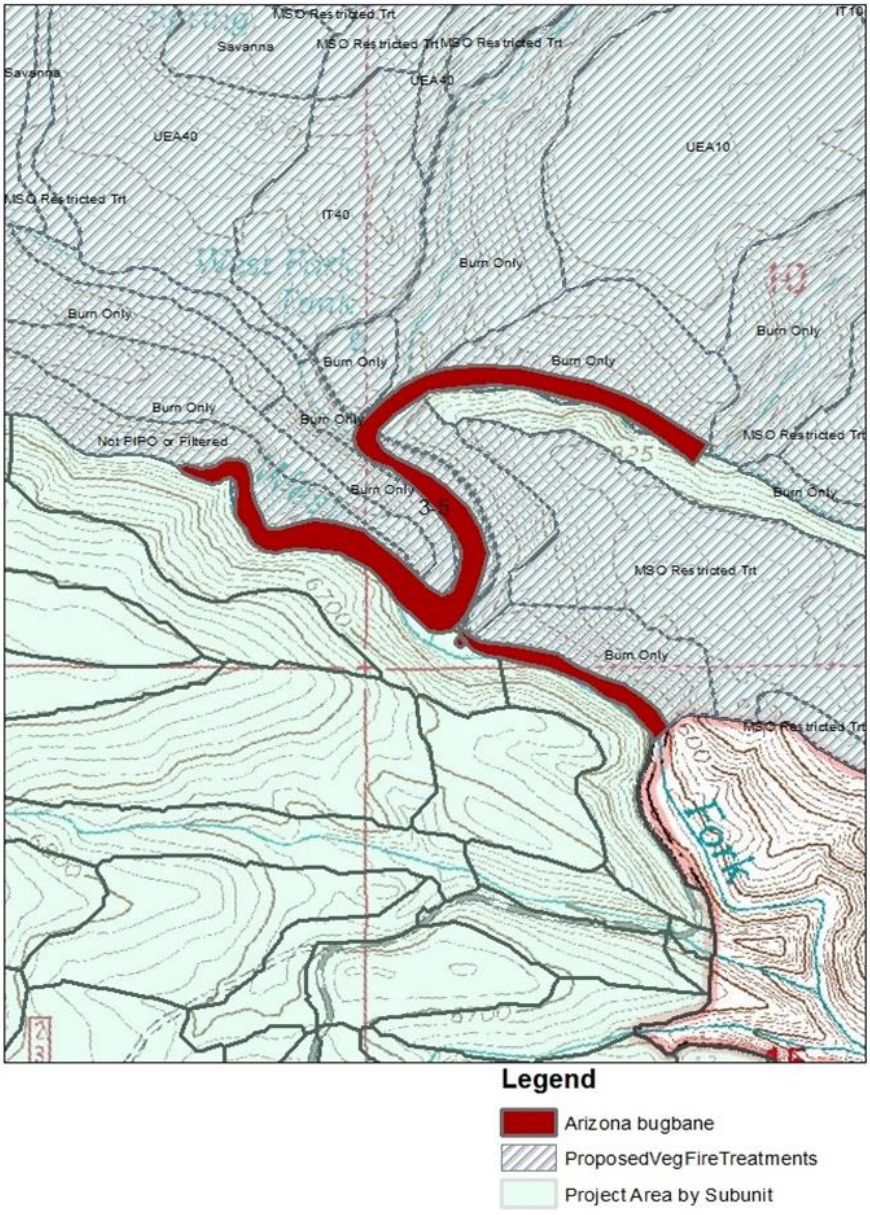


Figure 4. Closer View of Arizona Bugbane in the West Fork Area, Subunit 3.5

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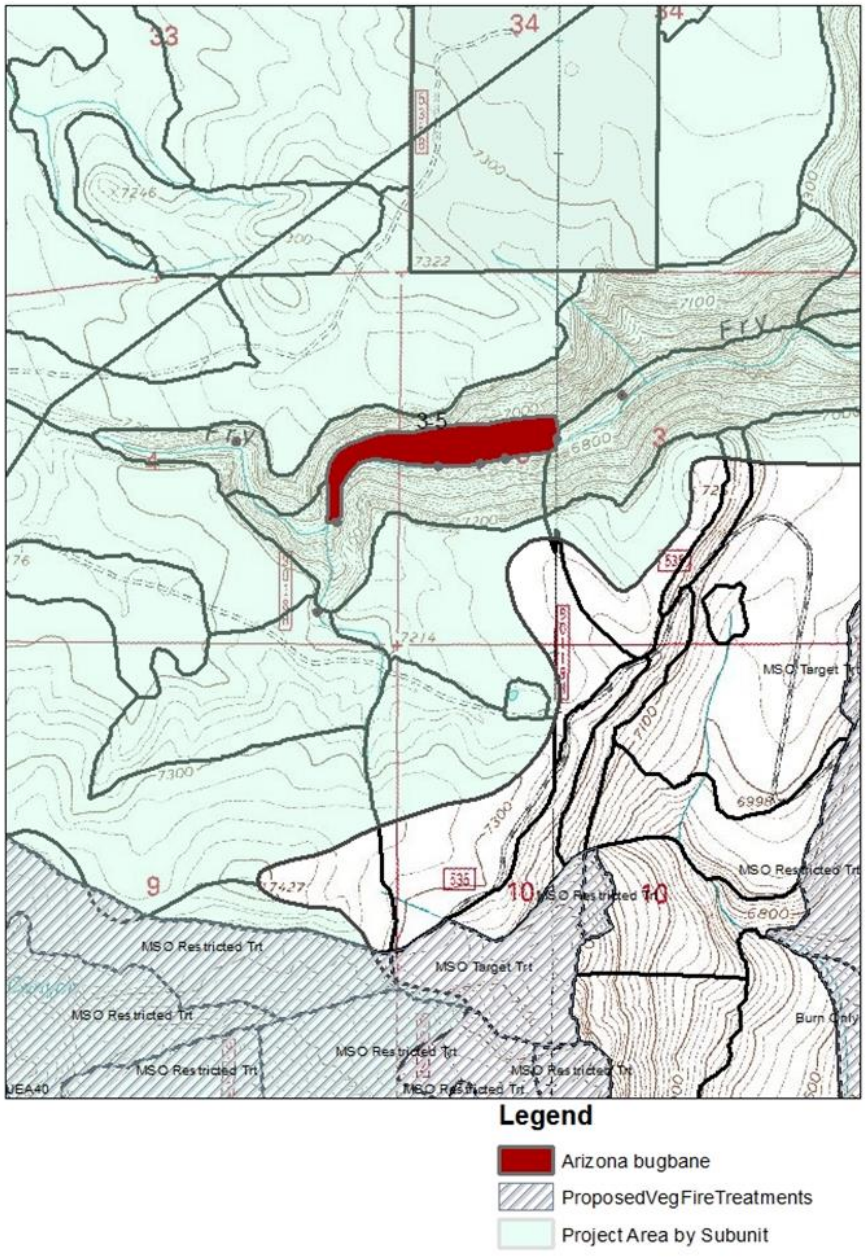


Figure 5. Arizona Bugbane in Fry Canyon, Subunit 3.5.

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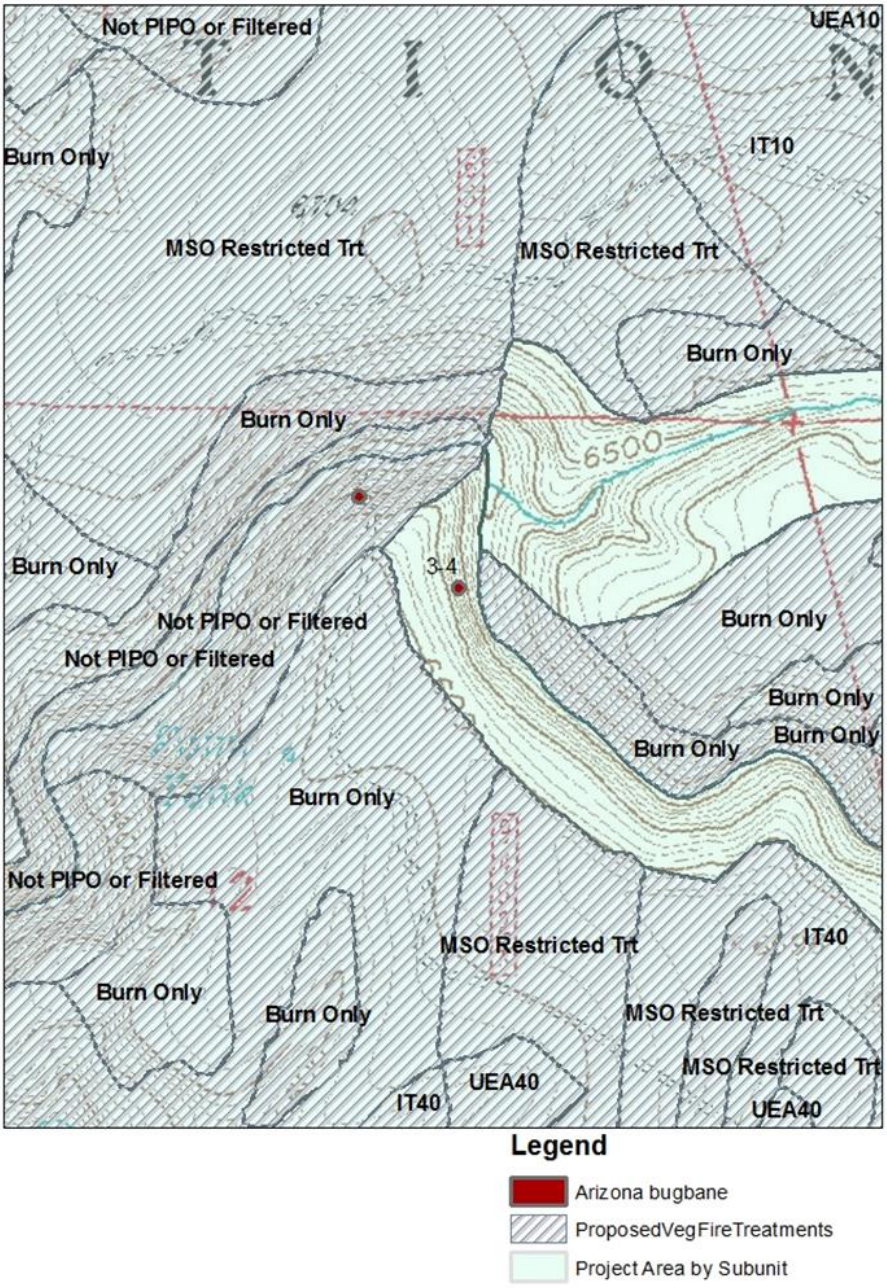


Figure 6. Arizona Bugbane Near James and Kelly Canyons in Subunit 3.4.

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Data Sources

Sources for this analysis include survey records and data. These include:

- Threatened, endangered and Region 3 sensitive plant and noxious or invasive weed data on file in NRM TESP/Invasives database, which is the national database of record for these data.
- Survey records for Arizona bugbane
- The current forest plans for Coconino and Kaibab National Forests (1987, 1988)
- The Arizona Bugbane Conservation Assessment and Strategy (1995).
- GIS data layers for the Coconino and Kaibab National Forests
- GIS data developed specifically for this project by Mark Nigrelli, GIS Specialist.
- SEINet on-line herbaria

Cover Types within the 4FRI Treatment Area

About 86% of the treatment area is ponderosa pine. Pine-oak forest constitutes about 8 % of the total ponderosa pine forest. Grasslands, savannas, and meadows combined are also about 8% of the area. Aspen and water each occur on <1% of the area.

Arizona bugbane generally does not occur in these cover types but may be affected by its close proximity to treatment units or by activities such as management actions associated with road maintenance, construction or decommissioning or by prescribed burning. Oak Creek Canyon, West Fork of Oak Creek and its tributaries are in or near the analysis area boundary.

Restoration Units and Subunits

Restoration unit 3 includes portions of the Williams, Flagstaff, and Red Rock districts and is generally located south of I-40 and west of I-17 (Figure 1). The occurrences of Arizona bugbane addressed in this analysis are limited to the Coconino National Forest where they generally occur in canyons such as West Fork of Oak Creek, Pumphouse Wash, and James Canyon. There is one documented population on Bill Williams Mountain on the Kaibab National Forest, but this population is outside of the analysis boundary and is being considered in a separate project analysis.

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Existing Conditions

The Arizona Bugbane (*Cimicifuga arizonica*) Conservation Assessment and Strategy, Coconino and Kaibab National Forests (1995) contains direction for several management concerns including degradation of the integrity of the ecosystem, which focuses on preservation of the shaded habitat needed for the species, grazing impacts, recreation impacts, mining, pesticide use and natural threats including certain plant diseases. Mining and pesticide use have generally not been threats.

Mexican Spotted-Owl

Status of the Species

The MSO was listed as a threatened species under the ESA in March 1993 (USDI FWS 1993). A detailed account of the taxonomy, biology, and reproductive characteristics of the MSO is found in the Final Rule listing the MSO as a threatened species (USFWS 1993), in the Recovery Plan (USFWS 1995), and in the Revised Recovery Plan (USFWS 2012). Information on MSO in the UGM Recovery Unit is also

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summarized in Ganey et al. (2011). The information provided in these documents is incorporated here by reference as summarized below.

MSO occupy and breed in canyons, mixed conifer, and pine-oak vegetation types within the 4FRI analysis area. Their habitat contains high canopy closure, high tree density, large trees, multi-layered canopies, numerous snags, and down woody material. MSOs are primarily nocturnal predators that hunt with a "perch and pounce" technique. They commonly eat small- and medium-sized rodents but also consume bats, birds, reptiles, and arthropods. Primary MSO prey in the 4FRI treatment area largely consists of mice and voles. Nesting and roosting habitat is characterized by high canopy closure, high tree stem density, large trees, multi-layered canopies, numerous snags, and down woody material. Owls typically nest in large trees (> 24 inches dbh) and will roost in both large and small trees. Owls use a broader range of habitat for foraging, including intensive use of areas around nest and roost sites during the nesting season and habitats with more variable forest structure. More open canopies allow more understory vegetation development which benefits most of the prey species in the pine-oak forests of the UGM Recovery Unit. MSOs generally lay eggs in late March or early April and the young fledge July to August, with a majority dispersing out of the nesting area in September.

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Distribution

MSOs occur in forested mountains and canyons in Utah, Colorado, Arizona, New Mexico, and the western portions of Texas south into several states of Mexico. However, MSOs do not occur uniformly across their range. Instead, they inhabit disjunct localities, including isolated forested mountain systems and steep, rocky canyons. In addition to natural variability in habitat, anthropomorphic actions have affected MSO occupancy across their range. The inherent variability in occupancy was one of the reasons the Recovery Plan subdivided the range of the MSO into smaller areas called recovery units (USDI FWS 1995). The 4FRI treatment area falls within the western portion of the UGM Recovery Unit. Owls in this part of the Recovery Unit primarily nest and roost in mixed conifer and pine-oak forests. The only MSO habitat located within the 4FRI treatment area is pine-oak forest. Although mixed-conifer habitat occurs within the greater 4 FRI analysis area, no mixed conifer forest would be treated under the 4FRI.

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Data Sources

Core areas are 100 or more acres encompassing all or most known nest and roost sites. Where nest sites are unknown, core areas should include known roost sites and the best nesting habitat. In many cases PACs were delineated without knowledge of nest or roost sites and core areas were never delineated. Core areas were delineated for 40 PACs (38 with burn only treatments proposed and 2 with mechanical treatments proposed) within the 4FRI treatment area. This work was done in coordination with the USFWS. Core areas were drawn to encompass as many of the nests and roosts as possible with a bias toward nests and the most recently observed roosts. Orthophotos and topographical maps were used to help identify the best habitat. Topographical features such as canyons and northerly aspects were used to identify the best microhabitat for inclusion in the core areas. In PACs where there were no known nests or roosts, the buffers were drawn to include the best habitat available with a bias toward where spotted owls have been observed in the past. Note that core areas were not drawn for PACs not being treated (i.e., PACs outside the actual treatment area but within the overall 4FRI footprint) or for PACs that are primarily in canyons (e.g., treatments are proposed along the rim of the West Fork of Oak Creek but the main PAC is within the Canyon outside of the treatment area).

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MSO Restricted Habitat Delineation

The 1995 Recovery Plan estimated that most Forest Service projects planned in the southwestern region addressed about 10,000 acres at a time. This was described as a "limited spatial scale" that precluded a review of MSO habitat at more meaningful ecological scales (USDI FWS 1995). The Recovery Plan

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recommended assessing MSO habitat at district-wide or larger landscapes when delineating target and threshold habitat. Strengths of landscape-scale planning include the ability to compare habitat across ecological scales and support landscape connectivity for MSOs as described in the Recovery Plan. The 4FRI area constitutes a large portion of two national forests. This effort did not include habitat in current or recent projects or within mixed conifer habitat because those acres are not part of the 4FRI treatment area. Working closely with the USFWS and wildlife biologists from both national forests, restricted habitat, including target and threshold habitats, was reviewed across the greater 4FRI area, allowing full consideration of habitat at a landscape scale. This approach better meets the goal of providing continuous replacement nesting and roosting habitat over *space* and time, as described in the Recovery Plan and the 1996 ROD that amended the forest plans in Arizona and New Mexico (USDA FS 1996).

Data from the Kaibab and Coconino National Forests (based on polygons) were merged with pine-oak data from the Lab of Landscape Ecology and Conservation Biology (raster data; Dr. Steve Sesnie and Jill Rundall, Northern Arizona University) to create one GIS layer (see project record for additional information). Stands meeting the definition of restricted habitat were identified using the following queries:

- Pine - oak stands with 150 BA or greater
- Stands with oak ≥5 inches drc occurring as at least 10% of the trees or greater than or equal to 10 BA
- Percent of trees 12 to 18 inches dbh and trees >18 inches dbh
- At least 20 tpa ≥18 inches dbh
- Stands with northerly aspects (assumed to be more sustainable), ranging from 292˚ to 67˚ (WNW to ENE)

Existing ("threshold ") or potential ("target ") future nesting and roosting habitats were further stratified from within this new layer with the following queries:

- Trees 18 - 24 inches dbh and trees >24 inches dbh
- Oak 5-12 inches drc and oak >12 inches drc.
- At least 20% BA for oak >5 inches drc
- Identifying slopes 0-20%, 20-40%, and slopes >40% (steeper slopes were assumed to support moister site conditions that would be more sustainable for dense forests through time; slopes greater than 40% were separated out as protected habitat)

Query results were evaluated in terms of providing functional habitat, i.e., stands were dropped from this dataset for a number of reasons, including:

- the discovery that remotely sensed data sometimes misidentified juniper as oak in the understory (this was primarily a problem on the Williams Ranger District near Sycamore Canyon);
- adjacency to newly designated 300-foot parking areas for campers on the Coconino National Forest under the Travel Management Rule, finalized in September 2011;
- whether apparently contiguous blocks of habitat were fragmented by roads and/or power-lines;
- or if stands were adjacent to major forest roads.

We felt this new layer better met the biological needs of MSOs than past efforts that were either limited in scale or based on older data.

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Proximity to PAC habitat was also an evaluation criterion for restricted habitat, including target and threshold habitats. We sought to augment existing PAC habitat using stands of pine-oak meeting the queries described above. This was based on the assumption that known or suspected owl use indicated quality habitat. We specifically considered the areas ranging from the northwest to the southeast of PACs for inclusion as restricted habitat. We rarely identified additional MSO habitat southwest of existing PACs unless stands were on northerly aspects. Winds are predominantly from the southwest, so areas southwest of PACs were reevaluated for treatments that would reduce the risk of high-severity fires entering PACs.

A final emphasis for identifying restricted habitat was placed on removing stands misclassified as restricted habitat to assure designated areas would truly function as MSO habitat. Field reviews were done for a subset of selected stands in autumn, 2011 as quality control. To ensure that the best stands are managed for future MSO nest/roost habitat, 4FRI implementation allows for local biologists to substitute better stands if it is discovered that selected areas do not function as MSO habitat.

The Recovery Plan directs managers to "[c]reate replacement owl nest/roost habitat where appropriate." We held meetings with wildlife biologists from the USFWS, both national forests, and members of the 4FRI team starting on March 4, 2011. We placed emphasis on developing future nesting and roosting habitat on the Coconino National Forest, which supports some of the highest numbers of resident owls in the Region. In contrast, the Kaibab National Forest supports very few owls. Although the Kaibab and Coconino National Forests share a common border within the 4FRI project area, the quality of pine-oak habitat changes on either side of this administrative line. Pine-oak forests on the Coconino National Forest frequently produce large diameter oak suitable for MSO nesting. Gambel oak trees large enough for MSO nesting are uncommon on the Kaibab National Forest where oak most frequently occurs in a shrubby form (Chambers 2002). Along with this habitat difference is a clear shift in MSO occupancy. There are 187 PACs entirely on or overlapping Coconino National Forest lands. In contrast, the Kaibab National Forest has 10 identified PACs and all are on the Williams Ranger District, including 4 PACs that overlap the Coconino National Forest. PACs on the Kaibab National Forest predominantly occur on either mountainous cinder cones or in canyons. While PACs on the Kaibab contain individual stands of pine-oak habitat, they principally consist of mixed-conifer forest. In contrast, MSOs on the Coconino National Forest use relatively large, contiguous patches of pine-oak forest.

MSO densities tend to be greatest in the center of the range and decrease toward the range periphery (USDI FWS 1995). The Williams Ranger District is at the extreme western edge of the species' range along the Mogollon Plateau. Over 20 years of project surveys for MSOs in pine-oak forests on the Williams Ranger District has resulted in a single detection of a MSO (in 1994). The location was near past detections of an owl associated with mixed-conifer forest on Bill Williams Mountain. MSOs appeared to have abandoned the mixed-conifer habitat on Bill Williams Mountain around 1994. A pair was recently found nesting and roosting in canyon habitat south of the mountain. Owls in this new PAC undoubtedly forage in pine-oak forest, but are nesting and roosting in canyon-like rock structures. Pinyon-juniper vegetation is also near the nest site. The adjacent Coconino National Forest has one of the highest numbers of MSO PACs in the UGM Recovery Unit, including many pairs of owls nesting, roosting, and foraging in pine-oak habitat. Because of the marked difference between MSO occupancy and use of pine-oak on the two national forests, we assumed the disparity indicated better habitat conditions on the Coconino National Forest. Therefore, we designated more target habitat on the Coconino National Forest.

Approximately 75,111 total acres of MSO restricted habitat were designated within the project area. Over 12% of the restricted acres were designated as either target or threshold habitat to support future nesting and roosting habitat. Only 1,977 acres met the habitat criteria for threshold habitat, i.e., existing conditions suitable for nesting and roosting, as described in table III.B.1 of the Recovery Plan (USDI FWS 1995). Iterative data reviews, field visits, and familiarity with ground conditions by district

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personnel eliminated potential target stands, eventually lowering the target/threshold component to about 11.8% of the total restricted habitat. The oak component quickly diminishes north of Interstate 40, so the majority of the habitat occurs south of I-40. Overall, 13% of the restricted layer (6,444 acres) was designated as target and threshold habitat on the Coconino National Forest and about 9% (2,246 acres) was designated as target and threshold habitat on the Kaibab National Forest.

Another goal of this effort was to ensure that MSO habitat was distributed across the landscape, including strategically located blocks that could potentially function as future PACs. Blocks of habitat were also designated with the intent of providing "stepping-stones" to facilitate owl dispersal and connect areas capable of supporting future nesting and roosting habitat per the Recovery Plan. Small, scattered stands of isolated habitat in a matrix of non-MSO habitat would not be expected to function as future nest or roost sites or provide for connectivity and were subsequently dropped from further consideration.

MSO PAC Habitat Evaluation

A similar process was initiated to consider the potential for mechanical treatments inside PACs. This work was done before 4FRI project boundaries existed and so we evaluated 117 PACs in and around the eventual 4FRI project area. Working closely with the USFWS and wildlife biologists from both national forests, we reviewed each individual PAC, looking at:

1) dominant MSO habitat (e.g., pine-oak, mixed conifer, or canyons),
2) habitat structure,
3) available biological data based on ongoing occupancy surveys or past research,
4) topographic attributes (e.g., aspect and slope),
5) human access,
6) designated wilderness boundaries,
7) recent and ongoing projects affecting PAC habitat,
8) fire history, and
9) status of current habitat.

We concluded that 99 of the 117 PACs assessed did not warrant mechanical treatments. Reasons for dropping PACs from consideration for mechanical treatment included whether:

1) PACs were recently evaluated (and sometimes treated) by other projects (n = 32),
2) PAC habitat was outside the scope of 4FRI (e.g., mixed conifer, designated wilderness, or canyon habitat (n = 20),
3) PACs had been burned in recent years (n = 10),
4) The habitat was already in good condition (n = 11),
5) Treating outside the PACs would be adequate for improving overall conditions (n = 24), or
6) there was not enough information available to evaluate the need for treatment (n = 2).

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Eighteen PACs (15%) were determined to be candidates for mechanical treatments. Prescribed burning was recommended for all PACs occurring in the treatment area, including core areas.

This analysis was followed by field visits to 13 of 18 PACs proposed for treatment (Appendix 2). We did not realize until conducting field reviews that this exercise consistently identified the PACs either lacking key habitat elements or containing habitat at risk due to forest structure conditions. We had essentially filtered out many of the PACs already maintaining and sustaining MSO nesting/roosting habitat. Once we confirmed the field conditions, discussions shifted from whether to mechanically treat these PACs to how best to mechanically treat PACs. The sole objective in developing mechanical treatments was to improve nesting and roosting habitat.

Consistent issues were identified during the field visits. Large, old pine (a.k.a. "yellow pine") and Gambel oak were suppressed or dying as a result of competition with dense stands of young to mid-aged trees. In general, oak was being overtopped and shaded out by dense stands of mid-aged pine. Openings were filling in with pine trees, reducing prey species food and cover. Some PACs had stands that lacked Gambel oak and instead were pure ponderosa pine. Field reviews also identified PACs with forest health issues in pine-oak. Mixed-conifer core areas appeared relatively healthy and were providing key habitat elements preferred by owls. All PACs had individual stands that were in good condition. The 4FRI silviculturist developed vegetation simulation modeling to identify potential treatments for existing stand conditions within individual PACs. The objective was to reduce inter-tree competition while maintaining or improving nesting and roosting attributes as described in the forest plans and the recovery plan. See "Description of the Action and Action Area" above.

Cover Types in the 4FRI Treatment Area

The majority of the treatment area is ponderosa pine (68%; Table 7). Pine-oak forest (108,847 acres) is a subset of the ponderosa pine forest (27%). Other cover types include aspen (<1%) and grasslands, savannas, and meadows (8%). Water occurs on less than 1% of the area.

Table 7. Vegetation cover type by restoration unit in the 4FRI treatment area

Cover Type	RU 1	RU 3	RU 4	RU 5	RU 6	Total	% of Area
Non-Vegetated							
Barren	120	134	129	1,301	48	1,732	0.3
Non-Forest Communities							
Grassland	8,225	12,777	22,661	4,928	93	48,684	8
Forest Communities							
Pinyon Juniper Woodland	1,428	5,884	7,283	8,845	2,219	25,658	4
Oak Woodland	287	1,580	926	386	30	3,209	0.5
Aspen	368	201	497	403		1,469	0.3
Pine Oak[1]	59,183	46,064	2,134	1,466		108,847	19
Ponderosa Pine	84,189	81,421	132,144	57,568	41,189	396,511	68
Total Forested Acres:	**145,455**	**135,151**	**142,983**	**68,668**	**43,437**	**535,694**	**91**
Total Analysis Area Acres:	**153,799**	**148,062**	**165,774**	**74,896**	**43,578**	**586,110**	**100**

[1]Pine-oak is a subset of ponderosa pine forest

At a coarse level, the recovery and forest plans define three levels of habitat management: protected, restricted, and other forest and woodland types. The intent is to achieve a diversity of habitat conditions

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across the landscape. Protected habitat includes PACs and slopes greater than 40% where timber harvest has not occurred in the last 20 years. Restricted habitat includes target and threshold habitat and opportunities for foraging and dispersal (designated as restricted "other" habitat in this biological assessment). There are no wilderness lands, congressionally recognized wilderness study areas, research natural areas, or wild and scenic rivers within the treatment area. One proposed research natural area is delineated at the north end of Garland Prairie but does not contain MSO habitat.

About 19% (108,846 acres) of the treatment area (586,110 acres) is designated as MSO habitat. Some areas are centers of concentrated use by MSOs (e.g., Mormon Mountain, Bar M Canyon), use is widely scattered in other areas (Williams Ranger District), and some areas have never had documented use and have no identified MSO habitat (Tusayan Ranger District).

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Protected Habitat

The treatment area contains about 35,019 total acres of MSO protected habitat, most of which occurs in Restoration Unit 1. There are 193 PACs occurring completely or partially on the Coconino and Kaibab National Forests. There are 70 PACs (about 34,183 acres) in the 4FRI treatment area (Figure 7 – note that this figure does not include changes identified in Table 1 and Table 2). The remaining protected habitat (836 acres) occurs on steep slopes where timber harvest has not occurred in the previous 20 years and is not proposed for mechanical treatment (Table 8). Proposed treatments for steep-slope protected habitat consist of prescribed fire only – no mechanical treatments are proposed for this category of habitat.

Table 8. Acres of Mexican spotted owl habitat within the treatment area

MSO Habitat	Habitat Acres by Restoration Unit					
	RU 1	RU 3	RU 4	RU 5	RU 6	Total
Protected Habitat						
Protected Activity Center	28,213	4,555	556	859	0	34,183
Pine Oak >40% Slope	595	239	3	0	0	836
Total MSO Protected Acres	**28,808**	**4,793**	**558**	**859**	**0**	**35,019**
Restricted Habitat – Pine Oak						
Restricted	25,584	37,373	1,576	606	0	65,139
Target	3,919	2,793	0	0	0	6,713
Threshold	872	1,104	0	0	0	1,976
Total MSO Restricted Acres	**30,375**	**41,271**	**1,576**	**606**	**0**	**73,828**
Total MSO Habitat Acres	**59,183**	**46,064**	**2,134**	**1,466**	**0**	**108,847**

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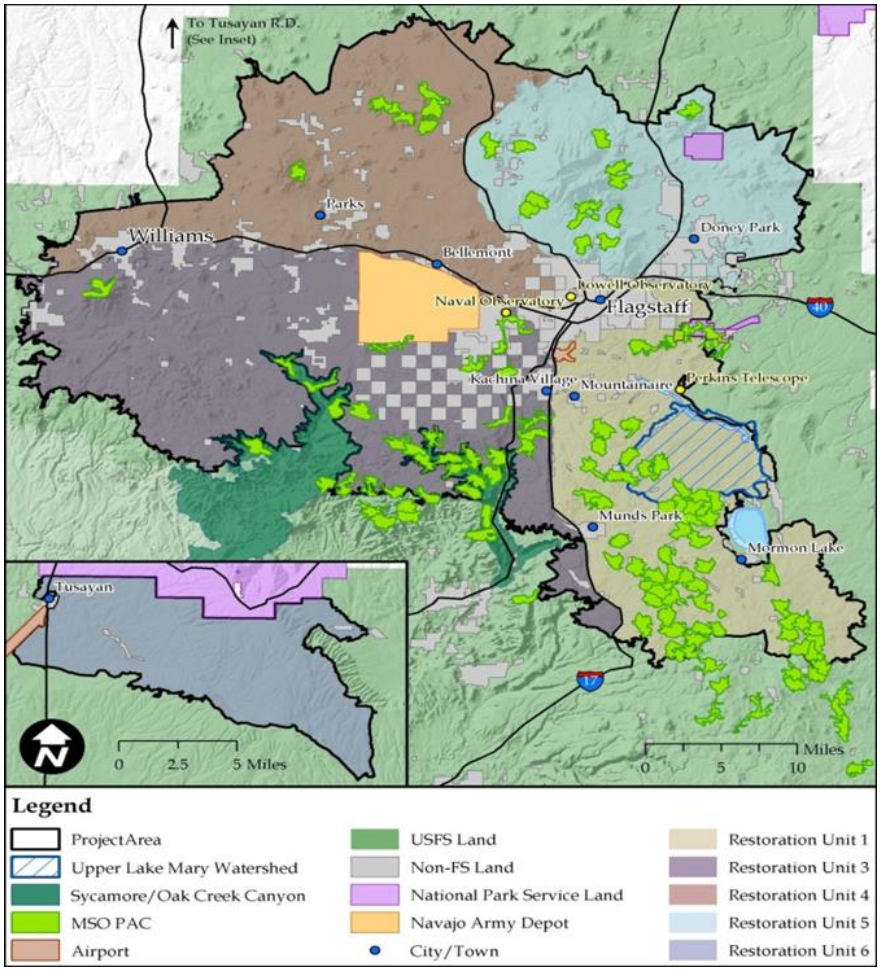


Figure 7. Locations of PACs within restoration units

Restricted Habitat

Restricted habitat within pine/oak is defined as having at least 10% of the site basal area consisting of oak greater than 5 inches diameter at root collar (DRC). Restricted habitat, by definition, is not considered occupied by spotted owls, but is assumed to be used by MSOs. The Recovery Plan recommends and current forest plan direction requires at least 10% of MSO restricted pine-oak habitat be designated as target or threshold habitat. Threshold habitat represents forest structure simultaneously meeting nesting and roosting criteria. Management activities in threshold habitat should not bring any of these habitat values below the minimums described in Table III.B.1 (USDI FWS 1995: page 92, and as identified in the forest plans) unless an abundance of such habitat could be demonstrated at large scales. The Recovery Plan also defines target habitat as areas approaching, but not currently meeting forest structure conditions described in Table III.B.1. Per Recovery Plan direction, any management in target habitat should move forest conditions toward nesting and roosting habitat if insufficient threshold habitat exists. Whether through threshold habitat or the combination of target and threshold, the intent is to manage at least 10%

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of restricted pine-oak habitat for future nesting and roosting habitat. Moving toward or attaining this goal assists in meeting the potential for MSO recovery.

About 75,111 acres of MSO restricted habitat exists within the treatment area, including 1,977 threshold acres and 6,715 target acres. Treatments would occur on 73,827 acres of restricted habitat, including 1,976 threshold acres and 6,712 target acres. Restricted habitat occurs in all Restoration Units except for the Tusayan Ranger District (Figure 8). Target and threshold habitat occur in Recovery Units 1 and 3 (Table 8).

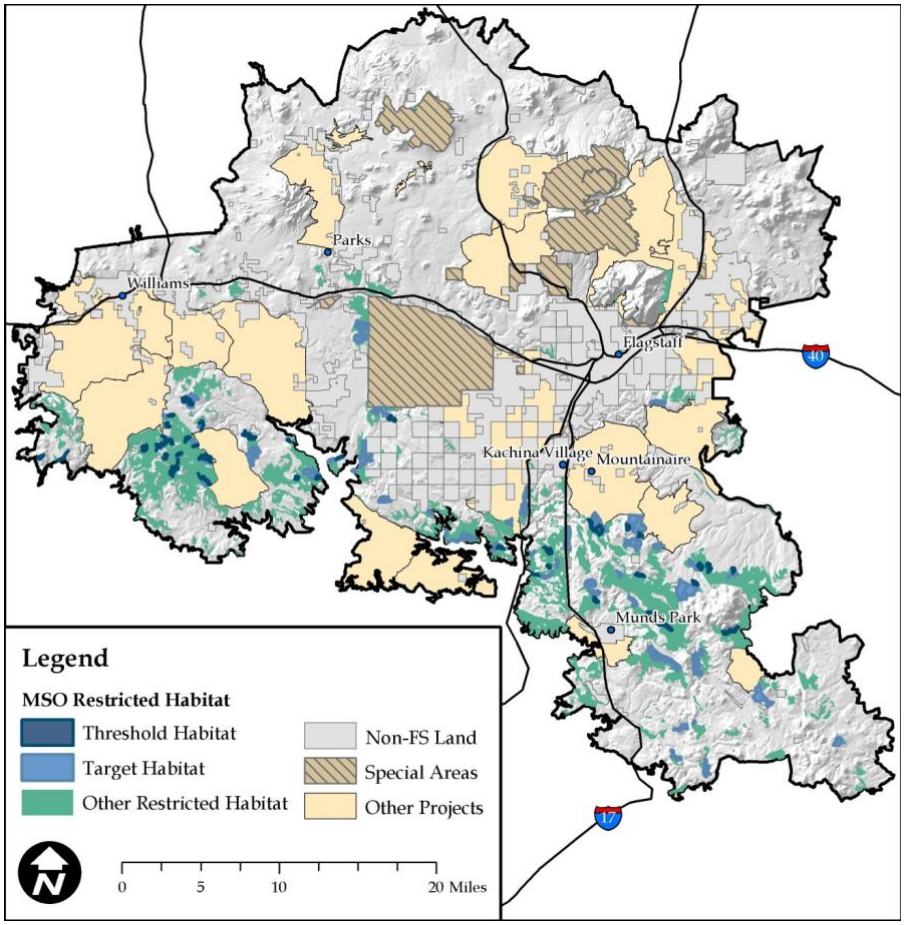


Figure 8. Location of MSO restricted habitat within the 4FRI

Existing Conditions for MSO Prey Habitat

Understory Status in the 4FRI Landscape

Canopy cover has a direct influence on understory development. Herbaceous cover declines rapidly under closed canopy conditions. Current conditions across much of the ponderosa pine forest, including pine-

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oak, include extensive closed canopies. The following summary is from Appendix 8 of the 4FRI Wildlife Specialist Report:

> Dense forests dominated by mid-aged pine trees limit sunlight reaching the forest floor, compete for water, and act as strong nitrogen sinks, creating unfavorable growing conditions for many understory species. More nutrients are translocated from the soil into forest canopies while slower nitrogen mineralization and nitrification rates occur beneath the forest floor. Combined with slower decomposition rates and allelopathic qualities associated with ponderosa pine litter, the current forest floor environment is creating selection pressure altering the understory community compared to what occurred here presettlement. Declines in total cover and species richness resulting from current forest conditions have been documented throughout the 20th century. The decrease in total cover and species richness resulting from current forest conditions includes selection pressures that limit total foliar production, flower production, and seed production. The net effects to wildlife are changes in vegetative cover and food quantity and quality, including reduced arthropod availability. In addition to effecting herbivores, negative impacts reflected in the arthropod community can directly influence wildlife by reducing food availability for insectivores and omnivores. In the long-term, reduced arthropod populations can exert secondary limits or selection pressures on the plant community by decreasing the pollinator assemblage. This can further limit the understory diversity with potential impacts moving up through community trophic levels [page 8].

Conditions in areas designated as nesting and roosting habitat limit understory development. However, small, scattered canopy gaps can create patches of food and cover for MSO prey species. Gambel oak, aspen, meadows, springs, and functioning ephemeral channels within MSO habitat can also provide prey habitat while still managing pine-oak forest on a trajectory for nesting and roosting habitat.

Status of Snags, Down Logs, and Coarse Woody Debris

Another identifiable feature of MSO habitat is the presence of down logs and large snags. MSOs and key prey species are associated with habitat containing numerous logs and large snags (Ganey et al. 2011). The Coconino and Kaibab forest plans call for an average of two large snags per acre in ponderosa pine forests, with large snags defined as 18 inches or larger dbh and 30 feet tall or higher. However, these forest plan specifications may be unrealistic. Ganey (1999) found only 30 percent of ponderosa pine plots in un-logged sites met or exceeded Forest Service snag guidelines and Waskiewicz et al. (2007) found pine snag densities well below Forest Service guidelines in relatively undisturbed forests in northern Arizona.

Note that in this report log values are estimates based on stand data collected in the field. Traditional stand data collection for down wood does not include length, which is a part of the definition of a log in terms of forest plan compliance. However, Brown et al. (2003) developed a conversion factor for this kind of stand data. The bole weight of a dead 12-inch dbh ponderosa pine tree averages about 0.332 ton. Knowing the diameter of downed wood allows an estimate of how many logs are included in the tonnage value. This report uses this log-equivalent conversion.

The present density of snags 18 inches dbh or greater is well below forest plan guidelines of two snags per acre in ponderosa pine forest. The Recovery Plan concluded that meeting the combination of BA, large (greater than 18 inches dbh) tree density, and tree size-class distribution served as surrogates for snag and downed log availability. The assumption was that if these live tree attributes are at adequate levels across the landscape, than adequate amounts of snags and downed logs should also be present (USDI FWS 1995).

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Fire promotes recruitment of large snags, but in a study conducted locally, 40% of snags resulting from high-severity fire fell within seven years (Chambers and Mast 2005). Over 80% of ponderosa pine snags created by high-severity fire fell within 10 years post-fire (Chambers pers. comm. 2008, Mast pers. comm. 2008). Similar fall rates appear to occur for beetle-killed ponderosa pine trees (Chambers and Mast 2014). Chambers and Mast (2005) found greater densities of large diameter snags in unburned plots vs. burned plots on the Coconino and Kaibab National Forests. Similarly, Holden et al. (2006) found significantly lower snag densities in the Gila National Forest (New Mexico) where fire had occurred two to three times since 1946 compared to areas that had only burned once. Bagne et al. (2008) found that in forests experiencing fire suppression for long periods of time, the greatest loss of snags occurred during first-entry burns (the first fire in a given location after missing three or more fire-cycles), but the long-term rate of loss decreased and eventually leveled off during subsequent burns.

Ganey and Vojta (2005) documented an increase in snag recruitment, but the greatest increase was among smaller-sized trees. This pattern is reflected in Forest Inventory Analysis (FIA) data collected between 1995 and 2007 that showed an overall increase in ponderosa pine snag density on the Kaibab National Forest (USDA FS 2010a), similar to results reported by Ganey and Vojta (2005). In 2011, Ganey and Vojta reported a 74 percent increase in ponderosa pine mortality from 2002 to 2007 compared to mortality between 1997 and 2002. This increase in snags was the result of a drought-mediated pulse in tree mortality (Ganey and Vojta 2011). While more trees were dying in the smaller size classes, proportions of dying trees were greatest in the largest size classes. The pulse in large snags was the direct result of a mortality pulse in large live trees. Both large trees and large snags are important to the MSO (USDI FWS 1995). Mortality of aspen and Gambel oak in pine-oak forests were also proportionally greater than expected, relative to species composition of live tree forests (Ganey and Vojta 2011). This short-term increase in large snags reduces large snag recruitment in the long term, as fewer large trees are available through time. Future pulses are likely as climate changes, further limiting the future large tree cohort if current trajectories in forest health and development are maintained.

The range in snag values indicates that the distribution of snags is patchy. While guidelines may be met at different scales, snags could be lacking within a given stand (Table 9). The distribution of snags relates to how they are formed. Individual snags may be a result of natural causes, but tree mortality resulting from beetles, fire, mistletoe, etc., tend to result in patches or small groups of snags. This emphasizes that, even where snag numbers may exceed forest plan guidelines in a given area, snag retention may still be important on a stand-by-stand basis.

Forest plan direction for woody debris is to leave three large downed logs per acre and 5 to 7 tons of coarse woody debris (CWD) per acre. Downed logs are defined as 12 inches in diameter and at least 8 feet long and CWD is 3 inches or larger on the forest floor. Ganey and Vojta (2012) documented increased fall rates of trees in plots across the Coconino and Kaibab National Forests since 2004. Plots with logs present increased by over 8% between 2004 and 2009 and log length, density, volume, and area covered all increased significantly ($p < 0.001$) during that same period. These changes represent initial results from a drought-mediated pulse in tree mortality (Ganey and Vojta 2011). Similar to snags, the range in logs values combined with on-the-ground knowledge of typical forest conditions suggests that distribution is patchy.

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Table 9. Existing snags and coarse wood > 12 inches diameter in MSO habitat by restoration unit (RU)

Habitat	RU	Acres	Snags 12 - 17.9" Per Acre		Snags ≥18" Per Acre		Coarse Wood (Tons per Acre)		Logs	
			Range	Avg	Range	Avg	Range	Avg	Range	Avg
MSO - Protected PACs & Protected Outside of PACs	1	28,808	0 to 11.4	2.9	0 to 5.3	0.6	0.2 to 20.5	5.4	0 to 22.1	2.1
	3	4,793	0 to 8.2	2.9	0 to 2.5	0.7	0.9 to 16.1	6.3	0 to 41.7	3.6
	4	558	0.3 to 4.5	2.0	0.1 to 1	0.4	2.4 to 6.6	5.7	0 to 5.2	1.3
	5	859	1.5 to 4.5	2.7	0.3 to 0.9	0.6	3.2 to 6.5	5.6	0.4 to 5.2	3.3
	All	**35,019**	**0 to 11.4**	**2.8**	**0 to 5.3**	**0.6**	**0.2 to 20.5**	**5.6**	**0 to 41.7**	**2.3**
MSO - Restricted Threshold	1	872	0.6 to 6.1	2.0	0.2 to 0.7	0.5	5.7 to 9	7.1	1.2 to 12.8	6.1
	3	1,104	0.6 to 6.1	3.0	0.2 to 1.4	0.7	3.2 to 9	4.4	0.5 to 12.8	1.8
	All	**1,976**	**0.6 to 6.1**	**2.5**	**0.2 to 1.4**	**0.6**	**3.2 to 9**	**5.6**	**0.5 to 12.8**	**3.7**
MSO - Restricted Target	1	3,919	1.7 to 3.3	2.5	0.2 to 1.4	0.5	5.6 to 6.4	6.0	2.9 to 9.6	4.6
	3	2,793	0.9 to 3.3	2.2	0.1 to 1.4	0.5	2.1 to 6.4	4.8	0.2 to 9.6	2.5
	All	**6,713**	**0.9 to 3.3**	**2.4**	**0.1 to 1.4**	**0.5**	**2.1 to 6.4**	**5.5**	**0.2 to 9.6**	**3.7**
MSO - Restricted Other	1	25,584	0.4 to 3.9	1.7	0.2 to 0.8	0.4	2.1 to 5.9	4.3	0.2 to 3.2	1.0
	3	37,373	0.4 to 3.9	1.8	0.2 to 1.1	0.4	1.4 to 7.4	3.9	0.2 to 12.5	1.4
	4	1,576	0.5 to 3.7	1.7	0.2 to 1.1	0.5	1.4 to 5.9	3.2	0.4 to 2.6	1.1
	5	606	0.6 to 2.9	1.1	0.2 to 0.8	0.4	2.1 to 5.4	3.2	0.2 to 1.9	0.6
	All	**65,139**	**0.4 to 3.9**	**1.8**	**0.2 to 1.1**	**0.4**	**1.4 to 7.4**	**4.0**	**0.2 to 12.5**	**1.3**

Forest Structure Summary for MSO Habitat

Key habitat components/primary constituent elements (PCE) of MSO habitat described in the Recovery Plan include:

- a range of tree sizes and ages with a preponderance of trees greater than 12 inches dbh,
- BA and density of pine and Gambel oak
- canopy cover and structure
- tree sizes suggestive of uneven-aged management, and
- large dead trees (snags) with a diameter of 12 inches or greater

MSO populations are influenced by prey availability. Key features of prey habitat include:

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- high volume of fallen trees (mid-point diameter of 12 inches or greater) and other woody debris
- plant species richness, including woody species
- residual plant cover to maintain fruits, seeds, and regeneration to provide needs of MSO prey species, and
- other improvements to prey habitat

These forest structure elements are reflected in the evaluation criteria and are used to describe the existing condition of the habitat and the effects of the proposed activities.

The 4FRI silviculture database and PAC reviews indicated a number of consistent issues relative to MSO habitat in the 4FRI project area, including:

- An imbalance in tree size classes leading to a lack of diversity in tree ages and structural diversity, with an abundance of mid-aged trees and a lack of large, old trees;
- Threats to existing big and old trees because of competition from smaller trees;
- Decreased quality in prey habitat due in part to uncharacteristic canopy connectivity from ingrowth of trees in smaller size classes;
- Overall decline in forest resilience due to competition among trees and, indirectly, from the risk of high-severity fire, insects, and disease resulting from the uncharacteristic levels of tree competition;
- Snags greater than 18 inches dbh are deficit across the landscape relative to forest plan direction; combined with snags 12 to 18 inches dbh MSO habitat needs may be met, but snags numbers vary considerably;
- CWD and logs tend to be abundant and meet forest plan direction, although stand-by-stand variation exists;
- The risk of high-severity fire within the ponderosa pine forest type remains high and outside desired conditions, threatening the ability to maintain MSO habitat components through time

Habitat loss from high-severity wildland fire was identified as a primary risk in the Recovery Plan in 1995, yet the three most active fire seasons in Arizona history have occurred since 2008, with nearly a million acres burned in 2011 alone (Paxon 2011). Because of the nature of closed canopy, dense forest structure, the risk of high-severity fire is greater in MSO habitat than is most other portions of the 4FRI treatment area (see fire ecology report for details). Minimum requirements for habitat components in MSO habitat, as outlined in the forest plans and Recovery Plan, do not allow the same flexibility in management as in ponderosa pine forest outside MSO habitat. While the higher fire risk is acknowledged in the Recovery Plan, the scale of 4FRI allows a strategic reduction of risk in areas outside owl habitat. In addition, the 4FRI also proposes treatments that both improve MSO habitat and reduce the risk of crown fire inside MSO habitat.

The Revised Recovery Plan listed 2 primary reasons for listing the MSO in 1993: (1) alteration of habitat as the result of even-aged timber-management practices; and, (2) the threat of these practices continuing as evidenced in the forest plans of that time. Stand-replacing fire was cited as a looming threat. Since publication of the first Recovery Plan (USFWS 1995), forest management has shifted away from a commodity focus and now emphasizes a sustainable, uneven-aged approach largely based on ecological function (USDA FS 1996). Concurrently, the primary threat to the owl in the U.S. portion of its range has transitioned to the risk of high-severity fire (USFWS 2012). Both shifts in management perspective have potential to benefit the MSO. Currently, high-severity fires are much larger than typical of ponderosa pine in the southwest (Swetnam 1990, Covington and Moore 1994; Swetnam and Betancourt 1998, Westerling

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et al. 2006). Climate variability, combined with unhealthy forest conditions, may also synergistically affect MSO habitat (see climate change below). The intensification of natural drought cycles and the ensuing stress placed upon overstocked forested habitats could result in larger and more severe stochastic events, particularly fire, in MSO habitat in the future. Managing for forest conditions that allow the return of low-severity fire back to southwestern ponderosa pine forest was also recognized in the revised recovery plan (USFWS 2012).

While MSO habitat is managed for denser conditions than forestland outside designated habitat, there is no reason to assume that historical conditions equaled the extensive, homogeneous conditions common in today's dense stand structure. The re-evaluation of nesting and roosting parameters by the MSO recovery team (USDI FWS 2012a) supports the concept of a mix of very dense conditions interspersed with a variety of other forest structures, including mature oak, aspen, and openings. This mixture would provide necessary nesting and roosting habitat while supporting an abundance of prey species.

Whereas retaining and developing nesting and roosting habitat is vital to the recovery of the MSO (USDI FWS 2012a), loss of nesting and roosting habitat to high-severity fire is increasingly predictable in today's landscape.

MSO Critical Habitat within the 4FRI Treatment Area

The USFWS designated MSO critical habitat in 2004 (USDI FWS 2004). Critical habitat is defined as protected and restricted habitats occurring within defined boundaries specific to each critical habitat unit. As such, values for the PCEs are averages of nesting and roosting habitat, future nesting and roosting habitat, and other owl habitat. By definition, there are more acres of restricted habitat than there are of PAC habitat. The values discussed below provide relative comparisons of alternatives, but provide limited insight into actual habitat conditions. Details on changes in habitat can found in the above discussions on protected and restricted habitat. PCEs are habitat features necessary for conservation of the species within the designated critical habitat units and are defined in the Final Rule published in the Federal Register (USDI FWS 2004). In pine-oak forest these include one or more of the habitat needs for nesting, roosting, and foraging and include:

Forest Structure:

- A range of tree species of different sizes and ages;
- Thirty to 45% of the trees with a dbh of 12 inches or greater;
- Shade canopy of 40% or more;
- Snags of 12 inch or greater dbh; and

MSO Prey Habitat:

- High volume of fallen trees and other woody debris;
- A wide range of tree and plant species, including hardwoods;
- Adequate levels of residual plant cover to maintain fruits, seeds, and plant regeneration.

Six critical habitat units (CHUs) occur within or overlap the 4FRI analysis area, encompassing about 488,974 total acres (Table 10). Designated critical habitat in the 4FRI area does not include State, private, Naval Observatory, or certain WUI areas (Figure 9). Approximately 88,143 acres of protected and restricted habitat in the 4FRI treatment area are within designated CHUs boundaries. Within the 4FRI treatment area non-MSO habitat occurs within CHUs and designated MSO habitat occurs outside of CHUs. All critical habitat acres within the 4FRI treatment area are proposed for burning. About 69

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percent of the acres (61,128 acres) are proposed for thinning. Comparisons of most attributes include the year 2050 to allow for changes in forest development to become most apparent. Results for 2020 are also displayed to display immediate effects of treatments. This is especially important for the relative index for understory development. Herbaceous response is strongly correlated with canopy closure and is maximized in the first couple of years after treatment. After that, tree growth would increase and the canopy would continue developing, causing a persistent decrease in understory response through 2050.

Table 10. Critical habitat units (CHUs) occurring in the 4FRI treatment area

Critical Habitat Unit	Total CHU Acres	Acres of Proposed Treatments	National Forest(s)	Approximate Location Description
UGM 11	144,790	48,923	Coconino	South-southeast of Mountainaire, encompassing: Howard, Mormon, and Hutch Mountains; Interstate 17 to Happy Jack; excluding Mormon Lake and Stoneman Lake
UGM 12	17,359	1,249	Coconino	East of Flagstaff
UGM 13	238,092	36,459	Coconino, Kaibab, and Prescott	Between Flagstaff and Williams, from Camp Navajo to the Mogollon Rim, including Bill Williams Mountain, Sycamore Canyon Wilderness, and Volunteer Canyon
UGM 14	55,533	918	Coconino	Due north of Flagstaff, encompassing the San Francisco Peaks, Hochderffer Hills, O'Leary Peak, the Dry Lake Hills, and Elden Mountain
UGM 15	22,286	593	Kaibab	Northwest of Flagstaff, west of Hwy 180, encompasses Kendrick Peak northwest to Wild Horse Canyon
UGM 17	10,914	0	Kaibab	North of Parks, including Sitgreaves Mountain, RS Hill, and Government Hill

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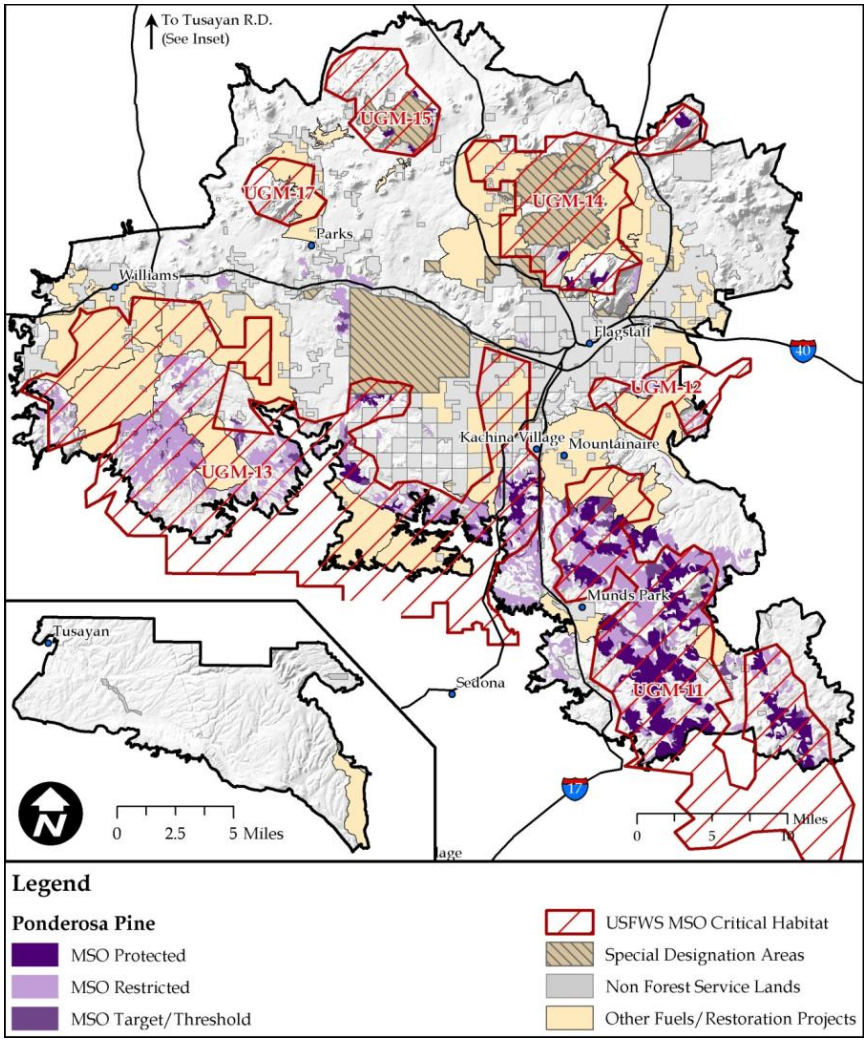


Figure 9. Mexican spotted owl critical habitat within the 4FRI treatment area

Thinning and Timber Harvest in Spotted Owl Habitat

No empirical data exists on the effects of thinning or other mechanical forest treatments on MSOs. The absence of information complicates planning for restoration of ponderosa pine forests while simultaneously conserving MSOs and their habitats. The following summarizes published research on habitat treatments within the range of spotted owls, including the northern and California sub species.

Meiman et al. (2003) used radio telemetry to follow a single male northern spotted owl before, during, and after a 237 acre commercial thinning. Thinning intensities varied from about 90 to 170 ft^2 BA. Tree harvest significantly reduced use of the thinned stand. The owl shifted its breeding-season home range to exclude part of the thinned area and used additional unthinned areas instead. However, results are difficult to interpret, in part because they are based on habitat use of a single owl. Also, information about

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temporal variation in space and stand use is lacking (USDI FWS 2012a). As the authors noted, "Because this was a case study involving one owl, we are unable to apply our findings to spotted owls in general; however, we believe that our results highlight important issues that need to be addressed…."

Seamans and Gutiérrez (2007) modeled the probability of territory colonization, territory extinction, and breeding dispersal in relation to the amount of mature forest within and among territories. They included a covariate to evaluate the effects of changes in mature conifer forest habitat after timber harvest. The amount of untreated mature conifer forest was positively related to the top models for colonization and the probability of occupancy. The top model for colonization indicated that territories in which ≥20 ha (49 ac.) of mature conifer forest habitat was altered by timber harvest experienced a 2.5% decline in occupancy probability. Territory extinction was inversely related to the amount of mature forest within a territory. The amount of mature forest treated was also related to breeding adults abandoning their territory and dispersing to other areas. However, Seamans and Gutiérrez (2007) did not provide details on the types of treatments implemented in this study and how the habitat was altered. This lack of information makes it difficult to compare their results with specific management proposals.

In another modeling effort, Lee and Irwin (2005) looked at effects to California spotted owl (CSO) habitat from reducing fire risk while maintaining forest canopy conditions. Their 60-year simulations found that mechanical thinning with or without fuel breaks did not degrade canopy conditions in productive owl territories and did not impede attainment of improved forest structure in non-productive territories. They concluded that forest treatments could reduce the risk of high-severity wildfire and maintain owl habitat.

Prather et al. (2008) looked at fuels reduction treatments in fire-excluded forest in MSO habitat. They used spatially-explicit modeling at a landscape scale to evaluate impacts of restoration-based treatments. They concluded that forest restoration was compatible with MSO conservation in at least two-thirds of the 2 million-plus acres analyzed across northern Arizona.

The Pacific Southwest Research Station of the Forest Service conducted a large scale monitoring effort on the Plumas and Lassen NFs (USDA FS 2010b). They monitored movements and habitat use of radio-marked CSOs in a portion of the northern Sierra Nevada Mountain Range modified by fuels treatments. Treatments included defensible fuel profile zones, understory thin, understory thin followed by underburn, and group selection. Treatment objectives were to reduce fuel continuity across the landscape. Treatments were typically located along roads and ridge tops to provide a defensible zone for fire suppression activities. Understory thinning treatments allowed removal of trees less than 10 inches dbh. Radio-marked owls avoided the defensible fuel profile zones. Use of other treatments was variable, but owls did not avoid the other fuels treatment types. Owl home ranges contained fuels treatments in proportion to their availability on the landscape. One owl strongly selected underburn treatments over untreated forest for foraging; limited availability of this treatment type within the study area prevented further analysis of this relationship. In three-years post-treatment CSOs were distributed similarly to the pre-treatment landscape. The authors concluded that the results provide empirical support that CSOs persist in landscapes treated for fuels or restoration treatments.

Irwin et al. (2004) found northern spotted owls on the eastside of the Cascade Mountains abandoned 45 territories that had abundant pole-sized trees and limited seedling and sapling-aged trees. In addition, northern spotted owl reproductive rates were lower in territories with more pole-sized trees. The most productive owl pairs occurred in forests most at risk to uncharacteristic wildfire. They recommended managers prioritize treatments in dry forests most at risk of uncharacteristically intense wildfire.

The literature is mixed in terms of spotted owl response to thinning and fuels treatments. However, there is support for reducing the risk of future high-severity fire in occupied spotted owl habitat. Unfortunately, there is no clear guidance relative to treatment types, extents, or spatial arrangements of treatments that

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would minimize negative impacts to owls. Available data is largely from CSOs and northern spotted owls, with little information specific to MSOs. Lacking such information, the MSO recovery team recommended that managers proceed cautiously in terms of treatment intensity and extent and should be aimed at balancing reduced fire risk with maintaining the mature forest structure that seems to be favored by spotted owls. Given the uncertainty, they concluded treatments in MSO habitat should include rigorous monitoring (USDI FWS 2012a). It is important to note the difference between treatments modeled or monitored in the literature and those proposed by the 4FRI.

The 4FRI is proposing treatments on nearly 74,000 acres of MSO restricted habitat and over 35,000 acres of protected habitat. These treatments are fundamentally different from the research described above. The objective of the 4FRI treatments is to improve MSO habitat. This is profoundly different from an emphasis on fuels reduction. Large trees would be retained and targeting mid-aged trees would improve the health, growth rates, and sustainability of large trees. Trees would be retained in all size classes; treatments in MSO habitat would not be a simple thin from below. Canopy gaps would increase understory production and benefit prey species. Treatment objectives include retaining Gambel oak and other non-ponderosa pine species to maintain overstory diversity. Improving meadows, riparian habitat, and aspen stands would improve foraging habitat. An artifact of these actions would be a reduction in fire risk, but the intent of the treatment design is to *improve* MSO habitat by using the recovery plan as a guide. The landscape approach of 4FRI allows emphasizing fuels reduction treatments outside of MSO habitat, particularly in stands southwest of PACs. Monitoring would be a key component of this work and success would be determined by conserving MSOs and their habitat.

Fire Behavior

More acres of PACs and critical habitat have been lost to high-severity fire within the U.S. portion of the range of the MSO than by management actions such as forest management, livestock grazing, recreation, etc., (USDI FWS 2012a). Most MSO habitat lost to high-severity fire has been within the UGM Recovery Unit (e.g., Rodeo-Chediski and Wallow Fires on the Apache-Sitgreaves National Forest – see Table 196 in Appendix 12 of the wildlife report) and Basin and Range West Recovery Unit (e.g., Horseshoe 2 Fire on the Coronado National Forest). Other Recovery Units have also been impacted such as the Southern Rocky Mountains Recovery Unit (e.g., the Las Conchas Fire on the Santa Fe NF) and the Colorado Plateau Recovery Unit (e.g., the Warm Fire on the Kaibab National Forest).

Currently, over 191,000 acres (39%) of the 4FRI treatment area has crown fire potential. Crown fire is, by definition, high-severity. It generally consumes the entire tree crown in ponderosa pine, producing 100% mortality. Acres within or adjacent to MSO habitat are at risk from high-intensity surface fire that can result in high-severity effects. High-intensity surface fires that burn through areas of heavy surface fuels, dense canopies, and low crown base height could scorch the canopy sufficiently to cause widespread mortality (Van Wagner 1973). Much of the landscape is still vulnerable to crown fire or to second-order fire effects such as flooding, erosion, and weed infestations. More information on existing fire conditions as related to canopy conditions and fuel loading can be found in the 4FRI fire specialist's report.

The 4FRI fire modeling and analysis was conducted at several scales, from the EIS analysis area (the largest scale) to individual forest type and habitat classifications (e.g., MSO habitats). Modeled fire effects to protected habitat are presented here, but results to individual PACs are not available because all modeling was done at larger scales.

Effects of Climate Change

Southwestern forests are particularly sensitive to drought and increasing temperatures (Williams et al. 2010). It is expected that large changes in plant community structure and species composition will occur

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due to the warming air temperatures and altered hydrological cycles. An overall decrease in forest productivity could ensue as a result of reduced precipitation (USDA FS 2010c). If temperature and aridity continue to rise as projected, trees will experience substantially reduced growth rates this century with ecotones and dense forest stands particularly vulnerable to fire mortality and drought-induced die-offs (Williams et al. 2010). These potential effects would have a direct influence on the sustainability of MSO habitat and the potential recovery of the species. Similarly, declines in deciduous trees and shrubs have already occurred within the coniferous forests of Arizona (Martin and Maron 2012). Long-term decreases in stem densities of deciduous woody plants were strongly associated with 25 years of declining snowfall (Martin and Maron 2012). The additive effects of multiple years of declining snowfall accounted for 85% of the documented decline in plant densities. Declines in woody plants, in turn, were associated with declines in 5 of 6 songbird species that nest on the ground or in the understory (Martin and Maron 2012). While this study did not track changes in small mammal communities, loss or significant reduction of this component of the ponderosa pine forest could affect the habitat of small mammals preyed on by MSO.

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In addition to density-related stress, winter precipitation is the dominant water source for large and old ponderosa pines in northern Arizona (Kerhoulas et al. 2013). Large and old trees depend on water from snowmelt and are not as strongly affected by summer monsoon rains. Climate change is predicted to reduce snowpack and increase evaporation and drought stress (NFWPCAP 2012). If this occurs, large and old trees will be more susceptible to stress and likely suffer increased mortality. Shifts in the timing of snowmelt have already been observed (Millar et al. 2007).

Climate change can work synergistically on the overstory as well. Large, old trees already stressed from competition with uncharacteristic quantities of mid-aged trees will be disproportionately susceptible to mortality from drought, insects and disease (see silviculture report for details). Dense, connected canopies are widespread in the relatively homogeneous forest in the Arizona ponderosa pine zone. This uncharacteristic forest structure is vulnerable to larger fires that burn as high-severity crown fires (e.g., Rodeo-Chediski). Each of these factors, working alone and synergistically, may lead to disproportionate mortality in the largest tree size classes. Other expected changes in MSO habitat due to climate change are described in Appendix 4.

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Road Systems

The Coconino and Kaibab National Forests identified the road system needed for public and administrative motorized use through the Travel Management Rule (TMR; see the transportation specialist report for details on forestwide transportation analyses). Within the 4FRI treatment area, the TMR process identified a need to decommission approximately 770 miles of existing system and unauthorized roads on the Coconino National Forest. About 134 miles of unauthorized roads (often referred to as user-created routes) were recommended for decommissioning on the Kaibab National Forest within the 4FRI area (Table 11). The desired condition is to restore decommissioned road prisms to their natural condition. Soils would be in satisfactory condition so that the soil can resist erosion, recycle nutrients, and absorb water. Understory species (e.g., grasses, forbs, and shrubs) diversity would be consistent with site potential and provide for infiltration of water and reduction of accelerated erosion. The understory would consist of a variety of cool and warm season vegetation.

About 2,793 miles of road would be needed to implement the project. Of this total, approximately 2,273 miles are existing, open roads. However, portions of these existing roads have resource concerns, which require maintenance or reconstruction prior to project use. There are no existing roads to provide access to treatments areas in some parts of the project area. Records and field review indicate some roads have been decommissioned in previous projects.

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There is a need to have adequate access to the project area for implementation. Adequate access includes utilizing existing roads and temporarily creating roads that can be returned to their natural state (decommissioned) at the completion of project activities. Additional maintenance, reconstruction, and restoration actions would be designed to meet site-specific conditions where possible and practicable.

Table 11. Approximate miles of road work in the 4FRI area

General Location	Temporary Construction and Decommission	Reconstruction/ Improvement	Relocation	Existing Road Decommission
Project Area	520	≤ 30	≤ 10	860
MSO Habitat[1]	74	8.1	1.5	153

[1]MSO Habitat represents a subset of total project acres

A 4-day review involving the 4FRI assistant team lead, 4FRI biologists, and the 4FRI GIS specialist was conducted to identify a road system for hauling harvested materials off forest during implementation of the 4FRI restoration activities. Haul routes were evaluated across the entire project area relative to each of the 70 MSO PACs in the treatment area. The objective was to delineate a functional road system that avoided or minimized potential impacts to MSOs. This broad scale effort was evaluated in a site-specific manner as roads around each individual PAC were examined in terms of functional haul routes that avoided disturbance to MSOs. We defined and assessed blocks of commercial treatment areas ranging from hundreds to thousands of acres and identified routes between these treatment blocks and major transportation corridors. The following criteria were used to select routes in and near PACs:

1) Roads were selected to avoid PACs
2) Where hauling in PACs could not be avoided, roads greater than a ¼ mile from core areas were selected (Woods PAC)
3) Where these criteria could not be met, timing restrictions were applied to prevent disturbance to MSO during the nesting season

A haul road network was identified, including secondary roads associated with harvest units, and primary roads leading off-forest.

Aquatic Species

Data Sources, Including Surveys Conducted

The Threatened, Endangered and Sensitive Species (TES) List for the Coconino National Forest was reviewed (USDA FS 2007) and a list of TES species was created for this project based on known occurrence or, in the absence of survey data, the presence of suitable habitat (Table 5).

Arizona Game and Fish Department stocking records and monitoring data were also used to describe historic and current distribution of these species.

Aquatic Habitat in the Analysis Area

Restoration Units and Subunits

1-1: This treatment area includes portions of four 6th Code HUC watersheds, but only one perennial stretch of stream, a portion of Rio de Flag. This subunit does not contain any proposed spring restoration

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areas, but several stream channel restorations are proposed, including portions of Fay Canyon1, Skunk Canyon, and Cherry Canyon.

Fish that may be present in Rio de Flag include largemouth bass, channel catfish and smallmouth bass. Native fish that may be present include speckled dace. There are no listed or sensitive fish or macroinvertebrates documented in this streamcourse.

Nearby water bodies include Lower Lake Mary and Marshall Lake, but both are upstream of the treatment area. All other streamcourses and water bodies in or near this subunit are ephemeral and therefore do not contain permanent populations of fish or macroinvertebrates.

1-2: There is no perennial water in this subunit, thus permanent populations of fish and macroinvertebrates are absent. Spring restoration is proposed for Sedge Spring. Mormon Lake is nearby and downhill from a portion of the subunit, but water in this natural lake is ephemeral, and thus any fish species present are the result of opportunistic stocking by the Arizona Game and Fish Department.

Mormon Lake went dry in the fall of 2009, and currently has no fish living in the lake. The final Environmental Assessment for sportfish stocking in Arizona (USDI FWS 2011) eliminated both Mormon Lake and Stoneman Lake from all future stocking of sportfish in order to protect populations of Northern Leopard Frog.

1-3: This treatment area includes portions of three 6th Code HUC watersheds, including Walnut Creek-Upper Lake Mary, Walnut Creek-Lower Lake Mary, and Pumphouse Wash. There are no perennial streams in this treatment area, but Walnut Creek fills both Upper and Lower Lake Mary, which hold water through most if not all of the year. Local runoff fills Marshall Lake, which occasionally holds enough water to support seasonal rainbow trout stocking. Stream channels in this treatment area also include Schoolhouse Draw, Pumphouse Wash, Kelly Canyon, James Canyon, Priest Draw, Howard Draw, and Newman Canyon. Proposed spring restoration in this subunit includes Thomas Spring, Hogworth Spring, Clarks Well, Babbit Spring, and Welmer Spring. Stream channel restoration projects are proposed for portions of Schoolhouse Wash, Pumphouse Wash, James Canyon, Priest Draw, Howard Draw, and Newman Canyon, in this subunit.

1-4: This treatment unit includes portions of five 6th Code HUC watersheds, including Yeager Draw, Kinnikinick Canyon, Grapevine Canyon, Sawmill Wash, and Long Lake-Chaves Pass Ditch. This restoration subunit includes only one stretch of perennial stream, the upper portion of Sawmill Wash. Proposed spring restoration includes Mint Spring and Dove Springs in Kinnikinick Canyon. The only proposed stream channel restoration is a small stretch of Sawmill Wash, downstream from perennial streamflow.

Macroinvertebrates are found in the ephemeral streamcourses when water is flowing, and year-round in the perennial portion of Sawmill Wash.

1-5: This treatment unit includes portions of seven 6th Code HUC watersheds, including Munds Canyon, Mormon Lake, Lower Woods Canyon, Upper Woods Canyon, Bar M Canyon, Rattlesnake Canyon, and Double Canyon Park-Jacks Canyon. Perennial streams near this treatment unit include a portion of Sawmill Wash and Munds Creek, downstream from Odell Lake. Six stream channel restoration projects are proposed along unnamed stream channels. Eighteen proposed spring restoration projects include Willard Spring, Howard Spring, Mud Spring, Dairy Spring, Double Springs, Smith Spring, Munds Spring, Sheep Spring, Bootlegger Spring, Bristow Spring, Rock Top Springs, Tree Spring, Railroad Spring, Lee Spring, Van Deren Spring, Tinney Spring, Broken Spring, and Seven Anchor Spring.

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Odell Lake is located near Munds Park. Fish in this artificial lake include northern pike, yellow perch, and fathead minnow. Flood events apparently wash fish from this lake downstream into the intermittent portions of Munds Canyon (M. Childs, USFS, pers. obs., 2010). Macroinvertebrates are present in the stream when water is present, and in Odell Lake.

3-1: This treatment unit includes portions of eleven 6th Code HUC watersheds, including Cataract Creek Headwaters, Dogtown Wash, Johnson Creek, Meath Wash, Devil Dog Canyon, Upper Hell Canyon, Rattlesnake Wash, Grindstone Wash, MC Canyon, Bear Canyon, and Government Canyon. There are no perennial streams in this treatment unit, but ephemeral flows provide water to three lakes that usually contain water: City, Dogtown, and Santa Fe Reservoirs. Thirteen streamcourses are located within this subunit. One stream channel restoration project is proposed, along an unnamed stream channel in the Johnson Creek watershed. No spring restoration projects are proposed for this subunit.

The lakes contain populations of macroinvertebrates. Ephemeral streamcourses in the subunit may occasionally contain macroinvertebrates, depending on flows.

3-2: This treatment unit includes portions of seven 6th Code HUC watersheds: Big Spring Canyon, Pitman Valley-Scholz Lake, Sawmill Tank, Garland Prairie, Government Prairie, Volunteer Wash, and Telephone Tank. There are no perennial streams in this treatment unit, but Scholz Lake usually contains water, with ephemeral flows from Frenchy Canyon. There are five ephemeral streamcourses within this subunit. No stream channel or spring restoration projects are proposed for this subunit.

Macroinvertebrate populations in this subunit are not permanent residents, as there is no perennial water. Ephemeral populations, however, occur in Scholz Lake and Perkins Tank, and some streamcourses.

3-3: This treatment unit includes portions of seven 6th Code HUC watersheds: Tule Canyon, Cedar Creek, Upper, Middle, and Lower Sycamore Creek, Little Lo Spring Canyon, and Volunteer Canyon. Perennial water occurs in upper Sycamore Creek, and in nearby West Fork of Oak Creek, which is southeast of the Little Lo Spring Canyon watershed. Eleven stream courses occur within this treatment subunit, including Lee Canyon, Tule Tank Wash, Government Canyon, Jacks Canyon, Dam Wash, Colcord Canyon, Sycamore Creek, Volunteer Canyon, Little Lo Spring Canyon, Railroad Draw, and Sinclair Wash. Streamcourse restoration is proposed for several unnamed streamcourses, and for portions of Volunteer Canyon and Railroad Draw. Spring restoration is proposed for Upper and Lower Hull Spring, Poison Spring, and Railroad Spring.

Fish present in Sycamore Creek include yellow bullhead, Western mosquitofish, green sunfish, and smallmouth bass (D. Weedman, AGFD, pers. comm.). Native fish that have been collected from Sycamore Creek include Sonora sucker, desert sucker, spikedace, roundtail chub, longfin dace, and speckled dace.

Macroinvertebrate populations occur in the perennial portion of upper Sycamore Creek and in nearby West Fork of Oak Creek.

3-4: This treatment unit includes portions of three 6th Code HUC watersheds: Upper Rio de Flag, Sinclair Wash, and Pumphouse Wash. Perennial water occurs in Pumphouse Wash and nearby Oak Creek. Five streamcourses occur within this treatment subunit, including Sinclair Wash, Woody Wash, Pumphouse Wash, Kelly Canyon, and James Canyon. No streamcourse restoration is proposed for this treatment subunit, but two spring restoration projects (Griffiths Spring, Scott Spring) are proposed.

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Fish in this subunit are found in Pumphouse Wash (rainbow trout, brown trout, speckled dace) and in nearby Oak Creek (see below). Cold water macroinvertebrate populations exist in both of these perennial streams.

3-5: The Turkey Butte/Barney Pasture Restoration Project removed a substantial portion of the SW portion of this treatment area. This treatment subunit includes portions of seven 6th Code HUC watersheds: Fry Canyon, West Fork Oak Creek, Upper Oak Creek, Munds Canyon, Middle Oak Creek, Lower Woods Canyon, and Upper Woods Canyon. Perennial water occurs in West Fork Oak Creek, Oak Creek, and Munds Canyon. Eleven streamcourses occur within this treatment subunit, including Casner Cabin Draw, Fry Canyon, Sterling Canyon, West Fork Oak Creek, Cookstove Draw, Surveyor Canyon, Crazy Park Canyon, Bee Canyon, Munds Canyon, Casner Canyon 1, and Woods Canyon. Oak Creek (Upper Oak Creek watershed) flows near the treatment subunit. Foxboro Lake is a small ephemeral lake in the Munds Canyon watershed. Eight streamcourse restoration projects are proposed in unnamed streamcourses, and two springs (Lockwood and Ritter Springs) are proposed for restoration.

Fish in this subunit are found in Oak Creek (rainbow trout, brown trout, speckled dace, roundtail chub, Sonora sucker, and desert sucker), in West Fork Oak Creek (rainbow trout, brown trout, speckled dace, Sonora sucker, desert sucker, and Gila trout[1]), and in the perennial portion of Munds Canyon (northern pike, yellow perch, fathead minnow, green sunfish, and rock bass). Macroinvertebrate populations occur in each of the perennial streams.

Oak Creek extends from the Mogollon Rim to its confluence with the Verde River near Cornville. Oak Creek survey data indicates a mixture of cold and warm water fish species (Table 12; C. Benedict, pers. comm.).

Table 12. Summary of past AGFD survey data (1991 through 2007); (AGFD unpublished data)

Species*	Total Captured
Desert sucker	235
Sonora sucker	93
Speckled dace	805
Smallmouth bass	59
Channel catfish	1
Brown trout	681
Green sunfish	80
Red shiner	1
Common carp	1
Rock bass	13
Flathead catfish	1
Rainbow trout	239
Bullhead catfish	37

*Note that roundtail chub were not captured in Oak Creek in any AGFD surveys between 1991 and 2007.

In 2007, (Rinker et al. 2007), the fish assemblage in Oak Creek upstream of the Grasshopper Point recreation site included rainbow trout (stocked and wild spawned), speckled dace, brown trout (wild spawned), Sonora sucker and desert sucker. The fish assemblage downstream of the Grasshopper Point

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[1] West Fork Oak Creek represents historic habitat for Gila trout.

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recreation site in 2007 included rock bass, green sunfish, smallmouth bass, channel catfish, bullhead catfish, common carp, rainbow trout (stocked), Sonora sucker, speckled dace and desert sucker.

Roundtail chub are known from Oak Creek as far upstream as the city of Sedona, but were likely present throughout perennial portions of the stream historically.

The West Fork of Oak Creek is a tributary of Oak Creek located near Sedona, Arizona, in the Coconino National Forest. Sampling in 2003 and 2010 (Rinker 2010) indicated that the fish community is composed primarily of speckled dace with a few rainbow trout and desert sucker. Speckled dace comprised the majority of the total catch at 98.5% with rainbow trout making up the other 1.5% (six individuals). Although not collected, small numbers of "suckers" (*Catostomus* spp) were also observed during the survey in deep pools close to the confluence with Oak Creek. Both desert and Sonora sucker are likely present. Gila trout were present historically. Narrow-headed garter snakes are currently known from Oak Creek Canyon.

Cold water macroinvertebrate populations exist in both Oak Creek and West Fork of Oak Creek.

4-2: This treatment subunit includes portions of five 6th Code HUC watersheds: Upper Cataract Canyon, Cataract Creek Headwaters, Dogtown Wash, Johnson Creek, and Juan Tank Canyon. There are no perennial streams within this treatment unit, but ephemeral streamcourses include Johnson Creek, K4 Draw, West Cataract Creek, Cataract Creek, Pine Creek, and Dogtown Wash. Water bodies in this treatment area include Cataract Lake, Gonzales Lake, Three Mile Lake, Kaibab Lake, and nearby Holden Tank. No streamcourse or spring restoration projects are proposed for this subunit.

Native fish are not present in this subunit. Macroinvertebrates occur in the ephemeral waters, when water is present.

4-3: This treatment subunit includes portions of three 6th Code HUC watersheds: Middle Spring Valley Wash, Smoot Lake, and Upper Red Lake Wash. There are no perennial streams within this treatment subunit. Ephemeral stream courses include Spring Valley Wash and Red Lake Wash. Four streamcourse restoration projects are proposed in the Middle Spring Valley Wash watershed, and two are proposed in the Upper Red Lake Wash watershed. No spring restoration projects are proposed.

No permanent fish or macroinvertebrate populations occur within this subunit.

4-4: This treatment subunit includes portions of seven 6th Code HUC watersheds: Pitman Valley-Scholz Lake, Sawmill Tank, Garland Prairie, Upper Spring Valley Wash, Government Prairie, Volunteer Wash, and Telephone Tank. There are no perennial streams within this treatment subunit. Ephemeral streamcourses include Spring Valley Wash, McDermit Canyon, and Volunteer Wash. Ephemeral water bodies include Dry Lake, Davenport Lake North, Duck Lake, Fay Lake, Raymond Lake, and Moritz Lake. No streamcourse or spring restoration projects are proposed for this subunit.

No permanent fish or macroinvertebrate populations occur within this subunit.

4-5: This treatment subunit includes portions of two 6th Code HUC watersheds: Upper Rio de Flag and Sinclair Wash. There is no perennial water in this subunit. Ephemeral streamcourses include Rio de Flag and Sinclair Wash. No streamcourse or spring restoration projects are proposed for this subunit.

Macroinvertebrate populations occur within Frances Short Pond and within the ephemeral portions of Rio de Flag when the streamcourse is flowing.

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5-1: This treatment subunit includes portions of eight 6th Code HUC watersheds: Upper Deadman Wash, Babbit Lake, Upper Spring Valley Wash, Government Prairie, Volunteer Wash, Upper Rio de Flag, Lower Rio de Flag, and Sinclair Wash. Perennial water in the treatment subunit can be found in a portion of Rio de Flag (Lower Rio de Flag watershed). Streamcourses within the subunit include: Deadman Wash, White Horse Canyon, Abineau Canyon, Reese Canyon, Volunteer Wash, Rio de Flag, Schultz Creek, Sinclair Wash, and Switzer Canyon. Two unnamed streamcourse restoration projects are proposed, and two spring restoration projects (Pat Spring and Chimney Spring) are proposed.

Native fish in the perennial portions of Rio de Flag may include speckled dace, but no recent surveys have been conducted. Macroinvertebrate populations exist year-round in this perennial water.

5-2: This treatment subunit includes portions of seven 6th Code HUC watersheds: Middle Deadman Wash, Bear Jaw Canyon, Lower Deadman Wash, Upper Kana-a Wash, Doney Park, Upper San Francisco Wash, and Cinder Basin. There is no perennial water within this treatment subunit. There are only two ephemeral streamcourses in this subunit, Bear Jaw Canyon and Weatherford Canyon. Two unnamed streamcourse restoration projects are proposed, and one spring restoration project (Little Elden Spring) is proposed.

No permanent fish or macroinvertebrate populations occur within this subunit.

6-2: This treatment subunit includes portions of three 6th Code HUC watersheds: Rain Tank Wash, Little Red Horse Wash, and Curley Wallace Tank. No perennial streams occur in this treatment subunit, and only one ephemeral streamcourse (Rain Tank Wash) is present. No streamcourse or spring restoration projects are proposed for this subunit.

No permanent fish or macroinvertebrate populations occur within this subunit.

6-3: This treatment subunit includes portions of two 6th Code HUC watersheds: Coconino Wash Headwaters and Red Horse Wash Headwaters, and their ephemeral streamcourses. No perennial water occurs within this subunit. Two unnamed streamcourse restoration projects are proposed in the Coconino Wash Headwaters watershed, but no spring restoration projects are proposed.

No permanent fish or macroinvertebrate populations occur within this subunit.

6-4: This treatment subunit includes portions of the Upper Lee Canyon 6th Code HUC watershed. There is no perennial water within this subunit, but the ephemeral Lee Canyon is located along the northeast border of the treatment area. Also, just downstream from the treatment subunit is Trash Dam, which holds water ephemerally as well. No streamcourse or spring restoration is proposed for this treatment subunit. No permanent fish or macroinvertebrate populations occur within this subunit.

Narrow-headed Garter Snake

Data sources for this analysis include and incorporate the analyses from the following Specialist Reports:

- Proposed Rule for listing in the Federal Register (USDI FWS 2013a)
- Fisheries and Aquatics Specialist Report
- Water Quality and Riparian Report
- Soils Specialist Report

The narrow-headed garter snake is the most aquatic of the garter snakes, seldom found far from quiet, rocky pools in large streams and rivers. Food items include fish (native species preferred), frogs, tadpoles,

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and salamanders. It is primarily a Mexican species, but occurs in various areas along the Rim. On the Coconino National Forest, narrow-headed garter snakes are currently known from Oak Creek Canyon and a few sightings from the East Verde River approximately 5 and 6 miles, respectively, from the project area. Population numbers in Oak Creek Canyon have decreased significantly, particularly in the lower third of the canyon. Since the late 1980s, they have been entirely absent downstream of Oak Creek Canyon. Historically, this species likely occurred throughout perennial riparian areas in the Verde Valley. Based on cottonwood/willow and mixed broadleaf riparian habitats, this species is considered a potential resident of all Coconino ranger districts. Neither this species nor its habitat occurs on the Kaibab National Forest. There are no known locations of narrow-headed garter snake within the project area; however, 2,894 acres of riparian habitat and ephemeral drainages could provide potential habitat. The entire area within Subunit 3-3 and 3-4 and portions of 3-5 was considered for potential impacts to downstream habitat in Oak Creek.

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Narrow-headed Garter Snake Critical Habitat

Proposed critical habitat is designated by the USFWS to provide for the survival and recovery of listed species. Proposed critical habitat for the narrow-headed garter snake was listed in the Federal Register on July 10, 2013 (USDI FWS 2013b; Figure 10). PCEs are developed based on current knowledge of the physical or biological features and habitats characteristics required to sustain the species' life history processes. The PCEs in relation to the project are discussed in the effects of the action below.

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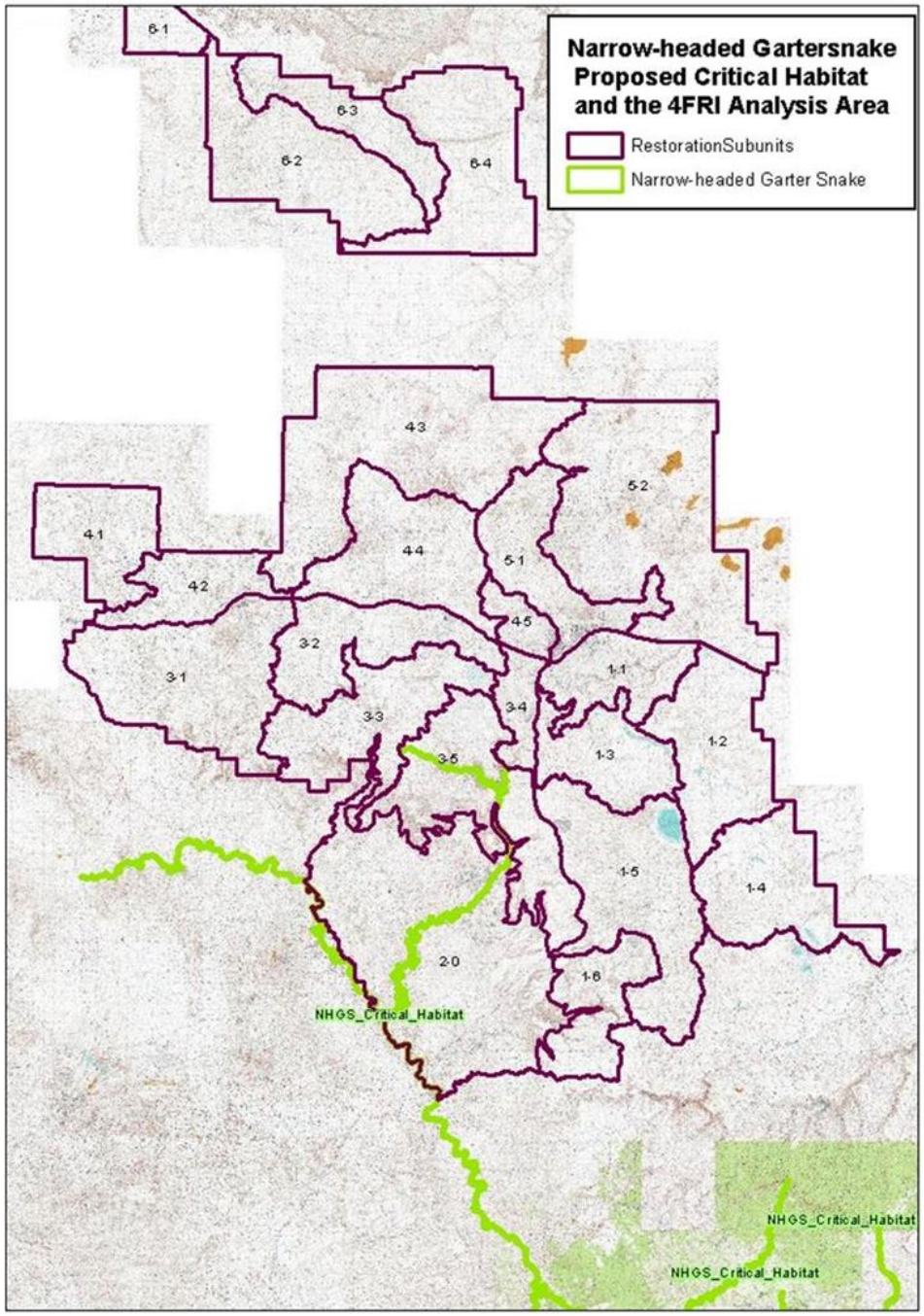


Figure 10. Proposed critical habitat for the narrow-headed garter snake

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Bald and Golden Eagles

Golden Eagle

Golden eagles are found nesting in a wide variety of habitats from arid desert scrub to open conifer forests. No matter what habitat they choose in the state, topographic features include tall cliffs or canyons in which they construct nests with nearby open areas for hunting (Driscoll et al. 2006). Most golden eagles nesting in Arizona are primarily residents, remaining within or near their home range throughout the year. In Arizona, cliff ledges are the most common nesting substrate used by golden eagles, but they will also use tall trees (especially ponderosa pine), junipers, rock outcrops, and in rare cases, transmission towers (Glinski et al. 1998 in AGDF 2005).

Sightings of golden eagles have been documented, and winter surveys are conducted annually on the Flagstaff and Williams Ranger Districts within the project area. Bald eagle annual winter surveys also document golden eagle sightings. There are 18 confirmed golden eagle nests representing 17 nesting areas in the project area. There are 11 additional potential nests but they have not yet been confirmed. Potential and confirmed nesting golden eagles within the project are located in Subunits 1-1, 1-3, 1-6, 2-0, 3-1, 3-4, 3-5, 4-1, 4-2, 4-3, 4-4, 5-2, and 6-2. Golden eagles often nest in areas of high rabbit populations. Golden eagles are well known for subduing large prey; however most of their diet consists of ground squirrels, rabbits, and prairie dogs. Potential foraging habitat within the treatment area is primarily 59,426 acres of grassland.

Bald Eagle

Bald eagles in central Arizona prefer to nest on cliff ledges or pinnacles or in tall trees (USDI FWS 1982). Bald eagles are habitat generalists and opportunistic feeders, typically taking the easiest and most abundant prey, regardless of whether it is dead or alive (Joshi 2009). They mainly forage on waterfowl and fish found along major streams, however, they do hunt in the uplands and forage on various mammal species, especially in the winter.

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a. Nesting

There are two nesting pairs of bald eagles within the project boundary. One breeding area occurs above the Rim near Lower Lake Mary. The same pair has used two different nest locations along Lower Lake Mary. The area at the most consistently and recently used nest is naturally protected due to limited access to the area and is periodically monitored by AGFD and Northern Arizona Audubon Society. The alternate nest location is adjacent to FR 296A and has a higher level of disturbance within the area. The second breeding area is at Whitehorse Lake on the Kaibab National Forest. This nest was first documented in May 2012, and is located in an area of high recreation use. The nest was monitored by AGFD and confirmed active with two young nestlings. April 2013, an adult eagle was documented on the 2012 nest in brood posture. In April, a hiker located a dead eagle in the area and this report was confirmed by the district biologist. AGFD flew the area in April and confirmed no adults or eggs in the nest.

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b. Wintering

Bald eagles occurring on the Coconino and Kaibab National Forests are primarily winter visitors. Bald eagles overwintering in northern Arizona are primarily migratory individuals that breed in the northern U.S. and Canada (Grubb et al. 1989). They are often seen scavenging on carrion, including large and small mammals, or around some of the waters supporting fish and waterfowl such as Lake Mary, Mormon, Ashurst and Kinnickinick Lakes on the Coconino National Forest and Kaibab Lake, White Horse Lake, and Sholz Lake on the Kaibab National Forest. Small to moderate-sized groups of bald eagles (typically 2-48) roost in clumps of large trees in protected locations such as drainages and hillsides

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(Grubb and Kennedy 1982, Dargan 1991, Grubb 2003). Bald eagle winter night roosts typically consist of clumps of large (average dbh of 30 inches) trees on steep slopes that tend to occur on east-facing aspects (Joshi 2009). Group sites are typically in stands of ponderosa pine trees less than an acre up to 43 acres, most often on north or northeast-facing slopes close to daytime foraging areas (Dargan 1991). Day roosts are often trees or snags near water or roadways. Bald eagles are highly mobile in the winter and can fly great distances in search of aquatic or terrestrial prey and suitable nighttime roosting habitat. There are currently 38 eagle roosts spatially identified in GIS for the project area, of which 19 have confirmed use by bald eagles. The remaining 19 roosts are identified as characteristics roosts and do not have documented use by bald eagles. Bald eagle confirmed and characteristic winter roosts are found in 7 of the 23 subunits. With the assistance of a grant from the American Eagle Foundation, a biologist working with the 4 Forest Restoration Initiative is currently surveying and assessing characteristic bald eagle roosts to determine bald eagle use and the need for vegetation treatments and fuel reduction.

Coconino Forest Plan direction for Management Area (MA3) states that in ponderosa pine and mixed conifer habitats on less than 40% slopes bald eagle winter roosts are to be protected. In addition to the actual roost trees, the forest plan states a 300-foot radius no-cut zone should be delineated. Road development should avoid the roost and uncut zone and human disturbance at roost sites should be avoided from October 15 to April 15 (Driscoll et al. 2006). Kaibab Forest Plan direction for GA 1 requires a 10-chain buffer (1,320-feet) around existing and potential roosts. The Arizona Conservation Assessment and Strategy guidelines restrict human activity within 500 feet of a roost, but allow for thinning to promote growth of large trees within roosts that are becoming less suitable due to loss of trees or snags (Driscoll et al. 2006). Potential habitat within the treatment area is about 507,839 acres of ponderosa pine forest, but eagle habitat is primarily within 2.5 miles from bodies of permanent water (i.e., Upper and Lower Lake Mary, Horseshoe Lake, Mormon Lake and Roger's Lake) and along major roadways (i.e., Interstate 17, 40, 89A and 89N and Federal Highway 3).

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5. Effects of the Action

This analysis evaluates the effects of the proposed action, alternative C (the preferred alternative in the 4FRI draft EIS) on bugbane, species listed under the ESA, and bald and golden eagles.

Arizona bugbane: Direct and Indirect Effects

Direct and indirect effects from fire may include loss of plants or the loss of shade from alteration of ponderosa pine stands on upland habitats. These effects would be mitigated to protect the shady environment needed by Arizona bugbane.

There are no known occurrences of Arizona bugbane in areas where activities such as timber harvesting or road activities will occur. Some timber harvesting will occur in the uplands above occurrences of Arizona bugbane in drainages. Potential effects of these actions include loss of shade from reduction of tree canopies near the canyon edges and changes to the moist microclimate near populations, but these effects would be mitigated.

Prescribed burning may occur in or near some populations of Arizona bugbane (Table 13). Short-term effects include mortality of individual plants. Long-term effects include the loss of shade from potential tree mortality. This can be mitigated by burning at intensities in all entries low enough to limit mortality to trees.

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Table 13. Treatment units with Arizona bugbane occurring in them

Restoration subunit	Date Collected	Location	Site	Alternative C
3-4	9/16/2004	368	1	Burn Only - Core Area
3-4	8/5/1994	368	13	Burn Only
3-4	8/9/1995	382	4	MSO Restricted
3-5	9/12/2012	167	30	Burn Only - Core Area
3-5	9/12/2012	167	33	Burn Only
3-5	9/12/2012	167	34	Burn Only
3-5	9/12/2012	176	3	Burn Only
3-5	9/1/1980	176	7	Burn Only
3-5	9/12/2012	176	10	Burn Only
3-5	8/15/1996	177	20	MSO Restricted

The knowledge of fire effects on Arizona bugbane is based largely on observations on a local wildfire, the Fry Fire in 2003. The fire covered 180 acres of upland and canyon habitats in Fry Canyon and was of mixed severity. The initial effects of the fire to Arizona bugbane were loss of the above-ground portions of individual plants. It is unknown if the underground portion of the plants died as well. However, on a visit in 2004, Arizona bugbane plants were observed along the fire line near the canyon bottom. There was a variety of plant sizes and ages, ranging from adults with mature fruits to seedlings. An adult plant with fruits and blackened soil at the base is shown in Figure 11. The Arizona bugbane populations were monitored again in 2005 and 2010, and no adverse effects from the fire were noted. No published data for fire effects to Arizona bugbane were found. A related species in the same genus, *Actaea rubra*, has been studied in the northwestern U. S. Data are available on the Fire Effects Information System website. In that species, the tops of plants are removed by fire and then plants regenerate from thick underground caudices, but seedlings did not appear for several years post-fire.

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Figure 11. Arizona bugbane 1 year after the Fry Fire

To address concerns of fire effects to Arizona bugbane, we are proposing a burning and monitoring treatment in locations and sites in the Upper West Fork area that are being analyzed for burning treatments as part of this action. The burning and monitoring may be carried out as part of this analysis or as a separate administrative study. The burning and monitoring would include a control, an area of partial raking with no burning to simulate the effects of bare ground and third area subjected to a burning treatment similar to the treatment proposed for the location/site already incorporated in this alternative. Pre- and post-monitoring would occur on one or more replications in this area and would be subject to other restrictions such as those for Mexican spotted owl, fire risk, and wilderness considerations.

Activities associated with roads and transportation in this project would be limited to the area where Forest Road 231 crosses the West Fork drainage. Forest Road 231 is one of the major forest roads accessing the southern portions of the Flagstaff Ranger District. This road has been in use for many years and its existence pre-dates the concern and conservation efforts for Arizona bugbane. The road has been used in the past as a haul route for several projects without incident. No hauling is proposed in the immediate area of Arizona bugbane populations. Indirect effects from road use would be limited to dust from road maintenance. Dust effects would be minimal and insignificant.

An indirect effect of management actions within the potential habitat of Arizona bugbane includes an increased risk of invasion from noxious or invasive weeds. This risk would be mitigated by incorporating Best Management Practices (BMPs). BMPs would mitigate the effects of increased disturbance from management activities and help control the spread and introduction of weeds within the habitat of Arizona bugbane. Currently, there are no recorded infestations within the populations of Arizona bugbane.

No Arizona bugbane were found within sites for spring or channel restoration, so there would be no direct effects to the species from these restoration activities. Indirect effects include introduction of noxious or invasive weeds, but these effects would be mitigated by following the BMPs for noxious or invasive

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weeds. Spring and channel restoration may indirectly benefit Arizona bugbane by improving the upland watershed condition for some areas where Arizona bugbane exists in canyons (Coconino National Forest).

MSO: Direct and Indirect Effects

Forest plan guidelines are used where the Recovery Plan does not define management targets, e.g., "provide an abundance of" indicates a specific metric is valuable to owls, but does not say how much is needed. Similarly, many output tables in this effects analysis include columns defining the status of habitat features if no management actions were taken. In NEPA, this is called the no action alternative. In the context of consultation under ESA, these values provide a baseline to evaluate whether an increase or decrease in a particular habitat component is simply the result of changes over time, from implementing the action, or a combination of the two. This is intended to better inform the reader on the effects of the action by reducing the background noise resulting from other changes in forest vegetation.

While treatment intensities are designed to be light in MSO habitats, they would further develop a mosaic of uneven-aged forest by diversifying the typically homogeneous conditions. Focusing actions on mid-sized trees contributes to the conservation of large trees (≥18 inches dbh) by reducing competition for water and soil nutrients. Thinning unnaturally dense forests (see the SDImax discussion) also reduces the risk of mortality to large trees from insects and disease. These actions would promote the growth and retention of larger trees through time and are expected to buffer the growing influence of climate change. Thinning and prescribed fire would improve understory conditions while reducing the probability of high-severity wildfire, thereby conserving the habitat features on which MSOs rely. While the proposed actions would improve key elements of MSO habitat in the long term, short-term adverse effects could occur to owls and elements of their habitat from these activities (see below).

Table 14. Prescribed fire and mechanical treatments in MSO pine-oak habitat in the proposed action

Treatment Type	MSO Habitat Types				Total Acres
	Protected[1]	Threshold	Target	Restricted	
Prescribed Fire Only	24,735	84	217	2,354	27,389
MSO Restricted - Group Selection[2] & Intermediate Thinning[3] + Prescribed Fire				62,785	62,785
MSO Target - Intermediate Thinning + Prescribed Fire			6,495		6,495
MSO Threshold - Intermediate Thinning + Prescribed Fire		1,892			1,892
PAC - Intermediate Thinning <18" dbh + Prescribed Fire	10,284				10,284
No Proposed Treatments	244	1[d]	2[d]	1,280	1,527
Total Analysis Acres	35,262	1,977	6,715	66,419	110,373

1 -Includes PAC and steep slope habitats

2 -Group selection is a cutting procedure which creates a new age class by removing trees in groups or patches to allow seedlings to become established in the new opening (SAF 1998)

3- Intermediate thinning is the cutting of trees to improve the composition, structure, condition, health, and growth of remaining trees (SAF 1998)

4 -These acres represent portions of stands occurring in a no-treatment control watershed as part of a paired watersheds study evaluating the effects of vegetation treatment on water yield and water balance.

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Table 15. Summary of MSO acres proposed for treatment in the 4FRI

MSO Habitat	Analysis Acres	Treatment Acres
Protected	35,262	35,019
PAC	34,426	34,183
PAC	29,531	29,495
Core Area	4,895	4,688
Protected Outside of PACs	836	836
Restricted	75,111	73,827
Threshold	1,977	1,976
Target	6,715	6,712
Restricted (Other)	66,419	65,139
Total Acres	**110,373**	**108,846**

Under the Proposed Action, treatments would occur in all MSO habitats, including low-severity prescribed burning in core areas (Table 14 and Table 15). The minimum post-treatment BA for nesting and roosting habitat would be 110 ft^2 per acre, in line with the revised Recovery Plan (USDI FWS 2012a). No trees ≥24 inches dbh would be removed through mechanical treatment. Tree groups (i.e., two or more trees with interlocking or nearly interlocking crowns) with diameters averaging 18 inches dbh or greater would not be cut for regeneration openings within MSO habitat. Meadow and aspen treatments in MSO habitat would occur as described below (see Other Habitat Effects). This analysis is based on the assumption that mechanical treatments and two low-severity prescribed fire treatments would occur within the project timelines (10 to 15 years). The Proposed Action would mechanically treat 81,456 acres and prescribe burn 108,846 acres of protected and restricted habitat.

General Effects of Mechanical and Prescribed Burning Treatments

Modeling assumptions include all treatments completed in the year 2020. In actuality, mechanical thinning and prescribed burning would take place at different times in different locations. Assuming that the work would all be completed by 2020 represents the highest level of disturbance. If work were completed in 10 years, on average about 8,146 acres of MSO habitat would be mechanically treated and 10,885 acres prescribed burned each year for 10 years' time. If implementation extends sometime beyond 10 years up to 15 years, then annual averages would be less. In any given year, implementation could include mechanical treatments in one area and prescribed burning in another area. No mechanical treatments would occur on slopes greater than 40% in MSO habitat. In this analysis, short-term effects are defined as those occurring after treatment, modeled as the year 2020. Long-term effects are those modeled for the year 2050 and beyond.

Modeling treatments over time indicates limited reductions in key MSO habitat elements in the short term; most forest structure metrics exceed desired minimum levels in both the short and long term (see below). However, localized effects, particularly from prescribed fire, could lead to unexpected reductions in elements like logs, snags, and canopy closure. Overall, treatments are expected to produce habitat improvements. The low-intensity nature of the treatments would limit results in protected, target, and threshold habitats.

Mechanical treatments include several stages with varying degrees of potential impacts to MSOs. Presale activity generally includes field crews implementing all or most of the following: Prescription

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development, marking, cruising, check cruising; surveys for wildlife, noxious weeds, botany surveys, marking cultural sites and sensitive wildlife habitats, and verifying land lines.

Field crews would typically consist of one to six people walking the treatment areas. Crews of two people are most common. More people present can increase the potential for disturbance, but decreases the duration of disturbance. Presale activity could occur during the breeding season and the presence of people on the ground could lead to disturbance of nesting or roosting owls. Presale activity conducted outside the breeding season could potentially disturb roosting owls.

Harvest activities would primarily be performed by feller-bunchers and downed materials moved to designated landings as whole trees by skidders. Trees would be delimbed and loaded onto logging trucks or chipped and loaded into chip vans at the landings. Overall, the degree of change in canopy and loss of green trees were designed to avoid adverse effects to MSOs in PACs, target, and threshold habitats. However, large snags could be reduced if they occur in locations where their presence represents safety threats to operators. Harvest activities in restricted "other" habitat could adversely affect owls through habitat modification in the short term. Loss of trees and ground disturbance could potentially affect MSO prey species during the season of harvest. Long-term improvements are expected in habitat structure and in the response of prey species. Details of the analysis of effects of mechanical treatments on key forest measures are below. Soil compaction is expected to be avoided through implementation of BMPs (Steinke 2013). The total level of soil disturbance is not expected to pose a risk to soil resources or soil productivity and watershed function is expected to be maintained. Soil erosion is predicted to remain within tolerable soil loss rates in proposed mechanical treatments (Steinke 2013).

Mechanical treatments in PACs would occur outside the nesting season to avoid disturbance to owls. This limited operating period would extend ¼ mile beyond core area boundaries. The intent of the project is to avoid disturbance to nesting MSOs from mechanical treatments. Treatments would not occur within PACs or outside PACs but within the ¼ mile core area buffer between March 1 and August 31. However, experience has demonstrated that because of changing timelines, weather events, and other unforeseen circumstances, exceptions could occur within the life of the project. It is not the intent of the project to modify the above guidelines, but if unforeseen circumstances did arise, there would be exceptions, limited in occurrence, and coordinated with the USFWS. While an unforeseen exception does not automatically mean an adverse effect, exceeding the above guidelines would increase the likelihood of negatively impacting MSOs.

Implementing fire treatments generally includes field reconnaissance before the actual burn plan is finalized. Reconnaissance is typically done from a vehicle and/or on foot. The objective of the reconnaissance is to determine whether there are existing features that could serve as firelines (such as roads or trails) and assessing what would be required so they function as such. Where there are no features that would work for firelines, a line is flagged for fireline preparation. Areas with higher potential for high-intensity/high-severity fire are noted. This work is typically accomplished by one or two people.

Prepping a burn unit may include any of the following:

- Limbing and cutting ladder fuels (chain saws);
- Redistributing jackpots of fuel (sometimes chain saws);
- Raking or leaf-blowing as needed around selected snags, logs, trees, firelines;
- Creating firelines with either hand tools, drag lines (pulling a drag behind an ATV), or dozers (most firelines consist of existing roads);
- Crushing ladder fuels with an ATV/UTV or dozer; and

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- Mowing lines in herbaceous surface vegetation in situations of continuous vegetation.

Combined, these activities on average would involve 4 to 10 people for 2 to 5 days.

Crews assemble on the day of the burn at pre-assigned locations, generally about ≥1/4 mile from the burn unit for an initial briefing. There could be as many as six engines, six pick-up trucks, and a crew vehicle or 2 (i.e., "shot buggy" or "crummy"). The number may be larger or smaller, depending on the size and complexity of the burn. Some vehicles would be left at these locations as the crew proceeds to the burn unit. If a decision is made to burn, personnel are positioned near the point of ignition and holding crews are sent out along the lines to ensure there are no new concerns since the last reconnaissance (such as fallen trees or snags, etc.).

When conditions come into prescription, a 'test burn' is ignited. Ignition proceeds if conditions support objectives. There may be as many as 10 firefighters walking though the unit with drip-torches and there may be a UTV carrying fuel or other supplies. Engines, trucks, and personnel would be moving around and patrolling the perimeters. Engines could stop along the perimeter and lay out hose at points of concern (e.g., a snag). Foaming agents are sometimes used along firelines. Combined, these activities could require 20 to 40 people working the area for 6 to 8 hours and 2 to 4 people continue to patrol for an additional 1 to 3 hours for 2 to 3 days.

Two to three people may continue to drive or walk the unit post-burn to monitor fire effects and document whether burn objectives were met. This may happen several times until the fire is determined to be out. Trees and snags that have become hazard trees may be felled. Fire personnel will visit the burn unit until no smoke or hot spots are detected for three consecutive days or up to a couple of weeks after the burn.

Most of the disturbance associated with thinning and burning results from the presence of people and the noise associated with their presence and associated machinery. Because these activities have timing restrictions, nesting owls would not be affected. Roosting and diurnally active owls could be impacted. Roosting and foraging owls could also be impacted if site conditions lent themselves to burning at night.

Protected Habitat Treatments

Most (>99%) protected habitat would have vegetation treatments. Most (>70%) vegetation treatments would be prescribed fire only, including all 836 acres of steep slope protected habitat. Little change would occur in forest structure and MSO prey habitat on steep slope habitat (Table 16 and Table 17).

Table 16. Modeled forest structure changes after proposed treatments in steep slope habitat in the short (Year 2020) and long term (Year 2050)

Forest Attributes	Existing Condition (Yr 2010)	Proposed Action Short Term (Yr 2020)	Proposed Action Long term (Yr 2050)	No Management Action (Yr 2050)
Acres	836			
% of SDI 12-18" dbh	29	30	26	27
% of SDI 18-24" dbh	12	15	21	20
% of SDI >24" dbh	8	9	12	12
% of Max SDI	81	80	83	84
TPA >18"	14	17	27	26
Ponderosa Pine BA	118	116	121	124
Gambel Oak BA	25	27	31	30
All BA	159	163	183	185
% Oak BA	15	16	17	16

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Table 17. Modeled changes after proposed treatments in prey habitat attributes within steep slope habitat

Forest Attributes	Existing Condition (Yr 2010)	Proposed Action Short-Term (Yr 2020)	Proposed Action Long-term (Yr 2050)	No Management Action (Yr 2050)
Acres	836			
Snags >12"	3.50	5.71	7.43	7.83
Snags >12" and <18"	2.81	4.98	5.71	6.12
Snags >18"	0.69	0.73	1.71	1.71
CWD >3" (tons/ac.)	5.90	3.13	8.34	12.52
Logs per Acre	2.23	2.08	6.40	7.27
CWD >12" (tons/ac.)	0.74	0.69	2.13	2.42
Understory Index	35	32	23	22

About 10,284 acres of PAC habitat would be treated mechanically (30% of the total 34,426 PAC acres in the treatment area). Approximately 3,378 acres (33%) of the mechanically treated acres would have a 9-inche dbh limit (Table 18). Removing trees up to 17.9 inches dbh would result in habitat improvements in eight individual PACs (599 total acres). Model results would be reassessed when site-specific silvicultural prescriptions are developed. At that time, the silviculturist in the field would have the ability to decrease, but not increase, dbh limits if it appeared that stand objectives could be met with smaller diameter limits. All stands identified for mechanical harvest would be marked by hand, and marking would be coordinated with the USFWS. Proposed treatments to move PACs toward desired conditions include:

- Fifteen PACs (Archies, Bar M, Bonita Tank, Foxhole, Frank, Holdup, Iris Tank, Knob, Lake No. 1/Seruchos, Lee Butte, Red Hill, Red Raspberry, Rock Top, Sawmill Springs, T-Six Tank) thinned up to 11.9 inches dbh on 1,335 acres;
- Seventeen PACs (Archies, Bar M, Bonita Tank, Crawdad, Foxhole, Frank, Holdup, Iris Tank, Knob, Lake No. 1/Seruchos, Lee Butte, Mayflower Tank, Red Hill, Red Raspberry, Rock Top, Sawmill Springs, T-Six Tank) thinned up to 13.9 inches dbh on 3,951 acres,
- Twelve PACs (Bar M, Bear Seep, Holdup, Crawdad, Foxhole, Frank, Holdup, Iris Tank, Knob, Mayflower Tank, Red Raspberry, Rock Top, and T-Six Tank) thinned up to 15.9 inches dbh on 1,022 acres, and
- Eight PACs (Bonita Tank, Crawdad, Frank, Iris Tank, Lee Butte, Mayflower Tank, Sawmill Springs, and T-Six Tank) thinned up to 17.9 inches dbh on 599 acres.

Under the proposed actions, mechanical treatments would take place within 18 of the 70 PACs (26%) occurring within the treatment area. Based on overlaying the GIS layers for the Terrestrial Ecosystem Survey soil units and PACs, the 18 PACs selected for mechanical treatment average about 88% mollisol (grassland) and mollic intergrade (open forest/savanna) soil types (range = 57 to 100% mollisol and mollic intergrade). Conversely, on average, 12% of the area in the selected PACs have soils that developed under closed forest conditions. The predominance of open habitat soils within the PACs supports the decision of thinning the current forest structure to enhance the ability to retain large trees over time. No mechanical treatments would occur in core areas.

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Table 18. General description and acres of mechanical treatment by tree size-class in the proposed action by PAC (all mechanically treated PACs occur on the Coconino National Forest)

PAC Name	General Description	MSO PAC Mechanical Treatment (acres)					
		Treat up to 9" dbh	Treat up to 11.9" dbh	Treat up to 13.9" dbh	Treat up to 15.9" dbh	Treat up to 17.9" dbh	Total Thinning Acres[1]
Archies	Pine-oak with strong oak component but few large oak – many pines < 9" dbh	444	41	11			495
Bar M	PAC is part of the mega-cluster of PACs within the Bar-M area, break up contiguous fuels in areas of pure pine, thin out dense clumps of pine to release oaks within clumps, provide openings for forage and grow larger trees	119	149	199	66		533
Bear Seep	PAC is pure ponderosa or oak, high density of trees > 9 inch dbh	453			144		596
Bonita Tank	Treatments to grow larger trees and release oaks are needed in southern portion of PAC outside of ridges and draws	37	203	429		127	795
Crawdad	Oak is suppressed by high densities of pine, need for creating gaps around oak and releasing individual oak trees	138		343	99	21	601
Foxhole	Dense thickets of pine with some oak, need for enhancing oak and thinning groups	10	124	136	178		450
Frank	PAC has areas of pure pine with dense pockets of VSS3 and VSS4, need to release any oaks present and encourage recruitment of oaks, reduce pine densities and increase diameters of both pine and oak	286	69	178	19	33	586
Holdup	Most of PAC is pure pine, thin around any existing oak and provide areas for oak to establish	57	197	264	18		535
Iris Tank	PAC has dense pine with pockets of doghair thickets; oak is present in all size classes but is suppressed by pine, need to release oaks and thin dense pockets of pine and reduce fuels southwest of the nest core	172	13	261	48	93	587
Knob	PAC has limited habitat, generally pure pine and open with some dense dog-hair thickets	273	26	252	114		665

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PAC Name	General Description	MSO PAC Mechanical Treatment (acres)					
		Treat up to 9" dbh	Treat up to 11.9" dbh	Treat up to 13.9" dbh	Treat up to 15.9" dbh	Treat up to 17.9" dbh	Total Thinning Acres[1]
Lake No. 1 Seruchos	Dense thickets of VSS3 pine, oak is competing with pine for nutrition, sunlight and moisture, need to grow larger trees over time, enhance oaks, create small openings	123	66	50			239
Lee Butte	Treat in dense pine to increase the amount of oak, reduce tree density, and increase tree diameter on slopes to improve habitat and protect nest core; Field review led to dropping 3 stands from treatment (457 acres)	111	1	128		67	306
Mayflower Tank	PAC has steep slopes, heavy fuels, limited number of small trees	257		139	118	99	612
Red Hill	Scrappy habitat that has been treated with an overstory removal in the past, dense pockets of ponderosa pine with heavy mistletoe infection in areas, thin pine to grow larger trees and reduce fire threat, enhance oak where present, grow larger trees over time and reduce competition	97	190	385			672
Red Raspberry	Diverse topography, protect microclimates from fire, high percentage of VSS 3 and VSS 4, need for enhancing openings, create, retain, and enhance larger trees	387	19	203	55		664
Rock Top	Treat in pure pine to increase the amount of oak and grow larger trees	98	57	506	90		751
Sawmill Springs	All size classes of pine and oak present, but thinning would enhance and maintain large dbh size classes	192	63	190		71	515
T-Six Tank	PAC has dense regeneration, need for removing dense patches of ponderosa pine, maintaining Gambel oak, and thinning dense pine doghair thickets	126	116	279	72	88	680
Total Mechanical Treatment Acres		**3,378**	**1,335**	**3,951**	**1,022**	**599**	**10,284**

[1]Total acres here does not include 35 acres of meadow treatment ("Grassland mechanical" in the silviculture report) in PACs that includes cutting up to 17.9 inches dbh post-settlement ponderosa pine.

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Low-severity prescribed burning would occur in all 70 PACs within the treatment area, with burn-only treatments occurring in 52 PACs. Although the implementation schedule is not yet known, if 4FRI implementation lasted 10 years then, on average, 1.8 PACs would be mechanically treated per year, or about 2.6% of the 70 PACs within a given year. About 5.2 PACs (less than 7.5% of the 70 total PACs in treatment area) would, on average, be prescribed burned each year.

Forest Structure and Density in MSO Habitat

Large Trees

Mechanical treatments would, by design, be conservative in protected habitat. Therefore, treatment results would be limited. None of the modeled forest structure attributes dropped below recommended levels immediately after treatment (Table 19). By the year 2050, percent SDI for trees > 18 inches dbh would increase in both size-class categories as would total TPA >18 inches dbh. The percentages of trees 18 to 23.9 inches dbh would show the most improvement. Abundance of trees >24 inches dbh would show consistent improvement in mechanically treated PACs (Table 19). Because treatments are site-specific and target the release of big trees from competition with young trees, the ability to retain existing large trees through time would also increase. Site-specific PAC visits identified density-dependent mortality as a current and ongoing threat to large pine and oak trees (Appendix 3). Prescribed burning would contribute toward reducing competition with slight reductions in numbers of small trees. The percent distribution of larger tree size classes would remain unchanged in the burn-only PACs (Table 19), but risk from high-severity fire would decrease (see fire effects below).

Basal Area

Ponderosa pine BA would be reduced post-treatment (Table 19). Pine BA would be slightly reduced in the burn-only PACs. Gambel oak BA would have slight increases and total BA would remain high in all time and treatment categories (Table 19).

Canopy Structure

The average canopy cover across stands would be ≥50%, based on BA, TPA, and tree dbh. Percent SDImax would decrease relative to no action, but at 71% it would remain well within the "extremely high density" range with full site occupancy, minimal understory development, and active competition-induced mortality, all of which indicate high canopy cover. Harvest would only target ponderosa pine, so while individual trees of other species could be affected by thinning and burning operations, the existing variability in overstory species would remain intact. Combined, these factors should maintain or enhance elements of canopy structure such as canopy cover, tree density, and overstory species diversity.

Overall, changes in the canopy structural elements would be limited, but would move PAC habitat toward desired conditions. While treated PACs would show limited change, the objectives behind the treatments are primarily site-specific, including the release of large oak and pine from competition, creating irregular spacing, and increase growth rates in the large tree cohort. The fact that the decrease is minimal when averaged across PACs is a reflection of the treatment design in PAC habitat. Changes in forest structure are summarized by individual PAC below (see "Individual PAC Treatment Summaries").

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Table 19. Modeled forest structure changes after proposed treatments in MSO PACs in the short (Year 2020) and long term (Year 2050)

Forest Attribute	Existing Conditions (Yr 2010)	Proposed Action (Yr 2020)	Proposed Action (Yr 2050)	No Management Action (Yr 2050)
PACs With Thinning Outside Core Areas and Prescribed Burning (n=18)				
Acres	12,587			
12 - 17.9" dbh (%)	30	33	26	28
18 - 23.9" dbh (%)	14	21	29	23
≥24" dbh (%)	8	11	15	12
% of Max SDI	75	57	63	78
TPA >18" dbh	15	18	29	27
Ponderosa Pine BA	124	106	118	137
Gambel Oak BA	19	20	25	26
All BA	148	134	157	174
% Oak BA	13	14	16	15
PACs With Prescribed Burning Only (n=52)				
Acres	21,840			
12 - 17.9" dbh (%)	31	32	28	28
18 - 23.9" dbh (%)	13	16	23	22
≥24" dbh (%)	8	8	12	11
% of Max SDI	79	78	82	83
TPA >18" dbh	15	18	28	28
Ponderosa Pine BA	120	119	124	127
Gambel Oak BA	22	24	28	27
All BA	159	162	183	185
% Oak BA	14	14	15	14

MSO Prey Habitat

Snags, Logs and Coarse Woody Debris

The number of snags >18 inches dbh would slowly increase over time, but remain below forest plan direction (Table 20). Retaining and improving growth rates of large trees would provide a more robust cohort of trees and eventually provide future large snags beyond 2050.

Logs would increase after mechanical treatments and remain essentially unchanged or decrease slightly in the burn-only PACs (Table 20). On average, CWD would drop below forest plan direction immediately after treatment, but would exceed these guidelines over time. Decreases were variable by individual PAC (see "Individual PAC Treatment Summaries" below).

Snags, logs, and CWD represent elements of small mammal habitat. While retaining adequate amounts of these habitat components is essential, site conditions are currently highly variable. We reviewed areas where downed wood was nearly absent across whole portions of stands, but encountered areas where a reduction in CWD would be desirable (e.g., in draws). Overall, restoration treatments can benefit the habitat of MSO prey species (Kalies et al. 2012, Martin and Maron 2012). Modeling results indicate treatments would sustain these habitat components in both the short and long term.

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Understory Index

A muted understory response in PACs is a reflection of the high canopy cover post-treatment (Table 20). The modeling for understory does not include the benefits of the post-burning nutrient pulse or reduction of the uncharacteristic pine litter layer that currently inhibits understory production (see Appendix 8 of the wildlife specialist report). However, much of the resulting nutrient pool would likely be absorbed by the overstory as the trees would presumably increase nutrient translocation into the canopy (Appendix 8 of the wildlife specialist report). Increases in biomass production would typically be limited in most PACs, but increases would vary by individual PACs and by site-specific conditions (see "Individual PAC Treatment Summaries" below). Understory response would be greater in PACs receiving both mechanical and prescribed burning treatments and in PACs that included aspen, meadow, spring, and ephemeral channel treatments. Biomass indices comparing current trajectories and those of the proposed action were graphed by individual subunit and can be found in Appendix 13 of the wildlife report.

Localized increases in biomass production represents increased grass and forb development, providing site-specific improvements in food and cover for arthropods, small mammals, and birds. These changes would be expected to increase localized prey availability, diversity, and total prey biomass for resident MSOs. The Recovery Plan notes total prey biomass is a strong influence on MSO fitness (USDI FWS 1995).

Table 20. Modeled changes after proposed treatments in prey habitat attributes within MSO PACs in the short (Year 2020) and long term (Year 2050)

Forest Attribute	Existing Conditions (Yr 2010)	Proposed Action (Yr 2020)	Proposed Action (Yr 2050)	No Management Action (Yr 2050)
PACs With Thinning Outside Core Areas and Prescribed Burning (n=18)				
Acres	12,587			
Snags >12"	3.2	4.4	5.9	7.1
Snags >12" and <18"	2.6	3.8	3.9	5.6
Snags ≥18"	0.6	0.6	1.6	1.5
CWD >3" (tons/ac.)	4.7	2.8	6.2	10.3
Logs per Acre	1.3	1.6	4.9	5.8
Understory Index	37	48	31	23
PACs With Prescribed Burning Only (n=52)				
Acres	21,840			
Snags >12"	3.6	6.1	7.6	8.1
Snags >12" and <18"	3.0	5.6	5.8	6.3
Snags ≥18"	0.7	0.7	1.8	1.8
CWD >3"	6.0	3.2	8.5	12.6
Logs per Acre	2.9	2.5	7.0	8.1
Understory Index	36	34	24	23

[1] = Only prescribed burning would occur within core areas

Fire Effects

Prescribed burning would occur in all 70 PACs in the treatment area, including all core areas with pine-oak forest within the treatment area (*n*=54). Core acres in wilderness, mixed conifer forest, canyons, or

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within other current and ongoing projects would be excluded from treatment under the 4FRI. Prescribed burning would occur twice across all PAC acres in the treatment area in the 10+ year of implementation.

All prescribed fire within PACs would be planned as low-severity burns. The goal for burning within PACs would be the reduction of the build-up of uncharacteristic levels of pine needles and duff. Changes to the upper canopy are not planned, but modeling indicates the crown base height would be raised. This would accomplish several objectives:

- Reduction of surface fuels would reduce potential flame lengths of future fires, thereby reducing the risk of future passive (i.e., torching) and active crown fires;
- Modeling indicates that the heat released in a surface fire would raise the canopy crown base height, further reducing the risk of future crown fires in PAC habitat (future crown fire initiation would require longer flame lengths to initiate torching);
- Raising crown base height would enhance foraging opportunities for MSO, which are "perch and pounce predators" that commonly hunt in sub-canopy space;
- Reduction of the litter and duff, the resulting nutrient pulse, increased crown base height, and canopy gaps resulting from mechanical treatments would contribute to the release of understory species. Increasing the herbaceous layer would provide food and cover for MSO prey species;
- An increased herbaceous layer would simultaneously produce fuel to carry future surface fires. Fire carried by herbaceous debris (as opposed to fire with current needle accumulation) would decrease surface fire intensity and alter the manner in which fire would carry across stands, better replicating historical conditions compared to current fire behavior;
- Combined, prescribed fire in PACs could potentially improve the ability to retain PAC habitat over time and improve MSO foraging potential, thereby potentially increasing prey delivery to nestlings.

Unintended torching could occur during a prescribed burn. Torching of individual or small groups of trees could mimic gap-producing processes that occur under natural forest processes. Depending on the exact location and specific habitat conditions, unintended torching could result in short- and long-term habitat improvements. However, torching could also create short- and/or long-term adverse effects. Similarly, loss of presettlement trees (a long-term effect), snags (short- or long-term effects), logs, and CWD (short-term effect) could occur. Loss of presettlement trees and large snags could be an adverse effect. A decrease in logs and CWD could be either a beneficial or adverse effect, depending on how much woody debris is left after the fire. Generally, both of these metrics increase in the first few years post-fire.

There is no data available on the effects of prescribed burning as a stand-alone treatment in PACs on the Coconino or Kaibab National Forest. Controlled burning has been done to protect PAC habitat from an approaching wildfire, but the choices on when and how to burn were limited, as were management options while it burned. Unplanned ignitions were allowed to burn in PACs, but again, this is a different scenario than when a burn boss can assess conditions at the selected time of ignition and determine how best to light it or to not ignite at all. Given the lack of data available and the scale of the proposed 4FRI treatments, the Forest Service decided to review past fires in PACs to better inform expectations (Appendix 5). It is reasonable to assume that these burns represent the high-end of managed treatment effects given the deciding officials did not have the option of waiting for more favorable burn conditions.

The report on fire effects in PACs included the Birdie fire, a suppression fire that accomplished some resource objectives with relatively low amounts of high-severity fire. Results from this fire were

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compared to fires managed explicitly for resource objectives. While this was the only suppression fire examined in this report, the data appeared representative, falling within documented and expected ranges for fires managed primarily for suppression. The average fire-created opening in the Birdie fire was >3 acres, or about 6-times the average opening size for resource objective fires. The range was from 0.14 to 43 acres, or about 5-times the maximum size of openings in resource objective fires. Of the 52 openings digitized from the portion of the Birdie fire burning through the Girdner PAC, 50% were 0.69 acres or smaller. Opening sizes at the 25th and 75th percentile were 0.46 and 1.72 acres, respectively. Fire-created openings equaled or exceeded 1 acre at the 69th percentile. The Birdie fire was not a worst case scenario, but 23% of the area resulted in high-severity openings. It is reasonable to expect a higher percentage of PACs to burn at high-severity fire in future suppression fires. More dramatic results have been documented for other unplanned ignitions such as the Pumpkin, Pot, Rodeo-Chedeski, and Wallow fires, where nearly entire PACs experienced high-severity fire.

Resource objective fires had less high-severity fire, averaging 4% overall within PACs. High-severity also occurred in smaller contiguous areas and with fewer openings than in the Birdie fire, although the McCarty PAC had 54 openings. Opening sizes ranged from 0.10 to 8.53 acres, with an average of 0.58. Overall, out of the 166 openings that were digitized from resource objective fires, 50% were 0.29 acres or smaller. Size of openings at the 25th, 50th, and 75th percentile, respectively, were 0.18, 0.29, and 0.54 acres (n = 5 fires). Fire-created openings equaled or exceeded 1 acre at the 88th percentile. Given this was a small sample size, it is reasonable to expect resource objective fires would commonly create patches of about 0.5 acre or larger in PACs. Trees <5 inches dbh were reduced 19 to 89%.

The data available for considering changes in amounts of logs, down woody debris, and snags pre- and post-fire are limited. In general, amounts of snags, logs, and down woody debris were approaching or exceeding minimum levels described in the forest plans. Results for the Ranger fire exceeded the upper limits described in the forest plans for these metrics.

Snag numbers in PACs were essentially unchanged in 4FRI implementation modeling. The loss of standing snags in fire modeling is likely ameliorated by the creation of new snags. However, snag quality is not always the same between existing and fire-created snags. Snags resulting from fire tend to fall in less than 10 years (Chambers and Mast 2005) and so represent a loss in snag quality for this already ephemeral feature. Fire-stressed trees are more susceptible to bark beetles, mistletoe, and drought, which can all increase snag recruitment. Both mistletoe and bark beetles are present in many of the PACs and across protected habitat in general (see the silviculture report for details). These vectors may contribute to snag recruitment over time. Also, design features associated with the 4FRI include managing for the retention of dead-top trees and trees struck by lightning. Both tree forms represent snag-like habitat sustained in living trees. The habitat they provide would be relatively resistant to surface fire and available to MSO prey species. Between modeling and local data from fire in PACs, we expect individual snags would be lost to prescribed fire, but the overall effect of the change in snags at the PAC level would be minimal to MSOs (see individual PAC discussions).

Effects to woody debris from prescribed fire was estimated two ways in the 4FRI fire specialist report: (1) as part of the FVS modeling which included fire effects, and (2) as part of the fire-specific modeling. Fire modeling correlated surface fuel loading with post-treatment canopy openness (Figure 12). Openness is an indication of the relative desired post-treatment interspace and tree group condition. Treatment types were combined and characterized by canopy openness, e.g., “High” indicates open canopy conditions achieved with a mosaic of tree groups and open interspace. “Very Low” indicates relatively connected canopy with little discernible interspace such as MSO protected habitat (see fire ecology report for more details). Results indicate CWD levels would decrease but continue to exceed desired amounts inside PACs after treatments. Forest plan guidelines for CWD (5 to 7 tons/acre) would be exceeded in PACs,

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including core areas, post-treatment in the proposed action. This graph provides a relative comparison to other 4FRI treatments and reiterates, from an entirely different perspective, the "light touch" approach for prescribed burning in PACs.

Modeling for this project and research in northern Arizona (Waltz et al. 2003) suggest that CWD levels increase a year or two after prescribed fire. Assumptions include no additional management treatments occurring after 2020. Additional burning could occur if lightning-caused fires were to start in areas deemed suitable for burning based on the current fuel, weather, and management conditions. Based on the results from other resource objective fires in PACs (Appendix 5), logs and other woody debris would likely approximate desired conditions. However, unplanned ignitions are outside the scope of this analysis. Given the results from modeling and from documenting the effects of unplanned ignitions, burning outside the nesting season in PACs is predicted to have little to no affect on MSOs or their prey. This conclusion is further supported by the intentionally light approach to changes in MSO protected habitat. In addition, the emphasis on low-severity fire would be expected to produce a patchier burn, resulting in a mosaic of habitat conditions for MSOs and their prey.

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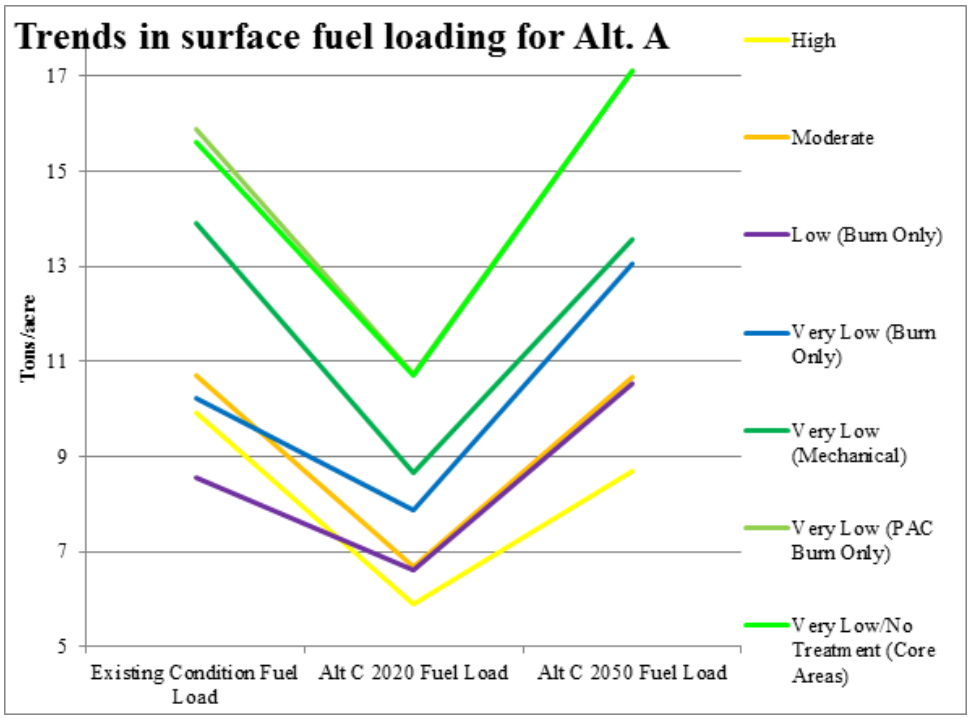


Figure 12. Modeled changes in surface fuel loading (litter, duff, CWD combined) by desired canopy openness for the proposed action

The ability to plan when and how to ignite a broadcast burn should limit torching and keep opening sizes closer to the averages or 50 percentiles presented in the fire report (Appendix 5). Broadcast burning outside of MSO habitat, where objectives emphasize fuels reduction, usually results in ≤10% of the area experiencing high-severity fire. The ability to plan when and how to ignite a broadcast burn should reduce these effects in MSO habitat. It is unlikely that 10% of a PAC area would experience high-severity fire given the objective, i.e., to reduce litter, is a relatively modest objective compared to typical fuels

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reduction efforts. Therefore, burning in PACs is expected to follow prescription and overstory mortality is expected to be limited. However, with a total of 70 PACs and nearly 110,400 total acres of MSO habitat proposed for burning, it is recognized that the sheer magnitude of the project creates opportunities for unexpected results. Spatially, there is high variability in fuels, moisture levels, topography, etc., across the landscape. The temporal aspect also adds an element of uncertainty. The amount of time it would take to complete all treatments increases the risk of unexpected weather shifts. The combined result is an increased risk of prescribed fire moving out of prescription within MSO habitat.

If conditions created unintended torching, large trees, canopy cover, logs, and existing woody debris could all be reduced inside PACs. The loss of big trees and canopy cover would represent a long-term loss of key MSO habitat elements. Tree boles and branches associated with fire mortality would be expected to replenish woody debris a year or two after burning. Small openings could benefit MSO and their prey by encouraging a greater understory response. However, given the imprecise nature of fire as a management tool, adverse effects to MSO habitat could result from prescribed fire.

Vegetation Condition Class (VCC) is presented below in lieu of Fire Regime Condition Class (FRCC). FRCC provides a single number to summarize the area of consideration. In this case, the one number would summarize over ½ million acres of ponderosa pine forest. VCC is a component of FRCC and, similar to FRCC, provides percent departure from reference conditions. Using percent of departure, a determination is made for the landscape being analyzed that displays acres of each of three condition classes. VCCs can be:

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- 0 – 33% departed (VCC 1)
- 34 – 66% departed (VCC 2)
- >66% departed (VCC 3)

VCC departure was modeled at the landscape level. Results are not specific to MSO habitat. However, an increase or decrease in departure from reference conditions reflects the loss of key ecosystem components to uncharacteristic fire at the landscape level. Landscape level risk is a reflection of the risk to MSO habitat within that landscape. Post-treatment fire modeling indicates the number of acres in VCC 3 would decrease by 57% in 2020, as a result of thinning and prescribed burning (Table 21). This would move over 289,000 acres of ponderosa pine forest that are currently highly departed (VCC 3) toward reference conditions (VCC 2). About 66,000 additional acres would move into reference conditions (VCC 1). The scale of change across the landscape would greatly decrease the risk of high-severity fire moving into protected habitat. The change in fire risk also increases the potential for managing future unplanned ignitions, further decreasing fire risk to MSO habitat. While high-severity fire remains a long-term threat to nesting and roosting habitat, the decrease in VCC 3 across the landscape increases the ability to sustain this habitat over time.

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Table 21. Vegetation condition class (VCC) ratings in Ponderosa pine forest across the 4FRI treatment area under the proposed action

Conditions	Year	Measure	VCC1	VCC2	VCC3
Existing	2010	Acres	71,097	126,960	309,782
		Percent	14	25	61
Proposed Action	2020	Acres	137,117	350,409	20,314
		Percent	27	69	4
	2050	Acres	81,254	248,841	177,744
		Percent	16	49	35

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Fire behavior was modeled for ponderosa pine forest in general and for MSO habitat specifically. While the threat of high-severity crown fire remains higher in PACs than in the general ponderosa pine forest, modeled fire behavior shows a decrease in crown fire risk as a result of the proposed treatments. Total area burned by active crown fire would decrease by about 22% in PAC habitat (about 7,860 acres) after treatments (Table 22). Predicted surface fire under the Proposed Action would increase in protected habitat by about 26% (nearly 9,000 acres) post-treatment.

Table 22. Predicted fire behavior in protected habitat under current conditions and after implementation of the proposed action

Forest Habitat	Total (Ac)	Surface Fire (Ac)	Passive Crown Fire (Ac)	Active Crown Fire (Ac)	Surface Fire (%)	Passive Crown Fire (%)	Active Crown Fire (%)
Existing Condition (Year 2010)							
Ponderosa Pine	507,839	316,630	48,023	143,186	62	9	28
Protected	35,262	18,122	3,034	14,106	51	9	40
Proposed Action (Year 2020)							
Ponderosa Pine	507,839	481,622	17,323	8,894	95	3	2
Protected	35,262	27,119	1,896	6,247	77	5	18

Active crown fire areas are currently centered on MSO habitat and permeate much of the 4FRI treatment area (Figure 13). Fire behavior would shift dramatically across the landscape after treatment (Figure 13 and Figure 14). Nevertheless, while existing active crown fire risk would decrease across most of the treatment area, it would remain centered around PAC habitat (Figure 14). Much of the restricted habitat would be a mix of surface and passive crown fire.

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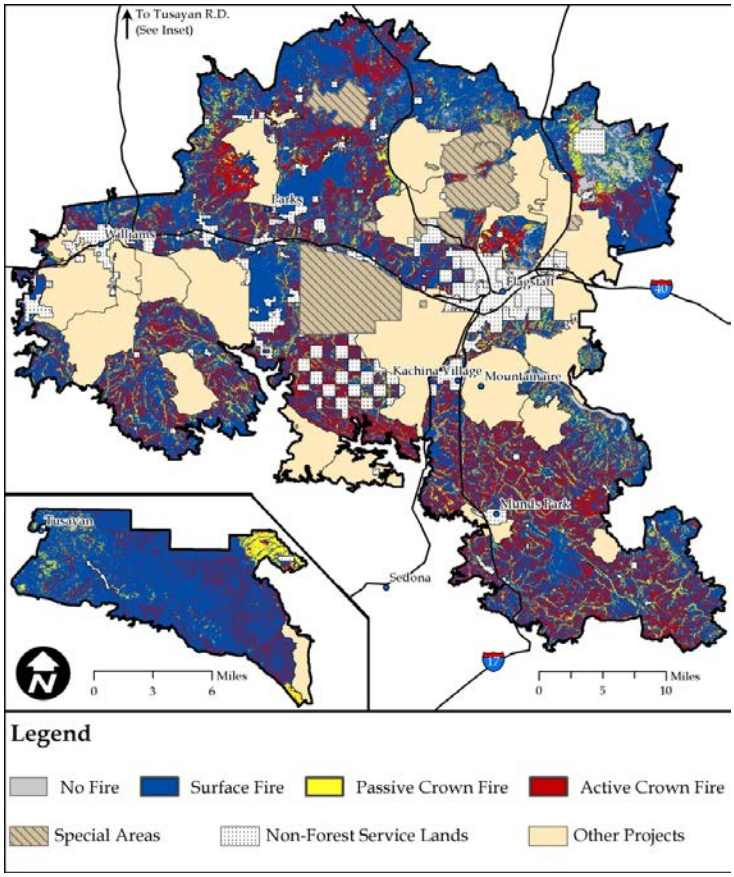


Figure 13. Current fire potential in the treatment area

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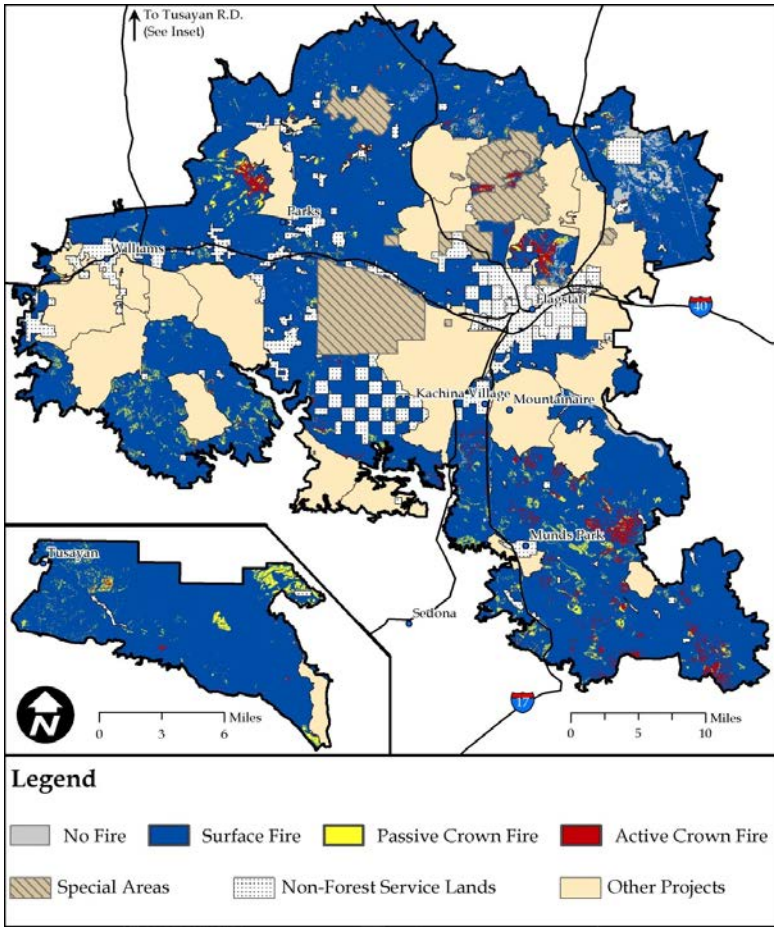


Figure 14. Modeled fire type for the proposed action, 2020

Reducing predicted crown fire across the ponderosa pine forest would allow more flexibility in managing unplanned fire ignitions to help meet desired conditions both inside and outside of designated MSO habitat. The ability to better protect MSO habitat from landscape-scaled fire events would contribute toward sustaining MSO habitat through time.

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Individual PAC Treatment Summaries

Overview

A total of 70 PACs are proposed for some kind of treatment. PACs range in size from 599 to 927 acres (average = 700 acres). All PACs would be treated with low-severity prescribed fire, including core areas that consist of pine-oak forest. An analysis of the PACs across and around the project area (*n*=113) determined that 18 PACs have conditions warranting mechanical treatments to enhance and retain key MSO habitat elements. The primary objective for mechanical treatments would be decreasing total BA in

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a manner that releases large and old pine trees and large oak from competition with mid-aged trees. Expected results from this thinning are increased large tree growth rates and enhanced resiliency for this limited resource. Mechanical treatments are designed to retain all tree species (i.e., Gambel oak, aspen, juniper spp., and pinyon pine) and retain important habitat components such as snags and large down logs. All PAC acres with mechanical harvest would also have prescribed fire treatments with the objective of decreasing duff, litter, and fine surface fuels. Some snags would be lost to prescribed fire, but overall numbers would increase with time. However, snag quality could decrease under this scenario until other mortality processes create longer lasting snags. Prescribed fire treatment objectives are to reduce flame lengths and potentially raise the crown base height to reduce the threat of surface fire becoming high-severity crown fire. In addition, the post-fire nutrient release should stimulate understory development in PACs. Forest plan amendments would be included to allow for improving habitat structure in addition to managing for fire risk abatement. Mechanical treatments within the 18 PACs would range from cutting trees < 9 inches dbh up to about 17.9 inches dbh, depending on individual stand conditions (Table 23).

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Table 23. Total PACs acres and percent of total acres by size-class for mechanical treatments [1]

Cutting up to 8.9” dbh		Cutting up to 11.9” dbh		Cutting up to 13.9” dbh		Cutting up to 15.9” dbh		Cutting up to 17.9” dbh		Total Mechanical Acres
Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres
3,378	33	1,335	13	3,951	38	1,022	10	634	6	10,319

[1]Note: these totals include 35 acres of meadow treatment where cutting would extend up to 17.9 inches dbh.

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Other habitat improvements treated by the 4FRI within PACs include meadows, aspens, springs, and ephemeral channels (Table 24). All are important to MSO prey species.

Table 24. Key prey habitats proposed for treatment in PACs

Habitat	Total	Average	Minimum	Maximum	# of PACs Affected
Meadows (ac.)	131	9	0.6	23	11
Aspen (ac.)	219	16	2	44	8
Springs (no.)	5	NA	NA	NA	4
Ephemeral Channel (miles)	1.7	0.3	0.02	0.7	6

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Some PACs and core areas overlap with the 4FRI boundary so that acres occur both inside and outside the project and treatment areas. In addition to pine-oak forest, core areas include mixed conifer, canyon habitat, occur in wilderness, or otherwise fall outside the treatment area boundary. Therefore, not all acres located within the analysis area occur in the treatment area (Table 25). A total of 54 PACs would have prescribed fire in core areas, including 15 with mechanical treatment and 39 burn-only treatments.

Table 25. Total and average core area acres within or overlapping the 4FRI boundary

Core Acres Overlapping the Project Area		Core Acres Within the Project Area		Core Acres Within the Treatment Area	
Total	Average	Total	Average	Total	Average
10,333	112	9,913	100	4,688	87

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PAC by PAC Summaries

PAC treatments are categorized as PACs proposed for mechanical and prescribed fire treatments and PACs with prescribed fire treatments only. The amount of treatment, treatment effects, and associated tabular results are provided below by individual PAC.

PACs Proposed for Mechanical and Prescribed Fire Treatments

Archies_030405034

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 13.9 inches dbh (Table 26). Most of the acres treated mechanically would remove trees < 9 inches dbh. Low-severity prescribed fire treatments would cover 100% of the core area and 100% of the PAC (Table 27).

Table 26. Acres of proposed mechanical treatments by size-class in Archies PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
444	41	11	0	0	599	83

Table 27. Acres of proposed fire treatments in the Archies PAC and PAC core area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
104	104	104	100	100

The % SDI in the 18- to 23.9-inch dbh tree size class would increase above no treatment values in the short and long term (Table 28). The % SDI in the > 24 inches dbh tree size class would remain similar to no treatment in the short and long term. Ponderosa pine (PP) BA would decrease in the short and long term, meeting one of the treatment objectives, but Gambel oak (GO) BA would increase as a result of canopy gaps resulting from the reduction in PP BA. Total BA decreases over time and remains above the minimum BA value. The positive response in the 18 to 23.9-inch dbh tree size class relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. Logs are relatively unchanged and remain below forest plan guidelines under all scenarios in this PAC. CWD decreases in the short term, probably due to repeated prescribed burns, but in the long term, it remains in the range recommended in the forest plans. Understory index, a comparison of the theoretical growth of herbaceous cover (see Appendix 8 in the 4FRI wildlife specialist report) is a net improvement in both the short and long term compared to no management actions. This would be beneficial for Mexican spotted owl prey. The understory reflects a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Increasing total BA also reflects the growth of large trees, and total BA remains lower than if no action occurred in the long term. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed separately. Maintaining prey habitat, including increasing food and cover, should maintain or enhance

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prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire. Effects of temporary roads on small mammals are discussed separately.

Table 28. PAC changes in MSO forest structure and prey habitat metrics

	Existing Condition	No Action		Proposed Action	
Archies	**2010**	**2020**	**2050**	**2020**	**2050**
% of SDI 12-17.9" dbh	33	34	33	36	34
% of SDI 18-23.9" dbh	10	14	25	16	29
% of SDI ≥24" dbh	4	5	8	5	9
TPA >18" dbh	8	11	24	11	24
PP Basal Area	90	99	118	89	108
GO Basal Area	19	20	27	20	25
All Basal Area	115	126	155	117	144
Snags 12-17.9" dbh	1.1	1.5	2.9	2.6	2.8
Snags >12" dbh	1.2	1.6	3.4	2.7	3.3
Snags ≥18" dbh	0.1	0.1	0.4	0.1	0.5
CWD >3" (Tons/Acre)	3.4	4.0	6.0	1.5	3.7
Logs per Acre	0.3	0.5	1.8	0.4	1.8
Understory Index (lbs./ac.)	67	54	32	65	39

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Bar-M_030405030

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 15.9 inches dbh (Table 29). Most of the PAC would be treated mechanically (over 80%) and low-severity prescribed fire treatments would cover 100% of the core area and 100% of the PAC (Table 30).

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Table 29. Acres of proposed mechanical treatments by size-class in Bar-M PAC

Cut up to 8.9” dbh	Cut up to 11.9” dbh	Cut up to 13.9” dbh	Cut up to 15.9” dbh	Cut up to 17.9” dbh	Total PAC Acres	% of PAC Treated
119	149	199	66	0	645	83

Table 30. Acres of proposed fire treatments in the Bar-M PAC and PAC core area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
112	112	112	100	100

The % SDI in large tree size classes would increase above existing conditions in the short term (Table 31). Both size classes of trees 18 inches dbh and greater would increase in the long term. PP BA would decrease, meeting one of the treatment objectives. GO BA would increase in the long term as a result of canopy gaps resulting from the reduction in PP BA. Total BA decreases over time and remains above the minimum BA over time. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD would remain within or above the ranges recommended by the forest plans. Logs would be slightly lower

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than forest plan guidelines in the short term, probably in response to repeated prescribed burning, and would increase in the long term to levels above guidelines in the forest plans. Understory index would increase post-treatment and remain higher through time. Understory response would increase as a result of canopy gaps resulting from the reduction in PP BA. The understory reflects a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed separately. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire. Effects of temporary roads on small mammals are discussed separately.

Table 31. PAC Changes in MSO forest structure and prey habitat metrics

	Existing Condition	No Action		Proposed Action	
Bar M					
% of SDI 12-17.9" dbh	21	23	23	26	20
% of SDI 18-23.9" dbh	17	18	20	25	28
% of SDI ≥24" dbh	9	10	14	13	20
TPA >18" dbh	19	21	27	22	30
PP Basal Area	141	143	143	109	118
GO Basal Area	21	22	32	22	32
All Basal Area	164	168	178	133	153
Snags 12-17.9" dbh	3.8	3.8	4.9	4.0	2.8
Snags >12" dbh	5.0	5.0	6.7	5.1	4.6
Snags ≥18" dbh	1.2	1.2	1.8	1.1	1.8
CWD >3" (Tons/Acre)	6.0	8.2	12.9	3.4	7.0
Logs per Acre	2.3	4.0	8.4	2.6	6.7
Understory Index (lbs./ac.)	27	25	21	48	33

Bear Seep_030405031

Overview: Mechanical treatments and prescribed fire are proposed, excluding burning in the core area. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 17.9 inches dbh, but would not include all size classes of trees (Table 32). Most of the acres treated mechanically (about 75%) would remove trees < 9 inches dbh. Low-severity prescribed fire treatments would not occur in the core area, but would occur in about 85% of the PAC (Table 33).

Table 32. Acres of proposed mechanical treatments by size-class in Bear Seep PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
453	0	0	144	10	713	85

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Table 33. Acres of proposed fire treatments in the Bear Seep PAC and PAC core area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
107	107	0	0	85

The % SDI in large tree size classes would increase above no treatment in the short term (Table 34). Both size classes of trees 18 inches dbh and greater would show strong increases in the long term. PP BA would decrease, meeting one of the treatment objectives. GO BA would decrease slightly in the short term, probably in response to repeated prescribed burns, and increase in the long term. Gambel oak is a vigorous resprouter in response to fire. The amount of oak is probably higher than in presettlement, and this decrease would likely have little effect on owls. Total BA decreases over time, remains above the minimum BA, and becomes high (> 150) in the long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD would remain at or above the guideline in the forest plans in the short and long term. Logs would remain below forest plan guidelines in the short term (similar to existing condition), probably in response to repeated prescribed burning, and increase above forest plan guidelines in the long term. Understory index shows an improvement over no action in both the short and long term, reflecting a peak response due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Table 34. PAC changes in MSO forest structure and prey habitat metrics

	Existing Condition	No Action		Proposed Action	
Bear Seep					
% of SDI 12-17.9" dbh	24	23	21	25	23
% of SDI 18-23.9" dbh	18	19	23	24	27
% of SDI ≥24" dbh	19	19	22	23	29
TPA >18" dbh	20	23	29	23	29
PP Basal Area	118	124	130	112	117
GO Basal Area	14	16	12	15	18
All Basal Area	138	147	165	135	151
Snags 12-17.9" dbh	2.0	2.3	4.1	2.7	3.7
Snags >12" dbh	2.9	3.3	6.0	3.5	5.8
Snags ≥18" dbh	1.0	1.0	1.8	0.9	2.1
CWD >3" (Tons/Acre)	4.9	6.2	9.9	3.0	6.5
Logs per Acre	2.0	3.1	6.4	2.1	5.5
Understory Index (lbs./ac.)	44	37	27	46	34

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA (compared to no action) increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed separately. Maintaining prey habitat,

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including increasing food and cover, should maintain or enhance prey populations while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire. Effects of temporary roads on small mammals are discussed separately.

Ten acres of meadow restoration (prescribed fire and cutting encroaching trees) would occur outside the nesting season. Subsequent herbaceous growth would benefit MSO prey species by enhancing food and cover for small mammals in both the short and long term.

About 0.5 mile of ephemeral stream restoration would occur within the PAC outside the nesting season. Short-term increases in sediment transport and movement would be expected due to disturbance during the reshaping and restoration process (MacDonald 2013). As restored stream banks stabilize over time, vegetative cover would improve as erosion slows and soil moisture increases. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. Protected herbaceous growth would benefit MSO prey species by enhancing food and cover in the long term.

Bonita Tank_030405014

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Most of the PAC (about 90%) would be treated mechanically (Table 35). Mechanical treatments would extend to trees up to 17.9 inches dbh, although no treatments are proposed in the 14- to 15.9-inch category. Low-severity prescribed fire treatments would occur throughout the entire core area and PAC (Table 36).

Table 35. Acres of proposed mechanical treatments by size-class in Bonita Tank PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
37	203	429	0	127	896	89

Table 36. Acres of proposed fire treatments in the Bonita Tank PAC and PAC core area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
100	100	100	100	100

The % SDI in large tree size classes would increase above existing conditions in the short term (Table 37). Both size classes of trees 18 inches dbh and greater would show strong increases in the long term. PP BA would decrease, meeting one of the treatment objectives. GO BA would increase in the short and long term. Total BA would decrease in the short term, remain above the minimum BA, and would increase over time. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below guidelines in the forest plans in the short term, and increase in the long term to levels about twice the forest plan guidance. Understory index is consistently higher than no treatment through time and would reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and the lack of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining

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large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed separately. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire. Effects of temporary roads on small mammals are discussed separately.

Table 37. PAC changes in MSO forest structure and prey habitat metrics

	Existing Condition	No Action		Proposed Action	
Bonita Tank	**2010**	**2020**	**2050**	**2020**	**2050**
% of SDI 12-17.9" dbh	35	35	28	38	19
% of SDI 18-23.9" dbh	16	19	30	26	40
% of SDI ≥24" dbh	5	6	9	8	13
TPA >18" dbh	19	22	36	24	41
PP Basal Area	139	144	149	107	122
GO Basal Area	28	29	31	30	33
All Basal Area	173	181	196	145	175
Snags 12-17.9" dbh	3.4	5.3	8.2	5.0	4.5
Snags >12" dbh	4.0	6.0	9.9	5.6	6.5
Snags ≥18" dbh	0.5	0.7	1.7	0.6	2.0
CWD >3" (Tons/Acre)	5.3	7.4	13.2	2.9	7.1
Logs per Acre	1.3	2.6	7.6	1.7	5.9
Understory Index (lbs./ac.)	23	20	15	38	22

Crawdad_030405047

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 17.9 inches dbh (Table 38). Most of the PAC (about 95%) would be treated mechanically and low-severity prescribed fire treatments would cover 100% of the core area and about 95% of the PAC (Table 39).

Table 38. Acres of proposed mechanical treatments by size-class in Crawdad PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
138	0	343	99	21	740	39

Table 39. Acres of proposed fire treatments in the Crawdad PAC and PAC core area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
102	102	102	100	95

The % SDI in large tree size classes would increase above no treatment in the short term (Table 40). Both size classes of trees 18 inches dbh and greater would show strong increases in the long term. PP BA

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would decrease more than if no treatments occurred, meeting one of the treatment objectives. GO BA would increase slightly relative to no action. Total BA would decrease, remain above the minimum BA in the short term, and would transition to levels above high BA in the long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below forest plan guidelines in the short term, increasing to levels above minimum forest plan guidelines in the long term. Understory index would be consistently higher than no treatment through time which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed separately. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire. Effects of temporary roads on small mammals are discussed separately.

Table 40. PAC changes in MSO forest structure and prey habitat metrics

Crawdad	Existing Condition	No Action		Proposed Action	
	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	40	41	37	41	32
% of SDI 18-23.9" dbh	11	14	24	18	32
% of SDI ≥24" dbh	6	7	8	9	12
TPA >18" dbh	13	16	28	17	31
PP Basal Area	128	135	149	110	128
GO Basal Area	22	24	30	25	31
All Basal Area	151	161	180	136	162
Snags 12-17.9" dbh	2.4	2.7	4.5	3.8	2.6
Snags >12" dbh	2.7	3.1	5.5	4.2	3.8
Snags ≥18" dbh	0.3	0.4	1.0	0.4	1.2
CWD >3" (Tons/Acre)	4.3	5.5	8.6	2.2	4.9
Logs per Acre	0.6	1.4	4.0	1.1	3.6
Understory Index (lbs./ac.)	35	29	20	46	28

Foxhole_030405038

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 15.9 inches dbh (Table 41). Most of the PAC (about 70%) would be treated mechanically and low-severity prescribed fire treatments would cover 100% of the core area and about 91% of the PAC (Table 42).

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Table 41. Acres of proposed mechanical treatments by size-class in Foxhole PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
10	124	136	178	0	642	70

Table 42. Acres of proposed fire treatments in the Foxhole PAC and PAC core area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
105	105	105	100	91

The % SDI in large tree size classes would increase above no treatment in the short term (Table 43). Both size classes of trees 18 inches dbh and greater would show strong increases in the long term. PP BA would decrease in both the short and long term, meeting one of the treatment objectives. GO BA would be the same as no treatment in the short or long term. Total BA would decrease, remain above the minimum BA in the short term, and would transition to levels above high BA in the long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below forest plan guidelines in the short term, probably in response to repeated prescribed burns, increasing to levels at or above minimum forest plan guidelines in the long term. Understory index would be consistently higher than no treatment through time, which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed separately. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire. Effects of temporary roads on small mammals are discussed separately.

Table 43. PAC changes in MSO forest structure and prey habitat metrics

Foxhole	Existing Condition	No Action		Proposed Action	
	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	23	25	28	27	24
% of SDI 18-23.9" dbh	10	12	15	19	23
% of SDI ≥24" dbh	8	9	10	11	14
TPA >18" dbh	13	15	20	16	23
PP Basal Area	142	144	148	102	117
GO Basal Area	18	19	24	19	24
All Basal Area	167	171	184	129	155
Snags 12-17.9" dbh	2.4	3.1	5.1	3.4	2.8

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Foxhole	Existing Condition	No Action		Proposed Action	
Snags >12" dbh	2.9	3.7	6.0	3.9	3.6
Snags ≥18" dbh	0.6	0.6	0.9	0.5	0.8
CWD >3" (Tons/Acre)	5.7	7.5	11.4	3.1	5.8
Logs per Acre	1.7	2.6	5.0	1.8	4.0
Understory Index (lbs./ac.)	26	24	19	51	32

Frank_030405037

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Mechanical treatments would extend to trees up to 17.9 inches dbh (Table 44). About 41% of the mechanical treatment acres would remove trees < 9 inches dbh. Most of the total PAC (over 80%) would be treated mechanically and low-severity prescribed fire treatments would cover 100% of the core area and 100% of the PAC (Table 45).

Table 44. Acres of proposed mechanical treatments by size-class in Frank PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
286	69	178	19	33	701	83

Table 45. Acres of proposed fire treatments in the Frank PAC and PAC core area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
115	115	115	100	100

The % SDI in large tree size classes would increase above no action in the short and long term (Table 46). PP BA would decrease, meeting one of the treatment objectives. GO BA would be slightly lower than no action. Although Gambel oak is a vigorous resprouter in response to fire, recruitment of oak into larger size classes would be delayed due to repeated prescribed fire. The amount of oak currently in the PAC is probably higher than during presettlement, so this slight decrease would likely have little effect on owls. Total BA would decrease compared to no action and remain above the minimum BA in both the short and long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below forest plan guidelines in the short term, probably in response to repeated prescribed burns, increasing to levels above minimum forest plan guidelines in the long term. Understory index would be consistently higher than no treatment through time, which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed below. Maintaining prey habitat, including increasing

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food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire.

Table 46. PAC Changes in MSO Forest Structure and Prey Habitat Metrics.

Frank	Existing Condition	No Action		Proposed Action	
	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	32	32	25	38	27
% of SDI 18-23.9" dbh	14	17	26	21	36
% of SDI ≥24" dbh	13	14	16	16	20
TPA >18" dbh	16	19	29	20	31
PP Basal Area	131	134	135	115	118
GO Basal Area	14	16	22	15	19
All Basal Area	145	150	158	131	137
Snags 12-17.9" dbh	4.2	5.1	6.6	5.6	5.4
Snags >12" dbh	4.9	5.9	8.4	6.4	7.6
Snags ≥18" dbh	0.7	0.8	1.8	0.8	2.2
CWD >3" (Tons/Acre)	4.7	6.5	11.1	2.6	6.9
Logs per Acre	1.2	2.5	7.2	1.8	6.5
Understory Index (lbs./ac.)	38	35	31	50	44

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Holdup_030405044

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Mechanical treatments would extend to trees up to 15.9 inches dbh (Table 47). About 74% of the PAC would be treated mechanically and low-severity prescribed fire treatments would cover 100% of the core area and 88% of the PAC (Table 48).

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Table 47. Acres of Proposed Mechanical Treatments by Size-Class in Holdup PAC.

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
57	197	264	18	0	723	74

Table 48. Acres of Proposed Fire Treatments in the Holdup PAC and PAC Core Area.

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
102	102	102	100	88

The % SDI in large tree size classes would increase above no action in the short and long term (Table 49). PP BA would decrease, meeting one of the treatment objectives, but GO BA would remain about the same as no action. Total BA would decrease compared to no action and remain above the minimum BA in both the short and long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below forest plan guidelines in the short term, probably in response to repeated prescribed burns, increasing to levels at or above minimum forest plan guidelines in the long term.

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Understory index would be consistently higher than no treatment through time, which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed below. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire.

Table 49. PAC changes in MSO forest structure and prey habitat metrics

	Existing Condition	No Action		Proposed Action	
Holdup	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	28	28	27	31	22
% of SDI 18-23.9" dbh	14	14	21	19	28
% of SDI ≥24" dbh	15	16	19	21	27
TPA >18" dbh	15	17	25	17	25
PP Basal Area	127	136	143	106	115
GO Basal Area	6	7	9	7	9
All Basal Area	134	144	156	115	129
Snags 12-17.9" dbh	1.2	1.7	5.4	2.6	4.1
Snags >12" dbh	1.8	2.5	7.3	3.8	6.3
Snags ≥18" dbh	0.6	0.7	1.9	0.8	2.2
CWD >3" (Tons/Acre)	3.8	4.6	7.7	1.8	5.1
Logs per Acre	1.0	1.7	5.1	1.3	5.1
Understory Index (lbs./ac.)	49	41	33	70	54

Less than 0.1 mile of ephemeral stream restoration would occur within the PAC outside the nesting season. Short-term increases in sediment transport and movement would be expected due to disturbance during the reshaping and restoration process (MacDonald 2013). As restored stream banks stabilize over time, vegetative cover would improve as erosion slows and soil moisture increases. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. Protected herbaceous growth would benefit MSO prey species by enhancing food and cover in the long term.

Iris Tank_030405006

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 17.9 inches dbh (Table 50). Most of the PAC (about 84%) would be treated mechanically and low-severity prescribed fire treatments would cover 100% of the core area and 100% of the PAC (Table 51).

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Table 50. Acres of proposed mechanical treatments by size-class in Iris Tank PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
172	13	261	48	93	699	84

Table 51. Acres of proposed fire treatments in the Iris Tank PAC and PAC core area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
103	103	103	100	100

The % SDI in large tree size classes would increase above no action in the short and long term (Table 52). PP BA would decrease, meeting one of the treatment objectives. GO BA would slightly decrease relative to no action. Although Gambel oak is a vigorous resprouter in response to fire, recruitment of oak into larger size classes would be delayed due to repeated prescribed fire. The amount of oak currently in the PAC is probably higher than during presettlement, so this slight decrease would likely have little effect on owls. Total BA would decrease compared to no action and remain above the minimum BA in both the short and long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below forest plan guidelines in the short term, probably in response to repeated prescribed burns, increasing to levels above minimum forest plan guidelines in the long term. Understory index would be consistently higher than no treatment through time, which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Table 52. PAC changes in MSO forest structure and prey habitat metrics

Iris Tank	Existing Condition	No Action		Proposed Action	
	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	32	31	25	32	22
% of SDI 18-23.9" dbh	18	21	28	28	36
% of SDI ≥24" dbh	8	9	12	11	16
TPA >18" dbh	21	24	33	25	34
PP Basal Area	142	144	139	118	119
GO Basal Area	22	24	31	23	29
All Basal Area	166	169	176	143	156
Snags 12-17.9" dbh	5.1	5.9	8.1	6.1	5.4
Snags >12" dbh	6.1	7.2	10.8	7.3	8.4
Snags ≥18" dbh	1.0	1.3	2.7	1.2	3.0
CWD >3" (Tons/Acre)	5.8	8.1	14.0	3.5	8.5
Logs per Acre	2.0	3.7	10.0	2.6	8.6
Understory Index (lbs./ac.)	26	25	22	40	31

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Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed below. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire.

Nine acres of meadow restoration (prescribed fire and cutting encroaching trees) would occur outside the nesting season. Subsequent herbaceous growth would benefit MSO prey species by enhancing food and cover for small mammals in both the short and long term.

Knob _030405029

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 15.9 inches dbh (Table 53). Most of the total PAC (about 87%) would be treated mechanically and low-severity prescribed fire treatments would cover 100% of the core area and 100% of the PAC (Table 54).

Table 53. Acres of proposed mechanical treatments by size-class in the Knob PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
273	26	252	114	0	766	87

Table 54. Acres of proposed fire treatments in the Knob PAC and PAC core area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
101	101	101	100	100

The % SDI in large tree size classes would increase above existing conditions in the short term (Table 55). Both size classes of trees 18 inches dbh and greater would show strong increases in the long term. PP BA would decrease, meeting one of the treatment objectives. GO BA would change little relative to no action. Total BA would decrease compared to no action and remain above the minimum BA in both the short and long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below forest plan guidelines in the short and long term, probably in response to repeated prescribed burns. Understory index would be consistently higher than no treatment through time, which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed below. Maintaining prey habitat, including increasing

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food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire.

Table 55. PAC changes in MSO forest structure and prey habitat metrics

	Existing Condition	No Action		Proposed Action	
Knob	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	28	31	33	33	32
% of SDI 18-23.9" dbh	15	16	20	20	25
% of SDI ≥24" dbh	7	8	13	9	15
TPA >18" dbh	11	13	21	13	22
PP Basal Area	109	117	135	97	119
GO Basal Area	11	12	17	12	16
All Basal Area	129	139	163	119	146
Snags 12-17.9" dbh	0.7	1.3	3.5	2.2	2.4
Snags >12" dbh	1.0	1.5	4.0	2.5	2.9
Snags ≥18" dbh	0.3	0.2	0.5	0.2	0.5
CWD >3" (Tons/Acre)	3.4	4.2	6.6	1.7	3.8
Logs per Acre	0.5	0.8	2.0	0.6	2.0
Understory Index (lbs./ac.)	52	43	28	62	38

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Lake #1/Seruchos_030405026

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Mechanical treatments would extend to trees up to 13.9 inches dbh (Table 56). About ¼ of the PAC would be treated mechanically and over ½ of the acres treated would be limited to trees <9 inches dbh. Low-severity prescribed fire treatments would cover 22% of the core area and 28% of the PAC (Table 57).

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Table 56. Acres of proposed mechanical treatments by size-class in Lake #1/Seruchos PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
123	66	50	0	0	927	26

Table 57. Acres of proposed fire treatments in the Lake #1/Seruchos PAC and PAC core area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
104	104	23	22	28

The % SDI in large tree size classes would increase above no action in the short and long term (Table 58). PP BA would decrease, meeting one of the treatment objectives, and GO BA would remain similar to no action in the short and long term. Total BA would decrease compared to no action and remain above the minimum BA in the short term, and transition to a high BA in the long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below forest plan guidelines in the short and long term, probably in response to repeated prescribed burns. Understory index would be

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consistently higher than no treatment through time, which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed below. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire.

Table 58. PAC changes in MSO forest structure and prey habitat metrics

	Existing Condition	No Action		Proposed Action	
Lake #1/Seruchos	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	29	29	30	34	29
% of SDI 18-23.9" dbh	13	13	20	17	26
% of SDI ≥24" dbh	6	7	7	8	10
TPA >18" dbh	13	15	23	15	27
PP Basal Area	128	138	159	104	130
GO Basal Area	19	21	23	21	24
All Basal Area	148	161	190	127	164
Snags 12-17.9" dbh	1.2	1.9	4.1	2.6	2.8
Snags >12" dbh	1.4	2.2	4.6	2.8	3.3
Snags ≥18" dbh	0.3	0.3	0.5	0.2	0.6
CWD >3" (Tons/Acre)	4.3	5.1	8.6	2.1	4.5
Logs per Acre	0.3	0.8	2.6	0.6	2.3
Understory Index (lbs./ac.)	36	29	17	54	27

Ephemeral stream channel restoration would improve < 0.1 mile of channel length outside the nesting season. Short-term increases in sediment transport and movement would be expected due to disturbance during the reshaping and restoration process (MacDonald 2013). As restored stream banks stabilize over time, vegetative cover would improve as erosion slows and soil moisture increases. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. Protected herbaceous growth would benefit MSO prey species by enhancing food and cover in the long term.

Lee Butte_030405020

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 17.9 inches dbh, although not all size classes within this range are proposed for cutting (Table 59). A little over ⅓ of the PAC would be treated mechanically and over ⅓ of the acres treated would be limited to trees <9 inches dbh. Low-severity prescribed fire treatments would cover 100% of the core area and 100% of the PAC (Table 60).

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Table 59. Acres of Proposed Mechanical Treatments by Size-Class in Lee Butte PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
111	0	128	0	67	867	35

Table 60. Acres of Proposed Fire Treatments in the Lee Butte PAC and PAC Core Area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
104	104	104	100	100

The % SDI in trees 18- to 23.9–inch large tree size classes would increase slightly in the short and long-term compared to no treatment (Table 61). The % SDI of trees in the ≥ 24 inches dbh size class would remain similar to no treatment in both the short and long term. PP BA would decrease, meeting one of the treatment objectives, but GO BA would remain similar to no treatment. Total BA would decrease compared to no action and remain at a high level in both the short and long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below forest plan guidelines in the short term, probably in response to repeated prescribed burns, increasing to levels above minimum forest plan guidelines in the long term. Understory index would be consistently higher than no treatment through time, which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Table 61. PAC Changes in MSO Forest Structure and Prey Habitat Metrics.

	Existing Condition	No Action		Proposed Action	
Lee Butte	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	34	35	35	37	36
% of SDI 18-23.9" dbh	10	13	25	14	27
% of SDI ≥24" dbh	3	4	4	4	5
TPA >18" dbh	10	14	27	14	27
PP Basal Area	138	145	157	136	150
GO Basal Area	15	16	20	16	19
All Basal Area	155	164	183	155	176
Snags 12-17.9" dbh	3.0	3.8	6.5	3.7	6.4
Snags >12" dbh	3.2	4.2	7.8	4.3	5.1
Snags ≥18" dbh	0.3	0.4	1.4	0.4	1.3
CWD >3" (Tons/Acre)	4.6	6.2	10.6	4.9	8.7
Logs per Acre	0.5	1.3	4.9	1.4	4.9
Understory Index (lbs./ac.)	32	27	19	32	22

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining

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large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed below. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire.

Mayflower Tank_030405022

Overview: Mechanical treatments and prescribed fire are proposed. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 17.9 inches dbh, but would not include all diameter classes within the range (Table 62). Most of the PAC (about 80%) would be treated mechanically. Prescribed fire is not proposed for the core area, but is proposed for about 87% of the PAC (Table 63).

Table 62. Acres of Proposed Mechanical Treatments by Size-Class in Mayflower Tank PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
257	0	139	118	99	768	80

Table 63. Acres of Proposed Fire Treatments in the Mayflower PAC and PAC Core Area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
100	100	0	0	87

The % SDI in trees 18- to 23.9-inch large tree size classes would increase slightly in the short and long term compared to no treatment (Table 64). The % SDI of trees in the ≥ 24-inch dbh size class would remain similar to no treatment in both the short and long term. PP BA would decrease in the short and long term, relative to no treatment, meeting one of the treatment objectives. GO BA would be similar to no action in the short term and increase in the long term. Total BA would decrease compared to no action, remain above the minimum BA in the short term, and transition to high BA in the long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below forest plan guidelines in the short term, probably in response to repeated prescribed burns, increasing to levels above minimum forest plan guidelines in the long term. Understory index would be consistently higher than no treatment in the short term, which would be beneficial for owl prey, and similar to no action in the long term. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed below. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire.

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Table 64. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Mayflower Tank	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	30	29	24	28	22
% of SDI 18-23.9" dbh	14	17	21	20	22
% of SDI ≥24" dbh	5	6	8	6	9
TPA >18" dbh	13	17	24	17	24
PP Basal Area	98	101	98	84	88
GO Basal Area	43	46	54	47	58
All Basal Area	147	156	175	140	174
Snags 12-17.9" dbh	3.5	4.7	7.1	4.7	4.6
Snags >12" dbh	4.0	5.2	8.8	5.2	6.2
Snags ≥18" dbh	0.5	0.5	1.7	0.5	1.6
CWD >3" (Tons/Acre)	4.3	6.3	11.5	2.7	6.6
Logs per Acre	0.9	2.0	6.4	1.5	5.0
Understory Index (lbs./ac.)	37	32	22	42	23

Aspen improvement is proposed for 61 acres of aspen remnants in the PAC. Mechanical thinning and physical soil disturbance are not proposed for aspen clones within PACs. Short-term effects would not be expected, because aspen treatments within PACs would be done outside the nesting season. Long-term benefits would consist of improving habitat for a range of MSO prey species, including small mammals, birds, bats, and invertebrates. Maintaining the clones sustains seral structure less prone to high-severity crown fire. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. If non-wire fencing options are not available, aspen treatments would not occur in PACs.

Red Hill_030402024

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 13.9 inches dbh (Table 65). Most of the total PAC (about 78%) would be treated mechanically and low-severity prescribed fire treatments would cover 100% of the core area and 100% of the PAC (Table 66).

Table 65. Acres of Proposed Mechanical Treatments by Size-Class in Red Hill PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
97	190	385	0	0	863	78

Table 66. Acres of Proposed Fire Treatments in the Red Hill PAC and PAC Core Area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
173	173	173	100	100

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The % SDI in large tree size classes would increase above no action in the short and long term (Table 67). PP BA would decrease, meeting one of the treatment objectives. GO BA would be similar to no action in the short term and increase in the long term. Although Gambel oak is a vigorous resprouter in response to fire, recruitment of oak into larger size classes would be slowed due to repeated prescribed fire. The amount of oak currently in the PAC is probably higher than during presettlement, so this slight change would likely have little effect on owls. Total BA would decrease compared to no action and remain above the minimum BA in the short term and transition into high BA in the long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below forest plan guidelines in the short term, probably in response to repeated prescribed burns, increasing to levels at or above minimum forest plan guidelines in the long term. Understory index would be consistently higher than no treatment through time, which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed below. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire.

Table 67. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Red Hill	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	31	33	31	34	23
% of SDI 18-23.9" dbh	18	20	26	25	32
% of SDI ≥24" dbh	5	6	10	7	13
TPA >18" dbh	22	23	32	24	37
PP Basal Area	155	157	158	119	132
GO Basal Area	11	12	12	12	14
All Basal Area	178	186	198	149	182
Snags 12-17.9" dbh	1.9	4.0	7.8	4.2	4.2
Snags >12" dbh	2.1	4.8	9.6	4.7	5.6
Snags ≥18" dbh	0.2	0.8	1.8	0.6	1.5
CWD >3" (Tons/Acre)	5.3	6.8	12.9	2.9	7.0
Logs per Acre	1.5	2.3	6.7	1.6	5.0
Understory Index (lbs./ac.)	23	20	16	39	21

Red Raspberry_030405003

Overview: Mechanical treatments and prescribed fire are proposed. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 15.9 inches dbh (Table 68). Most of the PAC (about 76%) would be treated mechanically. Prescribed fire is not proposed for the core area and is proposed for about 85% of the PAC (Table 69).

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Table 68. Acres of Proposed Mechanical Treatments by Size-Class in Red Raspberry PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
387	19	203	55		870	76

Table 69. Acres of Proposed Fire Treatments in the Red Raspberry PAC and PAC Core Area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
130	139	9	7	85

The % SDI in large tree size classes would increase above no action in the short and long term (Table 70). PP BA would decrease, meeting one of the treatment objectives. GO BA would remain similar to no action. Total BA would decrease compared to no action and remain above the minimum BA in the short term and transition to above high levels in the long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD would be below forest plan guidelines in the short term, probably in response to repeated prescribed burns, increasing to levels above minimum forest plan guidelines in the long term. Logs would remain at or above minimum guidelines in the forest plans in both the short and long term. Understory index would be higher than no treatment through time, which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed below. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire.

One spring would be restored inside the PAC outside the nesting season. Short-term increases in sediment transport and movement would be expected due to disturbance during the restoration process (MacDonald 2013). As restored areas stabilize over time, vegetative cover would improve as erosion slows and soil moisture increases. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. Protected herbaceous growth would benefit MSO prey species by enhancing food and cover in the long term.

About 16 acres of meadow restoration (cutting encroaching trees and prescribed fire) would occur outside the nesting season. Subsequent herbaceous growth would benefit MSO prey species by enhancing food and cover for small mammals in both the short and long term.

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Table 70. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Red Raspberry	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	29	28	24	30	22
% of SDI 18-23.9" dbh	15	19	24	21	27
% of SDI ≥24" dbh	9	10	13	12	16
TPA >18" dbh	16	19	28	19	29
PP Basal Area	94	99	108	88	97
GO Basal Area	29	29	32	29	32
All Basal Area	144	153	178	144	171
Snags 12-17.9" dbh	2.6	3.3	4.4	3.9	3.8
Snags >12" dbh	3.7	4.5	6.2	4.7	5.5
Snags ≥18" dbh	0.8	0.8	1.6	0.8	1.5
CWD >3" (Tons/Acre)	5.6	7.7	11.8	3.7	7.8
Logs per Acre	3.1	4.4	8.0	3	6.7
Understory Index (lbs./ac.)	39	33	21	39	24

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Aspen improvement is proposed for 61 acres of aspen remnants in the PAC. Mechanical thinning and physical soil disturbance are not proposed for aspen clones within PACs. Short-term effects would not be expected because aspen treatments within PACs would be done outside the nesting season. Long-term benefits would consist of improving habitat for a range of MSO prey species, including small mammals, birds, bats, and invertebrates. Maintaining the clones sustains seral structure less prone to high-severity crown fire. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. If non-wire fencing options are not available, aspen treatments would not occur in PACs.

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Rock Top_030405019

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 15.9 inches dbh (Table 71). Over half of the cutting (about 58%) would occur in the 12- to 13.9-inch dbh class. Most of the PAC (about 86%) would be treated mechanically and low-severity prescribed fire treatments would cover 100% of the core area and 100% of the PAC (Table 72).

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Table 71. Acres of Proposed Mechanical Treatments by Size-Class in Rock Top PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
98	57	506	90	0	875	86

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Table 72. Acres of Proposed Fire Treatments in the Rock Top PAC and PAC Core Area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
103	103	103	100	100

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The % SDI in large tree size classes would increase above no action in the short and long term (Table 73). PP BA would decrease, meeting one of the treatment objectives, and GO BA would change little compared to no action. Total BA would decrease compared to no action and remain above the minimum BA in the short term and transition to above high levels in the long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below forest plan guidelines in the short term, probably in response to repeated prescribed burns, and would increase to minimum forest plan guidelines in the long term. Understory index would be higher than no treatment through time, which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed below. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire in the long term.

Table 73. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Rock Top	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	33	34	28	35	25
% of SDI 18-23.9" dbh	14	16	24	19	28
% of SDI ≥24" dbh	5	6	8	7	10
TPA >18" dbh	14	16	26	16	28
PP Basal Area	111	117	124	96	108
GO Basal Area	18	20	26	20	27
All Basal Area	139	148	168	128	157
Snags 12-17.9" dbh	3.1	3.7	5.3	4.2	3.7
Snags >12" dbh	3.6	4.2	6.7	4.6	5.2
Snags ≥18" dbh	0.5	0.5	1.5	0.5	1.5
CWD >3" (Tons/Acre)	5.0	6.5	10.3	2.6	5.9
Logs per Acre	1.6	2.6	5.9	1.8	4.9
Understory Index (lbs./ac.)	43	36	25	52	31

Spring restoration would occur outside the nesting season attwo sites: Lee Spring and Rock Top. Short-term increases in sediment transport and movement would be expected due to disturbance during the reshaping and restoration process (MacDonald 2013). As restored areas stabilize over time, vegetative cover would improve as erosion slows and soil moisture increases. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. Protected herbaceous growth would benefit MSO prey species by enhancing food and cover in the long term.

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Sawmill Springs_030404009

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 17.9 inches dbh (Table 74). Most of the cutting (about 86%) would occur in trees 13.9 inches and smaller in diameter. No trees 14 to 15.9 inches dbh would be cut. Most of the PAC (about 82%) would be treated mechanically and low-severity prescribed fire treatments would cover 100% of the core area and 100% of the PAC (Table 75).

Table 74. Acres of Proposed Mechanical Treatments by Size-Class in Sawmill Springs PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
192	63	190	0	71	629	82

Table 75. Acres of Proposed Fire Treatments in the Sawmill PAC and PAC Core Area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
113	113	113	100	100

The % SDI in large tree size classes would increase above no action in the short and long term (Table 76). PP BA would decrease, meeting one of the treatment objectives. GO BA would decrease in the short and long term. Although Gambel oak is a vigorous resprouter in response to fire, recruitment of oak into larger size classes would be delayed due to repeated prescribed fire. The amount of oak currently in the PAC is probably higher than during presettlement, so this slight decrease would likely have little effect on owls. Total BA would decrease compared to no action and remain above the minimum BA in the short term and transition to above high levels in the long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD and logs would be below forest plan guidelines in the short term, probably in response to repeated prescribed burns, and would increase to or above minimum forest plan guidelines in the long term. Understory index would be higher than no treatment through time which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post-treatment.

Increasing tree growth rates and the large trees size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed below. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire.

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Table 76. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Sawmill Springs	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	35	36	32	39	34
% of SDI 18-23.9" dbh	15	16	22	19	26
% of SDI ≥ 24" dbh	5	6	10	7	13
TPA > 18" dbh	14	16	25	16	27
PP Basal Area	117	125	137	111	129
GO Basal Area	18	21	29	19	25
All Basal Area	136	147	169	131	155
Snags 12-17.9" dbh	2.2	2.6	5.6	3.7	3.5
Snags > 12" dbh	3.0	3.4	7.0	4.3	4.7
Snags ≥ 18" dbh	0.8	0.8	1.3	0.7	1.2
CWD > 3" (Tons/Acre)	4.4	5.6	9.0	2.2	5.1
Logs per Acre	1.2	2.0	5.1	1.4	4.1
Understory Index (lbs./ac.)	45	37	25	50	32

One spring would be restored inside the PAC outside the nesting season. Short-term increases in sediment transport and movement would be expected due to disturbance during the reshaping and restoration process (MacDonald 2013). As restored areas stabilize over time, vegetative cover would improve as erosion slows and soil moisture increases. After restoration work is completed the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. Protected herbaceous growth would benefit MSO prey species by enhancing food and cover in the long-term.

T6 Tank_030405016

Overview: Mechanical treatments and prescribed fire are proposed, including burning in the core area. Forest conditions were reviewed in the field (Appendix 2). Mechanical treatments would extend to trees up to 17.9 inches dbh and would be distributed across dbh size classes (Table 77). Most of the PAC (about 87%) would be treated mechanically and low-severity prescribed fire treatments would cover 100% of the core area and 100% of the PAC (Table 78).

Table 77. Acres of Proposed Mechanical Treatments by Size-Class in T6 Tank PAC

Cut up to 8.9" dbh	Cut up to 11.9" dbh	Cut up to 13.9" dbh	Cut up to 15.9" dbh	Cut up to 17.9" dbh	Total PAC Acres	% of PAC Treated
126	116	279	72	88	784	87

Table 78. Acres of Proposed Fire Treatments in the T6 Tank PAC and PAC Core Area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
104	104	104	100	100

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The % SDI in large tree size classes would increase above no action in the short and long term (Table 79). PP BA would decrease, meeting one of the treatment objectives. GO BA would remain about the same as no action in the short term with a 1% decrease in the long term. Total BA would decrease compared to no action and remain above the minimum BA in the short and long term. The positive response in large trees relates to the design features developed to maximize MSO habitat rather than implement simple fuels reduction or thin from below projects. CWD would be below forest plan guidelines in the short and long term, probably in response to repeated prescribed burns. Logs would be below guidelines in the forest plans in the short term and in the long term would reach levels above plan guidelines. Understory index would be higher than no treatment through time, which would be beneficial for owl prey. Understory values reflect a peak response in the short term due to opening the canopy, with a reduced response over time as the canopy closes due to increased growth and in the absence of future mechanical treatments. The scale of the understory response reflects the changes in canopy cover post treatment.

Increasing tree growth rates and the large tree size classes is recommended in the Recovery Plan and should benefit owls. Lowering total BA increases forest resiliency, increasing the likelihood of retaining large pine and oak trees through time, even as effects of climate change become more pronounced. Overall, changes in forest structure would be neutral to beneficial to MSOs in both the short and long term. Disturbance from these actions is discussed below. Maintaining prey habitat, including increasing food and cover, should maintain or enhance prey populations, while reducing the threat of ground fire in the PAC transitioning into high-severity crown fire.

Table 79. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
T6 Tank	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	26	26	24	29	23
% of SDI 18-23.9" dbh	12	14	20	18	27
% of SDI ≥24" dbh	16	16	17	20	23
TPA >18" dbh	13	16	23	16	24
PP Basal Area	112	121	133	96	112
GO Basal Area	14	15	20	15	19
All Basal Area	127	138	155	112	133
Snags 12-17.9" dbh	1.7	2.1	4.7	2.7	3.3
Snags >12" dbh	2.2	2.6	6.3	3.3	5.0
Snags ≥18" dbh	0.5	0.5	1.6	0.6	1.7
CWD >3" (Tons/Acre)	3.7	4.6	7.7	1.9	4.7
Logs per Acre	0.9	1.6	4.4	1.2	4.1
Understory Index (lbs./ac.)	53	44	32	70	48

PACs Proposed for Prescribed Fire Only

Overview: Because the effects to PACs from prescribed burning are similar, and small in scale, there is no PAC by PAC discussion below, however, tables are provided to show the effects to MSO forest structure and prey habitat metrics by PAC.

Little change would occur in the densities of medium and large trees in the short and long term without mechanical treatments and with limited objectives for prescribed fire (i.e., reduce surface fuels). PP BA would decrease in the short term, but is approaching the no treatment density in the long term. GO BA

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would remain about the same as taking no action. Total BA would also remain at about the same density too, failing to meet one of the objectives of PAC treatments.

Snags: 12 to 18 inches and >12 inches increase in the short term, but decrease slightly (about 0.5 snags/acre) in the long term. The short-term increase probably reflects post-treatment mortality of medium-sized trees. Fire-created snags and, probably, existing snags further weakened by fire, do not persist as long as snags created from other sources. Decreased longevity of fire-created snags may account for the long-term decrease. Nevertheless, snags <18 inches dbh remain abundant on the landscape, typically 3 to 4 times the numbers referenced in forest plan guidelines. Snags >18 inches do not appreciably change in number. Perhaps the combination of low-severity burning and larger structure minimizes the effects seen in smaller size classes.

CWD and logs would decrease in the short term. Both would increase over time. Understory index would increase slightly after burning, but would not show change over time. Understory response is based in large part on the relationship between forest canopy and herbaceous growth, and does not reflect the added nutrient pulse associated with fire. Nevertheless, with little to no change in the canopy, little or no additional sunlight would reach the forest floor, so herbaceous growth would continue to be suppressed.

Prescribed fire would bring little change to the forest structure and prey habitat components identified here. The limited changes in the BA and forest density limits growth rates of larger trees in the long term. However, fire modeling indicates that by reducing surface fuels, primarily duff, needle cast, and fine fuels, fire behavior could be changed. Combined with an expected rise in crown base height, the likelihood of future surface fires transitioning into high-severity crown fire is reduced (see the fire discussion). Raising crown base height could also improve foraging habitat for owls by increasing sub-canopy flight space for these "perch and pounce" predators. Because burning would be done outside the nesting season, no disturbance would result to nesting owls. There would be no effect in the short term and a long-term benefit related to the reduction in fire risk.

Blade Tank_030405024

This PAC is 610 acres and about 567 acres would be burned (about 93%). Prescribed fire in the PAC would include about 62% of the core area (Table 80). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 81.

Table 80. Acres of Proposed Fire Treatments in the Blade Tank PAC and PAC Core Area

Total Core Area	Project Area	Core Treatment	%of Core Area Treated	% of PAC Treated
111	111	69	62	93

Table 81. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Blade Tank	**2010**	**2020**	**2050**	**2020**	**2050**
% of SDI 12-17.9" dbh	33	33	28	33	28
% of SDI 18-23.9" dbh	13	15	23	16	24
% of SDI ≥24" dbh	7	7	11	8	11
TPA >18" dbh	15	19	29	19	30
PP Basal Area	125	129	130	123	127

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	Existing Condition	No Action		Proposed Action	
GO Basal Area	23	24	28	25	29
All Basal Area	165	174	190	168	188
Snags 12-17.9" dbh	3.4	4.3	6.8	5.9	6.4
Snags >12" dbh	4.1	5.1	8.7	6.6	8.2
Snags ≥18" dbh	0.7	0.7	1.9	0.7	1.9
CWD >3" (Tons/Acre)	6.1	8.1	13.2	3.3	8.9
Logs per Acre	2.5	3.6	8.2	2.3	7.2
Understory Index (lbs./ac.)	27	23	17	25	18

Boondock_030404037

This PAC is 655 acres and about 310 acres would be burned (about 47%). Prescribed fire would include about 12% of the core area (Table 82). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 83.

Table 82. Acres of Proposed Fire Treatments in the Boondock PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
101	12	12	12	47

Table 83. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Boondock	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	29	28	26	28	25
% of SDI 18-23.9" dbh	13	15	21	16	21
% of SDI ≥24" dbh	8	9	11	9	11
TPA >18" dbh	17	20	29	20	29
PP Basal Area	129	133	132	126	129
GO Basal Area	27	29	32	29	33
All Basal Area	173	182	196	176	195
Snags 12-17.9" dbh	3.3	4.1	6.4	5.5	6.0
Snags >12" dbh	4.1	5.0	8.4	6.4	8.0
Snags ≥18" dbh	0.8	0.9	2.0	0.9	2.0
CWD >3" (Tons/Acre)	6.1	8.1	13.4	3.3	9.0
Logs per Acre	2.2	3.4	7.9	2.2	7.0
Understory Index (lbs./ac.)	23	20	15	22	15

Bridge_03040238

This PAC is 637 acres and about 286 acres would be burned (about 45%). Prescribed fire would include about 1% of the core area (Table 84). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 85.

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Table 84. Acres of Proposed Fire Treatments in the Bridge PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
100	7	7	1%	45

Table 85. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Bridge	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	30	29	25	29	25
% of SDI 18-23.9" dbh	21	23	26	24	27
% of SDI ≥24" dbh	10	11	17	12	17
TPA >18" dbh	27	30	37	30	38
PP Basal Area	151	153	154	148	152
GO Basal Area	20	21	21	21	22
All Basal Area	185	191	203	186	201
Snags 12-17.9" dbh	3.2	5.1	6.6	6.6	6.1
Snags > 12" dbh	4.0	6.3	9.3	7.7	8.72
Snags ≥ 18" dbh	0.7	1.2	2.7	1.1	2.6
CWD > 3" (Tons/Acre)	7.1	9.0	14.4	3.9	9.8
Logs per Acre	5.9	7.0	12.2	4.3	10.0
Understory Index (lbs./ac.)	95	91	82	94	83

Bristow Tank/Limpios_030405018

This PAC is 656 acres and all of it would be burned (100%), including the core area Table 86). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 87.

Table 86. Acres of Proposed Fire Treatments in the Bristow Tank/Limpios PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
107	107	107	100	100

Table 87. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Bristow Tank/Limpios	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	26	26	25	26	24
% of SDI 18-23.9" dbh	13	14	18	14	18
% of SDI ≥24" dbh	9	9	12	10	12
TPA >18" dbh	13	15	23	15	23
PP Basal Area	101	106	111	101	107
GO Basal Area	23	25	30	25	31
All Basal Area	139	150	172	145	170

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	Existing Condition	No Action		Proposed Action	
Snags 12-17.9" dbh	2.3	2.8	4.9	3.9	4.6
Snags >12" dbh	3.0	3.5	6.5	4.6	6.1
Snags ≥18" dbh	0.7	0.7	1.5	0.7	1.5
CWD >3" (Tons/Acre)	5.4	6.8	10.8	2.8	7.2
Logs per Acre	2.9	3.7	6.9	2.3	5.9
Understory Index (lbs./ac.)	43	35	23	38	24

Casner_030405036

This PAC is 622 acres and all of it would be burned (100%), including the core area (Table 88). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 89.

Table 88. Acres of Proposed Fire Treatments in the Casner PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
129	129	129	100	100

Table 89. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Casner	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	30	31	28	31	28
% of SDI 18-23.9" dbh	13	15	21	16	22
% of SDI ≥24" dbh	6	7	10	7	10
TPA >18" dbh	15	18	27	18	28
PP Basal Area	124	129	131	123	128
GO Basal Area	25	26	30	26	30
All Basal Area	164	173	190	167	188
Snags 12-17.9" dbh	3.0	3.9	6.4	5.4	5.9
Snags >12" dbh	3.6	4.6	8.1	6.0	7.6
Snags ≥18" dbh	0.6	0.7	1.7	0.7	1.7
CWD >3" (Tons/Acre)	5.9	7.7	12.6	3.2	8.4
Logs per Acre	2.2	3.3	7.3	2.1	6.4
Understory Index (lbs./ac.)	27	23	17	26	17

Casner Cabin_030402017

This PAC is 610 acres and about 172 acres would be burned (about 28%). The core area has not been designated (Table 90). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 91.

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Table 90. Acres of Proposed Fire Treatments in the Casner Cabin PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
0	0	0	0	28

Table 91. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Casner Cabin	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	26	25	20	25	20
% of SDI 18-23.9" dbh	15	17	20	17	21
% of SDI ≥24" dbh	17	17	19	18	20
TPA >18" dbh	18	21	28	21	29
PP Basal Area	109	112	112	108	110
GO Basal Area	18	19	21	19	21
All Basal Area	149	158	178	154	177
Snags 12-17.9" dbh	2.8	3.3	4.8	4.3	4.4
Snags >12" dbh	4.2	4.7	7.3	5.8	6.9
Snags ≥18" dbh	1.3	1.5	2.5	1.5	2.5
CWD >3" (Tons/Acre)	7.8	9.3	13.6	4.0	8.9
Logs per Acre	8.0	9.0	12.9	5.4	10.1
Understory Index (lbs./ac.)	139	125	101	129	102

Cave Springs_030406001

This PAC is 788 acres and about 204 acres would be burned (about 26%). The core area has not been designated (Table 92). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 93.

Table 92. Acres of Proposed Fire Treatments in the Cave Springs PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
0	0	0	0	26

Table 93. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Cave Springs	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	38	38	29	38	28
% of SDI 18-23.9" dbh	15	18	27	18	28
% of SDI ≥24" dbh	6	7	12	7	13
TPA >18" dbh	15	18	32	18	32
PP Basal Area	111	116	120	111	117
GO Basal Area	15	16	20	16	21
All Basal Area	147	157	176	152	174

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	Existing Condition	No Action		Proposed Action	
Snags 12-17.9" dbh	3.2	4.3	6.9	5.9	6.4
Snags >12" dbh	3.7	4.9	8.8	6.5	8.3
Snags ≥18" dbh	0.5	0.7	1.9	0.6	1.9
CWD >3" (Tons/Acre)	6.3	8.0	12.8	3.3	8.7
Logs per Acre	3.9	5.0	9.7	3.1	8.3
Understory Index (lbs./ac.)	85	75	59	80	60

Clark _030405042

This PAC is not within the 4FRI treatment area. Hauling would occur outside the PAC, but within the core buffer. No timing restrictions would be applied because of the scale of operations in this area. However, topography would reduce noise affects. The road runs along a flat, then drops off into a drainage. Past MSO locations are within other draws.

Coulter Ridge_030405015

This PAC is 671 acres and all of it would be burned (100%), including the core area (Table 94). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 95.

Table 94. Acres of Proposed Fire Treatments in the Coulter Ridge PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
116	116	116	100	100

About 0.7 mile of ephemeral channel would be restored inside the PAC outside the nesting season. Short-term increases in sediment transport and movement would be expected due to disturbance during the restoration process (MacDonald 2013). As restored areas stabilize over time, vegetative cover would improve as erosion slows and soil moisture increases. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. Protected herbaceous growth would benefit MSO prey species by enhancing food and cover in the long term.

Table 95. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Coulter Ridge	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	33	33	29	34	29
% of SDI 18-23.9" dbh	13	16	23	16	23
% of SDI ≥24" dbh	7	7	10	7	10
TPA >18" dbh	14	18	28	18	29
PP Basal Area	124	128	132	123	129
GO Basal Area	22	23	27	24	27

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	Existing Condition	No Action		Proposed Action	
All Basal Area	161	170	187	164	185
Snags 12-17.9" dbh	3.3	4.1	6.5	5.7	6.0
Snags >12" dbh	3.9	4.8	8.3	6.4	7.8
Snags ≥18" dbh	0.6	0.7	1.7	0.7	1.7
CWD >3" (Tons/Acre)	5.8	7.6	12.5	3.1	8.4
Logs per Acre	2.0	3.1	7.3	2.0	6.5
Understory Index (lbs./ac.)	29	25	18	27	18

Coyote Park_030405025

This PAC is 643 acres and all of it would be burned (100%), including the core area (Table 96). Estimated effects to various MSO habitat metrics from prescribed burning are similar to those described in the overview and are displayed in Table 97.

Table 96. Acres of Proposed Fire Treatments in the Coyote Park PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
119	119	119	100	100

Table 97. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Coyote Park	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	28	28	26	28	26
% of SDI 18-23.9" dbh	12	15	20	15	20
% of SDI ≥24" dbh	8	8	10	8	11
TPA > 18" dbh	15	19	27	19	27
PP Basal Area	127	130	130	124	127
GO Basal Area	28	30	34	30	35
All Basal Area	169	178	193	172	192
Snags 12-17.9" dbh	3.1	3.9	6.4	5.3	6.0
Snags >12" dbh	3.8	4.7	8.2	6.1	7.8
Snags ≥18" dbh	0.7	0.8	1.8	0.8	1.8
CWD >3" (Tons/Acre)	5.9	7.8	13.0	3.2	8.7
Logs per Acre	1.9	3.0	7.2	2.0	6.4
Understory Index (lbs./ac.)	25	21	16	23	16

Crater Spring Tank_030402037

This PAC is 838 acres and about 63 acres would be burned (about 8%). Prescribed fire would not include the core area (Table 98). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 99.

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Table 98. Acres of Proposed Fire Treatments in the Crater Spring Tank PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
115	115	0	0	8

Table 99. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Crater Spring Tank	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	41	41	33	41	33
% of SDI 18-23.9" dbh	12	15	26	15	27
% of SDI ≥24" dbh	4	4	7	5	7
TPA >18" dbh	14	18	33	18	33
PP Basal Area	144	148	151	142	148
GO Basal Area	22	23	26	23	26
All Basal Area	177	185	199	179	198
Snags 12-17.9" dbh	4.5	5.6	8.3	7.8	7.6
Snags >12" dbh	5.0	6.2	10.0	8.4	9.2
Snags ≥18" dbh	0.5	0.6	1.7	0.6	1.7
CWD >3" (Tons/Acre)	6.4	8.6	14.1	3.5	9.6
Logs per Acre	1.7	3.0	7.9	2.0	7.3
Understory Index (lbs./ac.)	34	28	20	31	21

Dairy Spring_030405007

This PAC is 698 acres and about 204 acres would be burned (about 29%). Prescribed fire would not include the core area (Table 100). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 101. About 0.08 mile of haul route would occur within the ¼ mile core buffer along the edge of the PAC. The road is on the lower slopes of a tall, steep ridge. Known owl locations and the designated core area are at the top of the ridge. Drivers would not exceed 25 mph and hauling would only occur during daylight hours to minimize impacts to owls.

Table 100. Acres of Proposed Fire Treatments in the Dairy Spring PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
134	134	0	0	29

Table 101. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Dairy Spring	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	34	33	25	33	25
% of SDI 18-23.9" dbh	15	18	25	18	25
% of SDI ≥24" dbh	9	9	14	10	14

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	Existing Condition	No Action		Proposed Action	
TPA >18" dbh	16	20	31	20	31
PP Basal Area	111	115	116	110	113
GO Basal Area	18	19	23	19	24
All Basal Area	152	162	180	157	178
Snags 12-17.9" dbh	3.2	4.0	6.3	5.4	5.9
Snags >12" dbh	3.9	4.9	8.5	6.2	8.1
Snags ≥18" dbh	0.7	0.8	2.2	0.8	2.2
CWD >3" (Tons/Acre)	6.3	8.0	13.0	3.3	8.8
Logs per Acre	3.7	4.9	9.7	3.0	8.3
Understory Index (lbs./ac.)	34	28	20	31	21

Fain Mountain_030404010

This PAC is 673 acres and about 384 acres would be burned (about 57%). Prescribed fire would occur, including about 63% of the core area (Table 102). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 103.

Table 102. Acres of Proposed Fire Treatments in the Fain Mountain PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
134	84	84	63	57

Table 103. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Fain Mountain	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	36	35	27	35	27
% of SDI 18-23.9" dbh	14	17	25	18	26
% of SDI ≥24" dbh	8	8	12	8	12
TPA >18" dbh	16	20	32	20	32
PP Basal Area	125	129	131	124	128
GO Basal Area	20	21	24	21	24
All Basal Area	165	173	190	168	188
Snags 12-17.9" dbh	3.9	4.7	7.0	6.3	6.5
Snags >12" dbh	4.6	5.6	9.1	7.1	8.6
Snags ≥18" dbh	0.7	0.8	2.1	0.8	2.1
CWD >3" (Tons/Acre)	6.3	8.3	13.6	3.4	9.2
Logs per Acre	2.9	4.2	9.3	2.7	8.1
Understory Index (lbs./ac.)	27	23	17	25	17

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Fisher Point_030405001

This PAC is 831 acres and about 123 acres would be burned (about 15%). Prescribed fire would occur, including about 5% of the core area (Table 104). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 105.

Table 104. Acres of Proposed Fire Treatments in the Fisher Point PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
110	110	6	5	15

Table 105. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Fisher Point	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	15	14	11	14	11
% of SDI 18-23.9" dbh	14	12	12	12	12
% of SDI ≥24" dbh	30	31	30	32	30
TPA >18" dbh	17	18	21	18	21
PP Basal Area	69	72	70	69	69
GO Basal Area	11	12	14	12	14
All Basal Area	112	124	154	122	153
Snags 12-17.9" dbh	1.3	1.0	1.8	1.3	1.7
Snags >12" dbh	3.6	3.4	4.7	3.8	4.5
Snags ≥18" dbh	2.4	2.5	3.0	2.5	2.9
CWD >3" (Tons/Acre)	10.9	11.7	14.1	5.4	8.9
Logs per Acre	18.1	18.5	20.6	10.8	14.4
Understory Index (lbs./ac.)	211	180	127	185	128

Frog Tank_030405050

This PAC is 637 acres and all of it would be burned (100%), including the core area (Table 106). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 107.

Table 106. Acres of Proposed Fire Treatments in the Frog Tank PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
101	101	101	100	100

Grassland improvement (burning of 10 acres) is proposed in the PAC outside the nesting season. Subsequent herbaceous growth would benefit MSO prey species by enhancing food and cover in the short term.

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Table 107. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Frog Tank	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	30	30	27	30	27
% of SDI 18-23.9" dbh	16	18	23	18	23
% of SDI ≥24" dbh	8	8	12	8	12
TPA >18" dbh	16	19	28	20	28
PP Basal Area	124	128	132	123	129
GO Basal Area	24	26	29	26	29
All Basal Area	161	170	186	165	185
Snags 12-17.9" dbh	2.7	3.6	5.9	5.0	5.4
Snags >12" dbh	3.3	4.3	7.6	5.7	7.2
Snags ≥18" dbh	0.6	0.7	1.8	0.7	1.8
CWD >3" (Tons/Acre)	5.5	7.2	11.6	2.9	8.0
Logs per Acre	2.0	3.0	6.9	1.9	6.1
Understory Index (lbs./ac.)	29	24	18	27	19

Fry_030402014

This PAC is 649 acres and about 132 acres would be burned (about 20%). Prescribed fire would not include the core area (Table 108). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 109.

Table 108. Acres of Proposed Fire Treatments in the Fry PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
102	102	0	0	20

Table 109. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Fry	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	31	31	28	31	28
% of SDI 18-23.9" dbh	12	14	21	15	21
% of SDI ≥24" dbh	7	7	9	7	10
TPA >18" dbh	14	17	27	17	27
PP Basal Area	125	130	132	124	128
GO Basal Area	26	27	31	28	32
All Basal Area	163	173	189	167	187
Snags 12-17.9" dbh	3.3	4.1	6.6	5.6	6.1
Snags >12" dbh	3.9	4.7	8.2	6.2	7.7
Snags ≥18" dbh	0.6	0.7	1.6	0.7	1.6
CWD >3" (Tons/Acre)	5.7	7.6	12.5	3.1	8.4
Logs per Acre	1.6	2.7	6.8	1.8	6.1

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	Existing Condition	No Action		Proposed Action	
Understory Index (lbs./ac.)	78	70	58	75	59

Gash Mountain_030405021

This PAC is 634 acres and about 627 acres would be burned (about 99%). Prescribed fire would include 100% of the core area (Table 110). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 111.

Table 110. Acres of Proposed Fire Treatments in the Gash Mountain PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
102	102	102	100	99

Table 111. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Gash Mountain	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	33	34	30	34	30
% of SDI 18-23.9" dbh	14	17	24	17	24
% of SDI ≥24" dbh	6	6	10	6	10
TPA >18" dbh	15	18	29	18	30
PP Basal Area	131	136	140	130	137
GO Basal Area	24	25	28	25	29
All Basal Area	167	175	190	169	189
Snags 12-17.9" dbh	3.1	4.1	6.8	5.9	6.2
Snags >12" dbh	3.6	4.8	8.4	6.5	7.9
Snags ≥18" dbh	0.5	0.6	1.7	0.6	1.6
CWD >3" (Tons/Acre)	5.9	7.7	12.6	3.2	8.4
Logs per Acre	2.0	3.1	7.1	2.0	6.4
Understory Index (lbs./ac.)	26	22	17	25	17

Girdner_030405027

This PAC is 727 acres and all of it would be burned (100%), including the core area (Table 112). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 113.

Table 112. Acres of Proposed Fire Treatments in the Girdner PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
129	129	129	100	100

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Table 113. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Girdner	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	32	33	29	33	28
% of SDI 18-23.9" dbh	12	14	21	15	22
% of SDI ≥24" dbh	9	9	13	9	13
TPA >18" dbh	14	16	27	16	27
PP Basal Area	114	118	122	113	119
GO Basal Area	20	21	25	21	26
All Basal Area	152	161	180	156	178
Snags 12-17.9" dbh	2.5	3.5	6.1	5.0	5.6
Snags >12" dbh	3.1	4.2	7.8	5.7	7.3
Snags ≥18" dbh	0.6	0.7	1.7	0.7	1.7
CWD >3" (Tons/Acre)	6.1	7.7	12.3	3.2	8.3
Logs per Acre	3.8	4.7	8.6	2.9	7.3
Understory Index (lbs./ac.)	34	29	20	31	21

Harding Point_030402013

This PAC is 653 acres and about 134 acres would be burned (about 21%). The 134 acres proposed for treatment are the only ponderosa pine stands in the PAC. The core area has not been designated for this PAC (Table 114). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 115.

Table 114. Acres of Proposed Fire Treatments in the Harding Point PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
0	0	0	0	21

Table 115. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Harding Point	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	26	24	22	25	22
% of SDI 18-23.9" dbh	27	29	29	30	29
% of SDI ≥24" dbh	7	9	16	10	16
TPA >18" dbh	31	35	40	35	40
PP Basal Area	149	151	152	146	150
GO Basal Area	22	22	23	22	23
All Basal Area	184	189	202	185	201
Snags 12-17.9" dbh	3.0	4.8	6.2	5.9	5.7
Snags >12" dbh	3.7	6.1	9.1	7.2	8.6
Snags ≥18" dbh	0.8	1.4	3.0	1.3	2.9
CWD >3" (Tons/Acre)	7.1	8.8	14.1	3.8	9.4
Logs per Acre	6.0	7.1	12.4	4.3	9.9
Understory Index (lbs./ac.)	97	92	83	95	84

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Howard Mountain_030405013

This PAC is 649 acres and all of it would be burned (100%), including the core area (Table 116). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 117.

Table 116. Acres of Proposed Fire Treatments in the Howard Mountain PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
107	107	107	100	100

Table 117. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Howard	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	34	33	27	33	27
% of SDI 18-23.9" dbh	14	17	24	17	24
% of SDI ≥24" dbh	8	8	12	8	12
TPA >18" dbh	16	20	31	20	31
PP Basal Area	124	127	129	122	126
GO Basal Area	21	22	25	22	26
All Basal Area	165	174	190	169	188
Snags 12-17.9" dbh	3.5	4.4	6.8	6.0	6.3
Snags >12" dbh	4.3	5.2	8.9	6.8	8.4
Snags ≥18" dbh	0.7	0.8	2.1	0.8	2.1
CWD >3" (Tons/Acre)	6.3	8.3	13.5	3.4	9.1
Logs per Acre	3.0	4.2	9.1	2.7	7.9
Understory Index (lbs./ac.)	27	23	17	25	17

Grassland improvement (burning of 1 acre) is proposed in the PAC outside the nesting season. Subsequent herbaceous growth would benefit MSO prey species by enhancing food and cover in the short term.

Iowa Camp_030405004

This PAC is 672 acres and all of it would be burned (100%), including the core area (Table 118). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 119.

Table 118. Acres of Proposed Fire Treatments in the Iowa Camp PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
147	147	147	100	100

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Table 119. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Iowa Camp	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	27	29	28	29	28
% of SDI 18-23.9" dbh	11	13	19	13	19
% of SDI ≥24" dbh	7	7	9	7	9
TPA >18" dbh	13	16	24	16	24
PP Basal Area	120	124	126	118	122
GO Basal Area	29	31	35	31	37
All Basal Area	163	172	188	166	187
Snags 12-17.9" dbh	2.5	3.3	6.2	4.7	5.8
Snags >12" dbh	3.1	4.0	7.7	5.3	7.3
Snags ≥18" dbh	0.6	0.7	1.5	0.6	1.5
CWD >3" (Tons/Acre)	5.7	7.5	12.3	3.1	8.2
Logs per Acre	1.8	2.7	6.3	1.8	5.6
Understory Index (lbs./ac.)	28	23	17	26	18

James Canyon_030405009

This PAC is 727 acres and about 544 acres would be burned (about 75%). Prescribed fire would include about 55% of the core area (Table 120). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 121.

Table 120. Acres of Proposed Fire Treatments in the James PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
103	103	57	55	75

Table 121. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
James Canyon	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	32	32	28	32	28
% of SDI 18-23.9" dbh	13	15	22	16	22
% of SDI ≥24" dbh	7	7	10	8	11
TPA >18" dbh	15	19	29	19	29
PP Basal Area	127	131	132	125	129
GO Basal Area	25	26	29	27	30
All Basal Area	169	178	193	172	192
Snags 12-17.9" dbh	3.3	4.2	6.7	5.8	6.3
Snags >12" dbh	4.0	5.0	8.6	6.5	8.1
Snags ≥18" dbh	0.7	0.8	1.9	0.8	1.9
CWD >3" (Tons/Acre)	6.1	8.1	13.3	3.3	8.9
Logs per Acre	2.3	4.0	7.9	2.2	7.0

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	Existing Condition	No Action		Proposed Action	
Understory Index (lbs./ac.)	91	83	71	88	72

Jeep_030402029

This PAC is 680 acres and about 242 acres would be burned (about 36%). Prescribed fire would include about 72% of the core area (Table 122). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 123.

Table 122. Acres of Proposed Fire Treatments in the Jeep PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
127	127	91	72	36

Table 123. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Jeep	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	35	36	31	36	30
% of SDI 18-23.9" dbh	12	14	23	15	24
% of SDI ≥24" dbh	6	6	10	6	10
TPA >18" dbh	12	15	27	15	27
PP Basal Area	110	115	120	110	117
GO Basal Area	19	20	25	20	25
All Basal Area	146	156	176	151	174
Snags 12-17.9" dbh	2.8	3.6	6.4	5.2	6.0
Snags >12" dbh	3.3	4.2	8.0	5.8	7.5
Snags ≥18" dbh	0.5	0.5	1.5	0.5	1.5
CWD >3" (Tons/Acre)	5.8	7.4	11.9	3.0	8.0
Logs per Acre	2.8	3.7	7.6	2.3	6.6
Understory Index (lbs./ac.)	38	32	22	35	23

Aspen improvement is proposed on 29 acres in the PAC. Mechanical thinning and physical soil disturbance are not proposed for aspen clones within PACs. Short-term effects would not be expected because aspen treatments within PACs would be done outside the nesting season. Long-term benefits would consist of improving habitat for a range of MSO prey species, including small mammals, birds, bats, and invertebrates. Maintaining the clones sustains seral structure less prone to high-severity crown fire. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. If non-wire fencing options are not available, aspen treatments would not occur in PACs.

Kelly_030405039

This PAC is 659 acres and all of it would be burned (100%), including the core area (Table 124). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 125.

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Table 124. Acres of Proposed Fire Treatments in the Kelley PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
108	108	108	100	100

Table 125. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Kelly	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	29	29	27	29	27
% of SDI 18-23.9" dbh	13	15	20	15	21
% of SDI ≥24" dbh	9	9	12	9	12
TPA >18" dbh	15	18	26	18	27
PP Basal Area	123	128	130	122	127
GO Basal Area	26	27	30	27	31
All Basal Area	164	173	190	168	188
Snags 12-17.9" dbh	2.7	3.5	6.0	4.9	5.5
Snags >12" dbh	3.5	4.3	7.7	5.8	7.3
Snags ≥18" dbh	0.8	0.8	1.8	0.8	1.8
CWD >3" (Tons/Acre)	6.2	8.0	12.7	3.3	8.4
Logs per Acre	3.1	4.0	7.8	2.5	6.7
Understory Index (lbs./ac.)	93	84	71	89	72

Kendrick_030702010

This PAC is 827 acres and about 173 acres would be burned (about 21%). Prescribed fire would not include the core area (Table 126). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 127.

Table 126. Acres of Proposed Fire Treatments in the Kendrick PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
104	104	0	0	21

Aspen improvement is proposed on 2 acres inside the PAC. Mechanical thinning and physical soil disturbance are not proposed for aspen clones within PACs. Short-term effects would not be expected because aspen treatments within PACs would be done outside the nesting season. Long-term benefits would consist of improving habitat for a range of MSO prey species, including small mammals, birds, bats, and invertebrates. Maintaining the clones sustains seral structure less prone to high-severity crown fire. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. If non-wire fencing options are not available, aspen treatments would not occur in PACs.

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Table 127. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Kendrick	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	32	35	54	36	53
% of SDI 18-23.9" dbh	1	9	24	10	25
% of SDI ≥24" dbh	1	1	3	1	3
TPA >18" dbh	1	2	7	2	7
PP Basal Area	20	27	50	25	45
GO Basal Area	1	1	1	1	1
All Basal Area	22	29	53	28	49
Snags 12-17.9" dbh	0.6	0.9	1.6	1.2	1.5
Snags >12" dbh	0.8	1.1	2.5	1.4	2.4
Snags ≥18" dbh	0.2	0.2	0.9	0.2	0.9
CWD >3" (Tons/Acre)	6.5	6.4	6.4	2.3	3.1
Logs per Acre	0.1	0.2	1.2	0.2	1.2
Understory Index (lbs./ac.)	369	323	211	335	227

Lockwood_030405041

This PAC is 687 acres and about 268 acres would be burned (about 39%). Prescribed fire would not include the core area (Table 128). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 129.

Table 128. Acres of Proposed Fire Treatments in the Lockwood PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
106	106	0	0	39

Table 129. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Lockwood	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	29	29	26	29	25
% of SDI 18-23.9" dbh	13	16	21	16	22
% of SDI ≥24" dbh	8	9	11	9	12
TPA >18" dbh	17	21	29	21	30
PP Basal Area	130	134	133	128	130
GO Basal Area	27	28	31	28	32
All Basal Area	174	183	197	177	196
Snags 12-17.9" dbh	3.5	4.3	6.5	5.7	6.1
Snags >12" dbh	4.3	5.2	8.6	6.6	8.2
Snags ≥18" dbh	0.8	0.9	2.1	0.9	2.1
CWD >3" (Tons/Acre)	6.2	8.2	13.6	3.3	9.1
Logs per Acre	2.3	3.5	8.2	2.3	7.2

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	Existing Condition	No Action		Proposed Action	
Understory Index (lbs./ac.)	22	19	15	21	15

MB Smith_030404032

This PAC is 621 acres and about 571 acres would be burned (about 92%). Prescribed fire would include about 51% of the core area (Table 130). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 131.

Table 130. Acres of Proposed Fire Treatments in the MB Smith PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
100	100	51	51	92

Table 131. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
MB Smith	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	30	31	29	31	29
% of SDI 18-23.9" dbh	12	14	20	14	21
% of SDI ≥24" dbh	7	8	10	8	10
TPA >18" dbh	13	16	26	16	26
PP Basal Area	118	123	126	117	123
GO Basal Area	23	25	28	25	29
All Basal Area	155	165	184	159	182
Snags 12-17.9" dbh	2.8	3.5	6.0	5.0	5.6
Snags >12" dbh	3.5	4.2	7.6	5.7	7.1
Snags ≥18" dbh	0.7	0.7	1.6	0.7	1.6
CWD >3" (Tons/Acre)	5.9	7.6	12.1	3.1	8.1
Logs per Acre	2.8	3.7	7.3	2.3	6.3
Understory Index (lbs./ac.)	32	27	19	30	19

Meadow Tank_030404023

This PAC is 701 acres and about 132 acres would be burned (about 19%). Prescribed fire would include about 33% of the core area (Table 132). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 133.

Table 132. Acres of Proposed Fire Treatments in the Meadow Tank PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
110	36	36	33	19

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Table 133. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Meadow Tank	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	25	22	18	22	18
% of SDI 18-23.9" dbh	36	38	33	38	34
% of SDI ≥24" dbh	13	15	23	16	24
TPA >18" dbh	31	34	36	34	37
PP Basal Area	120	124	133	122	131
GO Basal Area	12	13	15	13	15
All Basal Area	138	145	161	142	160
Snags 12-17.9" dbh	1.4	2.5	3.1	3.4	2.9
Snags >12" dbh	2.1	3.7	5.9	4.5	5.6
Snags ≥18" dbh	0.7	1.2	2.7	1.2	2.7
CWD >3" (Tons/Acre)	4.2	5.1	8.5	2.1	5.9
Logs per Acre	2.9	3.8	7.9	2.3	6.7
Understory Index (lbs./ac.)	44	39	29	40	29

Grassland improvement (burning of 28 acres) is proposed in the PAC outside the nesting season. Subsequent herbaceous growth would benefit MSO prey species by enhancing food and cover in the short term.

About 0.02 mile of ephemeral channel would be restored inside the PAC outside the nesting season. Short-term increases in sediment transport and movement would be expected due to disturbance during the restoration process (MacDonald 2013). As restored areas stabilize over time, vegetative cover would improve as erosion slows and soil moisture increases. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. Protected herbaceous growth would benefit MSO prey species by enhancing food and cover in the long term.

Milos Butte_030405005

This PAC is 661 acres and about 658 acres would be burned (nearly 100%). Prescribed fire would include 100% of the core area (Table 134). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 135.

Table 134. Acres of Proposed Fire Treatments in the Milos Butte PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
109	109	109	100	100

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Table 135. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Milos Butte	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	33	32	27	32	27
% of SDI 18-23.9" dbh	13	16	23	16	23
% of SDI ≥24" dbh	7	8	11	8	11
TPA >18" dbh	17	20	31	21	31
PP Basal Area	135	138	139	132	136
GO Basal Area	25	26	29	26	30
All Basal Area	176	185	199	179	197
Snags 12-17.9" dbh	3.8	4.7	7.0	6.3	6.5
Snags >12" dbh	4.6	5.6	9.1	7.2	8.5
Snags ≥18" dbh	0.7	0.8	2.0	0.8	2.0
CWD >3" (Tons/Acre)	6.3	8.4	13.9	3.4	9.3
Logs per Acre	2.2	3.5	8.4	2.3	7.4
Understory Index (lbs./ac.)	22	19	14	21	15

Mint Spring_030405023

This PAC is 617 acres and about 597 acres would be burned (about 97%). Prescribed fire would include 100% of the core area (Table 136). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 137.

Table 136. Acres of Proposed Fire Treatments in the Mint Spring PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
136	136	136	100	97

Table 137. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Mint Spring	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	34	34	29	34	29
% of SDI 18-23.9" dbh	13	16	24	17	24
% of SDI ≥24" dbh	6	7	10	7	10
TPA >18" dbh	16	19	31	19	31
PP Basal Area	131	135	138	129	134
GO Basal Area	23	24	26	24	27
All Basal Area	169	177	193	171	191
Snags 12-17.9" dbh	3.6	4.6	7.0	6.3	6.5
Snags >12" dbh	4.3	5.3	8.9	7.0	8.3
Snags ≥18" dbh	0.6	0.7	1.9	0.7	1.9
CWD >3" (Tons/Acre)	6.2	8.1	13.3	3.3	9.0
Logs per Acre	2.4	3.5	8.2	2.3	7.2

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	Existing Condition	No Action		Proposed Action	
Understory Index (lbs./ac.)	25	21	16	24	16

Aspen improvement is proposed for 12 acres inside the PAC. Mechanical thinning and physical soil disturbance are not proposed for aspen clones within PACs. Short-term effects would not be expected because aspen treatments within PACs would be done outside the nesting season. Long-term benefits would consist of improving habitat for a range of MSO prey species, including small mammals, birds, bats, and invertebrates. Maintaining the clones sustains seral structure less prone to high-severity crown fire. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. If non-wire fencing options are not available, aspen treatments would not occur in PACs.

Moore Well/Rock Dike_030405011

This PAC is 680 acres and about 564 acres would be burned (about 83%). Prescribed fire would include about 68% of the core area (Table 138). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 139.

Table 138. Acres of Proposed Fire Treatments in the Moore Well/Rock Dike PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
131	131	89	68	83

Table 139. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Moore Well/Rock Dike	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	31	31	27	31	26
% of SDI 18-23.9" dbh	13	15	22	16	22
% of SDI ≥24" dbh	10	11	14	11	15
TPA >18" dbh	17	20	29	20	30
PP Basal Area	125	129	130	123	126
GO Basal Area	21	22	25	22	26
All Basal Area	167	175	190	169	188
Snags 12-17.9" dbh	3.0	4.1	6.3	5.6	5.9
Snags >12" dbh	3.8	5.0	8.4	6.5	8.0
Snags ≥18" dbh	0.8	0.9	2.1	0.9	2.1
CWD >3" (Tons/Acre)	6.5	8.4	13.5	3.5	9.2
Logs per Acre	4.2	5.3	9.9	3.3	8.4
Understory Index (lbs./ac.)	26	22	17	25	17

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Mustang_030405035

This PAC is 659 acres and all of it would be burned (100%), including the core area (Table 140). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 141.

Table 140. Acres of Proposed Fire Treatments in the Mustang PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
102	102	102	100	100

Table 141. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Mustang	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	34	35	27	35	27
% of SDI 18-23.9" dbh	13	16	24	16	24
% of SDI ≥24" dbh	7	8	13	8	13
TPA >18" dbh	12	15	27	15	27
PP Basal Area	96	101	105	96	102
GO Basal Area	17	18	23	18	24
All Basal Area	136	146	167	142	165
Snags 12-17.9" dbh	2.3	3.2	6.0	4.5	5.6
Snags >12" dbh	2.8	3.7	7.7	5.1	7.3
Snags ≥18" dbh	0.5	0.6	1.7	0.6	1.7
CWD >3" (Tons/Acre)	5.9	7.3	11.7	3.0	7.9
Logs per Acre	3.8	4.7	8.7	2.8	7.3
Understory Index (lbs./ac.)	46	38	26	41	27

Nestor_030405049

This PAC is 626 acres and about 464 acres would be burned (about 74%). Prescribed fire would include 100% of the core area (Table 142). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 143.

Grassland improvement (burning of 8 acres) is proposed in the PAC outside the nesting season. Subsequent herbaceous growth would benefit MSO prey species by enhancing food and cover in the short term.

Aspen improvement is proposed on19 acres within the PAC. Mechanical thinning and physical soil disturbance are not proposed for aspen clones within PACs. Short-term effects would not be expected because aspen treatments within PACs would be done outside the nesting season. Long-term benefits would consist of improving habitat for a range of MSO prey species, including small mammals, birds, bats, and invertebrates. Maintaining the clones sustains seral structure less prone to high-severity crown fire. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. If non-wire fencing options are not available, aspen treatments would not occur in PACs.

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Table 142. Acres of Proposed Fire Treatments in the Nestor PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
100	100	100	100	74

Table 143. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Nestor	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	34	33	27	33	27
% of SDI 18-23.9" dbh	13	16	24	17	24
% of SDI ≥24" dbh	7	8	11	8	11
TPA >18" dbh	16	20	31	20	31
PP Basal Area	131	135	136	129	133
GO Basal Area	23	24	27	25	28
All Basal Area	170	179	194	173	192
Snags 12-17.9" dbh	3.8	4.7	7.0	6.3	6.5
Snags >12" dbh	4.5	5.5	9.0	7.1	8.5
Snags ≥18" dbh	0.7	0.8	2.0	0.8	2.0
CWD >3" (Tons/Acre)	6.2	8.2	13.6	3.3	9.2
Logs per Acre	2.2	3.5	8.4	2.3	7.4
Understory Index (lbs./ac.)	24	21	16	23	16

O'Leary Peak_030402010

This PAC is 742 acres and about 461 acres would be burned (about 62%). Prescribed fire would not include the core area (Table 144). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 145.

Table 144. Acres of Proposed Fire Treatments in the O'Leary PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
106	106	0	0	62

Table 145. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
O'Leary Peak	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	36	36	27	36	27
% of SDI 18-23.9" dbh	15	17	26	18	26
% of SDI ≥24" dbh	8	9	15	9	15
TPA >18" dbh	12	15	27	15	27
PP Basal Area	80	86	92	82	89
GO Basal Area	9	11	17	11	17
All Basal Area	117	129	153	125	151

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	Existing Condition	No Action		Proposed Action	
Snags 12-17.9" dbh	2.2	2.9	5.5	4.1	5.2
Snags >12" dbh	2.7	3.5	7.3	4.7	7.0
Snags ≥18" dbh	0.5	0.6	1.8	0.6	1.8
CWD >3" (Tons/Acre)	5.8	7.0	10.9	2.8	7.5
Logs per Acre	4.6	5.5	9.5	3.3	7.9
Understory Index (lbs./ac.)	78	62	37	67	39

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Orion Spring_030402007

This PAC is 604 acres and about 250 acres would be burned (about 41%). Prescribed fire would not include the core area (Table 146). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 147.

Table 146. Acres of Proposed Fire Treatments in the Orion PAC and PAC Core Area

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Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
125	125	0	0	41

Table 147. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

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	Existing Condition	No Action		Proposed Action	
Orion Spring	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	30	31	30	31	29
% of SDI 18-23.9" dbh	13	15	21	15	21
% of SDI ≥24" dbh	6	6	10	7	10
TPA >18" dbh	12	15	25	15	25
PP Basal Area	108	114	121	108	117
GO Basal Area	17	19	24	19	25
All Basal Area	138	149	172	144	170
Snags 12-17.9" dbh	3.0	3.4	5.3	4.7	5.0
Snags >12" dbh	3.5	3.9	6.8	5.3	6.4
Snags ≥18" dbh	0.5	0.5	1.4	0.5	1.4
CWD >3" (Tons/Acre)	4.9	6.3	10.3	2.5	6.9
Logs per Acre	1.4	2.3	5.7	1.5	5.2
Understory Index (lbs./ac.)	44	36	23	40	24

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Pierce Tank_030404001

This PAC is 617 acres and about 406 acres would be burned (about 66%). Prescribed fire would include about 18% of the core area (Table 148). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 149.

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Table 148. Acres of Proposed Fire Treatments in the Pierce Tank PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
123	123	22	18	66

Table 149. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Pierce Tank	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	36	36	31	36	30
% of SDI 18-23.9" dbh	13	16	24	16	25
% of SDI ≥24" dbh	5	5	9	6	9
TPA >18" dbh	15	18	30	18	31
PP Basal Area	134	139	143	133	140
GO Basal Area	24	25	27	25	28
All Basal Area	170	178	195	173	193
Snags 12-17.9" dbh	3.6	4.7	7.3	6.6	6.6
Snags >12" dbh	4.1	5.3	9.0	7.2	8.3
Snags ≥18" dbh	0.5	0.6	1.7	0.6	1.7
CWD >3" (Tons/Acre)	6.1	8.0	13.2	3.3	8.9
Logs per Acre	2.1	3.3	7.7	2.1	6.9
Understory Index (lbs./ac.)	24	21	15	23	16

Aspen improvement is proposed on 32 acres within the PAC. Mechanical thinning and physical soil disturbance are not proposed for aspen clones within PACs. Short-term effects would not be expected because aspen treatments within PACs would be done outside the nesting season. Long-term benefits would consist of improving habitat for a range of MSO prey species, including small mammals, birds, bats, and invertebrates. Maintaining the clones sustains seral structure less prone to high-severity crown fire. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. If non-wire fencing options are not available, aspen treatments would not occur in PACs.

Powerline Tank_030404005

This PAC is 633 acres and about 366 acres would be burned (about 58%). Prescribed fire would include about 48% of the core area (Table 150). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 151.

Grassland improvement (burning of 14 acres) is proposed in the PAC outside the nesting season. Subsequent herbaceous growth would benefit MSO prey species by enhancing food and cover in the short term.

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Table 150. Acres of Proposed Fire Treatments in the Powerline Tank PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
108	108	52	48	58

Table 151. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Powerline Tank	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	25	28	31	28	31
% of SDI 18-23.9" dbh	11	12	16	12	17
% of SDI ≥24" dbh	6	6	8	6	8
TPA >18" dbh	10	12	20	12	20
PP Basal Area	104	110	117	104	113
GO Basal Area	23	25	31	26	32
All Basal Area	139	150	173	144	171
Snags 12-17.9" dbh	1.9	2.3	4.8	3.5	4.6
Snags >12" dbh	2.4	2.8	5.9	4.0	5.6
Snags ≥18" dbh	0.5	0.4	1.1	0.4	1.1
CWD >3" (Tons/Acre)	4.7	6.0	9.7	2.4	6.4
Logs per Acre	1.2	1.8	4.2	1.2	3.9
Understory Index (lbs./ac.)	43	35	23	39	24

Pumphouse Wash_030405012

This PAC is 606 acres and about 588 acres would be burned (about 97%). Prescribed fire would include 100% of the core area (Table 152). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 153.

Table 152. Acres of Proposed Fire Treatments in the Pumphouse Wash PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
100	100	100	100	97

Table 153. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Pumphouse Wash	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	33	33	29	33	29
% of SDI 18-23.9" dbh	14	16	23	17	23
% of SDI ≥24" dbh	8	8	11	8	12
TPA >18" dbh	17	20	31	20	31
PP Basal Area	136	140	142	134	139
GO Basal Area	23	25	27	25	28
All Basal Area	174	181	196	176	194

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	Existing Condition	No Action		Proposed Action	
Snags 12-17.9" dbh	3.3	4.6	7.0	6.3	6.4
Snags >12" dbh	4.0	5.4	8.9	7.0	8.3
Snags ≥18" dbh	0.6	0.8	1.9	0.8	1.9
CWD >3" (Tons/Acre)	6.4	8.4	13.6	3.5	9.2
Logs per Acre	3.3	4.4	8.9	2.8	7.7
Understory Index (lbs./ac.)	62	56	47	60	48

Racetrack Tank_030405017

This PAC is 674 acres and all of it would be burned (100%), including the core area (Table 154). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 155.

Table 154. Acres of Proposed Fire Treatments in the Racetrack Tank PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
111	111	111	100	100

Table 155. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Racetrack Tank	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	27	28	28	28	28
% of SDI 18-23.9" dbh	11	13	18	13	19
% of SDI ≥24" dbh	7	7	9	7	10
TPA >18" dbh	13	16	24	16	24
PP Basal Area	119	123	125	114	122
GO Basal Area	29	31	35	31	36
All Basal Area	162	171	188	165	186
Snags 12-17.9" dbh	2.4	3.2	5.9	4.5	5.6
Snags >12" dbh	3.0	3.8	7.4	5.2	7.1
Snags ≥18" dbh	0.6	0.7	1.5	0.6	1.5
CWD >3" (Tons/Acre)	5.6	7.4	12.1	3.0	8.0
Logs per Acre	1.9	2.8	6.2	1.8	5.5
Understory Index (lbs./ac.)	28	24	17	26	18

Grassland improvement (burning of 15 acres) is proposed in the PAC outside the nesting season. Subsequent herbaceous growth would benefit MSO prey species by enhancing food and cover in the short term.

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Rattlesnake_030401002

This PAC is 810 acres and about 671 acres would be burned (about 83%). Prescribed fire would include about 30% of the core area (Table 156). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 157.

Table 156. Acres of Proposed Fire Treatments in the Rattlesnake PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
151	45	45	30	83

Table 157. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Rattlesnake	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	36	35	26	35	26
% of SDI 18-23.9" dbh	15	18	26	18	26
% of SDI ≥24" dbh	8	9	14	9	15
TPA >18" dbh	15	19	31	19	31
PP Basal Area	106	110	112	105	109
GO Basal Area	15	16	20	17	21
All Basal Area	146	156	175	152	173
Snags 12-17.9" dbh	3.2	4.0	6.4	5.4	6.0
Snags >12" dbh	3.8	4.8	8.5	6.2	8.1
Snags ≥18" dbh	0.7	0.8	2.2	0.8	2.2
CWD >3" (Tons/Acre)	6.3	8.0	12.9	3.2	8.8
Logs per Acre	4.1	5.2	10.1	3.2	8.6
Understory Index (lbs./ac.)	38	31	22	34	23

Roundup_030405045

This PAC is 633 acres and about 554 acres would be burned (about 87%). Prescribed fire would include 100% of the core area (Table 158). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 159.

Table 158. Acres of Proposed Fire Treatments in the Roundup PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
119	119	119	100	87

Table 159. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Roundup	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	36	36	29	36	28
% of SDI 18-23.9" dbh	14	17	25	18	26

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	Existing Condition	No Action		Proposed Action	
% of SDI ≥24" dbh	7	8	12	8	12
TPA >18" dbh	14	18	30	18	30
PP Basal Area	115	120	124	115	121
GO Basal Area	18	19	23	19	23
All Basal Area	152	161	179	157	177
Snags 12-17.9" dbh	3.2	4.1	6.7	5.7	6.2
Snags >12" dbh	3.7	4.7	8.5	6.4	8.0
Snags ≥18" dbh	0.6	0.7	1.8	0.7	1.8
CWD >3" (Tons/Acre)	6.0	7.7	12.5	3.1	8.5
Logs per Acre	3.0	4.1	8.5	2.5	7.5
Understory Index (lbs./ac.)	34	29	21	31	21

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Spruce Tank_030404031

This PAC is 604 acres and about 478 acres would be burned (about 79%). Prescribed fire would include about 61% of the core area (Table 160). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 161.

Table 160. Acres of Proposed Fire Treatments in the Spruce Tank PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
106	106	65	61	79

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Table 161. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Spruce Tank	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	34	35	30	35	30
% of SDI 18-23.9" dbh	12	15	23	15	23
% of SDI ≥24" dbh	6	6	10	6	10
TPA >18" dbh	13	16	27	16	28
PP Basal Area	115	120	125	115	122
GO Basal Area	19	21	25	21	26
All Basal Area	150	160	180	154	178
Snags 12-17.9" dbh	3.1	3.9	6.4	5.5	5.9
Snags >12" dbh	3.6	4.4	7.9	6.0	7.5
Snags ≥18" dbh	0.5	0.6	1.6	0.5	1.5
CWD >3" (Tons/Acre)	5.7	7.3	11.9	3.0	8.0
Logs per Acre	2.2	3.2	7.1	2.0	6.3
Understory Index (lbs./ac.)	35	29	20	32	21

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Sterling_030402015

This PAC is 795 acres and about 262 acres would be burned (about 33%). None of the core area is within the 4FRI treatment area so none of the core would be burned (Table 162). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 163.

Table 162. Acres of Proposed Fire Treatments in the Sterling PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
0	0	0	0	33

Table 163. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Sterling	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	21	22	22	22	22
% of SDI 18-23.9" dbh	10	11	13	11	13
% of SDI ≥24" dbh	23	24	24	24	25
TPA >18" dbh	19	20	25	20	25
PP Basal Area	129	130	130	125	126
GO Basal Area	19	20	23	20	23
All Basal Area	165	171	187	165	185
Snags 12-17.9" dbh	1.6	3.3	4.7	4.6	4.3
Snags >12" dbh	2.8	4.6	6.9	5.9	6.5
Snags ≥18" dbh	1.2	1.3	2.2	1.4	2.2
CWD >3" (Tons/Acre)	7.8	9.4	13.8	4.4	9.5
Logs per Acre	10.4	11.1	14.4	6.6	11.1
Understory Index (lbs./ac.)	37	34	26	37	27

Stock Tank_030402030

This PAC is 682 acres and about 108 acres would be burned (about 16%). Prescribed fire would include about 20% of the core area (Table 164). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 165.

Table 164. Acres of Proposed Fire Treatments in the Stock Tank PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
109	109	22	20	16

Table 165. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Stock Tank	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	26	27	31	28	31

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	Existing Condition	No Action		Proposed Action	
% of SDI 18-23.9" dbh	17	19	23	20	23
% of SDI ≥24" dbh	8	9	13	9	13
TPA >18" dbh	12	13	19	13	19
PP Basal Area	73	81	95	77	91
GO Basal Area	9	11	15	11	16
All Basal Area	89	100	127	96	124
Snags 12-17.9" dbh	1.2	1.3	2.5	2.1	2.4
Snags >12" dbh	1.7	1.8	3.7	2.6	3.6
Snags ≥18" dbh	0.4	0.5	1.3	0.5	1.2
CWD >3" (Tons/Acre)	3.8	4.3	6.2	1.6	4.0
Logs per Acre	0.4	0.9	2.9	0.6	2.8
Understory Index (lbs./ac.)	107	88	54	94	57

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T Bird_030405043

This PAC is 603 acres and all of it is proposed for burning. Prescribed fire would include 100% of the core area (Table 166). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 167.

Table 166. Acres of Proposed Fire Treatments in the T Bird PAC and PAC Core Area

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Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
114	114	114	100	100

Table 167. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

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	Existing Condition	No Action		Proposed Action	
T-Bird	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	32	34	32	34	32
% of SDI 18-23.9" dbh	10	12	20	13	21
% of SDI ≥24" dbh	5	5	7	5	7
TPA >18" dbh	12	15	26	15	26
PP Basal Area	132	136	140	130	136
GO Basal Area	28	30	33	30	34
All Basal Area	172	181	196	175	195
Snags 12-17.9" dbh	3.0	4.0	7.0	5.8	6.4
Snags >12" dbh	3.5	4.5	8.4	6.3	7.8
Snags ≥18" dbh	0.5	0.6	1.4	0.5	1.4
CWD >3" (Tons/Acre)	6.0	7.9	13.0	3.3	8.6
Logs per Acre	1.6	2.6	6.3	1.7	5.7
Understory Index (lbs./ac.)	23	20	15	22	15

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Two Holes_030405028

This PAC is 622 acres and about 622 acres would be burned (100%). Prescribed fire would include 100% of the core area (Table 168). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 169.

Table 168. Acres of Proposed Fire Treatments in the Two Holes PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
117	117	117	100	100

Table 169. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Two Holes	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	33	32	27	32	27
% of SDI 18-23.9" dbh	13	16	23	16	23
% of SDI ≥24" dbh	7	8	11	8	11
TPA >18" dbh	16	19	30	20	30
PP Basal Area	127	131	133	126	130
GO Basal Area	24	25	28	25	29
All Basal Area	166	175	192	170	190
Snags 12-17.9" dbh	3.7	4.5	6.7	6.0	6.2
Snags >12" dbh	4.3	5.3	8.6	6.8	8.1
Snags ≥18" dbh	0.7	0.8	1.9	0.8	1.9
CWD >3" (Tons/Acre)	6.0	7.9	13.1	3.2	8.8
Logs per Acre	2.1	3.3	8.0	2.2	7.1
Understory Index (lbs./ac.)	26	22	16	24	17

Grassland improvement (burning of 14 acres) is proposed in the PAC outside the nesting season. Subsequent herbaceous growth would benefit MSO prey species by enhancing food and cover in the short term.

Upper West Fork_030402012

This PAC is 657 acres and about 276 acres would be burned (about 42%). Prescribed fire would include about 33% of the core area (Table 170). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 171.

Table 170. Acres of Proposed Fire Treatments in the Upper West Fork PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
119	119	39	33	42

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Table 171. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Upper West Fork	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	35	34	28	34	27
% of SDI 18-23.9" dbh	13	16	24	17	25
% of SDI ≥24" dbh	9	9	12	9	12
TPA >18" dbh	17	22	33	22	33
PP Basal Area	139	142	143	137	140
GO Basal Area	22	23	25	23	25
All Basal Area	177	185	199	180	198
Snags 12-17.9" dbh	4.2	5.2	7.3	7.0	6.7
Snags >12" dbh	5.0	6.1	9.5	7.9	8.9
Snags ≥18" dbh	0.8	0.9	2.2	0.9	2.2
CWD >3" (Tons/Acre)	6.7	8.8	14.4	3.7	9.8
Logs per Acre	3.2	4.6	9.7	2.9	8.5
Understory Index (lbs./ac.)	79	73	64	77	65

Volunteer_030402011

This PAC is 620 acres and about 430 acres would be burned (about 69%). Prescribed fire would include about 71% of the core area (Table 172). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 173.

Table 172. Acres of Proposed Fire Treatments in the Volunteer PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
114	114	81	71	69

Table 173. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Volunteer	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	32	31	26	31	26
% of SDI 18-23.9" dbh	17	20	25	20	25
% of SDI ≥24" dbh	9	9	13	10	14
TPA >18" dbh	19	23	32	23	32
PP Basal Area	129	132	135	127	132
GO Basal Area	21	22	24	22	25
All Basal Area	165	173	189	169	188
Snags 12-17.9" dbh	3.2	4.2	6.3	5.7	5.8
Snags >12" dbh	4.0	5.2	8.5	6.6	8.0
Snags ≥18" dbh	0.8	1.0	2.2	0.9	2.2
CWD >3" (Tons/Acre)	6.4	8.2	13.1	3.4	8.8
Logs per Acre	3.8	4.9	9.5	3.1	8.0

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	Existing Condition	No Action		Proposed Action	
Understory Index (lbs./ac.)	86	78	66	83	67

Grassland improvement (burning of 6 acres) is proposed in the PAC outside the nesting season. Subsequent herbaceous growth would benefit MSO prey species by enhancing food and cover in the short term.

Walnut 33_030405010

This PAC is 684 acres and about 113 acres would be burned (about 17%). Prescribed fire would include about 25% of the core area (Table 174). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 175.

Table 174. Acres of Proposed Fire Treatments in the Walnut 33 PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
99	99	25	25	17

Table 175. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Walnut 33	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	23	23	25	24	25
% of SDI 18-23.9" dbh	11	12	16	13	17
% of SDI ≥24" dbh	8	8	10	9	10
TPA >18" dbh	13	16	22	16	22
PP Basal Area	116	120	120	113	116
GO Basal Area	32	35	41	35	42
All Basal Area	159	169	185	163	184
Snags 12-17.9" dbh	2.2	2.8	5.6	4.0	5.3
Snags >12" dbh	2.9	3.5	7.1	4.6	6.8
Snags ≥18" dbh	0.7	0.7	1.4	0.7	1.4
CWD >3" (Tons/Acre)	5.3	7.1	11.7	2.9	7.8
Logs per Acre	1.3	2.3	5.5	1.5	5.0
Understory Index (lbs./ac.)	120	109	94	115	96

Weatherford2_03040239

This PAC is 666 acres and about 158 acres would be burned (about 24%). Prescribed fire would include about 8% of the core area (Table 176). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 177.

Aspen improvement is proposed on 10 acres in the PAC. Mechanical thinning and physical soil disturbance are not proposed for aspen clones within PACs. Short-term effects would not be expected because aspen treatments within PACs would be done outside the nesting season. Long-term benefits would consist of improving habitat for a range of MSO prey species, including small mammals, birds,

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bats, and invertebrates. Maintaining the clones sustains seral structure less prone to high-severity crown fire. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. If non-wire fencing options are not available, aspen treatments would not occur in PACs.

Table 176. Acres of Proposed Fire Treatments in the Weatherford2 PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
103	103	8	8	24

Table 177. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Weatherford2	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	32	31	25	31	25
% of SDI 18-23.9" dbh	15	18	23	18	24
% of SDI ≥ 24" dbh	9	9	13	10	13
TPA > 18" dbh	18	22	32	22	32
PP Basal Area	126	130	130	124	127
GO Basal Area	21	22	25	22	25
All Basal Area	167	176	192	171	190
Snags 12-17.9" dbh	3.9	4.6	6.4	5.9	6.0
Snags >12" dbh	4.7	5.5	8.7	6.9	8.3
Snags ≥18" dbh	0.8	0.9	2.3	0.9	2.3
CWD >3" (Tons/Acre)	6.2	8.1	13.4	3.3	9.0
Logs per Acre	2.7	4.0	9.1	2.6	7.9
Understory Index (lbs./ac.)	23	22	16	24	17

Weimer Springs_030405032

This PAC is 674 acres and about 91 acres would be burned (about 14%). Prescribed fire would include about 11% of the core area (Table 178). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 179.

Grassland improvement (burning of 4 acres) is proposed in the PAC outside the nesting season. Subsequent herbaceous growth would benefit MSO prey species by enhancing food and cover in the short term.

One spring (Weimer Springs) would be restored inside the PAC outside the nesting season. Short-term increases in sediment transport and movement would be expected due to disturbance during the restoration process (MacDonald 2013). As restored areas stabilize over time, vegetative cover would improve as erosion slows and soil moisture increases. After restoration work is completed, the area would be protected from ungulate grazing by non-wire fencing. Selection of fencing materials would be coordinated with the USFWS. Protected herbaceous growth would benefit MSO prey species by enhancing food and cover in the long term.

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Table 178. Acres of Proposed Fire Treatments in the Weimer Springs PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% PAC Treated
101	101	11	11	14

Table 179. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Weimer Springs	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	40	40	33	41	32
% of SDI 18-23.9" dbh	12	15	26	15	27
% of SDI ≥ 24" dbh	4	5	7	5	7
TPA > 18" dbh	14	18	33	18	33
PP Basal Area	143	148	151	141	148
GO Basal Area	23	24	26	24	27
All Basal Area	176	184	199	178	197
Snags 12-17.9" dbh	4.4	5.6	8.3	7.8	7.5
Snags >12" dbh	5.0	6.2	9.9	8.3	9.2
Snags ≥18" dbh	0.5	0.6	1.7	0.6	1.7
CWD >3" (Tons/Acre)	6.4	8.5	14.1	3.5	9.5
Logs per Acre	1.6	3.0	8.0	2.0	7.2
Understory Index (lbs./ac.)	22	19	14	21	15

Weir_030401004

This PAC is 610 acres and about 377 acres would be burned (about 62%). Prescribed fire would include about 23% of the core area (Table 180). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 181.

Table 180. Acres of Proposed Fire Treatments in the Weir PAC and PAC Core Area

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
123	28	28	23	62

Table 181. PAC Changes in MSO Forest Structure and Prey Habitat Metrics

	Existing Condition	No Action		Proposed Action	
Weir	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	32	34	29	34	29
% of SDI 18-23.9" dbh	12	14	22	15	22
% of SDI ≥24" dbh	6	7	11	7	11
TPA >18" dbh	11	14	25	14	25
PP Basal Area	101	106	111	101	107
GO Basal Area	20	21	26	22	27
All Basal Area	141	152	172	147	170

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	Existing Condition	No Action		Proposed Action	
Snags 12-17.9" dbh	2.1	2.9	5.9	4.3	5.6
Snags >12" dbh	2.6	3.5	7.5	4.9	7.1
Snags ≥18" dbh	0.5	0.5	1.5	0.5	1.5
CWD >3" (Tons/Acre)	5.8	7.3	11.6	3.0	7.8
Logs per Acre	3.3	4.1	7.6	2.5	6.5
Understory Index (lbs./ac.)	41	34	23	37	24

Woods_030405040

This PAC is 853 acres and all acres would be burned. Prescribed fire would include 100% of the core area (Table 182). Estimated effects from prescribed burning to various MSO habitat metrics are similar to those described in the overview and are displayed in Table 183.

Table 182. Acres of Proposed Fire Treatments in the Woods PAC and PAC Core Area.

Total Core Area Acres	Project Area Acres	Core Treatment Acres	% of Core Area Treated	% of PAC Treated
101	101	101	100	100

Table 183. PAC Changes in MSO Forest Structure and Prey Habitat Metrics.

	Existing Condition	No Action		Proposed Action	
Woods	2010	2020	2050	2020	2050
% of SDI 12-17.9" dbh	29	30	27	30	27
% of SDI 18-23.9" dbh	12	14	20	15	21
% of SDI ≥24" dbh	9	10	12	10	12
TPA >18" dbh	14	17	26	17	26
PP Basal Area	120	124	127	118	124
GO Basal Area	24	25	29	26	30
All Basal Area	159	168	186	162	184
Snags 12-17.9" dbh	2.8	3.5	6.0	5.0	5.5
Snags >12" dbh	3.6	4.4	7.7	5.8	7.2
Snags ≥18" dbh	0.8	0.9	1.7	0.8	1.7
CWD >3" (Tons/Acre)	6.4	8.1	12.7	3.4	8.4
Logs per Acre	3.8	4.7	8.3	2.9	7.0
Understory Index (lbs./ac.)	30	25	18	28	19

Effects to forest structure and prey habitat are summarized by PAC treatments, i.e., burn-only (*n*=52) thin and burn treatments (*n*=18), in Table 19 and Table 20 above.

Restricted Habitat

Mechanical treatments would occur on about 73,827 acres of restricted habitat, or 98% of the total 75,111 restricted acres in the treatment area. Treatments would include nearly 100% of the total target and threshold habitat (8,698 acres). Although the implementation schedule is not yet known, on average,

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7,383 acres would be treated per year if 4FRI implementation was completed in 10 years. On average, this would equal mechanical treatments in about 10% of the restricted in a given year. Most restricted habitat (>98%) would be prescribed burned. For modeling purposes, treatments in 4FRI assume one mechanical entry and two entries with prescribed fire by 2020.

Forest Structure and Density in MSO Habitat

Treatments in restricted habitat would follow Recovery Plan guidelines and would maintain (threshold habitat) and enhance (target habitat) future nesting and roosting habitat. Thinning objectives in target and threshold habitat would maintain an overall BA of >120 ft^2 per acre, as recommended in the revised Recovery Plan (USDI FWS 2012a). In addition, treatments in restricted habitat would provide a diversity of stand conditions and stand sizes across the landscape. Treatment design would develop uneven-aged forest structure, irregular tree spacing and various patch sizes by thinning tree groups and reestablishing interspace adjacent to tree groups. Large trees and Gambel oak would be released from competition with uncharacteristically dense groups of young and mid-aged pine trees.

Large Trees

Mechanical treatments would, by design, be conservative in target and threshold habitat and would focus on increasing both the percent area of trees in larger size classes and increasing tree growth rates, as recommended in the Recovery Plan. This would be accomplished by thinning trees < 18 inches dbh, which are over-abundant relative to desired conditions described in the Recovery Plan. Trees ≥24 inches dbh are limited on the landscape and an important component of MSO habitat (USDI FWS 1995).

Overall, trees <18 inches dbh would decrease after treatments in target and threshold habitats, but remain above the recommended minimum levels (Table 184 and Table 185). Trees >18 inches dbh would increase in target and threshold habitats. Changes in individual subunits are variable (Appendix 6), In target habitat, the % SDI for trees 12 to 17.9 inches dbh would remain at 15% or higher for all but subunit1-4, which would drop to 11% post-treatment. Many subunits would continue to decline through 2050. Subunits 1-4 (target habitat) and 3-2 would decline to 10 and 13% respectively. Trees ≥24 inches dbh would increase to 10 and 30% SDI, respectively, in these same subunits. Increases in trees >24 inches dbh are 3 to -6% greater by 2050 relative to taking no action (Appendix 6). The value for TPA greater than 18 inches dbh would increase in all subunits (Appendix 6). Overall, the % of SDImax would remain high in target and threshold habitats, indicating little change to the overall forest structure in this habitat.

Treatments were designed to improve the ratios, growth rates, and sustainability of large trees. Declines in trees 12 to 17.9 inches dbh would result from selecting trees < 18 inches dbh due to their uncharacteristic abundance. This would increase growth rates of neighboring trees, allowing them to achieve larger size classes more quickly. Conversely, fewer small trees would then be recruited into the 12- to 17.9-inch dbh range. Thinning smaller trees would also reduce density-dependent mortality of large trees, improving their resiliency and sustainability over time.

Trees 12 to 17.9 inches dbh would also decrease in restricted "other" habitat. This would result from targeting trees <18 inches dbh to reduce competition with trees ≥18 inches dbh (Table 186 and Appendix 6). Treatments would also create canopy gaps, irregular spacing, and diversify age-class distribution. Trees 18 to 23.9 inches dbh would increase in the short term, while trees ≥24 inches dbh increase substantially. Overall, TPA greater than 18 inches dbh would decrease relative to no management actions. These results were consistent across Restoration Units: Removing mid-sized trees would reduce overall tree densities, improving overall forest health, while increasing growth rates for the largest size classes. Increasing forest heterogeneity would improve MSO restricted habitat by maintaining current and future nesting and roosting structure in some areas, while also increasing prey habitat and potential MSO foraging opportunities in other areas.

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Basal Area

The objective of decreasing pine BA would be met in all restricted habitats (Table 184, Table 185, and Table 186). This represents a key contribution toward maintaining large trees and dense tree groups, while improving forest resiliency and reducing fire threat. Gambel oak BA would increase in target and threshold habitat and decrease in restricted "other" habitat. No oak would be targeted for removal; the decrease in restricted "other" habitat would result from increased operations leading to more individual trees lost from prescribed burning and inadvertent impacts from harvest activities. The decrease in oak would relate to the direct loss of predominantly small and medium diameter oak top-killed by fire, but few oak stems >6 inches drc would be expected to be top-killed by prescribed fire (Abella 2008). The immediate result would be a decrease in small diameter oak (<2 inches) followed by prolific sprouting, resulting in an overall increase in small diameter oak stems. Top-kill and re-sprouting of oak would delay recruitment of oak into larger size classes. This would reduce the BA of Gambel oak ≥5 inches drc in the long term in restricted "other" habitat, relative to no management activities. Treatments would move toward uneven spacing with canopy gaps as described in the Recovery Plan. Total BA would remain high in target and threshold habitat. It would decrease in restricted "other" habitat, further reducing competition-induced mortality and increasing resiliency to large-scale stochastic events.

Canopy Structure

Based on BA and SDImax, canopy cover would remain dense (Table 184, Table 185, and Table 186). SDImax would remain in the "extremely high density" range in target and threshold habitat, but decrease to "high density" in restricted "other" habitat. These values ensure that canopy cover would be 50% or greater at the stand level and much higher within tree groups in target and threshold habitat. Existing variability in overstory species diversity would remain by design. Combined, these factors should improve or maintain the elements of canopy structure such as cover, density, and species diversity.

Table 184. Changes in Forest Structure Attributes Within MSO Threshold Habitat Under the Proposed Action

Forest Attributes	Existing Condition (Yr 2010)	Proposed Action Short Term (Yr 2020)	Proposed Action Long term (Yr 2050)	No Management Action (Yr 2050)
Acres	1,977			
% of SDI 12-18" dbh	25	20	19	22
% of SDI 18-24" dbh	21	28	26	27
% of SDI >24" dbh	6	7	12	9
% of Max SDI	100%	84%	93%	101%
TPA >18"	26	28	33	36
Ponderosa Pine BA	119	83	95	127
Gambel Oak BA	60	63	69	63
All BA	193	163	195	217
% Oak BA	31	38	35	29

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Table 185. Changes in Forest Structure Attributes Within MSO Target Habitat Under the Proposed Action

Forest Attributes	Existing Condition (Yr 2010)	Proposed Action Short Term (Yr 2020)	Proposed Action Long term (Yr 2050)	No Management Action (Yr 2050)
Acres	6,715			
% of SDI 12-18" dbh	28	24	22	27
% of SDI 18-24" dbh	13	17	18	19
% of SDI >24" dbh	7	10	13	10
% of Max SDI	80%	67%	78%	84%
TPA >18"	14	16	22	23
Ponderosa Pine BA	112	81	93	122
Gambel Oak BA	33	36	48	41
All BA	152	129	164	183
% Oak BA	22	28	29	23

Table 186. Changes in Forest Structure Attributes Within MSO Restricted "Other" Habitat Under the Proposed Action

Restricted Other	Existing Condition (Yr 2010)	Proposed Action Short Term (Yr 2020)	Proposed Action Long term (Yr 2050)	No Management Action (Yr 2050)
Acres	66,419			
% of SDI 12-18" dbh	29	25	21	28
% of SDI 18-24" dbh	13	21	20	20
% of SDI >24" dbh	7	13	18	10
% of Max SDI	69%	37%	49%	76%
TPA >18"	12	11	17	23
Ponderosa Pine BA	102	52	70	119
Gambel Oak BA	26	20	30	35
All BA	137	79	112	169
% Oak BA	19	25	26	21

MSO Prey Habitat

Snags, Logs, and Coarse Woody Debris

Under the Proposed Action, snags >18" inches dbh would slightly increase in the short term in threshold and target habitats (Table 187 and Table 188), but would more than double in restricted "other" habitat (Table 189). Snags >18" inches dbh would continue to increase in the long term. However, current values are and would continue to be consistently below forest plan direction. The impact of low snag densities, relative to forest plan guidance, is unclear because of the uncertainty regarding natural snag levels in Southwest ponderosa pine forests (Ganey 1999, Waskiewicz et al. 2007). However, increased drought and beetle activity could lead to levels above those modeled here (Ganey and Vojta 2012). Snag mitigation includes selecting for residual trees with dead tops and lightning strikes to retain elements of snag habitat in living trees that are more resistant to fire (Waskiewicz et al. 2007).

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Logs would remain above forest plan direction in threshold and target habitats (Table 187 and Table 188). Logs would increase in the short term in restricted "other" habitat, but remain below forest plan direction (Table 189).

CWD is currently at the low end of or below the recommended range in all restricted habitats (Table 187, Table 188, and Table 189). CWD would decrease in the short term as a result of prescribed fire, but would increase over time.

Snags, logs, and CWD represent elements of small mammal habitat. Snags, logs, and CWD would primarily be affected by burning. While retaining adequate amounts of these habitat components is essential, site conditions are currently highly variable. Treatment objectives include lowering surface fuels to lower the risk of MSO habitat loss due to high-severity fire and thereby allow fire to play a more natural role in the ecosystem. Overall, restoration treatments can benefit the habitat of MSO prey species (Kalies et al. 2012, Martin and Maron 2012). Modeling results indicate treatments would sustain these habitat components for MSO prey species in the short term and provide adequate habitat in the long term.

Understory Index

Reduced BA and intermittent openings would increase light and moisture availability for herbaceous understory species. Understory biomass is currently low in threshold habitat. Index values would increase, but remain low after treatment because of the minimal treatments developed for future nesting and roosting habitat (Table 184). Understory response in target habitat would have similar results, although the index values would be higher than those for threshold habitat (Table 187). Biomass changes in restricted "other" habitat would have the strongest understory response (Table 187 and Table 188). These changes do not reflect the nutrient pulse associated with post-fire conditions or the decrease in competition with active tree roots, suggesting results on the ground would be above those modeled here.

Increased biomass production represents grass and forb development during the growing season, providing food and cover for arthropods, small mammals and birds. In turn, this can increase prey availability, diversity, and biomass for MSOs. Total prey biomass may be more influential on MSO fitness than the abundance of any one prey species (USDI FWS 1995). The recovery plan recommends managers provide diverse habitats to support a diverse prey base. However, improvements in understory production would gradually decline without future treatments as overstory canopies expand and new trees became established. Relative to no management action, the proposed action would represent both short- and long-term improvements to MSO habitat.

Table 187. Changes in Prey Habitat Attributes Within MSO Threshold Habitat Under the Proposed Action

Forest Attribute	Existing Condition (Yr 2010)	Proposed Action Short Term (Yr 2020)	Proposed Action Long term (Yr 2050)	No Management Action (Yr 2050)
Acres	1,977			
Snags >12"	3.12	3.51	3.82	6.10
Snags >12" and <18"	2.53	2.79	2.36	4.35
Snags >18"	0.59	0.72	1.46	1.74
CWD >3" (tons/ac.)	5.61	3.43	6.81	12.23
Logs per Acre	3.69	3.44	6.07	8.39
CWD >12" (tons/ac.)	1.23	1.15	2.02	2.80
Understory Index	16	28	16	11

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Table 188. Changes in Prey Habitat Attributes Within MSO Target Habitat in the Proposed Action

Forest Attribute	Existing Condition (Yr 2010)	Proposed Action Short Term (Yr 2020)	Proposed Action Long term (Yr 2050)	No Management Action (Yr 2050)
Acres	6,715			
Snags >12"	2.89	3.56	4.12	6.40
Snags >12" and <18"	2.37	3.03	2.93	5.03
Snags >18"	0.52	0.53	1.19	1.38
CWD >3" (tons/ac.)	5.51	3.19	6.41	11.28
Logs per Acre	3.74	3.19	5.46	7.27
CWD >12" (tons/ac.)	1.25	1.06	1.82	2.42
Understory Index	37	57	30	22

Table 189. Changes in Prey Habitat Attributes Within MSO Restricted "Other" Habitat Under the Proposed Action

Restricted Other	Existing Condition (Yr 2010)	Proposed Action Short Term (Yr 2020)	Proposed Action Long term (Yr 2050)	No Management Action (Yr 2050)
Acres	66,419			
Snags >12"	2.18	4.47	2.18	5.69
Snags >12" and <18"	1.76	3.54	1.29	4.54
Snags >18"	0.42	0.93	0.90	1.14
CWD >3" (tons/ac.)	4.00	3.35	5.99	8.72
Logs per Acre	1.27	2.30	4.77	4.42
CWD >12" (tons/ac.)	0.42	0.77	1.59	1.47
Understory Index	48	138	75	27

Changes in forest structure and prey habitat were designed to balance impacts to the various measures of MSO habitat with the need to develop and maintain large trees in a landscape dominated by mid-sized trees. Groups of large trees distributed across MSO habitat should improve dispersal habitat as well. Threshold habitat would maintain nesting and roosting conditions. These conditions would be achieved sooner in target habitat than if no action were taken.

Mechanical treatments in restricted habitats would be implemented during the nesting season. While most foraging is proximal to the nest site and would thus occur primarily in PACs, cutting in restricted habitat could disturb individual owls foraging or roosting outside PACs.

Fire Effects

Prescribed burning in association with mechanical treatments would occur across about 73,827 acres of restricted habitat, including 6,712 acres of target and 1,976 acres of threshold habitats. An additional 2,655 acres of burn-only treatments would occur in restricted habitat with about 300 acres of burn-only prescriptions in target and threshold habitat. About 289,000 acres of ponderosa pine forest across the treatment area would move from a highly departed state (VCC 3) toward reference conditions (VCC 2). About 66,000 additional acres would move into reference conditions (VCC 1; see Fire Effects in

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Protected Habitat for more detail). While these numbers are not specific to MSO habitat, they include it and also increase the likelihood of sustaining this habitat through time.

By definition, all crown fire in ponderosa pine produces high-severity effects (Lata 2012). Over 26,300 acres of restricted habitats would move from risk of crown fire to surface fire after 4FRI implementation. The probability of active crown fire would be reduced by 27 to 39% in restricted habitats immediately after implementation (Table 190). The dominance of surface fire (86 -98%) in restricted habitat and across the landscape (95%) would reduce the risk of stand-replacing fire in MSO habitat. Overall, thinning and burning treatments are projected to move restricted habitat toward the restoration of low-severity fire.

Table 190. Predicted Fire Behavior in Restricted Habitat Under Current Conditions and After Implementation of the Proposed Action in 2020

MSO Habitat	Total (Ac)	Surface Fire (Ac)	Passive Crown Fire (Ac)	Active Crown Fire (Ac)	Surface Fire (%)	Passive Crown Fire (%)	Active Crown Fire (%)
Existing Condition (Year 2010)							
Ponderosa Pine	507,839	316,630	48,023	143,186	62	9	28
Threshold	1,977	940	260	777	48	13	39
Target	6,715	3,348	662	2,705	50	10	40
Restricted "Other"	66,419	35,123	6,540	24,756	53	10	37
Proposed Action (Year 2020)							
Ponderosa Pine	507,839	481,622	17,323	8,894	95	3	2
Threshold	1,977	1,702	36	239	86	2	12
Target	6,715	6,572	50	92	98	1	1
Restricted "Other"	66,419	57,487	8,360	572	87	13	1

More mechanical treatments and the more open nature of foraging habitat would allow fire to achieve more fuels reduction in restricted habitat outside of target and threshold habitat (67,378 acres). The increase from about 50% of the restricted acres supporting surface fire to 90% or more would help to maintain MSO habitat over time. In addition, areas treated outside of MSO habitat would also move closer toward the historical range of variation, thereby decreasing the threat of high-severity fire reaching MSO habitat. Fire treatments in restricted habitats would be implemented during the nesting season. While most foraging is proximal to the nest site and would thus occur in PACs, burning in restricted habitat could disturb individual owls foraging or roosting outside PACs. In addition, the emphasis on low-severity fire would be expected to produce a patchier burn, resulting in a mosaic of habitat conditions for MSOs and their prey. Much of the restricted habitat would be a mix of surface and passive crown fire.

Summary Results for Mexican Spotted Owl Restricted Habitat

An overview of immediate post-treatment results (year 2020) and long-term changes to habitat structure (year 2050) are displayed at the Restoration Unit and subunit levels in Appendix 6. Existing conditions and long-term changes with no management action are also presented for comparison.

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Other Habitat Effects

Springs and Ephemeral Channels

The objectives for spring and ephemeral channel restoration are to move flow patterns, recharge rates, and geochemistry toward historical levels. Improving water quality and quantity would improve riparian habitat for wildlife, consistent with water rights and site capability. Restoration of springs and ephemeral channels would be evidence-based and designed to improve native vegetation species composition. Pre-settlement trees would be retained where present. The largest trees available would be left where only evidence of pre-settlement trees remains. Areas without evidence of pre-settlement trees would be treated to provide forest interspace. Restoration activities proposed for springs and ephemeral channels would include prescribed first-entry and maintenance burning.

The desired condition for vegetation near springs and ephemeral channels is for plant distribution and species composition to be resilient to natural disturbances. The objectives of the treatments are to conserve or recover native biological diversity and restore pre-settlement tree patterns in soil types that are regularly moist to avoid shading and uncharacteristic translocation of water and nutrients from affected soils. Design features associated with spring and ephemeral channel restoration include:

- All restored spring and ephemeral channel sites would be protected from ungulate browsing.
- Using soil and water BMPs to minimize the impacts of management activities within riparian areas
- Retain large snags and logs on site
- Avoid wire fencing (to exclude ungulates)in PACs
- Apply northern leopard frog mitigation where breeding habitat occurs
- All restoration activities would occur outside the MSO breeding season.

Springs

Twenty-three springs are proposed for restoration in MSO habitat, including both protected and restricted habitats. Eighteen springs proposed for restoration are in restricted habitat: 10 springs are on the Coconino National Forest and 8 springs are on the Kaibab National Forest. Five springs are proposed for restoration in PACs and all restoration in PACs would occur on the Coconino National Forest (Table 191): 2 springs are in meadows (Red Raspberry and Weimer Springs PACs) and 3 springs are in pine-oak forest (Rock Top and Sawmill Springs PACs). The maximum likely disturbance for spring restoration activities would include:

1) Thinning small conifers by chain saw with a crew of two to four people would take approximately one day per spring, for a total of 23 days of disturbance in MSO habitat; length of time would decrease with more personnel.

2) Non-wire fence construction in PACs to protect from ungulates – assume pipe and sucker rod or wood pole fence.

Pipe and sucker rod fence construction would include the following: (1) survey work for fence location, (2) transporting material, (3) digging holes to place posts, (4) placing posts with cement (may use a portable cement mixer), and (5) welding sucker rod to posts. Task would require a crew of two to four for approximately 1 week of disturbance per spring. Task may include a day of mechanized work (bobcat) per spring to assist with digging holes.

Wood pole fence construction would include the following: (1) survey work for fence location, (2) transporting material, and (3) fence construction activities would include nailing and drilling posts

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and likely run a generator for drilling. Task would take a crew of two to four for approximately one week of disturbance per spring.

3) Site monitoring, including noxious weeds: one person for one day for each spring

Ephemeral streams

Ephemeral stream channels proposed for restoration include those with and without riparian vegetation; none of the selected areas have woody shrubs associated with riparian treatment areas. Over 4 miles of ephemeral stream channel restoration is proposed within MSO habitat. Just over 3.3 miles of ephemeral channel restoration would occur in restricted habitat and nearly 1.7 miles of ephemeral channel restoration would happen in PACs (Table 191). Approximately 0.75 mile is in target and threshold habitat on the Coconino National Forest. About 2.4 of the 2.48 miles of ephemeral channel restoration in restricted "other" habitat is proposed for the Coconino National Forest and less than 0.10 mile is on the Kaibab National Forest. All channel restoration in PACs would occur on the Coconino National Forest (Table 191). Proposed restoration reaches in PAC s would average about 0.28 mile in length with a range of 0.02 to 0.72 mile. Only Holdup PAC has riparian vegetation within the ephemeral stream reach, but no woody vegetation is present.

Assuming maximum disturbance for total channel reconstruction, i.e., assuming potential re-contouring of stream channels and not just using equipment to lay the stream banks back, this work could require:

(1) Surveys by a two-person crew at each restoration site (approximately 2 days per 0.5 mile/800 yards of stream channel).

(2) Construct new channel using design from survey data with a one-week timeframe for construction per reach. Equipment used would include a bulldozer and bobcat, and could include a 10-yard dump truck to move material for fill. Construction would include removal of encroaching trees where necessary. Two to six people would be required.

3) Re-vegetating sites would require seeding with a hydromulcher and water tender for approximately three days. Site work could also include placement of erosion mats to provide mulch for seeding and/or planting grass and woody riparian vegetation plugs for an additional three days. Re-vegetation could require a total of six days. Protection of the site would be accomplished through fence construction as described above for spring restoration. Restoration monitoring could include assessing construction, vegetation response, and noxious weeds. This would require two people for a total of three days per channel reach.

Total time for each reach is two to three weeks and total personnel are two to six during that time.

Understory vegetation development is related to the amount of solar radiation reaching the ground. This creates a direct and inverse relationship between canopy closure and herbaceous cover. Existing, uncharacteristic forest structure in the ponderosa pine forests of northern Arizona restricts herbaceous growth. These forests are relatively homogeneous at larger scales. The site-specific variability that springs, streams, aspen, and meadows represent are important to MSO prey species, because they support understory vegetation that is limited or lacking at larger scales. Understory vegetation provides the food and cover that supports small mammal life histories. Most foraging by MSOs during the nesting season is proximate to the nest stand. Improvements to springs, ephemeral channels, and other non-ponderosa pine cover types can benefit MSOs in ways greater than simple area estimates indicate.

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Table 191. Springs and Ephemeral Channels Proposed for Restoration in Protected Activity Centers (PAC), Coconino National Forest

PAC	Spring Name		PAC	Channel Distance
Red Raspberry	Mud Spring		Bear Seep	0.46
Rock Top	Lee Spring		Clark	0.30
Rock Top	Rock Top		Coulter Ridge	0.72
Sawmill Springs	Sawmill Springs		Holdup	0.08
Weimer Springs	Weimer Springs		Lucida	0.08
-------	-------		Meadow Tank	0.02
Total = 4 PACs	**Total = 5 Springs**		**Total = 6 PACs**	**Total = 1.66 miles**

Spring and channel restoration would occur in four critical habitat units (CHUs) occurring within the treatment area (Table 192).

Table 192. Number of Springs and Miles of Ephemeral Stream Channel Restoration Proposed in MSO Critical Habitat Units under the 4 Forest Restoration Initiative

Feature	UGM-11	UGM-12	UGM-13	UGM-14
Spring (Coc NF)	8	0	9	0
Ephemeral Stream	1.9	0.48	0. 38	0.67

Grasslands, Savannas, and Meadows

Acres of meadow (and aspen) treatments in protected habitat were summarized by PAC. Each PAC represents a discrete polygon or defined unit of area in the Forest Service database. The polygons encompass MSO habitat as well as other inclusions such as meadows, aspen, rock, etc. Therefore, identifying the associated acres of each vegetation type within the polygon (i.e., within PAC habitat) was simply a matter of summing the individual acres associated with each stand of a particular vegetation type occurring in the PAC. However, meadows and aspen were problematic to summarize in restricted habitat.

The restricted habitat data layer is defined on a stand-by-stand basis. Restricted habitat boundaries are the actual stand boundaries, so other habitats do not occur "within" restricted habitat in the corporate database. Unlike PAC boundaries, a stand of non-MSO habitat, such as aspen, would not be included in the restricted habitat tally, i.e., there is no outer restricted habitat polygon within which non-MSO habitat such as meadows and aspen could be identified and counted. Even where restricted habitat is clustered, it is still defined on an individual stand basis. Therefore, meadows, aspen, or any other non-MSO vegetation type within restricted habitat could not be directly queried.

To account for this, we used CHU polygons as a proxy for assessing potential management impacts to stands between, adjacent, or near restricted habitat. The drawback to this approach is that critical habitat includes both protected and restricted habitat and both habitats also occur outside critical habitat. In addition, critical habitat boundaries include other non-MSO vegetation. However, CHUs on the 4FRI landscape encompass most of the MSO habitat and, on an area basis, most MSO habitat consists of restricted habitat. Therefore, we felt using critical habitat to define an area within which we could summarize and analyze impacts to restricted habitat was a reasonable approximation for the potential effects these actions could have on restricted habitat.

Up to about 130 acres of meadow treatments are proposed in 11 different PACs, including both burn-only (about 97 acres) and thin and burn (35 acres) treatments (Table 193). Meadow treatments would average

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12 acres per PAC, ranging from 1 acre (Howard Mountain) to 28 acres (Meadow Tank). All PACs with proposed meadow treatments are located on the Coconino National Forest. All meadow treatments in PACs would occur outside the nesting season. Burn-only treatments would occur in 8 PACs as operational burns. The goal is to move fire through the stand to burn in neighboring ponderosa pine habitat and avoid constructing fireline between forest stands and non-pine areas. This would reduce the habitat disturbance associated with implementing prescribed fire. In addition, operational burning would improve understory production and potentially kill young, encroaching conifers. The grass-forb response to burning would improve as a result of the nutrient pulse and litter reduction. This would directly improve food and cover for MSO prey species. However, burning in PACs would be designed to minimize effects to the overstory, potentially leading to higher survival rates of encroaching pine. Surviving trees would continue to expand their canopy and serve as seed sources, both of which would lessen the length of time that improvements would benefit understory species.

The combination of mechanical treatments and prescribed burning in three PACs would focus on meadow restoration (versus improvement) by mechanically removing encroaching post-settlement trees in addition to burning. Treatment design would retain pre-settlement trees, if present, and retain large post-settlement trees where evidence (e.g., stumps, logs) indicates past harvest of pre-settlement trees. The combination of thinning and burning would stimulate grass-forb vegetation in the short term and improve conditions over the long term by reducing conifer competition and tree seed sources. This approach would better maintain the herbaceous layer, i.e., food and cover for MSO prey species, through time. Enhanced prey habitat would potentially improve prey numbers within meadows and increase dispersal into the surrounding PAC. In addition, arthropod prey such as beetles and moths could increase from these treatments, adding to total prey biomass and diversity.

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Table 193. Meadow treatments within PACs (all are on the Coconino National Forest)

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Protected Activity Center	Acres Treated
Prescribed Fire Only	
Frog Tank	10
Howard Mountain	1
Meadow Tank	28
Nestor	8
Powerline Tank	14
Racetrack Tank	15
Two Holes	14
Volunteer	6
Prescribed Fire Only Total	97
Mechanical & Prescribed Fire	
Bear Seep	10
Iris Tank	9
Red Raspberry	16
Mechanical & Prescribed Fire Total	35
Total (11 PACs)	131

Grassland, savanna, and meadow treatments in restricted habitat would total about 16,782 acres (Table 194). Treatments are dispersed across the landscape, as evidenced by acres of treatment occurring in 6 CHUs and by total acres per National Forest. Treatment objectives vary, depending on circumstance.

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Restoration treatments are proposed for ponderosa pine stands with mollisol soils (16,670 acres/ 99% of grassland treatments in CHUs). Both mechanical tree removal and burning would be used to return the stands to an open reference condition. Fire objectives in restoration treatments would include deliberate tree mortality intended to restore the function of the meadow and grassland habitat. Meadow restoration would not occur in protected habitat. Forest conditions currently existing within PACs would remain forest regardless of soil type. "Improvement" treatments include mechanical and prescribed fire within existing grassland, savanna, and meadow habitats (about 112 acres/ 1%). Objectives would include removal/reduction of litter and removal of encroaching trees in existing openings. Treatment intensity is based on soil type: grasslands and meadows are on true mollisols and would have ≤ 10% tree cover. Savannas are on mollic intergrades and would retain 10 to 30% tree cover.

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Grassland, savanna, and meadow treatments would improve habitat for small mammals, birds, and arthropods, thereby increasing prey biomass for owls. MSOs have not been observed in openings ≥10 acres (Ganey et al. 2011), but these larger openings would improve potential source populations of prey species. Enhancing source populations could increase dispersal into MSO habitat, indirectly benefiting MSO. Restoration treatments occurring on meadow-derived soils within a forested matrix would also include areas smaller in scale (meadows). Meadow treatments <10 acres could directly benefit affected owls by increasing small mammal reproduction in areas used for foraging owls.

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Table 194. Acres of Grassland, Savanna, and Meadow Improvements (Burn-Only) and Restoration (Thin and Burn) in Restricted Habitat (i.e., Upper Gila Mountain Critical Habitat Units/UGM #) and by National Forest

Management Approach	UGM-11	UGM-12	UGM-13	UGM-14	UGM-15	UGM-16	Coconino National Forest	Kaibab National Forest	Total
Improve	91	0	6	15	0	0	112	0	112
Restore	5,656	113	9,400	171	1,291	38	7,549	9,121	16,670
Total	5,747	113	9,406	186	1,291	38	7,661	9,121	16,782

Aspen

Aspen clones are not an officially designated MSO habitat. However, islands of aspen occur in the general pine-oak forest, including within PACs. Aspen treatments in protected habitat would consist of prescribed burn-only treatments on about 219 acres within 8 PACs, including 7 PACs on the Coconino National Forest and 1 PAC on the Kaibab National Forest (Table 195). Burn-only aspen treatments would average about 27.5 acres; ranging from 2 (Kendrick PAC on the Kaibab National Forest) to 61 acres (Red Raspberry PAC on the Coconino National Forest). All aspen treatments in PACs would occur outside the nesting season. Returning fire to these habitats would improve aspen health and understory cover. All aspen treatments would include fencing. The USFWS suggests that new structures such as fences that are constructed after an area is occupied by an owl could increase the risk of collisions (USDI FWS 2012a). No wire fencing would be used for new fences in PACs. Instead, other fence designs such as double-welded pipe rail would be used. Fencing decisions would be made in collaboration with the USFWS. If non-wire fencing options are not available, aspen treatments would not occur in PACs.

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Table 195. Acres of Aspen Treatments in Protected Activity Centers (PACs)

PAC	Acres
Jeep	29
Mayflower Tank	55
Mint Spring	12

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PAC	Acres
Nestor	19
Pierce Tank	32
Red Raspberry	61
Weatherford2	10
Kendrick[1]	2
Total	**219**

[1] = Kaibab National Forest

Aspen treatments in PACs should decrease pine-aspen competition and increase aspen suckering. Fire would decrease litter levels within clones, benefiting both aspen and understory species and creating a short-term increase in understory biomass. However, effects to competing pine trees would be moderate, retaining encroaching pine and associated seed dispersal and needle cast through time.

Up to 958 acres of aspen treatment are proposed within restricted habitat (about 648 acres on the Coconino National Forest and about 310 acres on the Kaibab National Forest). These treatments are dispersed across the landscape, occurring in 5 CHUs (UGM-11, UGM-13, UGM-14, UGM-15, and UGM-17). Treatment objectives in restricted habitat vary from burn-only aspen improvements to mechanical thinning with prescribed burning intended to restore the long-term function of aspen habitat.

Prescribed burning alone would create short-term benefits, but have limited effect on encroaching and overtopping pine. Competition between pine and aspen and pine and understory vegetation would continue, limiting the potential post-treatment response of aspen and understory plants. Benefits from burn-only treatments would improve about 20% of the total aspen. Little change would be expected in aspen sustainability in the long term. Construction of fencing or other barriers after all treatments would occur to prevent loss of aspen regeneration to ungulate grazing.

Aspen restoration would include mechanical removal of post-settlement pine encroaching, scarifying soils to stimulate aspen suckering, and increasing surface fuels to better carry fire within 100 feet of clones. Treatments would be expected to improve the health, resiliency, and size of aspen clones and provide for a more robust understory response in about 80% of the total aspen. MSOs would be expected to benefit from increases in prey abundance for small mammals, birds, and arthropods in both the short and long term. Fencing or other barriers would be constructed after completing all treatments to prevent removal of aspen regeneration by ungulates.

At the scale of 4FRI, improvements to prey habitat from meadow, aspen, spring, and ephemeral channel treatments within protected habitat would be limited and site-specific. However, these collective treatments would enhance prey habitat within PACs where most foraging occurs during the nesting season. Resident MSOs concentrate their use within PACs even if they do not nest in a given year, and MSO reproductive success appears tied to prey availability (Ganey et al. 2011). MSO prey selection in the UGM, primarily peromyscid mice and voles (Ganey et al. 2011), reflects abundant edge habitat (USDI FWS 1995). Restoring/improving these habitats should also improve and increase edge habitat. Restoration treatments in general can benefit peromyscid mice and voles (Kalies et al. 2012, Martin and Maron 2012). Other small mammals, birds, and nocturnal flying insects (primarily lepidopterons and coleopterans) are also prey for MSOs. This should be particularly true in key habitat components like springs and ephemeral channels where a strong herbaceous response is expected. Overall prey abundance may be very important to nesting MSOs during years when individual prey species may be limited (Ganey et al. 2011). Providing localized patches of increased food and cover for prey species in the areas

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most heavily hunted during nesting season should directly benefit MSOs during an energetically stressed time of year, spanning egg-laying through fledging of juvenile birds.

Disturbance

Activities that could create disturbance to MSOs include moving and operating harvest machinery, hauling forest materials, building fire line, managing prescribed burns, smoke, personnel in the field, and road maintenance and construction. These activities could potentially disturb nesting, roosting, and foraging owls.

Road-Related Disturbance

Road Maintenance, Decommissioning, Construction, Relocation, and Dust Abatement

The 4FRI proposes a maximum of about 431,049 acres of mechanical treatment. This number is expected to be well above the number of acres actually treated under 4FRI. A review of Forest Service NEPA determined that, on average, about 40% of acres approved for treatment actually get treated (Hampton et al. 2008). In the case of 4FRI, this would equal about 172,420 acres of treatment. The contract awarded for 4FRI includes treatment on 249,600 acres, or nearly 57% of the treatment acres. More acres could be added under a variety of potential situations, although there are no expected changes at this time. Road disturbance and traffic volume would be directly related to total acres treated. Therefore, it was assumed that all 431,049 would be treated in order to be conservative given the uncertainty in this analysis.

About 108,846 acres (25% of the total 431,049 acres) represents MSO habitat proposed for treatment, including burn-only treatments. This total primarily consists of restricted habitat (68%), which by definition is unoccupied. MSO protected habitat proposed for treatment totals about 35,019 acres. Potential disturbance to owls and their habitat from road-related activities could be assessed at the level of occupied habitat or total MSO habitat, but the risk of collisions to owls could extend beyond their designated habitat. There is no way to predict where MSOs without a territory, seasonally migrating, or dispersing sub-adults may occur. Because there is no way to know for certain where owls might occur, effects of hauling will be based on the total number of acres of proposed treatment across the entire 4FRI area. This should ensure that the maximum possible effects to owls are addressed. We expect actual effects to be less than those disclosed here.

In general, 1 acre of treatment would yield enough harvested material to fill one logging truck. About every 3 acres of treatment would fill one chip van. Accordingly, it is assumed that each acre treated would require 2.67 truck trips to drive to the appropriate site, load logs and chips, and deliver the load off-forest. Because of variability in forest conditions and changing market values, more product may be chipped, reducing log truck trips and overall projected truck traffic. Assuming 2.67 truck trips per acre acknowledges site variability, but ensures road traffic estimates are at the high end of potential effects to owls from hauling. Total project implementation would take 10 to 15 years. While the BA is based on a 15-year implementation expectation, the uncertainty in the lifetime of the project is addressed here by assuming 10 years for completion, thereby assuming a higher number of average truck trips.

In general, hauling occurs about 9 months out of the year, with roads typically closed February through April. Sometimes heavy monsoon rains also close areas to truck traffic during the summer. However, weather can be highly variable across the landscape during monsoons. The scale of 4FRI would create flexibility in moving the emphasis area, allowing hauling to continue if some areas become unavailable due to monsoonal storms. Under this scenario, road activities would consistently occur May 1 through January 31, totaling 276 days.

Based on implementation of the maximum acreage, about 43,100 acres of tree harvest would occur each year for 10 years. With 2.67 truck trips required per acre of treatment, this would result in an estimated

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average of about 115,077 truck trips annually. On average, this would total about 417 truck trips per day across the 4FRI landscape during a 276-day hauling season. While the actual number would vary, we feel this represents the likely maximum number of truck trips per day. If fewer acres were treated, more product was chipped, or shorter winters extended the hauling season, this number of truck trips per day would be smaller.

Harvest units would be managed by assigning task orders to contractors. Task orders would focus the annual harvest to areas within 4FRI subunits, shifting the focus area as new task orders are issued. Task orders would be assigned annually and would typically require 2 to 3 years to complete. Year 1 activities would include site and sale preparation and reviews of the area to be treated. Road management activities may also occur. Year 2 would be the main disturbance-causing activities, including feller-bunchers harvesting trees, skidders hauling trees to landings where they would be stacked and/or chipped, trucks loaded, and the logs and chips hauled off the forest. Road traffic would be high and could run at night as well. Harvest and hauling would combine for a season of consistent diurnal and potential nocturnal disturbance. If a third year was necessary, it would include finishing remaining harvest-related activities and associated hauling. These activities would be at much lower levels than the main season of harvest. Road maintenance, decommissioning, construction, relocation, and dust abatement is discussed by individual MSO habitat type below.

Nearly 100 miles of road maintenance and temporary road construction would occur in protected habitat (Table 196). Road maintenance and temporary construction would occur pre-harvest. A detailed table showing road maintenance and construction by PAC can be found in Appendix 7. The term "temporary roads" in protected habitat consists of non-system roads that currently exist as open roads on the landscape. Therefore, temporary road construction would be variable and can encompass little to no work on the ground. Alternately, temporary road construction could require widening, tree removal, fill, and grading. Site-specific assessments have not been made, but a design feature for road work includes minimizing tree removal (see soils report). Temporary road construction/ road maintenance within PACs would take place outside of the nesting season. Temporary roads would typically function for 3 to 6 months before decommissioning. In addition, about 43 miles of existing road would be decommissioned in 52 PACs (Appendix 7). This represents about 29% of existing roads currently within these PACs and about 67% of open roads in the core areas of 13 PACs (Appendix 7). Decommissioning would occur outside the nesting season, avoiding potential noise disturbance to nesting MSOs. Owls roosting or foraging in PACs are also unlikely to be disturbed during nesting season. MSOs foraging or roosting outside of PACs or those that remain in the PAC vicinity outside of nesting season may be disturbed by noise disturbance from hauling and road maintenance, construction, and decommissioning activities.

Table 196. Road-related Mileage in Mexican Spotted Owl Protected Habitat

MSO Habitat	Road Maintenance	Temporary Roads	Road Relocation	Total Miles of Road Work
Protected Total	92.7	6.7	<0.1	99.4

About 355 miles of road maintenance would occur in restricted habitat, including about 41 miles in target and threshold habitats (Table 197). New temporary road construction would total about 69 miles in restricted habitat, with over 5 miles constructed in target and threshold habitat. The majority of these miles are known to currently exist as open non-system roads. An undetermined amount of temporary road could require blading a new grade. Temporary roads would again typically function for 3 to 6 months before decommissioning. Over a mile of road would be relocated to protect ephemeral stream channels in restricted habitat. One road segment would be relocated in target and one segment would be relocated in

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threshold habitat, totaling < 0.1 mile in length. Remaining relocated road segments would be in restricted "other" habitat.

Table 197. Road-related Mileage in Mexican Spotted Owl Restricted Habitat

MSO Restricted Habitat	Road Maintenance	Temporary Roads	Road Relocation	Total Miles of Road Work
Target/Threshold	40.9	5.3	<0.1	46.2
Restricted "Other"	314.5	62.5	1.4	378.2
Total	**355.4**	**67.8**	**<1.5**	**424.4**

Road maintenance could include a range of activities from blading the edges of a road and spot surfacing to culvert replacement and building turnouts. Temporary road construction and reconstruction of road segments could involve cutting and removing individual trees (although per the above-referenced design feature this would be minimized), realigning the road prism, subgrade repairs, and widening roadway prisms, lanes, shoulders, or ditches. Road relocations can involve creating a new road alignment in an upland position, with proper drainage and surfacing. This would require removal of vegetation and decommissioning the old road alignment. These actions can commonly require heavy machinery such as bulldozers, front-end loaders, and dump trucks. Road activities occurring in a general area would be completed within a single season. Activities in specific locations could last from a day to weeks.

After project implementation is complete, about 153 miles of road is proposed for decommissioning within MSO habitat (16% of the 957 total open roads in MSO habitat). Roads proposed for decommissioning would occur in each MSO habitat type. About 14% of the 787 miles of road within MSO critical habitat (111 miles) is proposed for decommissioning.

About 44 miles of open roads in protected habitat would be decommissioned across 4 RUs and 12 different subunits (Table 198). About 29% of total road miles in 52 PACs would be decommissioned. Decommissioning roads in PACs would occur outside the breeding season and average 0.8 mile of road per PAC (range of work = 0.02 to 3.8 miles in individual PACs). One PAC with road decommissioning is on the Kaibab National Forest (Sitgreaves with 0.8 mile proposed for decommissioning) and the remaining PACs are on the Coconino National Forest. Road decommissioning would occur in 13 core areas, including about 5 out of about 7.6 total road miles in core areas (66%). An average of 0.38 mile of road would be decommissioned per core area (range = 0.02 to 0.93 mile in individual core areas). All 13 core areas are on the Coconino National Forest.

Table 198. Road Miles Proposed for Decommissioning Within PAC Habitat by Sub-Unit

Forest	Subunit	Road Miles Proposed For Decommission	Total Road Miles	% of Roads Decommissioned
Coconino National Forest	1-1	0.1	1.7	6
	1-3	8.2	46.9	17
	1-4	1.2	11.7	10
	1-5	20.0	120.7	17
	3-3	0.7	2.9	24
	3-4	5.4	7.6	71
	3-5	2.3	17.7	13
	4-3	1.3	1.6	81

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Forest	Subunit	Road Miles Proposed For Decommission	Total Road Miles	% of Roads Decommissioned
	4-4	0.2	0.2	100
	5-1	4.4	19.3	23
	5-2	0.2	16.1	1
Kaibab National Forest	4-4	0.1	2.2	5
Total		**44.0**	**251**	**18**

Nearly 110 miles of open roads in restricted habitat would be decommissioned across 15 different subunits, including about 16 miles (20%) within target and threshold habitat (Table 199).

Table 199. Proposed Road Decommissioning in Restricted Habitat by Subunit on the Coconino (CNF) and Kaibab (KNF) National Forests

Forest	Restoration Sub-unit	Restricted Other Habitat			Target and Threshold Habitats		
		Road Miles Proposed for Decom-missioned	Total Road Miles	Percent of Total Roads Decom-missioned	Road Miles Proposed for Decom-mission	Total Road Miles	Percent of Total Roads Decom-missioned
CNF	1-1	6.0	21.6	28	0.9	1.7	55
	1-2	0.7	3.4	21	0	0	0
	1-3	8.6	62.9	14	5.0	15.7	32
	1-4	0.3	3.0	9	0.1	0.1	110
	1-5	14.1	92.4	15	4.3	14.1	30
	3-3	2.8	9.7	29	0.5	2	27
	3-4	5.4	19.9	27	2.1	3.2	65
	3-5	28.4	133.1	21	1.0	20.8	5
	4-5	0.2	0.6	29	0	0	0
	5-1	2.9	8.2	35	0	0.7	0
	5-2	2.5	10.0	25	0.4	1.3	32
KNF	3-1	8.2	126.1	7	0.1	7	1
	3-2	7.1	53.9	13	1.3	7.7	17
	3-3	4.4	70.2	6	0.4	7.5	6
	4-3	0.1	0.6	25	0	0	0
	4-4	1.4	8.9	16	0	0.3	0
Total		**93.1**	**623.9**	**15**	**16.3**	**82.1**	**20**

Site-specific determinations have not been made for road decommissioning techniques. Some may be closed by posting carsonite or fiberglass signs and placing obstructions, which would require a small crew and front-end loader. Some actions could include reestablishing natural drainage patterns and removing fill and culverts. Full obliteration would require re-contouring and restoring natural slopes. These latter activities require earth-moving machinery. Because of their short length, each road segment would be expected to be decommissioned within a single day. Full obliteration could take several days. Timing

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restrictions would avoid potential noise disturbance to nesting MSOs. Owls roosting or foraging in PACs during the nesting season would not be expected to be disturbed by these activities. MSOs foraging or roosting outside of PACs or those that remain in the PAC vicinity outside of nesting season may be disturbed by decommissioning activities.

Access provided by roads can affect elements of MSO habitat. While limits exist on the legal removal of snags and logs, a direct correlation was identified between snag availability and road access. Snags were nearly three times more abundant in stands away from roads as they were in stands with roads, and snags were less abundant in stands closer to towns or in flatter topography (Wisdom and Bates 2008). A similar relationship between human access and decreased snag and log availability was recognized in northern Arizona pine-oak habitat within the 4FRI treatment area (Chambers 2002, Ganey pers. comm. 2012). Road decommissioning within MSO habitat should help retain snags and logs for MSOs and their prey.

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Dust abatement would occur when hauling during dry conditions (Table 200) Treatments would be temporary and only used during active hauling on the identified road segment. Eight road segments have been identified for dust abatement, totaling less than 7 miles in length. Six of eight segments are outside of MSO habitat and two segments occur in restricted "other" habitat, totaling <1 mile in length. Neither segment includes stream channel crossings.

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Table 200. Road Segment Lengths Proposed for Dust Abatement in MSO Restricted "Other" Habitat

Road Number	Segment Length (miles)	General Location	Wildlife Habitat
140	0.5	Big Spring Canyon	MSO restricted
141	0.3	Pitman Valley	MSO restricted

An expert panel sponsored by the U.S. Environmental Protection Agency conducted a literature review of dust suppressants (Piechota et al. 2004) Magnesium chloride ($MgCl_2$) is the most widely used salt for suppressing dust. Salts move through soil easily with water and negatively impact plant growth near application sites. Salts can brown needles on live pine trees and, with repeated applications, increases tree mortality. Lignin, another common dust inhibitor, has been found to cause weight gain and colon ulcers in lab testing of rodents. Overall, lignin may be the most environmentally compatible dust suppressant and did not prevent seed germination in field trials (Piechota et al. 2004).

Piechota et al. (2004) concluded that determining environmental effects of dust must be based on assessing site-specific conditions. Dust abatement treatments would be limited in the 4FRI, occurring in selected areas where private landownership concerns could arise. The effectiveness of $MgCl_2$ increases with increasing humidity levels (Piechota et al. 2004). However, humidity is low in northern Arizona outside of the monsoon season, and there would be little or no need for dust abatement during the monsoon rains. Therefore, lignin would probably be used most often on the 4FRI landscape. Because of the limited application both spatially and temporally, and because locations do not include sensitive areas such as open water, dust abatement is not expected to result in measurable effects to MSO.

Noise Disturbance

Noise disturbance to owls has typically been a concern with road-related activities. In response, disturbance researchers have monitored owl response to different noise sources and volumes. Experiments have been conducted at varying distances from known nest and roost sites, correlating noise levels with the biology and/or behavior of owls. A simple but consistent relationship has been identified

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between noise and distance to birds: as stimulus distance decreased, spotted owl response increased, regardless of stimulus type or season (Wasser et al. 1997, Delaney et al. 1999).

In a study on helicopter and chainsaw disturbance, distance was a better predictor of spotted owl response to helicopter flights than noise levels (Delaney et al. 1999). MSO behavioral responses were minimal when helicopter and chainsaw noise disturbance stimuli were at least 115 yards/0.06 mile away. At this distance, no birds flushed from their nest. An alert response (i.e., turning toward the source of the noise) was documented at 0.25 mile (Delaney et al. 1999). Wasser et al. (1997) found a statistically significant difference in levels of the stress hormone corticosterone in male northern spotted owls within 0.25 mile from a major logging road compared to owls > 0.25 mile from the disturbance. Owls farther than 0.25 mile had lower levels of corticosterone. No difference between distances was apparent for female owls. Higher corticosterone levels were apparent for male owls in close proximity to clear-cutting versus those near selectively logged areas (Wasser et al. 1997). All areas were in the drier forest types on the east side of the Cascade Mountains. No nesting or roosting spotted owls flushed when motorcycles were beyond about 77 yards/0.04 mile (Delaney and Grubb 2003).

Adults never flushed in response to noise testing during the nesting season until after juveniles had left the nest; no flushes were elicited during the incubation and nestling phases (Delaney et al. 1999). While no physical response was noted, this does not address potential physiological responses in adult birds. However, flushing later in the reproductive cycle suggests a decrease in adult defensive or protective behavior as juveniles matured (Delaney et al. 1999). Similarly, mean fecal corticosterone levels more than doubled in adult females when young began to fledge in the absence of noise disturbance (Wasser et al. 1997). This pattern in female corticosterone levels was significant regardless of whether they nested. Spot samples collected ad libitum across Washington and Oregon revealed no effect of season on males (Wasser et al. 1997).

Flushing or displaying an alert response is a proximate behavior. More important is the effects of these behaviors on reproduction. Reproductive success, or the number of young fledged, did not differ between comparing manipulated and non-manipulated nest sites in noise experiments with helicopters and chainsaws (Delaney et al. 1999). While chainsaw noise elicited a stronger response than helicopter overflights (Delaney et al. 1999), chainsaw exposure did not result in a detectable increase in fecal corticosterone levels (Tempel and Gutiérrez 2003). All nesting spotted owls exposed to motorcycle testing successfully fledged young (Delaney and Grubb 2003). Noise from management activities conducted during the breeding season was evaluated using 19 years of demographic data for northern spotted owls and no direct effects were detected as measured by reproductive output (Damiani et al. undated). Although Damiani et al. (undated) hypothesized that it may take at least a decade for cumulative negative effects of disturbance to have an effect on reproductive output, the data did not support this relationship.

Spotted owls tend to be less affected by nonthreatening human activity occurring in close proximity than are most other raptor species (Delaney et al. 1999). Trend data suggest the likelihood of spotted owls habituating to repeated exposures to disturbance during the course of the nesting season, but sample sizes were too small to establish significance of the trends (Delaney et al. 1999). These findings corroborate the results of another study that suggested spotted owls can tolerate low-intensity human sound in their environment without eliciting a physiological stress response (Tempel and Gutiérrez 2003). Spotted owls are known to nest near roads with heavy truck traffic (Franklin pers. comm. 2013). While these studies are not definitive, the impacts of low-level repeated noise do not appear to affect reproduction. Based on these observations, 4FRI-related vehicle noises, including regular truck traffic occurring farther than 0.25 mile from owls, might not cause a detectable stress response in nesting and roosting MSOs.

Available research does not address the effect of noise to owls foraging outside of PACs or to owls outside the breeding season. Owls can be active during crepuscular hours and could, on occasion, forage

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during daylight, increasing the risk of noise disturbance from road activities to individual foraging MSOs. In addition, hauling of forest materials is also likely to occur at night. Disturbance to foraging owls would be site-specific and could cause owls to shift to areas that provide undisturbed foraging opportunities. There could be energetic costs and increased risk of predation associated with displacement of foraging owls. The likelihood of this occurring is unknown as are the actual effects.

Transportation-related activities have timing or distance restrictions in or near PACs and core areas. The intent and expectation is to avoid all mechanized equipment in core areas and avoid working in PACs during the nesting season. Hauling would occur in one PAC and along the border of another PAC during the nesting season. In both cases, the haul roads are >0.25 mile from the core areas. An added mitigation factor would require trucks to drive <25 mph within PAC boundaries. We expect to avoid noise disturbance to nesting and roosting owls as a result of preplanning, project design features, and mitigation. Foraging owls could be affected by noise, but based on research related to mechanical noise disturbance, we do not expect adverse effects. However, history has shown that timelines and circumstances can change in ongoing projects. It is not unreasonable to anticipate unforeseen circumstances leading to a need to conduct road work or hauling within a PAC during the breeding season. The risk of this occurring is exasperated by the spatial and temporal scales of the project. While this is not the intent of the project, if exceptions were to occur, they would be limited in number and scale and the USFWS would be notified.

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Collisions

In the short term, road work and particularly hauling materials off forest increases the risk of collisions between MSOs and vehicles involved in forest harvest activities. There are documented mortalities of MSOs from collisions with moving vehicles, including on unpaved forest roads (USDI FWS 2012a). Little information is available on how frequently collisions might occur and what conditions might relate to owls being more or less vulnerable. Birds migrating or dispersing through unfamiliar terrain may be at higher risk than resident birds (USDI FWS 2012a). As reported above, on average, there would be an estimated maximum of 420 truck trips per day across the 4FRI landscape during a 276-day hauling season. This average would be reduced if more chipping occurred rather than harvesting of merchantable materials, if shorter winters extended the hauling season, or if fewer acres were treated than the total analyzed, as is common for most projects. While collisions are not typically analyzed in vegetation manipulation projects, we felt the scale of the 4FRI in terms of time, area, and intensity of road traffic warranted this consideration.

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Task orders will be issued to implement work in defined portions of the 4FRI area on a yearly basis. Work will be spread across the treatment area and implementation would occur in an incremental manner as new annual task orders are issued. Vehicular activities resulting from harvest operations would increase current traffic levels well above existing conditions in portions of the treatment area on an annual basis for the duration of the project. This would typically create an increase in risk of collisions in localized areas for about 2 years before operations would shift to other areas. The level of short-term risk cannot be quantified, i.e., there is no defined relationship between open road miles or vehicle use and collisions with owls. Nevertheless, whatever the current risk level is, it would likely increase with implementation of the 4FRI. This localized, short-term risk would continue to move around the landscape for the duration of 4FRI-related harvest activities, although not all harvest and related actions would overlap with MSO habitat. Once harvest activities are complete, about 860 miles of road would be decommissioned, decreasing the risk of collisions across the implementation area over the long term.

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Habitat Loss and Fragmentation Due to Roads

Roads (versus road work) could potentially affect MSOs through impacts to prey species. Roads can both directly and indirectly affect individual wildlife species and their associated habitats. Roads can cause a

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decline in habitat effectiveness in addition to the outright loss of habitat. Roads can also present barriers to some species, potentially affecting a species' persistence of occupancy in fragmented habitats.

The footprint of a new road represents a direct loss of habitat. Temporary roads would be constructed with a minimum amount of disturbance, because they would be decommissioned when treatments are completed. A temporary road typically requires about an 18-foot-wide travel way. Depending on site conditions, they could also require roadside work such as ditches, slope cuts, fill, and berms. This could enlarge the overall road disturbance to 25 feet wide. Some roadside work would still support grasses, forbs, and shrubs, thereby retaining habitat value (Bissonette and Rosa 2009, Conniff 2013). Assuming a width of 25 feet, 1 mile of road would replace about 3 acres of habitat.

Over half of the needed temporary roads already exist as functional roads on the landscape. They are not part of the National Forest System road network and so are considered temporary. All proposed temporary roads in protected habitat currently exist on the ground. Temporary roads in restricted habitat would be a mix of existing and constructed roads. About 68 total miles of temporary roads would occur in restricted habitat. The exact breakdown of existing temporary roads and those requiring new construction are not known a priori. A conservative approach to estimating habitat loss (i.e., one that reflects the greatest impact to habitat) is to assume all temporary roads in restricted habitat would require new construction. Assuming all temporary roads would require a 25-foot- wide disturbance zone, 68 miles of new road construction would lead to the loss of about 204 acres of forest in the short term. However, no new permanent roads would be constructed in MSO habitat and all temporary roads would be decommissioned when treatments are complete, including currently existing temporary roads. In the long term, available habitat would increase as a result of temporary road decommissioning.

In addition to direct habitat loss, wildlife species sensitive to road effects can potentially be affected by decreases in habitat quality near roads, risk of mortality from collisions with vehicles, loss of access to resources on the other side of the road (barrier effect), and loss of population/meta-population function as animals are split into smaller and more vulnerable fractions (i.e., loss of connectivity/habitat fragmentation; Jaeger et al. 2005). Roads will affect persistence of animal populations differently depending on (1) road avoidance behavior of the animals (e.g., noise avoidance, road surface avoidance, and car avoidance); (2) population sensitivity to road effects; (3) road size and type; and (4) traffic volume (Jaeger et al. 2005).

Bissonette and Rosa (2009) examined how roads affect habitat in vegetation zones adjacent to an Interstate highway in the Southwest. They evaluated road effects and habitat effectiveness by examining small mammal communities at increasing distances from the highway. They recorded 11 genera and 13 species, but detected no clear road effects on wildlife abundance, density, or diversity. Two of 13 species were never captured near roads. The abundance of the remaining 11 small mammal species was either similar at different distances from the road or increased closer to the road. Comparable results were documented by McGregor et al. (2008) who found small mammal densities did not decrease near roads and found no evidence for decreases in small mammal densities with increasing traffic levels. Bissonette and Rosa (2009) concluded that adjacent zones of vegetation often provide favorable microhabitat for many small mammals. In an unrelated study that quantified the relationship between road density and relative wildlife abundance, none of the habitat and vegetation variables measured showed a significant correlation with road densities and were dropped from further analysis (Rytwinski and Fahrig 2011). Managing for improved roadside and median vegetation was proposed as a way to increase beneficial aspects of wildlife habitat near roads (Conniff 2013).

Another study tested the hypotheses that mobile species should be more negatively affected by road mortality than less mobile species (because they interact with roads more often) and that species with lower reproductive rates and longer generation times should be more susceptible to road effects because

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they are less able to rebound quickly from population declines (Rytwinski and Fahrig 2011). Low reproductive rates were the best predictor of negative population-level responses to roads, explaining nearly 70% of the variation in the coefficients relating mammal abundance to road density (Rytwinski and Fahrig 2011). Increasing body size and increasing home range area were also predictors of negative effects of road density on relative abundance of wildlife. None of the possible confounding vegetation and habitat variables they measured were significantly correlated with road density. The authors suggested priority should be placed on mitigating road effects on large mammals with low reproductive rates (Rytwinski and Fahrig 2011). The lack of negative effects for species with high reproductive rates, small body size, and smaller home range movements agree with the results described by McGregor et al. (2008) for small mammals and road densities. Some of the small mammals included in this study were of the same genera as MSO prey species.

Fahrig and Rytwinski (2009) completed a systematic review of 79 studies addressing road effects on wildlife. Interestingly, they never define "road," but the implication is that they are assessing highways. This implication is based on repeated references to traffic levels that present direct barriers, traffic noise levels that indirectly inhibit songbird communication, fencing along roadways that inhibit movement, effects of road surfaces inhibiting wildlife movements with associated figures displaying paved roads, and potential wildlife crossings ("ecopassages") to mitigate road effects. This is an important point, given the significant differences between highways and the temporary forest roads proposed in the 4FRI in regard to scale of the roadway footprint, native rock surfacing, lack of fencing, much lower traffic volumes, and the ephemeral nature of the roads.

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Fahrig and Rytwinski (2009) concluded roads had negative effects on most species (114), positive effects on 22 species, and 56 species showed no effects. Patterns were apparent within taxa and based on body size. Amphibians and reptiles tended to show negative effects. Birds showed mainly negative or no effects, with a few positive effects for some small birds and for vultures. Small mammals generally showed either positive effects or no effect, mid-sized mammals showed either negative effects or no effect, and large mammals showed predominantly negative effects. General patterns for invertebrates were not apparent, because of the small number of studies for this group. The small mammal species reviewed included some of the same genera and sometimes the same species as those preyed on by MSOs (Table 201). They concluded that some small mammal species that are not disturbed by road traffic, and have small movement ranges, small territory sizes, and high reproductive rates are unlikely to be negatively affected by roads because road mortality is low and viable populations can exist within areas bounded by roads.

Table 201. Small mammal response to roads, adapted from Fahrig and Rytwinski 2009

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Common Name	Scientific Name	Response
Ground squirrel	*Ammospermophilus*	neutral
Voles	*Microtus* spp	neutral/positive
Woodrat	*Neotoma lepida*	neutral
Deer Mice	*Peromyscus* spp	neutral/negative, neutral, neutral/positive, and positive
Other Mice	*Ochrotomys* and *Mus* spp	neutral & positive
Chipmunk	*Tamias* spp	positive

McGregor et al. (2008) looked specifically at road effects on small mammals and they did document avoidance behavior. They found no significant effects on small mammal densities near roads or in association with road traffic. When they experimentally translocated animals they did find that every

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intervening road reduced the probability of successful returns by 50%. They concluded that roads were partial barriers and also detected some indications that small mammals avoided cars. They also determined that small mammals were avoiding the road surface itself and not the traffic or traffic noise. All roads included in the study were paved. Road widths including shoulders ranged from 22 to 58 feet.

Jaeger et al. (2005) conducted a systematic review and meta-analysis of road effects on wildlife populations. They built a model addressing road effects and persistence of wildlife populations. The most vulnerable populations were those with high noise and high road surface avoidance. Small mammals do not seem to avoid road noise (McGregor et al. 2008). Road definitions for the model included small roads consisting of one lane in each direction and large roads with two or more lanes in each direction. All roads were assumed to be paved (Jaeger et al. 2005). Similar to McGregor et al. (2008), they found road effects strongly tied to the surface pavement. An additional finding of Jaeger et al. (2005) was that population persistence was tied more to traffic volume than road size. They assumed that a species avoiding noise would not live in a place adjacent to low traffic volumes. Conversely, a species with only slight noise avoidance would breed in appropriate habitat irrespective of distance from roads. As described above, no clear effects were detected for small mammal abundance, density, or diversity relative to distance from roads, including species and genera preyed on by MSOs.

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While roads are barriers to animal movement and could affect population persistence for some species, this by itself is a very broad generalization. The literature indicates that relatively small, unpaved roads are not likely to affect populations of small mammals, including MSO mammalian prey species (Jaeger et al. 2005, McGregor et al. 2008, Bissonette and Rosa 2009, Fahrig and Rytwinski 2009). While individual animals may be killed by vehicles while they are crossing the road, overall effects to small mammals are not likely to occur at a scale that would affect MSOs. Decommissioning over 900 miles of currently open roads across the 4FRI treatment area would further benefit owls and their prey in the long term by restoring habitat.

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Fire

Smoke Disturbance

Burning in PACs would occur outside the MSO breeding season (i.e., from September 1 through February 28) and would include core areas, eliminating the need to build firelines inside most PACs (see below). In addition to direct habitat loss, burning could potentially disturb owls due to smoke emissions.

A series of meetings were held with fire experts from the Coconino and Kaibab National Forests and members of the 4FRI team to address the risk of smoke settling into PACs from fires ignited outside of PACs (Appendix 8). Risk evaluations were based on landscape features, air movement, whether an area had burned in the last 20 years or whether a prescribed fire under 4FRI would be outside the normal fire return interval, and using the combined experiences of fire personnel led to identifying exclusion and opportunity zones. Areas outside of but upwind and in proximity to PACs (in terms of air flow, regardless of distance) were delineated across the project area. These buffer areas were identified as exclusion zones where burning would only occur outside the breeding season in order to minimize of the risk of smoke settling into downwind PACs. Opportunity zones are areas outside of protected habitat that could be burned during the breeding season (March 1 – August 31) and where smoke is unlikely to affect downwind PACs. Results were reviewed with the USFWS.

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Vulnerability of each individual PACs to collect was also evaluated across the 4FRI project area. Smoke and air movement patterns were evaluated and landscape-scaled features that affect air movement patterns were evaluated in addition to drawing on expert experience. It was concluded that most PACs on cinder cones (e.g., Kendrick, Sitgreaves, Mormon Mountain, etc.) and other prominent, raised topographic

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features, and most PACs in or immediately adjacent to Sycamore Canyon, Oak Creek Canyon and the Mogollon Rim would not be expected to have smoke settle long enough to cause discernible effects to MSOs. Conversely, smoke is more likely to settle in PACs with core areas occurring in small canyons (e.g., James, Kelly, Walnut, etc.).

Dense smoke settling for multiple consecutive nights could affect the lungs of incubating adults and nestlings. Japanese quail continuously exposed to ozone for seven days had lung damage when concentrations were maintained at 0.15 ppm (Rombout et al. 1991). Ozone concentrations of 1.50 ppm led to statistically significant damage to a critical portion of quail lungs on the region where gas exchange occurs. Avian lung design is similar across species in that they are composed of interconnecting air sacs that create unidirectional air flow which, combined with blood flow, contribute to the remarkable efficiency in gas exchange (Maina 1988). This efficiency could increase susceptibility to lung damage. Mammalian airways form a tree-like branching pattern that terminate in alveoli rather than forming a unidirectional air flow. Japanese quail appear to lack the morphological and biochemical repair ability observed in mammals (Rombout et al. 1991). Therefore, it is assumed that prolonged exposure to smoke would cause permanent lung damage to MSO nestlings from ozone and, presumably, from particulate matter. Causing irreparable lung damage to adults or juveniles would be a long-term adverse effect.

Prolonged exposure causing lung damage to Japanese quail was seven days of continuous contact. Here prolonged exposure is defined as three or more continuous days and nights of smoke contact. Smoke settling into PACs less than three continuous days and nights would not be expected to cause adverse effects.

Fire experts on the Coconino and Kaibab National Forests indicated smoke associated with prescribed fire typically does not typically settle into low-lying areas for more than two or three nights. Limited smoke within PACs represents an aspect of the evolutionary environment for wildlife in northern Arizona and, as such, should result in negligible effects to MSO (Horton and Mannan 1988). However, first-entry burns would include fuel loads above historical levels, causing quantities of smoke greater than what would likely have occurred during frequent fire return intervals. As a result, uncharacteristically dense smoke could settle into PACs during initial burn operations.

Dense smoke from first-entry burns (i.e., areas that have not burned in 20 or more years) settling into core areas early in the season (March through June) could affect brooding females. The adult female is not likely to flush from the nest at this time. This is based on observations of nesting goshawks that, in terms of ecological niche, are similar to a diurnal equivalent of spotted owls. Incubating goshawks are tolerant of low levels of human disturbance and smoke, but are notoriously aggressive once the nestlings are older (Reynolds pers. comm. 2013). While there are no equivalent observations of MSOs, adults responding to noise disturbance only flushed after juveniles had left the nest; no flushes were elicited during the incubation and nestling phases (Delaney et al. 1999). While flushing is unlikely, leaving eggs unattended would be considered an adverse effect if an adult MSO interrupted egg incubation due to management activities.

Smoke from prescribed fire would comply with Arizona Department of Environmental Quality requirements (ADEQ). Smoke effects are regulated and permits are required by ADEQ before burning is initiated. Air quality requirements specify management actions will meet air quality standards. ADEQ considers the cumulative effects of smoke emissions from multiple jurisdictions prior to approving daily prescribed burning activities. This mitigates the potential for severe smoke effects from multiple prescribed fire projects across the entire treatment area.

Because burning within exclusion zones would be conducted in association with PAC burning outside the breeding season, smoke from prescribed fire would not be expected to result in adverse effects to MSO.

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MSO Critical Habitat

Forest Structure

Critical habitat is a mix of protected and restricted habitat. Therefore, results are similar to those described above for protected and restricted habitat. However, restricted habitat has a greater influence on critical habitat results because of the greater acreage. Overall, projected changes in tree size-class distribution in critical habitat would be small. The general pattern in the distribution of tree size classes across CHUs includes:

1) a consistent short-term decrease in the percentage of trees <18 inches dbh (1 to 6% by individual CHU) where thinning actions would be focused;

2) a consistent increase in trees 18 to 23.9 inches dbh in the short term (1 to 5% by individual CHU) as a result of thinning actions;

3) increases in the ratio of trees ≥24 inches dbh (1 to 10% by individual CHU) in the short and long term.

Model results displaying differences of a few percentages or less may not relate to real differences on the ground. However, consistent differences likely reflect real change. Most critical habitat acres (68%) occurring in the treatment area would be thinned and all critical habitat acres would be burned (Table 202). Treatments are the same as those described above for protected and restricted habitat.

Table 202. Thinning and Burning Treatments in MSO Critical Habitat (CH)

Acres Thinned	% of Total	Acres Burned	% of Total
61,128	69	88,143	100

Distribution of Large Trees

While the area dominated by large trees would increase, the actual count of TPA >18 inches dbh would decrease or stay about the same (Table 203). The difference between occupied area and stem count results from thinning trees 12 to 18 inches dbh. One result of the thinning is to retain and enhance large trees and large tree growth rates. Another result is fewer trees entering the larger dbh size classes in the future. Nevertheless, the average number of trees ≥18 inches dbh would be greater than or equal to existing conditions in all CHUs with increases in trees >24 inches dbh.

Basal Area

Ponderosa pine BA would decrease and BA for Gambel oak would decrease or stay about the same (Table 203). Treatment objectives are to avoid oak, but loss is expected due to operations, including prescribed fire. Loss of oak due to operations is expected to be rare and site-specific, therefore the changes are likely a result of burning. Presumably most oak lost to prescribed fire would be in smaller diameter classes (Abella 2008). Because Gambel oak is a prolific sprouter, small oak should return quickly. However, small-diameter oak produces fewer acorns, and the development of potential nest in roost structure would be delayed. However, total BA would range from 85 to 159.

Canopy Structure

The BA, TPA, and SDI values post-treatment are designed to provide for dense canopy conditions. Only ponderosa pine would be targeted for selection unless small trees of other species occur within a crown diameter of old ponderosa pine trees or large Gambel oak. Only when non-ponderosa pine trees are in direct competition with large and old ponderosa pine and oak, would they be targeted for removal. This

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would ensure structural heterogeneity remains in the canopy. Loss of oak would result from prescribed fire, but design features would be in place to minimize loss of larger oak, thereby limiting effects to canopy structure. Canopy continuity would be maintained in MSO habitats, but some canopy openings would be created, especially in restricted "other" habitat. Combined, this would retain nesting and roosting habitat in protected, target, and threshold habitats and move restricted "other" habitat toward a blend of denser forest with an interspersion of increased foraging opportunities. Forest densities would remain high, limiting the long-term forest health and resiliency benefits of MSO treatments. Nevertheless, treatments would focus on releasing large trees from competition, increasing growth rates of large trees and maintaining species diversity in the overstory.

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Table 203. Modeled Changes in Forest Structure Attributes in Upper Gila Mountain (UGM) Critical Habitat

Critical Habitat Unit	Existing Condition Year 2010	No Management Action Year 2020	Proposed Action Year 2020	Proposed Action Year 2050	No Management Action Year 2050
UGM-11					
Acres	48,677				
% of SDI 12-17.9" dbh	31	31	29	25	29
% of SDI 18-23.9" dbh	13	15	19	23	22
% of SDI ≥24" dbh	7	8	11	15	10
% of Max SDI	75%	77%	58%	65%	80%
TPA >18"	13	16	15	24	26
Ponderosa Pine BA	117	123	89	101	130
Gambel Oak BA	23	24	22	29	29
All BA	150	159	122	149	178
% Oak BA	15	15	18	19	16
UGM-12					
Acres	1,150				
% of SDI 12-17.9" dbh	24	25	21	20	25
% of SDI 18-23.9" dbh	13	14	19	17	17
% of SDI ≥24" dbh	12	13	19	22	15
% of Max SDI	63%	66%	40%	50%	70%
TPA >18"	12	14	12	17	20
Ponderosa Pine BA	101	107	61	77	118
Gambel Oak BA	19	21	17	25	28
All BA	126	136	85	114	159
% Oak BA	14	15	19	21	17
UGM-13					
Acres	37,609				
% of SDI 12-17.9" dbh	29	30	26	20	26
% of SDI 18-23.9" dbh	14	16	21	21	21
% of SDI ≥24" dbh	7	7	12	16	10
% of Max SDI	72%	75%	48%	58%	78%
TPA >18"	13	16	13	20	25

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Critical Habitat Unit	Existing Condition Year 2010	No Management Action Year 2020	Proposed Action Year 2020	Proposed Action Year 2050	No Management Action Year 2050
Ponderosa Pine BA	100	106	64	78	114
Gambel Oak BA	31	33	25	34	39
All BA	141	151	99	130	173
% Oak BA	21	21	25	26	22
UGM-14					
Acres	908				
% of SDI 12-17.9" dbh	34	34	34	27	28
% of SDI 18-23.9" dbh	14	16	17	24	23
% of SDI ≥24" dbh	7	8	8	13	12
% of Max SDI	64%	67%	62%	69%	71%
TPA >18"	13	16	16	27	27
Ponderosa Pine BA	97	102	94	101	108
Gambel Oak BA	14	16	15	21	21
All BA	132	143	134	159	165
% Oak BA	10	11	12	13	13
UGM-15					
Acres	570				
% of SDI 12-17.9" dbh	33	35	36	37	38
% of SDI 18-23.9" dbh	10	14	15	25	24
% of SDI ≥24" dbh	5	5	5	9	8
% of Max SDI	47%	50%	48%	53%	55%
TPA >18"	9	11	11	20	20
Ponderosa Pine BA	77	84	79	92	96
Gambel Oak BA	11	12	12	15	15
All BA	98	107	102	125	129
% Oak BA	8	8	8	9	9

MSO Prey Habitat

Snags, Logs, and Coarse Woody Debris

Snags 12 inches dbh and greater are important elements of MSO habitat and a primary constituent element of critical habitat. Snags ≥18 inches dbh are currently low in all CHUs relative to forest plan direction, and would remain so in the long term. However, snags ≥12 inches dbh would be abundant in all CHUs after treatment except for CHU 12, where they are currently low (Table 204). Future snag habitat would be improved because more large trees and improved growth rates for large trees would help ensure future recruitment of large snags, as described in the Recovery Plan.

Levels of CWD are currently above 4 tons per acre in all CHUs (Table 204). CWD levels would be reduced immediately post-treatment. Burn objectives would be to reduce surface fuels, particularly needles and duff. Therefore, a reduction in CWD levels would also occur. Nevertheless, CWD would accumulate relatively quickly after both thinning and burning. CWD would be abundant in the long term. Logs are currently across CHUs, relative to forest plan direction. Changes would be slight after harvest (fractions of a log per acre) but increases would be common (Table 204). Low-severity prescribed burning

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is expected to create a patchy mosaic, including unburned areas where logs and CWD would be higher, creating a heterogeneous distribution of woody debris.

Species Richness and Abundance in the Herbaceous Layer

Understory response would be variable relative to existing conditions. It would consistently increase in all CHUs relative to no action through 2020 (Table 204). Increases in the relative index for understory response relates to biomass quantity. It is assumed that large post-treatment increases in understory yield would also increase understory species richness and increase arthropod abundance and richness as well (Appendix 8 of the 4FRI wildlife specialist report). Prescribed burning, which is not factored into the index equations, would also contribute positively to understory response by reducing the inhibiting effects of pine duff and needles, adding a nutrient pulse to the soils, and exposing portions of the seed bank to smoke, thus increasing germination rates (Appendix 8 of the 4FRI wildlife specialist report). Combined, this would increase food and cover for most MSO prey species. These values would likely peak within a couple years of implementation and then decrease as the overstory canopy expanded and pine needles began accumulating on the forest floor.

Table 204. Modeled Changes in Prey Habitat Attributes in Upper Gila Mountain (UGM) Critical Habitat

Critical Habitat Unit	Existing Condition Year 2010	No Management Action Year 2020	Proposed Action Year 2020	Proposed Action Year 2050	No Management Action Year 2050
UGM-11					
Acres			48,677		
Snags >12" dbh	2.99	3.81	4.81	4.91	7.00
Snags 12" – 17.9" dbh	2.45	3.23	4.11	3.58	5.59
Snags ≥18" dbh	0.53	0.58	0.71	1.32	1.41
CWD >3" (tons/ac.)	5.12	6.63	3.23	6.85	10.78
Logs per Acre	1.93	2.79	2.26	5.50	6.10
CWD >12" (tons/ac.)	0.64	0.93	0.75	1.83	2.03
Understory Index	35	30	59	36	21
UGM-12					
Acres			1,150		
Snags >12" dbh	1.73	2.18	3.34	2.55	4.56
Snags 12" – 17.9" dbh	1.23	1.68	2.54	1.63	3.56
Snags ≥18" dbh	0.50	0.49	0.80	0.91	1.01
CWD >3" (tons/ac.)	4.15	5.11	2.80	5.25	7.98
Logs per Acre	1.58	2.07	1.98	4.13	4.04
CWD >12" (tons/ac.)	0.53	0.69	0.66	1.38	1.35
Understory Index	182	160	319	210	123
UGM-13					
Acres			37,609		
Snags >12" dbh	2.49	3.27	4.93	3.10	5.95
Snags 12" – 17.9" dbh	2.01	2.70	3.98	1.98	4.59
Snags ≥18" dbh	0.48	0.57	0.95	1.13	1.35
CWD >3" (tons/ac.)	4.11	5.45	3.25	6.54	9.26

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Critical Habitat Unit	Existing Condition Year 2010	No Management Action Year 2020	Proposed Action Year 2020	Proposed Action Year 2050	No Management Action Year 2050
Logs per Acre	1.76	2.45	2.41	5.33	5.34
CWD >12" (tons/ac.)	0.59	0.82	0.80	1.78	1.78
Understory Index	52	44	110	63	30
UGM-14					
Acres	908				
Snags >12" dbh	3.15	3.83	5.12	6.74	7.25
Snags 12" – 17.9" dbh	2.61	3.24	4.51	5.04	5.55
Snags ≥18" dbh	0.54	0.59	0.61	1.70	1.71
CWD >3" (tons/ac.)	5.51	6.86	2.83	7.43	10.95
Logs per Acre	3.18	4.10	2.57	6.88	7.98
CWD >12" (tons/ac.)	1.06	1.37	0.86	2.29	2.66
Understory Index	42	35	44	27	23
UGM-15					
Acres	570				
Snags >12" dbh	2.39	2.97	4.30	5.23	5.56
Snags 12" – 17.9" dbh	2.00	2.53	3.82	3.92	4.24
Snags ≥18" dbh	0.40	0.43	0.47	1.31	1.31
CWD >3" (tons/ac.)	5.55	6.42	2.53	5.82	9.06
Logs per Acre	1.26	1.90	1.24	4.29	4.60
CWD >12" (tons/ac.)	0.42	0.63	0.41	1.43	1.53
Understory Index	95	80	87	58	53

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Aquatic Species and Critical Habitat Direct and Indirect Effects

Effects of Vegetation Management

Direct effects of vegetation management on stream systems should be minor when Forest Service BMPs are followed (Region 3 FSH 2509.22). These include providing an adequate buffer from harvest operations, designation of all channel crossing locations by mechanized equipment, and designation of skid trails, to avoid crossing stream channels (ephemeral and intermittent). Limiting vegetation management activities from impacting stream courses should lead to minor or inconsequential direct effects to stream habitat and associated biota. While prescribed fire has the ability to have direct effects to stream channels, none of the action alternatives propose for ignitions to occur within riparian areas or along stream channels, but fire is allowed to back downslope into these areas. If fire burns riparian areas, there is the potential for some ash and localized erosion to occur; however, these effects should be minor in degree and extent, particularly if BMPs are followed (Table 205).

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Table 205. Resource Protection Measures Required for All Action Alternatives

BMP #	Mitigation	Why
1	Implement Best Management Practices prior to project implementation.	To minimize impacts to soil and water resources from project implementation, to minimize non-point source pollution, to adhere to the Clean Water Act, and to adhere to the intergovernmental agreement between Region 3 of the Forest Service and the Arizona Department of Environmental Quality.
2	Minimize mechanical operations when ground conditions are such that soil compaction can occur. All activities should be limited/restricted to when soils are dry or frozen. If compaction occurs, mitigate through ripping, seeding and covering compacted areas with slash.	To minimize soil compaction, soil detachment & sediment transport. To maintain long-term soil productivity.
3	All fueling of vehicles will be done on a designated protected, upland site. If more than 1320 of gallons of petroleum products are to be stored on site above ground or if a single container exceeds 660 gallons, then a spill prevention control and countermeasures plan (SPCC) will be prepared as per 40 CFR 112).	To prevent contamination of waters from accidental spills.

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BMP #	Mitigation	Why
4	The following applies to any personnel implementing ground-disturbing actions: Prior to moving off-road equipment onto a project area, contractor shall identify the location of the equipment's most recent operation. Contractor shall not move any off-road equipment that last operated in an area infested with one or more invasive species of concern onto sale area without having cleaned such equipment of seeds, soil, vegetative matter, and other debris that could contain or hold seeds, and having notified Forest Service, as provided in (iii). If the location of prior operation cannot be identified, then contractor shall assume that the location is infested with invasive species of concern. If the contractor has worked in areas where potential chytrid fungus could occur, contractor shall assume chytrid fungus is present and must disinfect equipment prior to work adjacent to water bodies. (i – intentionally omitted) (ii) Prior to moving Off-road equipment from a cutting unit or cutting area that is shown on contract area or sale area map to be infested with invasive species of concern to, or through any other area that is shown as being free of invasive species of concern, or infested with a different invasive species, contractor shall clean such equipment of seeds, soil, vegetative matter, and other debris that could contain or hold seeds and/or disinfect as necessary, and shall notify the Forest Service, as provided in (iii) Prior to moving any off-road equipment subject to the cleaning and disinfecting requirements set forth above, contractor, shall advise Forest Service of its cleaning measures and make the equipment available for inspection. Forest Service shall have 2 days, excluding weekends and Federal holidays, to inspect equipment after it has been made available. After satisfactory inspection or after such 2 day period, contractor may move the equipment as planned. Equipment shall be considered clean when a visual inspection does not disclose seeds, soil, vegetative matter, and other debris that could contain or hold seeds. Contractor shall not be required to disassemble equipment unless so directed by the Forest Service after inspection. (iv) If contractor desires to clean off-road equipment on National Forest land, such as at the end of a project or prior to moving to, or through an area that is free of invasive species of concern, contractor shall obtain prior approval from contracting officer as to the location for such cleaning and measures, if any, for controlling impacts.	To minimize the spread of non-native species
5	If construction crews are to live on-site, then an approved camp and suitable sanitation facilities must be provided.	To protect surface and subsurface water from unacceptable levels of bacteria, nutrients and chemical pollutants.

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BMP #	Mitigation	Why
Prescribed burning and managed fires		
6	On areas to be prescribed burned, fire prescriptions should be designed to minimize soil temperatures over the entire area. High intensity fire should occur on 10% or less of the entire area. Fire prescriptions should be designed so that soil and fuel moisture temperatures are such that fire intensity is minimized and soil health and productivity are maintained. If containment lines are put in place, rehabilitate lines after use by either rolling bermed material back over the entire fireline, spreading slash across the fireline or waterbar the fireline. If line is only to be waterbarred, disguise the first 400 feet of line to discourage use as a trail.	To maintain long-term soil productivity and minimize sediment delivery from containment lines.
7	On areas to be prescribed burned, manage for 5-7 tons/acre of course woody debris in ponderosa pine be left on-site after the prescribed burns to maintain long-term soil productivity on areas to be burned outside of the buffers around private land in. Within the pinyon-juniper cover type, snags would be managed for 1 per acre over 75% of the area and coarse woody debris (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" and ≥10' in length.	To maintain long-term soil productivity.
8	On areas to be prescribed burned, establish filter strips (also known as streamside management zones. These stream reaches will be designated as protected streamcourses. The following are recommendations to protect streamcourses. **Riparian streamcourse**: Severe erosion hazard: 120 feet on each side of streamcourse. Moderate erosion hazard: 100 feet on each side of streamcourse. Slight erosion hazard: 70 feet on each side of streamcourse. **Non-riparian streamcourse**: Severe erosion hazard: 100 feet on each side of streamcourse. Moderate erosion hazard: 70 feet on each side of streamcourse. Slight erosion hazard: 35 feet on each side of streamcourse. Do not ignite fuels within this buffer area. Some creep may occur into the buffer.	To minimize sediment and/or ash delivery into drainages and maintain water quality.
9	All burning will be coordinated daily with the Arizona Department of Environmental Quality (ADEQ). Burning will not take place on any portion of the project without prior approval from ADEQ. Coordination with ADEQ will take place through the Kaibab and Coconino National Forest Zone Dispatch Center and the Prescribed Burning Boss.	To ensure that smoke management objectives are met.

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BMP #	Mitigation	Why
Road Reconstruction and Channel Restoration		
10	Complete all required permitting (404 permits) and Water Quality Certification (if necessary), prior to project implementation.	To comply with Clean Water Act provisions.
11	Site rehabilitation on upland sites for stream channel and road reconstruction projects where ground disturbance occurs: Seed at 5 pounds/acre with native, certified weed free seed mix. Potential vegetation for individual sites should utilize the Kaibab and Coconino National Forest Terrestrial Ecosystem Survey to identify species to be utilized. Where feasible, protect site with slash spread across the disturbed area to create microclimates and protect from grazing ungulates.	To minimize soil erosion and minimize noxious weed spread and mitigate severe erosion hazard.
12	Site rehabilitation on riparian sites for stream channel and road rehabilitation projects where ground disturbance occurs: Seed at 5 pounds/acre with certified weed free native seed mix to rehabilitate the site and minimize impacts of noxious weeds. Potential vegetation for individual sites should utilize the Kaibab and Coconino National Forest Terrestrial Ecosystem Survey to identify species to be utilized. Where feasible, protect site with a variety of methods (e.g., ungulate proof fence, spreading slash etc.).	To comply with State and Federal water quality standards by minimizing soil erosion through the stabilizing influence of vegetation ground cover. Minimize noxious weed spread.
13	Install silt fences and/or waddles downstream from ground-disturbing activities in stream channels to minimize the chance of sediment being lost downstream during construction and until revegetation is completed.	To comply with State and Federal water quality standards by minimizing sediment delivery to drainages.
14	Provide site protection on newly disturbed soils (e.g. hydromulch, erosion mat, spread slash etc.) in channel restoration and road reconstruction sites on all sites as needed and where feasible.	To comply with State and Federal water quality standards by minimizing sediment delivery to drainages, minimize impacts on severe erosion hazard soils, and to create microclimate for regeneration of grass/forb community and minimize noxious weed spread.
15	Bring rock material from a local upland site to any headcut drop structures that may be installed in channel restoration projects.	To minimize disturbance in drainage systems and minimize sediment production within channel.
16	Site rehabilitation on disturbed sites at and stream channel shaping on previously obliterated roads: Site rehabilitation consists of several revegetation methods, such as, but not limited to: 1) Store sod removed from the initial ground disturbance and replace the sod from the top of the bank on the disturbed site; 2) Seed with a native seed mix (see BMPs above) 3) Protect site with slash spread across the disturbed area to create microclimates and protect from grazing ungulates. Slash placement will be limited to the upper 2/3 of the bank to limit transport downstream of woody material; 4) Fence out ungulates for 1 to 2 years (or until the site has re-established); 5) use mycorrhizal inoculum on severely disturbed sites where no topsoil is left, 6) install erosion mat.	To comply with State and Federal water quality standards by minimizing soil erosion through the stabilizing influence of vegetation ground cover. Minimize noxious weed spread.
17	Do not borrow road fill or embankment materials from the stream channel or meadow surface on road maintenance projects. End-load all material hauled on-site and compact fill.	To minimize disturbance in drainage systems and minimize sediment production within channel.

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BMP #	Mitigation	Why
18	Where feasible, relocate roads out of filter strips into an upland position. If this is not feasible, use riprap or velocity checks to stabilize or disperse outfall on road maintenance projects when roads are located within filter strips.	To minimize sediment delivery into drainage and to minimize disturbance in drainage systems and minimize sediment production within channel.
19	At riparian stream reach restoration sites, restore riparian dependent grasses through 1) seeding of native species, 2) planting plugs of rushes, sedges, and spike rushes to improve success of regeneration efforts. Fence with ungulate proof fencing for 1 to 2 years (or until plants are established) if grazing is inhibiting regeneration efforts.	To comply with State and Federal water quality standards by minimizing soil erosion through stabilization of ground cover. Minimize noxious weed spread.
20	On areas that have had roads previously obliterated and the remaining roadbed will be removed, add slash/or erosion mat and seed to the disturbed areas.	To add surface roughness a To comply with State and Federal water quality standards by minimizing soil erosion through stabilization of ground cover and to diminish the impact of the first rain event and to speed recovery of the site.
Springs and seeps		
21	At spring restoration sites, restore riparian dependent species through 1) seeding of native species, 2) planting plugs/cuttings of native plants to improve success of regeneration efforts. Fence with ungulate proof fencing for 1 to 2 years (or until plants are established) if grazing is inhibiting regeneration efforts.	To comply with State and Federal water quality standards by minimizing soil erosion through stabilization of ground cover. Minimize noxious weed spread.
Harvesting operations		
22	Do not blade roads when the road surface is too dry. If the road surface is too dry, a water truck can apply water, or the project can be scheduled for when adequate moisture occurs to complete the project.	To minimize sediment detachment and to minimize impacts on .severe erosion soils
23	In grassland restoration sites, limit skidding and designate skid trails if wood is to be removed. Where material is not to be removed, do not skid logs in meadows and lop and scatter is the preferred method of treating slash. Do not machine pile within meadows. If skidding has to occur across a riparian or non-riparian streamcourse, designate any crossing prior to skidding.	To minimize impacts to streams and soils in meadows from tree harvesting operations.
24	Skid trails and obliterated roads will have slash placed on the trail or cross-ditched (waterbarred) to break the energy flow of water. Placing slash on skid trails is the preferred method to dissipate the energy flow of water. Waterbars are only to be implemented with equipment with an articulating blade (no skidders) or by hand.	To minimize soil erosion and maintain soil productivity. and to minimize impacts on .severe erosion soils
25	Landing locations will be in upland positions and out of meadows, riparian and non-riparian filter strips.	To minimize sediment delivery into drainage. and to minimize impacts on .severe erosion soils
26	Mechanical harvest or mechanical fuel treatment are only allowed on Cinder Cones greater than 25% slope with designated skid trails and slash mats placed on the skid trails. On other sites, mechanized harvesting can occur up to 40% slopes.	To maintain long-term soil productivity on slopes with severe erosion hazard potential
27	Designated skid trails and log landings will be required within the Integrated Resource Service Contract (BMP 24.18 in FSH 2509.22) on all cutting units. Skid trail design should not have long, straight skid trails that would direct water flow. Skid trails should also be located out of filter strips (exceptions are at approved crossings).	To minimize the number of acres disturbed and to minimize impacts on .severe erosion soils .

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BMP #	Mitigation	Why
28	Felling to the lead will be required within the Integrated Resource Service Contract (IRSC) to minimize ground disturbance from skidding operations (BMP 24.18).	Felling of timber should be done to minimize ground disturbance from skidding operations and to minimize impacts on .severe erosion soils.
29	The IRSC outlines the timing and application of erosion control methods to minimize soil loss and sedimentation of streamcourses. Seed mix can include any of the following certified weed free native species at a minimum of 5 lbs./acre pure live seed: Potential vegetation for individual sites should utilize the Kaibab and Coconino National Forest Terrestrial Ecosystem Survey to identify species to be utilized. Corresponding BMPs from FSH 2509.22 to minimize soil loss and sedimentation of include 24.13, 24.21, 24.22, 24.23, 24.24, and 24.25. The preferred erosion control method on the skid trails in the harvest areas will be by spreading slash. Other acceptable erosion control measures include, but are not limited to, waterbarring (waterbars should not be more than two feet deep and need at least a ten foot leadout. Waterbars are only to be implemented with equipment with an articulating blade (no skidders) or by hand.), removing berms, seeding, mulching and cross-ripping. Erosion control after skidding operations must be timely to minimize the effects of log skidding.	Minimize soil loss and sedimentation of streamcourses from skidding operations and to minimize noxious weed spread and re-establish native vegetation and to minimize impacts on .severe erosion soils
30	Road drainage is controlled by a variety of methods (BMP 41.14), including rolling the grade, insloping outsloping, crowning, water spreading ditches, and contour trenching. Sediment loads at drainage structures can be reduced by installing sediment filters, rock and vegetative energy dissipaters, and settling ponds. Design of roads is included in the transportation plan of the IRSC and T-specs.	To minimize soil movement and maintain water quality and to minimize impacts on .severe erosion soils.
31	Road maintenance (BMP 41.25) through the IRSC should require prehaul and post haul maintenance on all roads to be used for haul.	To minimize soil movement and maintain water quality. and to minimize impacts on severe erosion soils

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BMP #	Mitigation	Why
32	The designation of filter strips (also known as streamside management zones) minimizes on-site soil movement from timber harvest activities along streamcourses (BMP 24.16). These stream reaches will be designated as protected streamcourses. Locations of protected streamcourses are included in the individual Task Order Maps and will be designated with a protected streamcourse designation. The following are recommendations to protect streamcourses within the proposed tree harvest units in relation to riparian and non-riparian streamcourses. The guidelines for filter strip designation are as follows: **Riparian streamcourse**: Severe erosion hazard: 120 feet on each side of streamcourse. Moderate erosion hazard: 100 feet on each side of streamcourse. Slight erosion hazard: 70 feet on each side of streamcourse. **Non-riparian streamcourse**: Severe erosion hazard: 100 feet on each side of streamcourse. Moderate erosion hazard: 70 feet on each side of streamcourse. Slight erosion hazard: 35 feet on each side of streamcourse. Accepted harvest activities within riparian and non-riparian filter strips include mechanical and conventional tree felling and limited skidding on designated skid trails and not across streamcourses. Landings, decking areas, machine piles, and roads (except at designated crossings) are planned outside of riparian and non-riparian filter strips.	Filtering sediment and/or providing bank stability on all streamcourses and to minimize impacts on .severe erosion soils. To implement the Oak Creek *E. Coli* TMDL and Lake Mary Region Mercury TMDL and to filter sediment and/or provide bank stability.
33	Manage for a minimum of 5 to 7 tons per acre in ponderosa pine sites that will be left on-site on all cutting unit sites.	To promote long-term soil productivity.
34	Mechanical crushing of lopped slash can only occur on 0-25% slopes.	To incorporate slash into the soil to promote long-term soil productivity.
35	Identify landings, staging area for heavy equipment and sites for any in woods processing sites outside of filter strips and meadows. Sites will be rehabilitated after use by methods such as, but not limited to: 1) ripping to remove compaction, 2) seeding with certified weed free native seed to 5 lbs. per acre. Potential vegetation for individual sites should utilize the Kaibab and Coconino National Forest Terrestrial Ecosystem Survey to identify species to be utilized; and 3)spreading of slash to disguise the site and provide for a mulch for seeds	To minimize and mitigate impacts from activities that compact sites and to restore long-term soil productivity and to minimize impacts on .severe erosion soils .
36	Manage for a minimum of 1 to 3 tons per acre in pinyon-juniper sites that will be left on-site on all cutting unit sites. Where available, a portion would include two logs greater than or equal to 10 inches and 10 feet in length.	To promote long-term soil productivity.

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Effects of Prescribed Fire

Most effects to aquatic habitat and biota are the result of upland terrestrial changes that result in changes to sediment and water transport in the watershed. The primary negative impacts to aquatic systems and their associated biota from vegetation treatment and prescribed fire come as indirect effects. These indirect effects include: increased sediment, loss of riparian vegetation, altered macroinvertebrate assemblages, lowering of groundwater tables and decreased perennial flows, increased stream temperature, larger peak flows, stock tank impacts, and changes in channel form (Bisson et al. 2003, Swank et al. 1989).

Sedimentation and erosion are natural processes and ecosystems have evolved to handle the natural background levels and the episodic events of fire (Bisson et al. 2003). However, when land management activities alter the natural levels in a watershed, deleterious effects to the habitat and biota can occur, and this can be compounded when a system's natural resiliency has been degraded by past activities, such as fire suppression, drought, road building, and grazing, etc. Vegetation management can contribute to the deterioration of soil stability and porosity, increasing erosion and compaction. These factors can lead to increased sedimentation into streams and changes in the hydroperiod.

Sediment adversely impacts stream fishes directly through: changing fish behavior, altering fish physiology, impairing growth, shifting blood chemistry, inducing gill trauma, reducing disease resistance, increasing egg mortality, and direct mortality of juveniles and adults if strong enough (Anderson 1996, Argent and Flebbe 1999, Bisson and Bilby 1982). Sediment indirectly affects fish through behavior modifications, including increased frequency of the cough reflex, avoidance of suspended sediment, reduction in feeding, and temporary disruption of territoriality. The severity of changes in fish behavior is associated with the timing of disturbance, the level of stress, and the importance of the habitat that the fish may be excluded from (Anderson 1996, Bisson and Bilby 1982, Rice et al. 2001). Other indirect effects on stream fishes from sediment can occur by modifications to stream habitat. These changes include: altered channel morphology, loss of spawning habitat, loss of rearing habitat, changes in the food supply (macroinvertebrate assemblage), and decreased over-wintering habitat (Lisle 1989, Miller and Benda 2000, Wood and Armitage 1997).

Watershed hydroperiod can be altered by fire and cause vegetation removal, resulting in accelerated soil erosion and loss of soil productivity, and contribute to increased soil compaction. Reductions in soil productivity can limit the vegetation potential, resulting in less moisture that is taken up by plants. Increased soil compaction decreases the amount of water infiltration into the soil. Both of these factors compound to lead to higher surface runoff and higher flood pulses in stream channels (Swank et al. 1989, Ziemer et al. 1991). The erosive energy of floods can cause stream channel down-cutting or incision, causing water to drain from floodplains into the channel, resulting in lower groundwater tables (Agee and Skinner 2005, Lertzman et al. 1998, Ziemer et al. 1991). This results in a narrowing or loss of riparian vegetation because they are left in drier soils. Additionally, with less water entering upslope and riparian soils, less water is available to provide late season flows. Therefore, the higher flows during precipitation events are often followed by low or no flow during the drier weather periods (Rinne and Miller 2006).

The effects of hydroperiod alterations listed above can result in deleterious effects to aquatic biota. Lower water tables that reduce or eliminate riparian vegetation affect macroinvertebrate communities. Streamside vegetation provides both allochthonous (produced outside stream ecosystem) and autochthonous (produced within stream ecosystem) food sources for macroinvertebrates and the quantity and quality of these inputs plays a critical role in regulating the macroinvertebrate assemblage that is present (Gregory et al. 1991). In turn, macroinvertebrates are a primary food source for aquatic vertebrates (icthyofauna and herpetofauna) and alterations to the food web at the lower levels will have repercussions to these higher-level consumers. Additionally, riparian plant communities with rooted

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plants retard stream bank erosion, filter sediment out of the water, build and stabilize stream banks and streambeds, and provide shade and nutrients for aquatic species. Healthy riparian areas act as sponges during high water periods and raise water tables, maintaining stream water during dry seasons, resulting in more flow throughout the year (Elmore and Kauffman 1994, Kauffman et al. 1997). The loss of riparian vegetation, therefore, can result in a negative feedback loop where conditions continue to break down until active management is undertaken to repair degraded areas.

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Effects of Spring and Ephemeral Channel Restoration

Spring conditions would improve for up to74 springs within the analysis area (Appendix 9). Additional surface flow would support more macroinvertebrates (the food base for higher organisms) to become established. Initially, spring habitats would experience short-term increases in sediment production and transport as a result of restoration activities. As restored springs stabilize, however, springs would return to a more natural state, with increased surface flows and improved groundwater levels. Additionally, vegetation treatments at the watershed scale combined with prescribed burning could restore or improve hydrologic function of springs that currently have reduced discharge due to evapotranspiration losses of soil water that could otherwise recharge groundwater in perched or shallow aquifers (MacDonald 2013).

Thirty-nine miles of ephemeral streamcourses (Appendix 9) would be returned to a more natural condition, thus reducing channel and bank scour, down-cutting, aggradation, and uncharacteristic levels of sediment transport. Initially, ephemeral streamcourse restoration would likely exhibit slight increases in short-term sediment production and transport since stream banks and channels would be disturbed during the reshaping and restoration process (MacDonald 2013). As restored areas stabilize, these ephemeral streamcourses would return to a more natural state with banks having more gentle angles of repose that would support vegetative cover, more favorable floodplains to increase soil water storage, and reduced stream velocities; thus decreasing sediment transport, channel down-cutting, and stream bank undercutting that results in bank failure.

Effects of Road Restoration and Decommissioning

Runoff from road surfaces can detach and transport the fine material from road prisms and ditches. Sediment delivery directly from road surfaces to water courses is difficult to estimate since it occurs as non-point source runoff. Sediments delivered to streams from roadside ditches may have originated from sheet or rill erosion prior to entering road surfaces or drainage ditches (MacDonald 2013). In the absence of vehicle traffic, sediment concentrations in road runoff decreases over time. However, vehicle traffic, particularly trucks, can pulverize road surface aggregates, resulting in more fine particles that are easily transported in runoff. Additionally, the pressure of vehicular tires on saturated road surfaces can force fine particles from below the surface to move upward to the surface (Truebe and Evans 1994). Road proximity and connectivity to drainages can strongly influence sediment delivery to watercourses and peak flows in streams. Roads within the project area intersect numerous ephemeral drainages. These points of intersection occur as both culvert crossings and low-water crossings. Road-stream intersections are the primary location where sediments are delivered to stream courses.

A total of approximately 860 miles of existing system roads and unauthorized roads would be decommissioned. Site-specific determinations have not been made for road decommissioning techniques. Some may be closed by posting carsonite or fiberglass signs and placing obstructions such as boulders. Some actions could include reestablishing natural drainage patterns and removing fill and culverts. Full obliteration would require re-contouring and restoring natural slopes, ripping and seeding or mulching road surfaces, and stream crossings would be re-contoured and unstable sidecast or cutslopes removed or stabilized, with entrances blocked to prevent access. These activities would return unproductive acreage to a more stable, productive status over the long term by improving water infiltration, naturalizing water flow, increasing vegetative ground cover, and reducing erosion (MacDonald 2013). Upon completion of

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road decommissioning activities, long-term erosion rates for decommissioned roads are expected to approach natural erosion rates for TEUs where these roads occur. With implementation of appropriate BMPs as outlined in Table 205, water quality and riparian ecosystem conditions would be improved.

Approximately 40 miles of existing, open roads would be reconstructed along their original alignments for safety and for resource protection; no new permanent roads would be constructed. Up to 30 miles of road would be improved to allow for hauling materials, primarily involving the widening of corners to improve turn radiuses, and about 10 miles of road would be relocated out of stream channels. Relocated roads would include rehabilitation of the moved road segment. These legacy roads are located in close proximity to, or within streamcourses. By relocating these roads to upland locations, sediment delivery directly to streamcourses would be minimized.

Approximately 520 miles of temporary roads would be necessary to implement the 4FRI. Road construction would use the BMPs outlined in Table 205, thus minimizing adverse impacts to surface water quality. Temporary roads would typically function for 3 to 6 months before decommissioning. No temporary roads are proposed within riparian areas.

Effects of Dust Abatement

Road-related operations would include dust abatement treatments. An expert panel, sponsored by the U.S. Environmental Protection Agency, conducted a literature review of dust suppressants (Piechota et al. 2004). Magnesium chloride ($MgCl_2$) is the most widely used salt for suppressing dust. Salts move through soil easily with water and, in areas near the application, could potentially have negative impacts on plant growth near application sites. Chloride concentrations as low as 40 ppm have been found to be toxic to trout. Salt concentrations greater than 1,800 mg/L have been found to kill daphnia and crustaceans (Sanders and Addo 1993), and 920 mg/L of calcium chloride has been found to be toxic to daphnia (Anderson 1950). A mortality of 50% was achieved for rainbow trout exposed to 2,500 mg/L ligninsulfonate for 275 hours. Lignin has been found to cause weight gain and colon ulcers in lab testing of rodents. It did not prevent seed germination in field trials and may be the most environmentally compatible dust suppressant (Piechota et al. 2004).

Piechota et al. (2004) concluded that the determination of effects must be based on assessing site-specific conditions. Dust abatement treatments would be limited in the 4FRI, occurring in selected areas where private landownership concerns could arise. Eight road segments have been identified for dust abatement, totaling less than 7 miles in length. The average dust abatement treatment length would be about 0.9 mile, ranging from 0.3 to 2.5 miles. The effectiveness of $MgCl_2$ decreases with decreasing humidity levels (Piechota et al. 2004). Dust abatement for the 4FRI would be very limited, if necessary at all, during the monsoon season. Therefore, lignin would probably be used most often in the 4FRI landscape. Treatments would be temporary and only be used when hauling would occur on a particular road. None of the proposed treatment segments are near open water. Because of the limited application spatially and temporally, and because locations do not include sensitive areas such as open water, dust abatement is not expected to result in measurable effects to aquatic species or their habitat.

Narrow-Headed Garter Snake

Direct/Indirect Effects

Proposed activities would potentially have direct effects to the 229 acres (1%) of potential habitat in the West Fork of Oak Creek Subunit by reducing vegetation through thinning and burning (Figure 15). Thinning and burning may affect narrow-headed garter snakes through the short-term removal of vegetation along West Fork of Oak Creek that allows for thermoregulation, gestation, shelter, protection from predators, and foraging opportunities. These effects would be mitigated through BMPs that provide

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filter strips and maintain CWD (see BMPs #7, #8, #32 and #33).Since no narrow-headed garter snakes are known to occur along this portion of West Fork of Oak Creek and this portion does not contain perennial water or aquatic habitat characteristics, there would be no direct effects on the species or its habitats.

Project activities may indirectly affect garter snakes if soils are disturbed, increasing sediment in and turbidity of the water channel, and thereby, decreasing water quality for the species and its primary prey including native and non-native, soft-rayed fish. Decreases in water quality can result in potential negative effects to macroinvertebrate and native fish populations. It is unlikely that the proposed action would contribute enough sediment or other pollutants to ephemeral or intermittent drainages within the project area to result in impairment of any downstream waterbodies (Water Quality and Riparian report). Treatments in subunits connected to these watersheds could potentially lead to increased sedimentation and/or ash flow into narrow-headed garter snake prey habitat (Fisheries and Aquatics report). However, this increase in sediment or ash over background levels would not have negative impacts on habitat for native fish species or garter snakes. Conversely, moving the forested uplands toward historic conditions would increase resilience of these systems and decrease the risk of uncharacteristic, high-severity wildfire. Protective stream buffer strips would be used along Sterling Canyon streamcourse in the proposed action to reduce the risk of sediment and ash flow into the Upper Oak Creek.

Spring restoration would increase riparian vegetation, increasing availability of food and reproductive sites for native fish species. However; restored springs are too disconnected to provide habitat for the highly aquatic garter snake.

Narrow-headed garter snake habitat does not occur within the paired watershed study and associated structures are not expected to increase sedimentation or reduce flow to habitat therefore, no indirect effect is expected from activities associated with the study.

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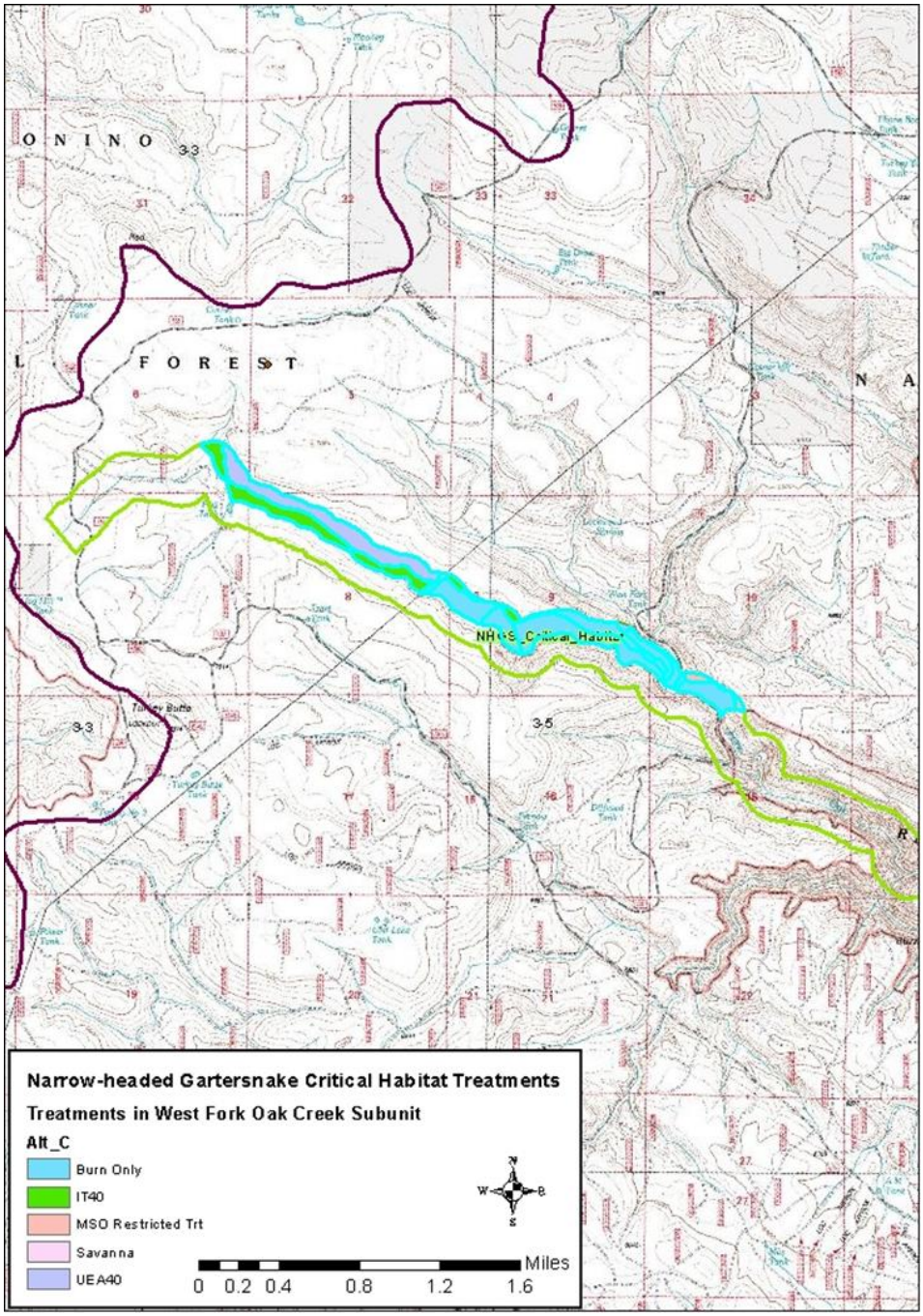


Figure 15. 4FRI Treatments and Proposed Critical Habitat for the Narrow-Headed Garter Snake

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Narrow-Headed Garter Snake Critical Habitat

PCEs for proposed critical habitat are listed in the Federal Register (USDI FWS 2013b) and addressed below as they relate to the proposed actions:

Direct and Indirect Effects

1) Stream Habitat, which includes:

a. *perennial or spatially intermittent streams with sand, cobble, and boulder substrate and low or moderate amounts of fine sediment and substrate embeddedness, and that possess appropriate amounts of pool, riffle, and run habitat to sustain native fish populations*;

Prescribed fire treatments in subunits connected to this watershed or its 6th HUC watersheds upstream could potentially lead to short-term increases in sedimentation and/or ash flow into narrow-headed garter snake critical habitat.

The soils and water report (Steinke 2013) indicates that prescribed fire treatments under the proposed action could result in soil erosion in areas where slope exceeds 15%. There is a short-term risk (1 to 2 years) of sedimentation or ash flow resulting from these treatments. However, BMPs (Table 205) would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope. Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in this critical habitat unit.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. Again, BMPs would be in place to mitigate these short-term risks in order to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would not have measurable effects on narrow-headed garter snake proposed critical habitat, as discussed above.

b. *A natural, unregulated flow regime that allows for periodic flooding or if flows are modified or regulated, a low regime that allows for adequate river functions. Such as flows capable of processing sediment loads;*

The proposed action would not regulate or alter flow. The project will reduce the high risk of increased sedimentation and ash flows resulting from stand-replacing crown fires.

c. *Shoreline habitat with adequate organic and inorganic structural complexity (e.g. boulders, cobble bars, vegetation, and organic debris such as downed trees or logs, debris jams), with appropriate amounts of shrub and sapling-sized plants to allow for thermo regulation , gestation shelter, protection from predators, and foraging opportunities;*

Subunit 3-5 of the project area borders West Fork of Oak Creek Subunit. This portion of West Fork of Oak Creek is an ephemeral stream and rarely contains running water or pools. There are 111 acres proposed for thinning and burning and 118 acres for burning only in the western portion of this drainage, which would directly modify shoreline habitat. Resource protection measures would be put in place to minimize the potential for soil disturbance within the drainage reducing impacts to

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shoreline habitat(see BMPs #7, #8, #32, #33). Large dead and down logs and snags would be maintained as per Forest Plan direction and bank side scrub vegetation would increase, improving basking and foraging habitat over time.

d. *And aquatic habitat with no pollutants or, if pollutants are present at levels that do not affect survival of any age class of the narrow-headed garter snake or the maintenance of prey populations.*

Minor, short-term changes (i.e., 1 to 2 years) in water quality are possible in waterbodies adjacent to or downstream from mechanical vegetation treatments, areas subjected to prescribed burning, areas of temporary road construction and decommissioning, and where stream channel restoration activities are conducted. However, long-term surface water quality is expected to improve through more resilient forest conditions that minimize uncharacteristic fire behavior and through improved vegetative ground cover that minimizes soil erosion and sediment transport to connected streamcourses and other waterbodies (Water Quality and Riparian Area Report).

Resource protection measures are put in place to minimize nonpoint source pollution as outlined in the intergovernmental agreement between the Arizona Department of Environmental Quality (ADEQ) and the Southwestern Region of the Forest Service (ADEQ 2008). BMPs referenced within the mitigation text are outlined in the Region 3 USFS Soil and Conservation Handbook (R3) FSH 2509.22 and are listed above.

Dust abatement would have no effect on narrow-headed garter snake critical habitat, as no dust abatement treatments are proposed near open water.

2) Adequate terrestrial space (600 feet lateral extent to either side of bankfull stage) adjacent to designated stream systems with sufficient structural characteristics to support life history functions such as gestation, immigration, emigration, and brumation.

Oak Creek receives water in this 6th Code HUC watershed from four streamcourses that run through project subunit 3-5: Bee Canyon, Surveyor Canyon, Crazy Park Canyon, and Sterling Canyon. All three action alternatives propose prescribed burning near Bee Canyon, Surveyor Canyon, and Crazy Park Canyon, but burning is excluded from slopes greater than 15% in these areas. However, lower Sterling Canyon has prescribed burning proposed on slopes greater than 15% for the proposed action. Thus, there is a greater risk of sediment and ash flow to Sterling Canyon for this alternative. A buffer strip of at least 70 feet (BMP #8; Steinke 2013) along the Sterling Canyon streamcourse would be used to mitigate negative effects.

3) A prey base consisting of viable populations of native fish species or soft-rayed, nonnative fish species.

The Fisheries Specialist Report (Childs 2013) determined some short-term, localized impacts to native fish may occur as a result of project implementation, however, BMPs are expected to mitigate these impacts. Native fish occurring in the Verde River Subbasin Unit (i.e., longfin dace, desert sucker, sonoran sucker, roundtail chub) are long-lived species (adults live over 10 years), so the risk of short-term effects is mitigated by the fact that the species is adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated. Additionally, any effects to native fish would be insignificant and discountable.

4) *An absence of nonnative fish species of the families Centrarchidae and Ictaluridae, bullfrogs (Lithobates catesbeianus), and/or crayfish (Orconectes virilis, Procambarus clarki, etc.), or occurrence of*

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these nonnative species at low enough levels such that recruitment of narrow-headed garter snakes and maintenance of viable native fish or soft-rayed, non-native fish populations (prey) in still occurring.

The project is not expected to change the occurrences of nonnative fish, bullfrog or crayfish. Native fish species may be affected by the proposed action, but are not likely to be adversely affected (Fisheries and Aquatics Specialist Report).

Effects to Golden and Bald Eagle

Golden Eagle

Direct/Indirect Effects

Direct effects would be from activities that cause disturbances (smoke, auditory or visual) to golden eagles nesting or foraging within or adjacent to the project. Under the Proposed Action, there would be no direct adverse effects to nesting eagles as project design features would eliminate disturbance near known nesting sites. No vegetation treatments would occur within ½ mile (2,500 feet), unless mitigated by topography, of an occupied golden eagle nest between March 1 and August 31. Drift smoke from prescribed fire is expected in most places; however, concentrations of smoke that might settle in an area for more than one or two nights when a female is on the nest could have adverse effects to individuals. Prevailing southwest winds and the topography of the area typically act to lift smoke, carrying it away from ignition sites. Nests on cinder cones and other raised topographic features and in Sycamore and Oak Creek Canyons or in canyons immediately adjacent to Sycamore and Oak Creek Canyons or the Mogollon Rim are not expected to have smoke settle in them long enough to cause measurable effects to eagles because of the air movement in these landscape-scaled features. Conversely, nests in areas occurring in small canyons or valleys may have dense smoke settle in nesting locations.

When smoke settles into low-lying areas it typically does not last more than one or two nights. Limited smoke at nest locations would be expected to expose adult eagles to negligible effects as this would repeat an aspect of their evolutionary environment (Horton and Mannan 1988). However, on occasion, dense smoke may settle into specific nest locations. Dense smoke settling into nest areas early in the season (March through June) could disturb brooding females. If the female flushed long enough to affect incubation this could result in loss of viability of the eggs. Dense smoke settling for multiple consecutive nights could affect developing lungs of nestlings. Unlike mammals, damaged avian lungs do not repair themselves through time (Rombout et al. 1991). Causing the female to discontinue incubating eggs or affecting lung development of nestlings would cause long-term adverse effects. Outside of these examples, smoke settling in nest locations would typically be short term and not likely to cause adverse effects.

Within the project area, subunits were designed using 6th code watersheds as boundaries; USFWS and fire specialists identified subunits as an appropriate boundary for determining smoke impacts. Fire specialists and biologists reviewed all current and historic golden eagle nests potentially affected by the project to determine if smoke would be expected to settle for more than 24 hours at nest locations (Table 206). Of the 29 nests, 6 are in areas where smoke would settle if conditions are not optimal and fuels loads are heavy, particularly during first-entry burns. In consultation with USFWS, the Forest Service designed mitigation for those specific nest locations to include monitoring to determine if the nest is occupied/active and if so, a timing restriction would be placed on first-entry burning within the subunit where the nest was located until young had fledged. Table 206 lists confirmed and potential golden eagle nests by Forest and subunit and identifies whether there is potential for smoke to settle for extended periods at a nest location. Subunits that could be restricted are 1-1, 1-3, 3-5 and 5-2.

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Under the proposed action, mechanical treatments, prescribed, burning, road construction and decommissioning, hauling of timber and other restoration activities may cause visual or auditory disturbance to foraging golden eagles. This disturbance would be localized, of short duration and low intensity and would not be expected to substantially interfere with normal feeding behavior. Up to 40,000 acres of prescribed burning and 45,000 acres of mechanical treatment would occur annually; however, these are short-term effects and would be minimized due to activities being spatially and temporally separated. Additionally, prescribed burning effects would dissipate over time as first entry burns are usually related to consumption of accumulated surface fuels, raising crown bulk height and reducing crown bulk density (Fire Ecology report). In ponderosa pine, maintenance burns or second entry fuel loads would be significantly lower and produce low-severity effects with fewer emissions (Fire Ecology report).

Indirect effects to the golden eagle include affects to habitat, prey species, or prey species habitat. There are no anticipated adverse effects to prey species or their habitats. Grassland and savanna treatments would maintain and improve foraging habitat on 59,391 acres of grassland and 45,142 acres of savanna habitat, improving prey species habitat resulting in an indirect beneficial effect.

Table 206. Confirmed and potential golden eagle nests potentially affected by the 4FRI.

Status	Name	Subunit	Forest	Potential for Smoke to Settle	Comments
Confirmed	Colton Crater	4-3 (border)	CNF	No	0.3 miles from Forest boundary.
Confirmed	Mount Elden Sandy Seep	5-2	CNF	No	Nest located in cliff with no eagles seen. In treatment area.
Confirmed	Red Mountain	4-3	CNF	No	Cliff nest. Not in treatment area.
Confirmed	Red Mountain	4-3	CNF	No	Alternate nest site at Red Mountain. Not in treatment area.
Confirmed	Secret Mountain (aka north of Lost Mountain and Boynton Canyon).	3-5	CNF	No	Outside treatment area. At the edge of Munds Mountain- Secret Mountain Wilderness
Confirmed	Upper Lake Mary South	1-3	CNF	Yes	Tree nest. In treatment area.
Confirmed	Walnut Canyon	1-1	CNF	Yes	Outside treatment area. Within Walnut Canyon National Monument.
Confirmed	Johnson Canyon	4-2	KNF	No	Outside treatment area.
Confirmed	Eagle Rock	4-4	KNF	No	Outside treatment area.
Confirmed	Cedar Mountain	4-3	KNF	No	Outside treatment area.

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Status	Name	Subunit	Forest	Potential for Smoke to Settle	Comments
Confirmed	Wild Horse Canyon	4-3	KNF	No	In treatment area.
Confirmed	Eagle Nest Mountain	4-1	KNF	No	Outside treatment area.
Confirmed	Double A Knoll	4-1	KNF	No	Outside treatment area.
Confirmed	Steiger Tank	4-1	KNF	No	Outside treatment area.
Confirmed	Rabbit Bill (aka Flat Mesa)	3-1	KNF	No	Outside treatment area.
Confirmed	MC Canyon	3-1	KNF	No	In treatment area.
Confirmed	Muleshoe	4-2	KNF	No	Outside treatment area.
Confirmed	Grand Canyon Trading (aka Prairie Dog Tank)	4-2	KNF	No	Outside treatment area.
Potential	O'Leary	5-2	CNF	No	Outside treatment area. Golden eagles often seen in area.
Potential	Dry Lake	3-5	CNF	No	Could be a roost site.
Potential	Bear Sign Canyon	3-5	CNF	No	No data on this sight. Eagles seen in area during surveys in 2009 and 2010.
Potential	San Francisco Wash	5-2	CNF	Yes	No data or information on this site. Digitized point appears to be in bottom of wash, road on top. In treatment area. Within 0.1 mile of powerline.
Potential	Upper Lake Mary North	1-3	CNF	Yes	Tree nest. Record isn't clear if this is a confirmed nest or not. In treatment area.
Potential	Deadwood Draw (aka Walker Creek)	2-0	CNF	No	Reported to Forest Service, not confirmed. Non-Forest Service. Not in project area.
Potential	Woody Ridge	3-5	CNF	Yes	Outside treatment area. No data or information on this site.
Potential	Cedar Flat	1-6	CNF	No	Outside treatment area.
Potential	Lee Mountain	2-0	CNF	No	No in treatment area.
Potential	Bill Williams Mountain	3-1	KNF	No	Outside treatment area. Nest sight not yet located but nest building expected.
Potential	Red Butte Mountain	6-2	KNF	No	Location not confirmed. In pinyon-juniper on Tusayan RD. Outside treatment area.

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Bald Eagle

Direct/Indirect Effects

Direct effects would be from activities that cause disturbances (smoke, auditory or visual) to golden eagles nesting or foraging within or adjacent to the project and are similar as those effects listed for the golden eagle. Under the proposed action, there would be no direct adverse effects to nesting eagles as project design features would eliminate disturbance near known nesting sites. No vegetation treatments would occur within ½ mile (2,500 feet), unless mitigated by topography, of an occupied bald eagle nest between March 1 and August 31.

Fire specialists and biologists reviewed the three bald eagle nest locations within the project area to determine if smoke would be expected to settle for more than one or two nights. Of the three nests, two at Upper Lake Mary were identified as areas where smoke would settle if conditions are not optimal and fuels loads are heavy. This is of particular concern with first-entry burns. In consultation with USFWS, the Forest Service designed mitigation for those specific nest locations to include monitoring to determine if the nest is occupied/active, and if so, a timing restriction would be placed on first-entry burns within the subunit with nests until the young fledge. At present, the subunit that could have a restricted burning period is 1-3. Alternative B would defer all confirmed roost sites and nest sites with a 300-foot no cut zone from mechanical thinning treatments. Additionally, timing restrictions during the winter roosting season would provide protection from disturbance to roosting eagles. Potential roost treatments would be designed to maintain and develop roost characteristics such as, large trees and snags, while reducing surface fuel loading and crown fire potential within the roost increasing roosting habitat for eagles in the project.

There is no effect to nesting or roosting eagles, however, short-term disturbance to foraging bald eagles would occur during mechanical treatments, prescribed burning, hauling of timber and other project activities may cause visual or auditory disturbance. Approximately 40,000 acres of prescribed burning and 45,000 acres of mechanical treatment would occur annually; however, these are short-term effects and would be minimized due to activities being temporally and spatially separated. Additionally, prescribed burning effects would dissipate over time as first-entry burns are usually related to consumption of accumulated surface fuels, raising crown bulk height, and reducing crown bulk density (Fire and Fuels report). In ponderosa pine, maintenance burns or second-entry fuel loads would be significantly lower and produce low-severity effects with fewer emissions (Fire and Fuels report). Disturbances would be localized and of short duration and may affect individual birds, but would not affect the overall distribution or reproduction of the species.

One documented roost is located within an Arizona Game and Fish Research site; however, these treatments are designed to provide group sizes up to 15 acres in size and will be tailored to meet Forest Plan guidelines. All alternatives are designed to eliminate disturbance to and provide habitat for nesting and roosting bald eagles.

Indirect effects to the bald eagle include effects to habitat, prey species, or prey species habitat. There are no anticipated adverse effects to prey species or prey species habitat. Indirect effects to habitat would occur from treatments that modify the number of trees in a group of suitable roost trees, as eagles prefer to roost in large trees near other large trees. However, thinning would improve old tree longevity, resulting in beneficial effects. In restoration units with documented bald eagle use, snags would slightly increase post-treatment (2020) and continue to increase in the long term. Ignition techniques and site preparation would reduce potential mortality to these components from burning activities. In addition, the proposed action would include developing old growth in about 36% of the area post treatment and 60% of the area 30 years later that may be used as future winter roost sites for bald eagles.

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6. Cumulative Effects

According to the Final ESA Section 7 Consultation Handbook (USFWS 1998), "cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the proposed action area. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Endangered Species Act."

There are nearly 38,000 acres of Indian, private, and state lands within the 4FRI analysis area (Table 207).

Table 207. Indian, Private and State Lands in the 4FRI Analysis Area

Ownership	Acres	Minimum Polygon Acres	Maximum Polygon Acres	Average Polygon Acres	Number of Polygons
Inholdings	19,899	0.1	1,010	118	188
Indian	101	100.7	101	101	1
Private	19,645	0.1	1,010	118	186
State	154	154.0	154	154	1
Checkerboard	18,028	3.5	2,356	644	28
State	18,028	3.5	2,356	644	28
Total Acres	37,928	0.1	19,711	305	448

Arizona Bugbane

Past Actions

The boundary of this discussion is the range of Arizona bugbane within the Coconino and Kaibab National Forests. The time limit for this analysis begins in 1993, when monitoring for Arizona bugbane began on the Coconino and Kaibab National Forests. The following past actions have affected the abundance and Arizona bugbane and have established baseline current condition for Arizona bugbane.

Monitoring for Arizona bugbane has occurred on the Coconino and Kaibab National Forests since 1993. Some impacts observed include grazing, recreation, wildfire and natural disturbances such as flooding, drought, tornados and mortality in overstory trees. Grazing impacts were addressed in the Conservation Strategy (USDA FS 1995) and included fencing and monitoring. This has led to a reduction in these conflicts. Signs of domestic and wild grazers have been observed in the populations at West Fork. Cow dung has been observed on the canyon floor near known populations. No herbivory that can be directly attributed to cattle has been observed recently but cattle may trample plants or crush them while walking or "loafing" in the shade.

Herbivory and trampling from elk have been observed during visits to several populations in the Upper West Fork area. This was especially apparent during drought years (1996 and 2002) when animals were seeking food, water and shelter in canyons

A wildfire, the Rattle Fire (1972) occurred in the uplands near populations in a tributary of West Fork, reducing the amount of shade produced by vegetation above the canyon. Prior to the fire, timber had been harvested in the area in approximately 1970. After the fire occurred, trees damaged or killed by the fire were harvested in a salvage sale. The fire area was seeded with various grasses and ponderosa pine seedlings have been planted in the fire area on at least two different occasions (Bataineh et al, 2006). The overall result in the fire and associated management actions was a more open stand condition than

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previously existed, leading to a more open xeric environment, making upper portions of the drainage unsuitable for Arizona bugbane.

The Fry Fire burned into Fry Canyon. The source of the fire was a lightning strike on August 9, 2003, near the south edge of Fry Canyon. The fire burned approximately 180 acres of ponderosa pine and mixed conifer forest in upland areas and canyons slopes. Activities during the suppression effort included but were not limited to fire line construction and felling of trees in the canyon. Additionally, some backfires were set in the upland areas to reduce fire spread and intensity. We visited the fire area in 2004 and again in 2005. On these subsequent visits, we observed Arizona bugbane growing along the fireline (see Figure 5). Many were growing vigorously and had produced fruits. In 2010, during a scheduled monitoring visit, we noted an area where the tree canopy had died as a result of the fire. However, there were numerous healthy bugbane plants on the site.

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The Taylor Fire (2009) reached into areas near the populations in West Fork. There were no direct impacts such as loss of shade to the populations. There was some minor degradation of the habitat through siltation, resulting from erosion from the fire site, but it was minor and insignificant.

The Woody Ridge Project, analyzed in 2004, authorized approximately 8,000 acres of timber harvest and around 11,000 acres of prescribed burning. Teacup Timber Sale is part of the Woody Ridge Restoration Analysis. It is immediately adjacent to the south slope of Fry Canyon. It was harvested in 2010. Timber sale administrators mitigated the effects of harvest on Arizona bugbane by locating populations and avoiding them during implementation.

In October 2010, a series of tornados struck certain areas in the Coconino National Forest, including an area in upper West Fork. As a result, overstory trees were damaged or destroyed. Impacts of the tornado to Arizona bugbane are unknown at this time, but likely resulted in a more open environment in some areas. Some of the area affected by the tornadoes includes the same stands in Table 210 in the Upper West Fork area. The Flagstaff District analyzed certain areas of the tornado's path, including the area near Upper West Fork. The justification for this analysis was the increased risk of bark beetle infestations that are presently occurring. Harvesting in or near Arizona bugbane areas on this project was limited by steep slopes.

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Other natural events have affected the habitat and distribution of Arizona bugbane in some areas. Some populations in Lower West Fork were lost to flooding in 1993 (Arizona Game and Fish Department, 2012). Drought and insect outbreaks have resulted in the loss of some of the conifer trees on at least one site in West Fork. This resulted in the loss of shade and change in character on a permanent monitoring site. On this site, deciduous trees such as New Mexico locust and box elder, combined with shade from the canyon walls seem to be providing enough shade for the plants to persist. There has also been some mortality in the overstory trees on Bill Williams Mountain including aspen trees on that site. A landslide in at least one population (West Clear Creek) resulted in a large rock slabs sliding down onto a population of plants, resulting in mortality of some plants on a permanent monitoring transect.

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The Rattle Fire in 1972 affected the upland areas above Arizona bugbane and resulted in a minor loss in potential habitat in the upper reaches of the canyons. The Fry and Taylor Fires mentioned above did not have the same effects, because there was no major loss of the overstory components (trees) near the populations.

Ongoing and future foreseeable actions

These management actions are ongoing within the habitat of Arizona bugbane. Some items in the cumulative effects document also apply.

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Grazing by livestock and wildlife still occurs in or near some populations. Cattle grazing is a management action that can be addressed and mitigated by Forest Service actions, while wildlife grazing is not under the control of forest. Monitoring to assess the conditions of allotment fences to assure cattle are excluded in some areas near the Fernow Draw and West Fork of Oak Creek areas is a required condition of the conservation.

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Recreation impacts include hiking and trampling by humans. These impacts were addressed in the strategy and in Amendment 12 of the Coconino NF Forest Plan. Hikers trample plants and degrade habitat by leaving established trails and establishing social trails within suitable habitat. This issue was addressed by confining the trails leading from Lower West Fork to a single trail prism. Occasional off-trail incursions into populations still occur in areas such as Lower West Fork.

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Trail maintenance is necessary to keep the trail confined to the prism, but mitigates the effects of trampling to non-significant levels.

The Bill Williams Restoration Project is an ongoing analysis encompassing Bill Williams Mountain and the Arizona Bugbane Botanical Area. This is a related action with treatments such as burning proposed in or near the Botanical Area. Many treatments in the project are similar to activities in the proposed action. A decision on the project is expected in 2012.

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Activities such as vehicle travel on established roads and road maintenance occur in some areas near the populations but do not directly affect plants.

MSO

The cumulative effects boundary was identified as the 4FRI project area (nearly 989,000 acres) plus a ½-mile buffer around the entire project area to identify activities that could affect MSOs across the 4FRI landscape, e.g., habitat changes in PACs adjacent to the boundary, disturbance, or effects from burning. This was considered an adequate scale because the 108,846 acres of MSO habitat proposed for treatment occurring within the 586,110 acres of total treatment is patchily distributed. Adding an additional ½-mile area around the project area should adequately capture past, present, and reasonably foreseeable actions that may cause additive effects to the direct and indirect impacts already analyzed for the MSO. The Tusayan Ranger District (Restoration Unit-6) was dropped from further analysis because no designated MSO habitat or records of MSO sightings occur on this district. The balance of the project area boundary includes most of the Williams and Flagstaff Ranger Districts. A thorough list of past, present, and reasonably foreseeable projects was created by the NEPA coordinator and GIS specialist on the 4FRI team. This list included state and private actions with accompanying documentation (Table 208). Projects that affected the evaluation criteria developed for the MSO analysis, including measurable attributes related to forest structure, forest density, and MSO prey habitat (see wildlife report for details) were included in the cumulative effects analysis.

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Table 208. Description of Projects on State and Private Lands

Forest/RD	Project	Year	Planned Treatments by Type and Size (acres)	Project Objective
			Past Actions	
GFFP[1]/ State Forestry	AZ State Forestry	2000 to 2010	1,310 acres of private land thinned through State Forestry grants Implement during funding windows	Data from AZ State Forestry
GFFP	GFFP	2012	100 acres of thinning and prescribed burning	100 acres of private property made up of 20 parcels within the GFFP boundary – ongoing
			Reasonably Foreseeable	
GFFP Projects	GFFP	2013-2014	535 acres of vegetation thinning and prescribed fire on private land parcels within 180,000-acre GFFP boundary	245 acres (5 private land parcels) in 2013, 190 acres (4 to 10 parcels) in 2014, and 100 acres of prescribed burning through 2014
AZ State Lands Dept, C-Flagstaff	Grapevine Canyon Wind Project	2012 analysis in progress	22 miles southeast of Flagstaff, AZ - general location is south of I-40 to Happy Jack – 200 ft ROW – construction on 8.5 miles of NFSL and construction of a 15-acre switchyard	AZ State Lands Dept, C-Flagstaff

[1] GFFP: The Greater Flagstaff Forests Partnership is an alliance of environmental, governmental, and business organizations dedicated to researching and demonstrating approaches to forest ecosystem restoration in the ponderosa pine forests surrounding Flagstaff

There are no tribal lands within the historical range of MSOs that overlap the 4FRI portions of the Coconino and Kaibab National Forests. Activities on State lands include potential land exchange for development, vegetation treatments, grazing, and recreation. Most acres treated from vegetation treatments involve mechanical harvest and/or burning treatments. They can also include slash disposal, invasive weed treatments, and limited acres of animal damage control, erosion control, and diseased tree harvest. Activities on private land vary but include housing development, roads, recreation, and grazing. Development on private lands will likely increase as the economy recovers. Activities on private and State land could influence MSOs by reducing quality and quantity of nesting and foraging habitat and increasing disturbance in foraging habitat.

There is no information available to predict future site-specific impacts to MSOs and their habitat by actions taken on State and private lands. However, the overlap of PACs with non-federal land within the 4FRI is limited. State and private lands could affect Volunteer PAC at the south end of Camp Navajo Army National Guard Base and in and around the San Francisco Peaks. However, potential effects of non-federal land ownership in these areas are likely part of the baseline conditions for these PACs. None of the PACs in these areas are proposed for treatment under the 4FRI. Private forest inholdings are scattered across both the Kaibab National Forest and Coconino National Forest, including in MSO restricted habitat. Habitat conversion and home development could affect foraging and dispersing MSOs. However, given the scale of this ownership relative to available habitat on federal lands, private and state lands are not likely to contribute significant additive effects to the 4FRI.

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GFFP thinning projects focus on removing small to medium-sized trees to reduce hazard fuels on State and private lands in and around Flagstaff (Figure 16). The GFFP has three primary goals: restore natural ecosystem function; manage forest fuels; and learn more about the ecological, economic, and social dimensions of forest restoration. Project design features have retained large and old trees and provided openings for rooting space. Removing small trees reduces ladder fuels, thereby decreasing the risk of surface fire becoming crown fire. Thinning treatments open the overstory canopy and remove subcanopy structure, allowing more light to reach the forest floor and increasing moisture availability. The open spacing in canopies tends to be a short-term event, as increased growth rates in residual trees reestablish continuous canopy cover. This allows for a short-term increase in understory production, improving prey food and cover resources. Snags would be decreased due to human health and safety concerns during operations. Removing conifer competition with mid and understory oak as part of the thinning can contribute to maintaining and improving oak growth and vigor. These projects are small in scale and are outside MSO habitat. Some treatments are near PACs and could potentially be used by foraging MSO. Opening the forest would provide benefits to prey habitat as a result of understory development.

The Grapevine Canyon Wind Project is located on lands east of the Coconino National Forest. The location is outside of pine-oak/MSO habitat. A 200-foot-wide right-of-way across national forest lands will allow transmission lines to connect into the existing power grid. A 15-acre switch site will be located in lands currently forested and is also located outside of MSO habitat. Section 7 consultation has already been completed for this project because of a federal nexus, and so is not part of cumulative effects under the ESA.

Private lands typically occur in small parcels and are scattered across the forests. Larger private inholdings are close to Flagstaff and Williams, but most are small-scale. Subdividing, livestock ownership, and infrastructure development can be expected to continually erode MSO habitat values over time. While these lands are not expected to support MSOs, they may provide foraging or dispersal habitat. The cumulative loss of habitat function in these lands is unlikely to contribute much to the status of federal lands because of the small size and widely scattered distribution of most private lands.

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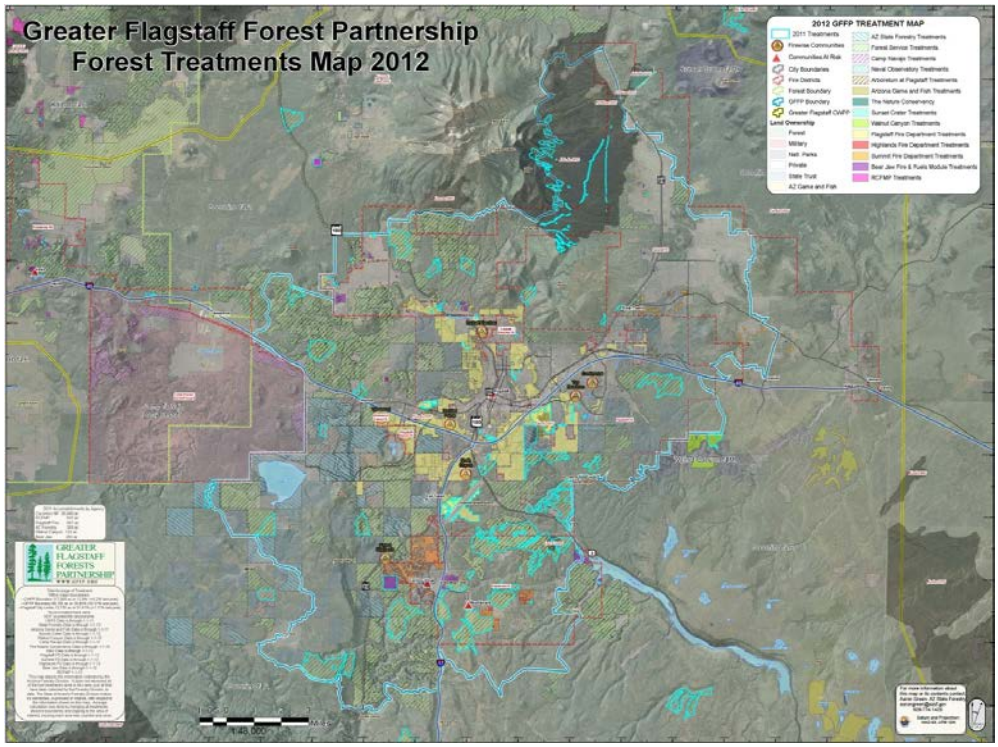


Figure 16. Most Recent Map of GFFP Project Areas in the Flagstaff Vicinity (http://gffp.org/about_gffp/images/2011-Dec_Owner.jpg)

Forests on State lands are managed by the Arizona State Forestry Division. The State Forestry Division implements forest health policies, administers cooperative forestry assistance programs, and provides for the prevention and suppression of fire (Arizona State Forestry Division at http://www.azsf.az.gov/search/node/state%20forestry%20mission%20statement). Throughout the 2000s, ponderosa pine management across northern Arizona's Colorado Plateau has focused on reducing fire threat in the wildland-urban interface. This first started under the Forest Land Enhancement Program, a part of the 2002 Farm Bill, and continued under The Statewide Strategy for Restoring Arizona's Forests (Governor's Forest Health Advisory and Oversight Councils 2007). The latter is a 20-year vision to restore forest health, protect communities from fire, and encourage forest-based economic activity assessed individual regions around Arizona. Recommendations for the Western Mogollon Plateau, which includes the 4FRI area, prioritize treatments to protect communities, apply restoration treatments in degraded ponderosa pine forests, and enhance the use of fire as a treatment tool.

A key area of State land, in terms of MSO habitat, occurs between the volunteer PAC (largely on Department of Defense lands in Camp Navajo) and the Red Hill PAC on the Coconino National Forest. This area is a checkerboard of alternating sections managed by the Forest Service and by the Arizona State Forestry Division (Figure 16). Because there are no communities in this area, the assumption is that forest management would provide for foraging and dispersal habitat, but would not maintain nesting and roosting habitat.

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Functional nesting and roosting habitat is likely limited on State and private lands now, and little, if any, is expected in the future. Foraging and dispersal habitat would be expected to remain on most State forest lands, but quantity and quality of this habitat will both probably decline on private lands. Because of the limited overlap between MSO habitat and State and private lands, combined with the small scale of most national forest inholdings and their widely scattered distribution, forest management on these lands is expected to have little influence on MSO populations within the 4FRI analysis area. Closed canopy habitat corridors are designed into 4FRI treatments, including near the checkerboard pattern of State and federally managed forest lands south of Camp Navajo.

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Aquatic Species and Critical Habitat

The geographic setting and boundary for the cumulative effects analysis will be all 81 6th HUC watersheds within or intersecting the project boundary for a total of about 2,032,000 acres.

There are 101,461 acres of private land within the cumulative effects boundary area. Of these acres, there are variable levels of development ranging from municipal development in areas such as Flagstaff, Williams, Tusayan, and Sedona to completely undeveloped. For this analysis, each private land parcel was classified as either having high or low development by examining air photos of each parcel. For areas of high development, a disturbance factor of 70% was applied (this is the equivalent disturbed area factor used on the Apache-Sitgreaves Equivalent Disturbed Area process for high development). For areas of low development, a 10% disturbance factor was applied after examining aerial photos (the Apache-Sitgreaves Equivalent Disturbed Area process for low development applies a 20% disturbance factor and, after reviewing parcels by air photo, this factor was too high because there is a general lack of development on many of the parcels). The total ground disturbance for private land is calculated at about 30,900 acres, or less than about 2% of the entire cumulative effects area.

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There are four 6th code watersheds where urban development has a large impact on ground disturbance areas—Cataract Creek Headwaters (11% baseline ground disturbance) associated with the City of Williams, Sinclair Wash (25%) and Lower Rio de Flag (18%) associated with the City of Flagstaff, Middle Oak Creek (11%) associated with Sedona and private land developed adjacent to Oak Creek.

Reasonably Foreseeable Future Actions

Recreational activities include: hiking, viewing wildlife, hunting, dispersed car-camping, backpack camping, orienteering, horseback riding, caving, rock climbing, photography, picnicking, taking scenic drives, ORV/ATV use, bicycling, shooting, and gathering in family or social groups. Snowmobile use and cross-country skiing are increasing as popular uses in the area. During normal winters, snowmobiles are the only vehicles that access the area.

Other potential uses within the project area include firewood cutting, post and pole cutting, collecting boughs and cones, collecting and transplanting wildlings, gathering antlers, collecting food and medicinal resources such as berries, nuts, mushrooms, and bracken fern, and collecting biological specimens for research. These activities are unquantifiable.

General Effects of Vegetation Management and Prescribed Fire

Effects of vegetation management on stream systems should be minor when Forest Service BMPs are followed (Region 3 FSH 2509.22). These include providing an adequate buffer from harvest operations, designation of all channel crossing locations by mechanized equipment, and designation of skid trails, to avoid crossing stream channels (ephemeral and intermittent). Limiting vegetation management activities from impacting stream courses should lead to minor or inconsequential effects to stream habitat and associated biota. While prescribed fire has the ability to affect stream channels, none of the action

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alternatives propose for ignitions to occur within riparian areas or along stream channels, but fire is allowed to back downslope into these areas. If fire burns riparian areas, there is the potential for some ash and localized erosion to occur; however, these effects should be minor in degree and extent, particularly if BMPs are followed (see Table 205 above).

Most effects to aquatic habitat and biota are the result of upland terrestrial changes that result in changes to sediment and water transport in the watershed. The primary negative impacts to aquatic systems and their associated biota from vegetation treatment and prescribed fire come as indirect effects. These indirect effects include: increased sediment, loss of riparian vegetation, altered macroinvertebrate assemblages, lowering of groundwater tables and decreased perennial flows, increased stream temperature, larger peak flows, stock tank impacts, and changes in channel form (Bisson et al. 2003, Swank et al. 1989).

Sedimentation and erosion are natural processes and ecosystems have evolved to handle the natural background levels and the episodic events of fire (Bisson et al. 2003). However, when land management activities alter the natural levels in a watershed, deleterious effects to the habitat and biota can occur, and this can be compounded when a system's natural resiliency has been degraded by past activities, such as fire suppression, drought, road building, and grazing. Vegetation management can contribute to the deterioration of soil stability and porosity, increasing erosion and compaction. These factors can lead to increased sedimentation into streams and changes in the hydroperiod.

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Sediment adversely impacts stream fishes directly through: changing fish behavior, altering fish physiology, impairing growth, shifting blood chemistry, inducing gill trauma, reducing disease resistance, increasing egg mortality, and direct mortality of juveniles and adults, if strong enough (Anderson 1996, Argent and Flebbe 1999, Bisson and Bilby 1982). Sediment affects fish through behavior modifications, including increased frequency of the cough reflex, avoidance of suspended sediment, reduction in feeding, and temporary disruption of territoriality. The severity of changes in fish behavior is associated with the timing of disturbance, the level of stress, and the importance of the habitat that the fish may be excluded from (Anderson 1996, Bisson and Bilby 1982, Rice et al. 2001). Other effects on stream fishes from sediment can occur by modifications to stream habitat. These changes include: altered channel morphology, loss of spawning habitat, loss of rearing habitat, changes in the food supply (macroinvertebrate assemblage), and decreased over-wintering habitat (Lisle 1989, Miller and Benda 2000, Wood and Armitage 1997).

Watershed hydroperiod can be altered by fire and cause vegetation removal causing accelerated soil erosion and loss of soil productivity, and contribute to increased soil compaction. Reductions in soil productivity can limit the vegetation potential, resulting in plants taking up less moisture. Increased soil compaction decreases the amount of water infiltration into the soil. Both of these factors compound to lead to higher surface runoff and higher flood pulses in stream channels (Swank et al. 1989, Ziemer et al. 1991). The erosive energy of floods can cause stream channel downcutting or incision causing water to drain from floodplains into the channel resulting in lower groundwater tables (Agee and Skinner 2005, Lertzman et al. 1998, Ziemer et al. 1991). This results in a narrowing or loss of riparian vegetation since they are left in drier soils. Additionally, with less water entering upslope and riparian soils, less water is available to provide late season flows. Therefore, the higher flows during precipitation events are often followed by low or no flow during the drier weather periods (Rinne and Miller 2006).

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The effects of hydroperiod alterations listed above can result in deleterious effects to aquatic biota. Lower water tables that reduce or eliminate riparian vegetation affect macroinvertebrate communities. Streamside vegetation provides both allochthonous (produced outside stream system) and autochthonous (produced within stream ecosystem) food sources for macroinvertebrates, and the quantity and quality of these inputs plays a critical role in regulating the macroinvertebrate assemblage present in the system

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(Gregory et al. 1991). In turn, macroinvertebrates are a primary food source for aquatic vertebrates (icthyofauna and herpetofauna) and alterations to the food web at the lower levels will have repercussions to these higher-level consumers. Additionally, riparian plant communities with rooted plants retard streambank erosion, filter sediment from the water, build and stabilize streambanks and streambeds, and provide shade and nutrients for aquatic species. Healthy riparian areas act as sponges during high water periods and raise water tables, maintaining streamwater during dry seasons, and resulting in more flow throughout the year (Elmore and Kauffman 1994, Kauffman et al. 1997). The loss of riparian vegetation, therefore, can result in a negative feedback loop where conditions continue to break down until active management is undertaken to repair degraded areas.

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Effects of Spring Restoration

Spring conditions would improve for up to74 springs within the analysis area (Appendix 9). Initially, spring habitats would experience short-term increases in sediment production and transport as a result of restoration activities. As restored springs stabilize, however, springs would return to a more natural state, with increased surface flows and improved groundwater levels. Additionally, vegetation treatments at the watershed scale combined with prescribed burning could restore or improve hydrologic function of springs that currently have reduced discharge due to evapotranspirational losses of soil water that could otherwise recharge groundwater in perched or shallow aquifers (MacDonald 2013).

Effects of Stream Restoration

Thirty-nine miles of ephemeral streamcourses (Appendix 9) would be returned to a more natural condition, thus reducing channel and bank scour, downcutting, aggradation, and uncharacteristic levels of sediment transport. Initially, ephemeral streamcourse restoration would likely exhibit slight increases in short-term sediment production and transport since streambanks and channels would be disturbed during the reshaping and restoration process (MacDonald 2013). As restored areas stabilize, these ephemeral streamcourses would return to a more natural state with banks having more gentle angles of repose that would support vegetative cover, more favorable floodplains to increase soil water storage, and reduced stream velocities; thus decreasing sediment transport, channel downcutting, and streambank undercutting that results in bank failure.

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Effects of Road Restoration and Decommissioning

Runoff from road surfaces can detach and transport the fine material from road prisms and ditches. Sediment delivery directly from road surfaces to watercourses is difficult to estimate since it occurs as non-point source runoff. Sediment delivered to streams from roadside ditches may have originated from sheet or rill erosion prior to entering road surfaces or drainage ditches (MacDonald 2013). In the absence of vehicle traffic, sediment concentrations in road runoff decreases over time. However, vehicle traffic, particularly trucks, can pulverize road surface aggregates, resulting in more fine particles that are easily transported in runoff. Additionally, the pressure of vehicular tires on saturated road surfaces can force fine particles from below the surface to move upward to the surface (Truebe and Evans 1994). Road proximity and connectivity to drainages can strongly influence sediment delivery to watercourses and peak flows in streams. Roads within the project area intersect numerous ephemeral drainages. These points of intersection occur as both culverted crossings and low-water crossings. Road-stream intersections are the primary location where sediments are delivered to streamcourses.

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A total of approximately 860 miles of existing system roads and unauthorized roads would be decommissioned. Site-specific determinations have not been made for road decommissioning techniques. Some may be closed by posting carsonite or fiberglass signs and placing obstructions such as boulders. Some actions could include reestablishing natural drainage patterns and removing fill and culverts. Full obliteration would require re-contouring and restoring natural slopes, ripping and seeding or mulching

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road surfaces, and stream crossings would be re-contoured and unstable sidecast or cutslopes removed or stabilized, with entrances blocked to prevent access. These activities would return unproductive acreage to a more stable, productive status over the long term by improving water infiltration, naturalizing water flow, increasing vegetative ground cover, and reducing erosion (MacDonald 2013). Upon completion of road decommissioning activities, long-term erosion rates for decommissioned roads are expected to approach natural erosion rates for TEUs where these roads occur. With implementation of appropriate BMPs as outlined in Table 205, water quality and riparian ecosystem conditions would be improved.

Approximately 40 miles of roads would be reconstructed to reduce adverse effects to surface water quality. These legacy roads are located in close proximity to, or within streamcourses. By relocating these roads to upland locations, sediment delivery directly to streamcourses would be minimized.

Approximately 520 miles of temporary roads would be necessary to conduct vegetation treatments. These roads would be constructed using BMPs as outlined in Table 205, thus minimizing adverse impacts to surface water quality. No riparian areas would be adversely affected by temporary road construction as none are proposed within riparian areas.

Effects of Dust Abatement

Road-related operations would include dust abatement treatments. An expert panel, sponsored by the U.S. Environmental Protection Agency, conducted a literature review of dust suppressants (Piechota et al. 2004). Magnesium chloride ($MgCl^2$) is the most widely used salt for suppressing dust. Salts move through soil easily with water and, in areas near the application, could potentially have negative impacts on plant growth near application sites. Chloride concentrations as low as 40 ppm have been found to be toxic to trout. Salt concentrations greater than 1,800 mg/L have been found to kill daphnia and crustaceans (Sanders and Addo 1993), and 920 mg/L of calcium chloride has been found to be toxic to daphnia (Anderson 1950). A mortality of 50% was achieved for rainbow trout exposed to 2,500 mg/L ligninsulfonate for 275 hours. Lignin has been found to cause weight gain and colon ulcers in lab testing of rodents. It did not prevent seed germination in field trials and may be the most environmentally compatible dust suppressant (Piechota et al. 2004).

Piechota et al. (2004) concluded that the determination of effects must be based on assessing site-specific conditions. Dust abatement treatments would be limited in the 4FRI, occurring in selected areas where private landownership concerns could arise. Eight road segments have been identified for dust abatement, totaling less than 7 miles in length. The average dust abatement treatment length would be about 0.9 mile, ranging from 0.3 to 2.5 miles. The effectiveness of $MgCl_2$ decreases with decreasing humidity levels (Piechota et al. 2004); Dust abatement for the 4FRI would be very limited, if necessary at all, during the monsoon season. Therefore, lignin would probably be used most often in the 4FRI landscape. Treatments would be temporary and only be used when hauling would occur on a particular road. None of the proposed treatment segments are near open water. Because of the limited application spatially and temporally, and because locations do not include sensitive areas such as open water, dust abatement is not expected to result in measurable effects to aquatic species or their habitat.

Summary of Cumulative Effects to Aquatic Species

As stated above, there are four 6th code watersheds where urban development has a large impact on ground disturbance areas. This project, plus current and future foreseeable projects, impacts these watersheds in the following manner: In the Cataract Creek Headwaters watershed there was an 11% baseline ground disturbance prior to any activities. This percent of ground disturbance would increase to 14% total cumulative ground disturbance. In the Sinclair Wash watershed, there was a 25% baseline ground disturbance prior to any activities. This percent of ground disturbance would increase slightly to

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26% total cumulative ground disturbance with all current and foreseeable projects. In the Lower Rio de Flag watershed, there was an 18% baseline ground disturbance that would increase to 20% total cumulative ground disturbance. In the Middle Oak Creek watershed, there was an 11% baseline ground disturbance that would increase to 13% total cumulative ground disturbance.

Implementation of BMPs will minimize impacts to watersheds, and will be especially important in the watersheds that already have a high urban impact.

Narrow-Headed Garter Snake

The geographic setting and boundary for the cumulative effects analysis will be all 81 6th HUC watersheds within or intersecting the project boundary for a total of about 2,032,000 acres. Cumulative effects include past timber sales and their associated roads; hazardous fuel and prescribed burning projects that can affect the acres of soil disturbance, primarily through fuel treatments, as well as past burning and wildfires; range allotments; roads; private land; power corridors; and recreation activities. Recreation activities are dispersed across the cumulative effects boundary area and are not quantifiable. For a more detailed analysis, see the above description for Aquatic Species and Critical Habitat.

Protection of soil resources is provided by using BMPs that minimize the potential for soil disturbance under the proposed action. The implementation of Identified BMPs is expected to reduce the risk of accelerated erosion, sediment delivery and nonpoint source pollution to connected streamcourses, and maintain water quality in all watersheds. In addition to the use of BMPs, the completion and implementation of the Travel Management EIS will further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Because of these facts, this alternative would not provide a detrimental cumulative effect to soil resources within the Cumulative Effects boundary.

Narrow-Headed Garter Snake Critical Habitat

For past, present and reasonably foreseeable actions, including the 4FRI proposed action, the extent (about 8%) and magnitude of soil disturbance within the cumulative effects boundary is expected to remain well below the 15% threshold where soil productivity would be affected. Further protection of soil resources is provided by using BMPs that minimize the potential for soil disturbance. Identified and implemented BMPs are expected to reduce the risk on accelerated erosion, sediment delivery and nonpoint source pollution to connected streamcourses and maintain water quality in all watersheds. In addition to the use of BMPs, the completion and implementation of the Travel Management EIS will further reduce the number of acres disturbed by closing and decommissioning roads within the cumulative effects boundary. Therefore, this alternative will not provide a detrimental cumulative effect to soil resources within the cumulative effects boundary (Fisheries and Aquatics Specialist Report).

Effects to Golden and Bald Eagle

Golden Eagle

The area analyzed for cumulative effects for the golden eagle is the project area and area within a ½ mile of the project boundary. Past, present, and reasonably foreseeable projects are listed in Appendix 12 of the wildlife report and past projects have implemented thinning on 2,304 acres and prescribed burning on 8,951 acres in grasslands. There is no effect to nesting eagles; however, there may be potential short-term disturbance to potential foraging habitat with long-term benefits. Short-term disturbance to foraging eagles would occur during thinning, hauling, temporary and permanent road construction, and prescribed burning activities and may cause eagles to forage in nearby areas for the duration of the activity. Other activities that may have similar effects include temporary disturbances caused by prescribed fire (104,750

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acres) and thinning (104,990 acres) in adjacent projects, or effects to roosting habitat from utility infrastructure development and maintenance (500 acres). These short-term impacts added to similar effects from other activities were considered. Implementation activities of other fuel reduction project activities could occur simultaneously; however, it is not anticipated to combine to cause a negative effect.

Bald Eagle

The area analyzed for cumulative effects for bald eagle is the ponderosa pine within the project and ½ - mile of the project boundary. Current, ongoing and reasonably foreseeable projects are listed in Appendix 12 of the wildlife report and include fuels reduction, forest health, aspen regeneration, tornado rehabilitation and powerline development and maintenance. Short-term impacts added to similar impacts from nearby projects were considered. Implementation of other project activities could occur simultaneously however, it is not anticipated to combine to cause a negative effect. All alternatives would improve and develop quality potential nesting and roosting habitat by developing groups of large trees and snags that are more fire resistant. This positive effect would be combined with similar effects from activities such as the Travel Management Rule efforts that may decrease the frequency of disturbance on the majority of potential roost sites, slightly counteracting the effects of utility line and road construction and maintenance and short-term disturbances from vegetation management and prescribed fire.

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7. Monitoring

Arizona Bugbane Administrative Study: Burn effects

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The Forest Service is collaborating with the USFWS to finalize a strategy to monitor the impacts of prescribed fire on Arizona bugbane. The strategy will be finalized and incorporated into the final Biological Opinion.

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Introduction

This treatment and monitoring is designed to be incorporated into the current 4FRI analysis and the Arizona Bugbane Conservation Strategy (1995), which is currently under revision.

To address concerns of potential fire effects to Arizona bugbane, we are proposing a prescribed burning and monitoring project at plant locations and sites in the Upper West Fork area that are currently proposed for treatment. The burning and monitoring project may be carried out as part of this analysis or as a separate administrative study.

Pre and post monitoring would occur on one or more replications in this area. All activities would be subject to other restrictions such as timing restrictions as they apply to MSO nesting seasons, fire risk and wilderness considerations.

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As part of 4FRI implementation, prescribed burning may occur in or near some populations of Arizona bugbane. Direct effects to Arizona bugbane could include the death or top killing of individual plants. Indirect effects may come from the unintentional loss of shade from trees killed in the surrounding area. Decrease of pine needle litter and the resulting nutrient pulse from burning may stimulate growth of plants and increase seedling establishment. Under the current NEPA analysis, mitigations would include managing prescribed fires to limit rates of overstory tree mortality.

Knowledge of fire effects on Arizona bugbane is based largely on observations from a local wildfire, the Fry Fire in 2003, on the Coconino National Forest (Crisp et al. 2004, personal observation). The fire covered 180 acres of upland and canyon habitats in Fry Canyon and was of mixed severity. The highest

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severity fire effects in areas with individual Arizona bugbane plants initially included loss the above ground portions. On a subsequent visit in 2004, Arizona bugbane plants were observed along the fire line near the canyon bottom, some in severely burned areas. Observers noted a variety of plant sizes and ages, ranging from immature plants to adults with mature fruits. An adult plant with fruits and blackened soil at the base is shown in Figure 17. The lower portion of the canyon supports mixed-conifer forest and is more mesic than the upland ponderosa pine forest along the rim of the canyon. Arizona bugbane populations were informally monitored again in 2005 and 2010, and plants were persisting and thriving.

A literature search did not locate any published data for fire effects to Arizona bugbane. However, based on taxonomic information for the genus *Cimicifuga* in the Flora of North America, members of the genus *Cimicifuga* have long-lived perennial rhizomes (see Vol. 3 page 177) that would persist after the top portions of the plants senescence in the fall. This allows the plants to regenerate from the underground rhizomes when conditions are favorable in the spring. Pyke et al (2010) addressed the persistence of plants after wildfires using several traits including life form. Perennial species such as bugbane are categorized as cryptophtyes (see table 1 of article). Plants with this life form are generally one of the most protected from death during fire because the soil insulates the underground portions of the plants. In these cases, the top portions of the plant may be lost but the underground structures such as rhizomes are able to persist. Limitations on this survival method include high-severity fires (Pyke et al., 2010).

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Figure 17. Arizona bugbane plants near the fire line on Fry Fire. September 2004.

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A related species in the same genus, *Actaea rubra*, has been studied in the northwestern U.S. Data are available on the Fire Effects Information System website. In that species, the tops of plants are removed by fire and then plants regenerate from thick underground caudices, but seedlings did not appear for several years post-fire.

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Over a 25-year period, the majority of natural ignitions within an area of approximately 55,000 acres around known populations of Arizona bugbane (Figure 18) occurred from May to September (Table 209). Prescribed fires have most commonly been implemented before May or after mid-September. Implementing prescribed fire at these times may produce stress on bugbane since adaptations likely relate to fires typically occurring between May and September. However, only the Fry Fire is known to have burned into an Arizona bugbane population during the May to September time period (Figure 18). Arizona bugbane often grows in rocky areas with poor soil where surface fuel may be discontinuous in and/or around the populations. One population on Bill Williams Mountain on the Kaibab National Forest is in mixed conifer forest, the type locality for this species. In both of these cases, it is possible that fire did not burn though these areas as often as it did though the surrounding area. The Fry Canyon population for which there are some observations indicated that at least some of the plants regenerated after the fire. It seems possible, then, that Arizona bugbane may be adapted to fire, although the fire frequency may be less than in the surrounding vegetated areas.

Table 209. Number of fires Forest Service personnel responded to over a 25-year period within the area shown in Figure 18. In Figure 18, these fires are shown in lightning bolts.

Month	Number of fires
January	0
February	0
March	1
April	1
May	12
June	30
July	146
August	106
September	39
October	17
November	1
December	0
Total	353

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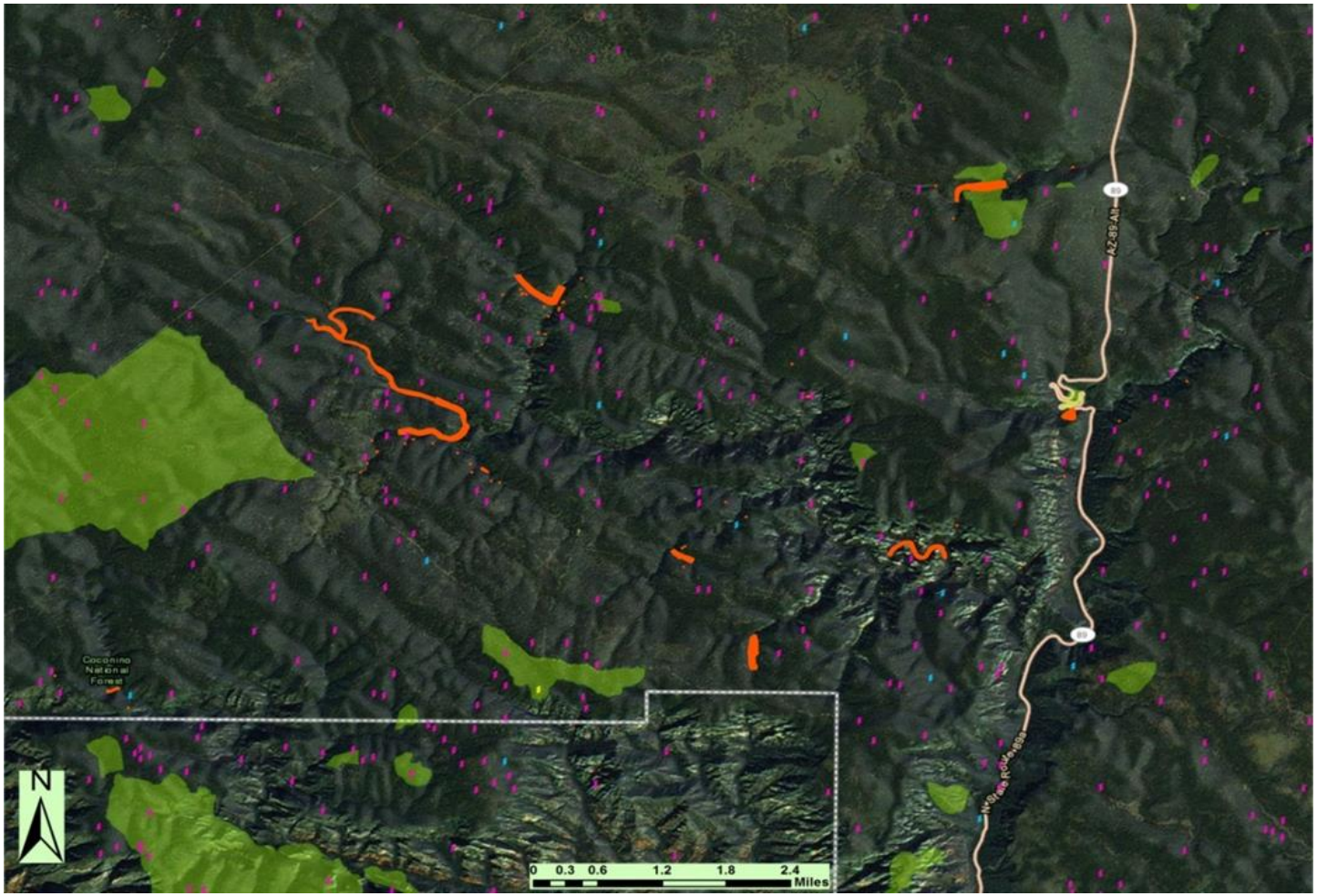


Figure 18. Arizona bugbane populations in orange. Lightning fires for 25 years are shown as: 1) Ignitions are indicated by lightning: Yellow = January through April; Pink = May through September; Blue = October through December. 2) Perimeters of lightning fires that grew to 10 acres or larger.

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Given the frequency of fire in the areas surrounding the populations, it seems unlikely that it would not have some adaptations. Even if separated from the frequent fire areas, there would be years when embers would spot near or in populations, an instance that is more likely in dry years, or between the end of the spring precipitation and the onset of monsoons.

Although we do not know the details of its fire adaptations, there is an unnaturally high surface fuel buildup in areas surrounding these populations and possibly within them as well. This raises concerns about the potential effects of a wildfire occurring under circumstances that could produce unnaturally high-severity fire effects in and around populations of bugbane. Given this, it seems advisable to use prescribed fire in a manner that seems most likely to benefit the species, based on the limited information we have, and to document the effects for informing future management actions.

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Study design

This monitoring/burning project was designed by Fire Ecologist Mary Lata, and Forest Botanist Debra Crisp. We would coordinate with the USFWS and a fuels specialist in the selection of one or more sites in the West Fork Area within the 4FRI project boundary.

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The proposed study area consists of stands within the Upper West Fork MSO PAC (Figure 19). No bugbane test burning would occur in the core area. The Recovery Plan (USDI FWS 2012) does not recommend burning in MSO PACs during the breeding season (March 1 to August 31) except when non-breeding is confirmed or inferred that year. The area would be surveyed for MSO before implementation of the raking and burning treatments.

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Table 210. Arizona bugbane locations and sites in the Upper West Fork PAC

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Restoration subunit	Date Collected	Location	Site	Alternative C
3-5	9/12/2012	167	33	Burn Only
3-5	9/12/2012	167	34	Burn Only
3-5	9/12/2012	176	3	Burn Only
3-5	9/1/1980	176	7	Burn Only
3-5	9/12/2012	176	10	Burn Only

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The study would include one or more areas to accomplish three different treatments as follows:

1) Control (about half of the individual population): The control area would not be burned although, as stated above, it would receive whatever mechanical treatments have been prescribed for the area, and would serve as a comparison for the other two treatments.

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2) Partial raking with no burning (about one-quarter of the individual population): The intent of this treatment is to mimic historical levels of litter and duff under characteristic fire levels and document plant response without including fire effects. If these areas burned periodically, even if it was a lower frequency than surrounding areas (there are no site-specific, definitive data for fire frequency in Bugbane populations) it is likely that there would normally have been less litter and duff than are present today.

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3) Prescribed fire (about one-quarter of the individual population): This area would be subjected to a burning treatment as proposed for the location/site and already incorporated in this alternative. Fire within the bugbane population would be managed to produce only low-severity effects.

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Some effects of fire that would not be present in the partial raking treatment, but may have an effect on the bugbane include.

A fireline surrounding all three areas would be created to aid in administering consistent fire treatments. The total area, including all three treatments, would comprise about an acre or less.

The preferred time for conducting burn treatments would be between May and August, when fire would have been historically expected to burn in this area. However, given the proximity of the Upper West Fork and Bridge PACs, smoke from first-entry burns within the Upper West Fork PAC is a concern due to surface fuel loading that likely exceeds historical conditions. Theoretically, a fall burn would be expected to be less harmful than a spring burn because individual plants would have had the preceding growing season to produce and store energy. A site-specific field evaluation with the USFWS would assist in establishing the appropriate burn season.

Raking and fire line construction would occur immediately prior to the ignition of fire to assure that there is no effect from timing of treatments. The area to be burned will be on the downhill side (if there is a slope) to prevent overland flow from carrying nutrients from the burned area into one of the non-burned areas, potentially biasing results.

During ignition and burning, the fire would be monitored to document fire behavior (FL). Scorch would be kept to less than 5 feet.

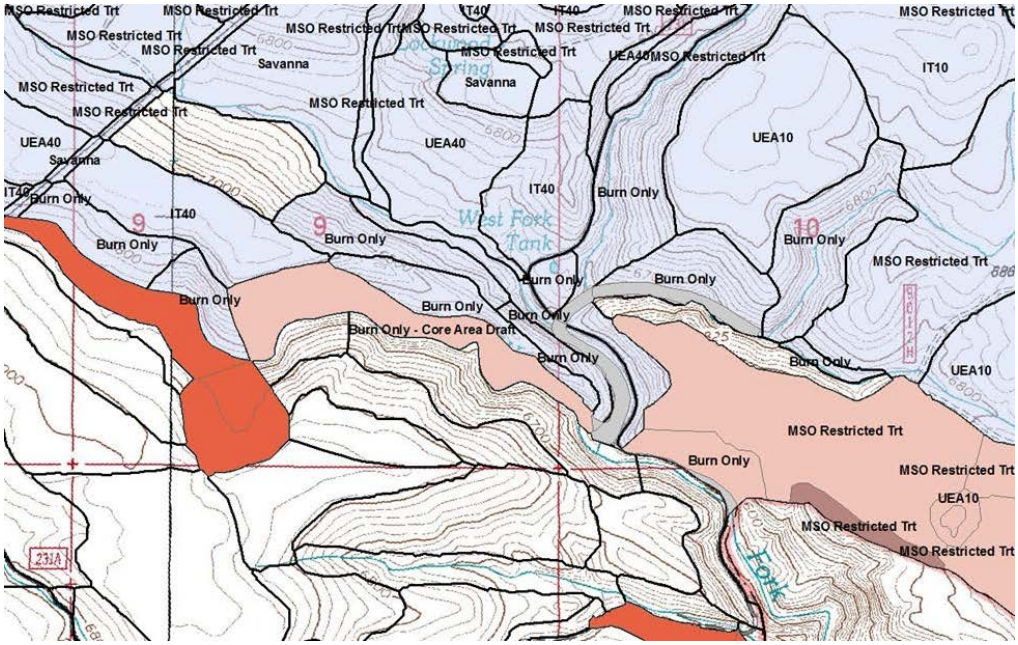


Figure 19. Map showing potential areas. Potential locations and sites are shown in gray.

Design Features

1. Implementation will require coordination between the Forest Botanist, District Wildlife Biologists, Fuels, 4FRI Fire Ecologist and Wildlife Biologist, and the USFWS.

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2. If owls are not present, we would like to mimic what would likely fit the pattern of ecological evolution in this area and burn between May and August, when natural fire would have been present in the plant community. If the presence of owls prohibits a summer burn, it would occur in the late/summer fall.

3. The area will be surveyed for MSO before implementation. If MSO presence is detected, the treatments will be conducted outside of the breeding season (after August 31).

Pre-treatment data

The following data would be collected immediately before burning occurred to minimize the effects of time on the treatment

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Plant data

Plant measurement would include:

1. Size, number of leaves, and age class of plant (adult or young). Individual stems will be counted as opposed to clumps of plants to avoid the need to determine underground connectivity of the plants.

2. Phenology – vegetative, blooming, flowering, fruiting and/or senescent.

3. Evidence of other activities at the site such as grazing by wildlife and/or cattle, recreation, etc.

4. These data should be collected for plants on each treatment (untreated, raking and burning).

Fire/fuel parameters

1. Litter depth (pre and post)

2. Downed woody material (pre and post)

3. Exposed mineral soil (pre and post)

4. Timing of fire (season)

5. Fuel moisture

6. Flame length (used as a proxy for intensity)

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7. Fire weather at the site

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Post-treatment data

Plant data

Collection of the plant data will occur as soon as possible after treatment and then at least once a year during the growing season for the next 3 years. The yearly data should be collected as near to the same date as the burning treatment. Weather data for the date of collection and the season prior should be noted. This is to consider the effects of weather on plant growth at the treatment sites.

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Fire parameters

Litter depth and the amount of downed woody material should be recorded at each visit on each treatment type (untreated, raking, and burning). Recent deadfall and tree mortality rates should also be recorded.

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Reporting

Data sheets will be prepared and data recorded in a standard manner on each visit to assure data consistency. Data sheets and field notes will be entered electronically into the 2670 Arizona bugbane file in an area established and designated for the monitoring/study. Data will also be shared with the USFWS, 4FRI monitoring coordinator and other interested parties.

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Mexican Spotted Owls

The Forest Service is collaborating with the USFWS to develop a strategy to monitor the impacts of the proposed actions on MSOs. The strategy will be finalized and incorporated into the final Biological Opinion as part of the requirement (50 CFR 13.25 and 18.27) to report the impacts of take that are incidental to the implementation of the 4FRI.

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8. Conclusions

Determination of Effects for Arizona Bugbane

It is my recommendation that after considering direct, indirect and cumulative effects, the implementation of the 4FRI **may impact individuals, but is not likely to cause a trend towards federal listing or loss of viability** for Arizona bugbane.

Determination of Effects for Mexican Spotted Owls and Their Habitat

Overall, the risk of adverse effects to owls is believed to have been minimized by:

- Mechanical and prescribed fire treatments were designed to meet the habitat objectives described in the MSO Recovery Plan
- Mechanical and prescribed fire treatments inside PACs and within ¼ mile of the core area would be conducted outside the nesting season
- Areas where smoke is more likely to drift into PACs and PACs that are vulnerable to settling smoke were identified and would not be treated during the nesting season
- Burn objectives inside PACs would be limited to reducing surface fuels, primarily needle cast and duff, producing low-severity fire, and minimizing the risk of unintended effects from fire
- Prescribed fire would be managed to minimize the risk of smoke settling into PACs through ignition techniques, weather conditions, and avoiding burning areas during the nesting season where the risk of resulting smoke settling into PACs was identified.
- A network of haul routes was identified to avoid or minimize effects to MSO
- Habitat improvements to aspen, meadows, springs, and ephemeral channels within PAC habitat would occur outside the nesting season
- Combined, treatments inside and outside of MSO habitat significantly reduce the risk of high-severity crown fire in protected and restricted habitats, improve forest metrics related to nesting, roosting, foraging, and prey habitat

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Therefore, long-term effects of the 4FRI should be beneficial to MSOs by enhancing key habitat components for MSO and their prey. The likelihood of maintaining MSO habitat into the future is also enhanced by reducing the predicted risks from climate change-induced changes in temperature and precipitation patterns.

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However, there is potential for short-term adverse effects to owls and their habitat.

Modeling of treatments in target and threshold habitats indicates that, in the long term, some trees 12 to 17.9 inches dbh would drop below the minimum 15% described in the Recovery Plan. Trees in this size class are currently at or exceed the 15% threshold. Trees >24 inches dbh are well below the 15% threshold. The long-term benefits of thinning 12 to 17.9 inches dbh trees are the effects on growth rates and resiliency of trees >24 inches dbh.

The use of prescribed fire brings inherent uncertainty. While this would be minimized through the use of ignition and control techniques, the sheer number of acres and discrete applications of fire (i.e., all or parts of 70 different PACs) increases the risk of fire burning out of prescription. While individual tree or pockets of torching could improve habitat conditions by adding diversity in dense, relatively homogeneous stands of pine-oak, the same action in other stands or larger areas of torching could create long-term adverse effects to MSO habitat. Adverse effects would only happen if burning exceeded prescription, therefore, the degree of risk is unknown and unquantifiable, but remains a risk.

Smoke may have an adverse effect if predicted weather conditions were to change during burn operations. Smoke tends to settle into low-lying areas, including canyons which serve as owl habitat. Lung damage could occur if smoke settled into PACs with incubating adults or nestling MSOs for continuous days and nights. Lung damage could result from continuous exposure to high smoke levels. MSOs could be forced to alter foraging behavior as a result of extended smoke. Altered foraging behavior could leave owls vulnerable to predators. Under these circumstances, smoke settling into PACs could cause adverse effects. The risk of this is low due to the design features specifically developed to minimize this threat. However, some risk remains, although it is considered low and is unquantifiable.

Because of planning and timing restrictions, noise disturbance to owls is not expected in PAC habitat where the majority of foraging is done by nesting owls. Owls foraging outside PACs during nesting season could potentially be displaced by harvest activities and increased truck traffic. Owls could also be displaced by harvest activities and increased truck traffic outside the nesting season. Displaced owls could be more vulnerable to predation.

Vehicular traffic would not simultaneously increase across the entire implementation area, but harvest-related traffic increases would occur in localized areas somewhere on the landscape for every year of implementation. Most traffic is expected to occur during diurnal hours when MSO activity would be minimal. However, hauling of materials from harvest locations to highways could occur at night when owls are active. Once harvest activities are complete, traffic is expected to return to pre-harvest levels.

The amount of traffic increases the risk of collisions between owls and trucks. There have been documented instances of spotted owls being hit by vehicles on paved and unpaved roads. Although little information is available on the frequency or conditions related to the risk of collisions, the assumption is being made that, because of the scale of increase in truck traffic, the risk of collisions with owls would increase. The threat of collisions would be reduced below existing conditions in the long term as a result of about 860 miles of road decommissioning.

Because of the short-term risks of adverse effects, it is my determination that after considering direct, indirect and cumulative effects, the implementation of the 4FRI **May Affect and is Likely to Adversely Affect** MSOs and their habitat.

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Determination of Effects for Mexican Spotted Owl Critical Habitat

Overall effects to MSO critical habitat are expected to be beneficial in the long term. Proposed treatments have limited effects on forest structure and prey habitat post-treatment, but consistently move PCEs toward desired conditions.

In the short term, the use of prescribed fire brings inherent uncertainty. While this would be minimized through the use of ignition and control techniques, the sheer number of acres (about 108,846 acres) and discrete applications of fire across the landscape increases the risk of fire burning out of prescription somewhere in MSO habitat. Individual trees or small pockets of torching could improve habitat conditions in some stands. The same action in other stands or larger areas of torching could remove PCEs and create long-term adverse effects to MSO habitat. Adverse effects would only happen if burning exceeded prescription, therefore, the degree of risk is unknown and unquantifiable, but remains a risk to an unspecified number of critical habitat acres.

Modeling of treatments in target and threshold habitats indicates that, in the long term, trees 12 to 17.9 inches dbh would drop below the minimum 15% described in the Recovery Plan. Trees in this size-class are currently at or exceed the 15% threshold. Trees >24 inches dbh are well below the 15% threshold. The long-term benefits of thinning 12 to 17.9 inches dbh trees are the effects on growth rates and resiliency of trees >24 inches dbh, which would exceed 15% after treatment.

It is my determination that after considering direct, indirect and cumulative effects, the implementation of the 4FRI **May Affect and is Likely to Adversely Affect** Mexican spotted owl critical habitat.

Certification and Signature: William O. Noble, journey level biologist on the 4 Forest Restoration Initiative, has reviewed this document and certified its compliance with manual requirements and made the final determination for the MSO and its critical habitat and for Arizona bugbane.

Prepared by: /s/ *William O. Noble* Date: February 14, 2014

William O. Noble

4FRI Wildlife Biologist

Aquatic Species and Critical Habitat Effects

Threatened, endangered, and sensitive aquatic species in and adjacent to the project area are all located on the Coconino National Forest. Units and subunits (and relevant 6th Code HUC watersheds) that contain these species are: 1-3 (Pumphouse Wash), 1-4 (Sawmill Wash), 1-5 (Munds Canyon), 3-3 (Lower Sycamore Creek, Middle Sycamore Creek, \ Upper Sycamore Creek), 3-4 (Pumphouse Wash), 3-5 (Middle Oak Creek, Munds Canyon, Upper Oak Creek, West Fork Oak Creek), and 5-1 (Lower Rio de Flag). All other watersheds within the analysis area do not contain TES aquatic species habitat, and therefore, are not considered further with respect to TES species effects.

Spikedace Critical Habitat

Within the analysis area, critical habitat for spikedace exists in the middle and lower portions of Oak Creek (USDI FWS 2012b). Prescribed fire treatments in subunits connected to this watershed or its 6th HUC watersheds upstream could potentially lead to short-term increases in sedimentation and/or ash flow into spikedace critical habitat.

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Based on current knowledge of the life history, biology, and ecology of spikedace and the habitat requirements for sustaining the essential life-history functions of the species, the physical constituent elements for spikedace are (USDI FWS 2012b):

1. Habitat to support all egg, larval, juvenile, and adult spikedace, which includes:
    a. Perennial flows with a stream depth generally less than 1 meter (3.3 feet), and with slow to swift flow velocities between 5 and 80 centimeter per second (1.9 and 31.5 inches per second).
    b. Appropriate stream microhabitat types including glides, runs, riffles, the margins of pools and eddies, and backwater components over sand, gravel, and cobble substrates with low or moderate amounts of fine sediment and substrate embeddedness;
    c. Appropriate stream habitat with a low gradient of less than approximately 1.0 percent, at elevations below 2,100 meters (6,890 feet); and
    d. Water temperatures in the general range of 8.0 to 28.0 °C (46.4 to 82.4 °F).
2. An abundant aquatic insect food base consisting of mayflies, true flies, black flies, caddisflies, stoneflies, and dragonflies.
3. Streams with no or no more than low levels of pollutants.
4. Perennial flows, or interrupted stream courses that are periodically dewatered, but that serve as connective corridors between occupied or seasonally occupied habitat and through which the species may move when the habitat is wetted.
5. No nonnative aquatic species or levels of nonnative aquatic species that are sufficiently low as to allow persistence of spikedace.
6. Streams with a natural, unregulated flow regime that allows for periodic flooding or, if flows are modified or regulated, a flow regime that allows for adequate river functions, such as flows capable of transporting sediments.

The soils and water report (Steinke 2013) indicates that prescribed fire treatments under the Proposed Action could result in soil erosion in areas where slope exceeds 15%. Cumulative soil disturbance across the 4FRI landscape is estimated to be about 8% of the aerial extent. This is well below the 15% threshold where soil productivity would be affected. However, there is a short-term risk (1 to 2 years) of sedimentation or ash flow resulting from these treatments; sediment has been shown to limit or affect spikedace habitat by altering macroinvertebrate assemblages, and spikedace abundance decreases where sediment fills interstitial spaces in the substrate. However, BMPs would be in place to mitigate these risks and proposed treatments would occur for 10 or more years, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope. Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which spikedace live.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. Again, BMPs would be in place to mitigate these short-term risks to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on spikedace critical habitat, as no dust abatement treatments are proposed near open water.

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Finally, the proposed Coconino and Kaibab Forest Plan amendments would have no measurable effects on spikedace critical habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, the Proposed Action **May Affect but is Not Likely to Adversely Affect** spikedace critical habitat.

Loach Minnow Critical Habitat

Within the analysis area, critical habitat for loach minnow exists in the middle and lower portions of Oak Creek (USDI FWS 2012b). Prescribed fire treatments in subunits connected to this watershed or its 6th HUC watersheds upstream could potentially lead to short-term increases in sedimentation and/or ash flow into loach minnow critical habitat.

Based on the current knowledge of the life history, biology, and ecology of loach minnow and the habitat requirements for sustaining the essential life-history functions of the species, the physical constituent elements for the loach minnow are (USDI FWS 2012b):

1. Habitat to support all egg, larval, juvenile, and adult loach minnow which includes:
    a. Perennial flows with a stream depth of generally less than 1 meter (3.3 feet), and with slow to swift flow velocities between 0 and 80 centimeters per second (0.0 and 31.5 inches per second);
    b. Appropriate microhabitat types including pools, runs, riffles, and rapids over sand, gravel, cobble, and rubble substrates with low or moderate amounts of fine sediment and substrate embeddedness;
    c. Appropriate stream habitats with a low stream gradient of less than 2.5 percent and are at elevations below 2,500 meters (8,202 feet); and
    d. Water temperatures in the general range of 8.0 to 25.0 °C (46.4 to 77 °F).
2. An abundant aquatic insect food base consisting of mayflies, true flies, black flies, caddisflies, stoneflies, and dragonflies.
3. Streams with no or no more than low levels of pollutants.
4. Perennial flows, or interrupted stream courses that are periodically dewatered, but that serve as connective corridors between occupied or seasonally occupied habitat and through which the species may move when the habitat is wetted.
5. No nonnative aquatic species or levels of nonnative aquatic species that are sufficiently low to allow persistence of loach minnow.
6. Streams with a natural, unregulated flow regime that allows for periodic flooding or, if flows are modified or regulated, a flow regime that allows for adequate river functions, such as flows capable of transporting sediments.

The Soils and Water Report (Steinke 2013) indicates that prescribed fire treatments under the Proposed Action could result in soil erosion in areas where slope exceeds 15%. Cumulative soil disturbance across the 4FRI landscape is estimated to be about 8% of the aerial extent. This is well below the 15% threshold where soil productivity would be affected. However, there is a short-term risk (1 to 2 years) of sedimentation or ash flow resulting from these treatments; sediment has been shown to limit or affect loach minnow habitat by altering macroinvertebrate assemblages, and loach minnow abundance decreases where sediment fills interstitial spaces in the substrate. However, BMPs would be in place to mitigate these risks and proposed treatments would occur for at least ten-years, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope. Finally, the

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short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which loach minnow live.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. Again, BMPs would be in place to mitigate these short-term risks to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on loach minnow critical habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would have no measurable effects on loach minnow critical habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, the Proposed Action **May Affect but is Not Likely to Adversely Affect** loach minnow critical habitat.

Roundtail chub

Roundtail chub (*Gila robusta*) is a candidate species under the ESA and has been precluded from listing now due to higher priority actions to amend current species lists (USDI FWS 2006; USDI FWS 2009). The roundtail chub was included on the Regional Foresters' (USDA Forest Service – Southwestern Region) October 1, 2007, sensitive species list.

Roundtail chub is a moderately streamlined member of the minnow family (Cyprinidae); it has a slender caudal peduncle and a deeply forked, relatively large caudal fin. Coloration of adults is silvery shading dorsally to dusky yellow or light green. Both sexes have orange-red coloration of the ventrolateral surface and on all fins except the dorsal. Both males and females possess breeding tubercles to a highly variable degree. Adult roundtail chub can attain 20 inches (51 centimeters) in length and 2 pounds (0.9 kilograms) in weight, while adult headwater chub generally do not grow as large.

Roundtail chub is widespread in moderate to large rivers of the Colorado River Basin. In Arizona, it still occurs in the mainstem and tributaries to the Verde and Salt Rivers. Roundtail chub are also still thought to occur in the Upper Clear Creek watershed. Populations have declined considerably during the past few decades. This report will analyze effects to roundtail chub and its habitat, as it is present in Oak Creek and Sycamore Creek.

Roundtail chub occupy cool to warm water, mid-elevation streams, and rivers where typical adult microhabitat consists of pools up to eight feet deep adjacent to swifter riffles and runs. Cover is usually present and consists of large boulders, tree rootwads, submerged large trees and branches, undercut cliff walls, or deep water. Smaller chub generally occupy shallower, low-velocity water adjacent to overhead bank cover. Roundtail chub appear to be very selective in their choice of pools, as they are commonly found to congregate in certain pools, and are not found in similar, nearby pools. Spawning takes place over gravel substrate. Tolerated water temperatures approach 80 °F.

Young chub feed on small insects, crustaceans, and algal films, while older chub move into moderate velocity pools and runs to feed on both terrestrial and aquatic insects along with filamentous algae. Large roundtail chub take small fish, and even terrestrial animals such as lizards that fall into the water.

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Roundtail chub breed in early summer, often in habitats associated with beds of submergent vegetation or other kinds of cover such as fallen trees and brush, as spring runoff is subsiding. Fertilized eggs are randomly scattered over gravel substrate with no parental care.

Within the analysis area, roundtail chub occupies 77.9 miles of perennial stream (22.2% of its habitat on the Coconino National Forest), including Munds Canyon, Oak Creek, Pumphouse Wash, Sterling Canyon, Sycamore Creek, and West Fork of Oak Creek. Prescribed fire treatments in subunits connected to these watersheds could potentially lead to short-term increases in sedimentation and/or ash flow into roundtail chub habitat.

The Soils and Water Report (Steinke 2013) indicates that prescribed fire treatments under the Proposed Action could result in soil erosion in areas where slope exceeds 15%. Cumulative soil disturbance across the 4FRI landscape is estimated to be about 8% of the aerial extent. This is well below the 15% threshold where soil productivity would be affected. However, there is a short-term risk (1 to 2 years) of sedimentation or ash flow resulting from these treatments. However, BMPs would be in place to mitigate these risks and proposed treatments would occur over a 10-year period, rather than all at once, so any impacts should be localized in extent. In addition, the Soils and Water Report (Steinke 2013) indicates that mechanical treatments would result in negligible levels of erosion, regardless of slope. Finally, the short-term risks incurred by the proposed vegetation treatments and prescribed fire are necessary for the long-term benefit of the Forest, including restoring the health of watersheds and streams in which roundtail chub live. Furthermore, roundtail chub is a long-lived species (adults live over 10 years), so the risk of short-term effects to roundtail chub and its habitat is also mitigated by the fact that the species is adapted to occasional sediment pulses and can reproduce after such occurrences have dissipated.

Spring and stream restoration, as well as road decommissioning activities could also result in short-term increases in soil movement and sedimentation. Again, BMPs would be in place to mitigate these short-term risks to see long-term benefits from restored hydrologic function at spring sources, reduced potential for severe flooding in restored ephemeral channels, and reduced erosion and runoff resulting from properly decommissioned and/or relocated roads.

Dust abatement would have no effect on roundtail chub or its habitat, as no dust abatement treatments are proposed near open water.

Finally, the proposed Coconino and Kaibab Forest Plan amendments would have no measurable effects on roundtail chub or its habitat, as discussed above.

Therefore, considering direct, indirect, and cumulative effects, the Proposed Action **May Affect but is Not Likely to Adversely Affect** roundtail chub or its habitat.

Certification and Signature: Michael Childs, journey level biologist on the Coconino National Forest, has reviewed this document and certified its compliance with manual requirements and made the final determination for spikedace and loach minnow critical habitats and for roundtail chub.

Prepared by: /s/ *Michael Childs* Date: February 14, 2014

Michael Childs

Red Rocks Ranger District, Coconino National Forest

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Determination of Effects for Narrow-Headed Garter Snake

Considering the direct, indirect, and cumulative effects, implementation of the Proposed Action **May Affect, but is Not Likely to Adversely Affect** the narrow-headed garter snake.

Determination of Effects for Narrow-Headed Garter Snake Critical Habitat

Considering direct, indirect, and cumulative effects, implementation the Proposed Action **May Affect, but is Not Likely to Adversely Affect** proposed narrow-headed garter snake critical habitat.

Determination of Effects for Golden and Bald Eagle

The proposed treatments and activities would not result in take as defined in the Eagle Act for golden or bald eagles because of the conservation measures incorporated into the actions associated with the implementation of the proposed action.

For bald eagles, the Forest Service Sensitive species analysis showed that effects from implementation of the Proposed Action may impact bald eagles, but is not likely to result in a loss of viability or trend toward federal listing.

For golden eagles, all nests will be protected from disturbance during project implementation. Project design features will mitigate potential for disturbance from noise or smoke to nesting golden eagles. Project activities will not substantially interfere with foraging behavior. Restoration treatments will improve foraging habitat and reduced potential of high-severity fire impacting nest locations.

Certification and Signature: Cary L. Thompson, journey level biologist on the Flagstaff Ranger District, Coconino National Forest, has reviewed this document and certified its compliance with manual requirements and made the final determination for narrow-headed garter snakes and narrow-headed garter snake critical habitats and for compliance with the Bald and Golden Eagle Act.

Prepared by: /s/ *Cary L. Thompson* Date: February 14, 2014

Cary L. Thompson

Flagstaff Ranger District, Coconino National Forest

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Appendix 3. Management Actions Crosswalk between Mexican Spotted Owl Recovery Plans

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MSO Consistency Evaluation
2012 MSO Recovery Plan to 1995 MSO Recovery Plan To 4FRI

During the process of analyzing the effects of the proposed Four Forest Restoration Initiative (4FRI) – including 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 Mexican Spotted Owl (MSO) Recovery Plan from 1995 was the official guidance for 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 it 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.

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 U.S. Fish and Wildlife Service (FWS) as well as with the Coconino and Kaibab NF's Forest Plans.

Table 1. 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 protected activity centers (PACs)

2012 Mexican Spotted Owl Recovery Plan	1995 Revised Mexican Spotted Owl Recovery Plan	4FRI FEIS Desired Conditions
Desired Condition	**Desired Condition**	**Consistency**
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. Alternatives B through 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 and larger, down logs larger than 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 and larger, down logs greater than 12-inch 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 include snags 18 inches and larger, down logs larger than 12-inch midpoint diameter, and hardwoods. (Silviculture Report page 238)

2012 Mexican Spotted Owl Recovery Plan	1995 Revised Mexican Spotted Owl Recovery Plan	4FRI FEIS Desired Conditions
Desired Condition	**Desired Condition**	**Consistency**
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).	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).	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. 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).	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 than retains existing large oaks and promotes the growth of additional large oaks (page 94).	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).
4. Diverse composition of vigorous native herbaceous and shrub species (Ward 2001).*	4. Habitat components that should be retained or enhanced include large logs (larger than 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).

2012 Mexican Spotted Owl Recovery Plan	1995 Revised Mexican Spotted Owl Recovery Plan	4FRI FEIS Desired Conditions
Desired Condition	**Desired Condition**	**Consistency**
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 (larger than 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. Stands outside wildland-urban interface (non-WUI) 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 16 inches d.b.h. or larger contributing 50% or greater 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 inches d.b.h. in pine-oak forests at 45% or more 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 more than 30% of trees density is larger than 18 inches d.b.h. (CFP)

PAC = protected activity center; WUI = wildland-urban interface; VSS = vegetation structural stage; BA = basal area; TPA = trees per acre; d.b.h. = diameter at breast height

Table 2. Summary of recommended management actions in core areas, PACs, and recovery habitats

2012 Mexican Spotted Owl Recovery Plan	1995 Revised Mexican Spotted Owl Recovery Plan	4FRI FEIS Desired Conditions
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 consultation with the FWS (page 125).	1. Consultation with the FWS on endangered species is a requirement and was initiated on January 21, 2011 (FEIS page 10, Chapter 4).

2012 Mexican Spotted Owl Recovery Plan	1995 Revised Mexican Spotted Owl Recovery Plan	4FRI FEIS Desired Conditions
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.	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).	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. 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.	3. Light burning of ground fuels may be allowed within the 5OO 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)	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).
Protected Activity Center (PAC)		
4. All activities within the PAC should undergo consultation with the appropriate FWS office.	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)	4. Consultation with the FWS on endangered species is a requirement (FEIS page 10, Chapter 4) and will be completed before the signing of the Record of Decision.

2012 Mexican Spotted Owl Recovery Plan	1995 Revised Mexican Spotted Owl Recovery Plan	4FRI FEIS Desired Conditions
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.	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 less than 22.4 cm (9 inches) d.b.h, treatment of fuels, and prescribed fire can be used no reduce fire hazard and no improve habitat conditions for owl prey. Habitat components that should be retained or enhanced include large logs (larger than 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 no mimic natural mosaic patterns (pages 86-87).	5. The implementation plan is designed to be consistent with the Revised Recovery Plan. The 4FRI is contained within the UGM EMUs. 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.	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).	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).

2012 Mexican Spotted Owl Recovery Plan	1995 Revised Mexican Spotted Owl Recovery Plan	4FRI FEIS Desired Conditions
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.	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).	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	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)	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. Monitor treatment effects as described in Appendix C. See Table 1 for desired conditions for PACs.	9. Silvicultural applications must be evaluated over time by rigorous monitoring procedures to assess their effectiveness in managing or creating owl habitat (page 84).	9. A monitoring plan has been developed. The plan development is deferred to the project's FWS Biological Opinion (Silviculture Report page 174).
Recovery Nest/Roost Habitat: **Forested stands identified as meeting or exceeding owl nest/roost conditions.**		

2012 Mexican Spotted Owl Recovery Plan	1995 Revised Mexican Spotted Owl Recovery Plan	4FRI FEIS Desired Conditions
10. Manage for nest/roost replacement habitat.	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).	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 well distributed across the landscape (FEIS page 70). 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 than 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 inches d.b.h, trees greater than 24 inches d.b.h, and TPA larger than 18 inches d.b.h. after treatment.
13. Retain large trees. Strive for spatial heterogeneity.	13. SEE # 11	13. Per CFLRA 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 (18.0 inches d.b.h. and larger) 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 inches d.b.h, trees larger than 24 inches d.b.h, and TPA larger than 18 inches d.b.h. after treatment.
14. Manage for species diversity. Retain key owl habitat elements (large trees, snags, large logs, hardwoods, etc.).	14. SEE # 11	14. SEE # 13

2012 Mexican Spotted Owl Recovery Plan	1995 Revised Mexican Spotted Owl Recovery Plan	4FRI FEIS Desired Conditions
15. Emphasize large hardwoods, where Appropriate	15. SEE # 11	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.

FWS = U.S. Fish and Wildlife Service; FS = Forest Service; MSO = Mexican spotted owl; PAC = protected activity center; UGM = Upper Gila Mountain; EMU = ecosystem management unit; PFA = post-fledging family area; VSS = vegetation structural stage; TPA = trees per acre; d.b.h. = diameter at breast height

Table 3.Minimum desired conditions for mixed-conifer and pine-oak forest areas managed for recovery nesting/roosting habitat. 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. (1995 MSO Recovery Plan, Table C.3)

EMU(s)Forest Type	%of area[1]	% BA by size class 30-46 cm d.b.h. (12-18 in)	% BA by size class >46 cm d.b.h.(>18 in)	Minimum tree BA[2]	Minimum density of large trees[3]
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[5]	10	>30	>30	25.3 (110)	30 (12)

1. % of area pertains to the percent of the planning area, subregion, and/or region in the specified forest type that should be managed for threshold conditions.
2. BAs in m^2/ha (ft^2/acre), and include all trees >1 inch d.b.h. (i.e., any species). We emphasize that values shown are minimums, not targets.
3. Trees > 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: ≥10% of the stand BA or 4.6 m^2/ha (20 ft^2/ac) of BA consist of Gambel oak ≥ 13 cm (5 in) d.r.c.
5. Pine-oak recommendations apply only to the Mount Taylor and/or Zuni Mountains regions within the CP EMU

Table 4. 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.

Recovery Units / Forest type	% of area[1]	% 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]
Basin and Range - East RU						
Mixed-conifer	20	10	10	10	32 (150)	49 (20)
Mixed-conifer	10	10	10	10	39 (170)	49 (20)
All RUs, except Basin and Range - East RU						
Mixed-conifer	25	10	10	10	32 (150)	49 (20)
Mixed-conifer	10	10	10	10	39 (170)	49 (20)
Colorado Plateau, Upper Gila Mountains, Basin and Range - West RUs						
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 m^2/ha (ft^2/acre).

[3] Trees >45.7 cm (18 inches) dbh. Density is trees/ha (trees/acre).

[4] For pine-oak, 4.6 m^2/ha (20 ft^2/acre) of oak must be provided as a threshold/target condition.

Table 5. Summary comparison of 1995 Mexican Spotted Owl Recovery Plan to the 2012 MSO plan Table III.B1 and C3, respectively

	1995 MSO Recovery Plan	2012 MSO Recovery Plan	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 larger than 18 inch	Same
	15% in >24 inch		
Minimum tree BA/acre	150	110	Decreased
Minimum no. large trees larger than 18 inches d.b.h.	20	12	Decreased

Differences in the tables from the two plans are in three areas: distribution of basal area by size class, basal area, 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 plan 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 percent in the retention of 12- to 18-inch d.b.h. trees from 15 percent of total basal area up to 30 percent of total basal area. The desired condition retention for trees greater than 18 inches remains at 30 percent for both plans. The minimum basal area for the 2012 plan is now lowered from 150 square feet per acre down to 110 square feet per acre, and it reduces the number of large trees (larger than 18inches d.b.h.) from 20 down to 12. The 2012 plan requires that the stands carry 60 percent of their basal area in trees larger than 12 inches d.b.h. while the prior 1995 plan only required that 45 percent of the basal area be in tress larger than 18 inches d.b.h.. This effectively will raise the QMD of the stands and lower the amount of basal area stocked in the less than 12-inch d.b.h. diameter classes.

The resulting shift in stocking (BA, trees larger than 18 inches, and BA distribution) represents a potential reduction in Stand Density Index (SDI) in the 2012 plan. The SDI associated with 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.

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 percent more basal area within the 12- to 18-inch d.b.h. 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 between the 2012 Recovery Plan and 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 a 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 Endangered Species Act (ESA) five-factor threats analysis.
- Changes restoration units (RUs) to ecosystem management units (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:

- 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 percent 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 4. Field Review of Mexican Spotted Owl Protected Activity Centers within the Four Forest Restoration Initiative Treatment Area

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Overview

A data review of 117 individual protected activity centers (PACs) occurring in and near the Four Forest Restoration Initiative (4FRI) project area was completed by biologists from the Coconino and Kaibab National Forests (NFs), the U.S. Fish and Wildlife Service (FWS), and the 4FRIproject team (see Modeling and Habitat Evaluation in the main body of the wildlife report). The results of this review indicated that 18 of 117 PACs were candidates for management treatments to reduce fire risk and improve the development and maintenance of habitat components important to Mexican spotted owls (MSOs) and their prey. This appendix provides the notes from this review. See the MSO Recovery Plan for details on the habitat needs and habitat conditions for MSOs and their prey (USDI 1995).

Following this review, a series of field visits to individual PACs were conducted. The objectives of the field visits were primarily to evaluate the potential for treatments that could improve MSO habitat. Potential management objectives were defined based on site-specific observations. The following are summaries, notes, and photographs from discussions and observations that occurred among attendees during the course of the field reviews. The notes in and of themselves do not represent any decisions or conclusions regarding treatments. These notes were used to inform subsequent discussions on PAC treatments that eventually led to the proposed treatments. Decisions reached during the course of this effort were that treatments would benefit the 18 PACs that were originally screened as candidates for management; also, to be cautious about implementing management recommendations, mechanical treatments within core areas were dropped from consideration until the time when we learn from monitoring the vegetation manipulations within PAC habitat.

Mayflower Tank, Bear Seep, and Red Raspberry PAC Assessments

Attendees: Shaula Hedwall (FWS), Bill Austin (FWS), Cary Thompson (Flagstaff District Biologist/4FRI Wildlife), Preston Mercer (Mormon Lake AFMO), Mary Lata (4FRI-Fire), Neil McCusker (4FRI-Silviculture), Bill Noble (4FRI-Wildlife), Henry Provencio (4FRI-Team Lead) attended the 1st stop.

Friday, May 6, 2011

Objectives: Treatments must improve MSO habitat; reducing fire threat alone is not adequate reason for treating within PACs; achieving both is ideal.

Discusssion: All PACs are available for burning. The desire is for cooler burns, such as when coarse woody debris (CWD) is moist. Snags are particularly important within nest cores and can provide nest structure. All decay classes of logs are used by different prey species. Topography will require staging: when south slopes are ready to burn, north slopes would likely be cool and damp and could even have snow present. When north slopes are ready, south slopes could likely be too dry.

Preston: “Schedule” basically means maintenance, or how much time passes before return burning after first entry. Most fuel reduction generally occurs in the first burn but tree mortality is cumulative within about 5-6 years post-treatment. The 2nd burn and beyond = maintenance. Need good descriptions of desired conditions so fire managers can determine how cool conditions should be, when a backing fire is necessary, levels of acceptable mortality, avoidance of igniting CWD, etc. Knowing more detail on desired conditions is key in translating objectives to practitioners. Knowing desired tons/acre of CWD allows assigning percent reduction by fuels size class. Whereas effects analysis is by the numbers, treatment is visual. Treating 100 acre nest cores will be labor intensive and costly. Burning hotter (i.e.,

medium to medium-high) will achieve more in terms of fuels reduction but also loss of habitat structure. This would achieve results in 1-2 entries rather than piece-meal results from 3-4 entries. The reality note: fire will require a 30-year window to get 2-3 treatments done. If every PAC has a different burn plan it is less likely it will all turn out as desired in the end. This raised questions as to whether there could be consistent desired conditions and consistent approaches in achieving them and whether flexibility could be built into section 7 consultation requirements of the Endangered Species Act to allow for adaptive management?

Mayflower Tank PAC (#30405022):

This PAC has steep slopes with heavy dead and down wood (estimated to be about 60 tons/acre in one area). Heavy fuels would burn too hot. This PAC could be burned when heavy fuels are still wet, but would be expensive as we would not be looking to meet fuels objectives in first or even second entry due to risk associated with heavy fuel loads. Some discussion of whether coarse woody debris could be removed or redistributed mechanically prior to fire entry, but due to slopes and working around trees, this may be difficult. Note: Thinning from below would not achieve much in the stand we were viewing due to limited development of small trees. There are opportunities for aspen restoration treatments. The PAC would have to be revisited to see remaining portions for treatment evaluation.



Figure 1. Opening at edge of Mayflower Tank PAC; heavy surface fuels begin immediately within PAC boundary

Bear Seep PAC (#30405031):

[We walked in from Road 132, crossed an open, forested flat, walked down into a roaded meadow, and up into the "nest draw"]. Except for the nest core area, the majority of this PAC is pure ponderosa pine or pretty open pine-oak that is ready for prescribed fire. We walked into the northern portion of the PAC – the flat on top is open pine-oak that hits a mostly pure pine slope and then opens up into a meadow along Road 240.

Shaula: Openings are not bad inside a PAC. 1 - 2 acre openings could be created in the flat area on top. Below it is **relatively dense with 12- to 14-inch trees** and some openings there could benefit prey species. An objective could be maintaining/releasing oak (but see Abella et al. [2008] for which soil types

indicate oak could benefit from the effort to release them). Openings would need to be balanced with maintaining denser forest within the PAC in general.

Adjacent to the meadow on the south side of Road 240 is a patch of aspen that could be opened up to improve conditions for the aspen. The Bear Seep nest core area is located up the drainage in the southwest portion of the PAC. This area consists of mixed conifer and **we would not recommend mechanical or burning treatments in the nest core** (at least from Road 240 across the drainage to the rock wall that lines the western edge of the core area). The southeast arm of the PAC and areas west of the road would benefit from treatment.

In general, treatments would focus on areas of lesser habitat and avoid patches of better habitat. The PAC can be treated to promote primary constituent elements (PCEs) and develop a groupy, clumpy structure (tree size and diversity); Neil commented an intermediate thin (IT) treatment would be appropriate in some areas; aspen and meadow treatments are viable options (at small scales) as are oak and presettlement pine release; openings in pure pine could enhance owls and their prey and contribute large down logs (areas are lacking in large (1000-hour fuels) dead and down. **A diameter cap would not make it worthwhile to treat due to the density of trees larger than 9 inches d.b.h.**



Figure 2. Open, pine-oak flat on northern end of Bear Seep PAC



Figure 3.Slope between 132A and 240 Road in Bear Seep PAC. This slope contained some oak, but area is transitioning to pine in flat below.



Figure 4. Meadow along 240 Road in Bear Seep PAC. The meadow could use some work to repair drainages and impacts from recreationists and other impacts (large dispersed camping area). Improving meadow condition could improve prey habitat for MSO.



Figure 5. Pure pine area between meadow and slope in Bear Seep PAC. Area definitely has potential for treatment (e.g., create groups/clumps, small openings to improve prey habitat).

Red Raspberry PAC (#30405003):

This PAC contains very diverse topography with many knobs and valleys that would seem to offer mechanical treatment opportunities in some areas and not others. Treatments could work with topography to protect microclimates (e.g., treat south-facing slopes to protect drainages and north/northwest facing slopes from fire; avoid mechanical thinning in drainages). The southwest corner of the PAC contains pine-oak habitat that could be treated to enhance openings, reduce competition between pines (i.e., create, retain and enhance larger trees), and enhance Gambel oak patches on south-facing slopes. Leave denser patches of trees on north-facing aspects and drainages. This corner of the PAC would be easy to tie into treatments in the adjacent habitat to the southwest.

The nest core area is mixed conifer and would not be recommended for mechanical treatment. However, the meadow area/swale that contains Raspberry Tank could be treated to remove encroaching pine. The area north of the meadow is a fairly, open productive site consisting of many large ponderosa pines and some Gambel oak. This area is ready to burn without mechanical treatment. However, the historic basal area was probably 40 to 60 square feet per acre and existing basal area is in the 120 to 140 range. There are opportunities to enhance openings, open-up the oak, and overall to reduce basal area.

In general, areas that warrant treatment should result in oak and aspen release, meadow and seep restoration, creating gaps or releasing pre-settlement pine in the thickets of vegetation structural stages (VSS) 3 and 4 (except in known nest/roost areas). **Mechanical treatments would require thinning trees larger than 9 inches d.b.h. to meet objectives.** It looks like at least trees 12 -14 inches d.b.h. would need to be cut.



Figure 6. Meadow area east of Raspberry Tank in the Raspberry Tank PAC



Figure 7. Fairly open pine-oak slope in northeast corner of PAC. Area consists of larger pines, but has little in the way of vertical heterogeneity.

Red Raspberry PAC Burn Discussion:

- Need a plan for communicating specific ideas to those implementing treatments
- Lining of logs is not realistic or effective

- Burning technique and timing of burning (fuel moistures) are more important/effective
- Don't expect conditions to be met in first burn entry
- First-entry burning reduces the most tons/acre, maintenance burns needed every 5-6 years
- Identify percent mortality acceptable and/or percent reduction needed
- If you exclude nest core there would be escalated fire behavior if nest core fuel density is higher than the area immediately adjacent and outside nest core
- Operational – need 20 year window for burning
- May need to burn in nest cores from an operational standpoint in some PACs

Knob, T-Six, and Foxhole PAC Assessments

Attendees: Shaula Hedwall (FWS), Bill Austin (FWS), Bill Noble (4FRI-Wildlife), Cary Thompson (Flagstaff District Biologist), Linda Wadleigh (Regional Fire Ecologist), Roger Joos (Kaibab South Zone Biologist), John DeLuca (Kaibab South Zone Biologist)

Monday, May 9, 2011

Knob PAC (#30405029):

We walked north from Road 226E to hilltop and then north to the road and then southwest back to Road 226. PAC is very limited in terms of MSO habitat and there are no nest or roost locations documented. There are patches that contain Gambel oak, but oak is sparse in the majority of the PAC. The current core area does not meet Recovery Plan guidance and should be redrawn to include the entire length of the south-facing slope that runs along the drainage (drainage along Road 226). We recommend treating the majority of the PAC (mechanical and/or fire treatments). If fire is allowed to burn in the nest core, some mechanical treatment is recommended to enhance existing openings and create some breaks in the canopy. We do not want fire to result in torching or and want to minimize loss of CWD (see Graham et al. for guidance based on soil types – note that in PACs we'd generally be looking at the upper end of the recommended ranges). There are many pre-settlement pines throughout this PAC, including some nice groups of yellow pines within the nest core (especially once it is redrawn as the west end of the drainage), but they are commonly set among dense "doghair thickets." Groups of yellow pine within the nest core could perhaps be enhanced, but this would be a very specific prescription that should be created with the biologists and silviculturist to ensure protection of key habitat components in this relatively small area. The majority of the PAC is pure pine and very open. Treatments could be more aggressive, relative to other PAC recommendations, in the areas of non-MSO habitat.

In general, treatment objectives would include:

- Treating about 70 percent of PAC that really is not owl habitat
- Redraw nest buffer to include south-facing slope up to hilltop and expand westerly as well. This is where most of the larger oak is located. There are three areas along the lower southern ridge that might provide nest/roost habitat.
- Enhance oaks
- Create openings among large groups of pine in the existing thickets (can go up to 2 acres)
- Manage for patches and larger groups
- Use natural features, such as swales, for openings

- Thin around yellow pines and larger oaks
- 7-20 tons/acre of 1000 hour+ fuels to maintain healthy soils in ponderosa pine (1 snag = about 10 tons/acre)
- Needs 2 years of survey (if owls are detected) to determine nest buffer
- Treat outside breeding season
- Abundant large snags throughout
- Could meet many objectives by thinning up to 9 inches d.b.h. but this would limit the ability to meet all objectives

These areas might not have resident owls due to existing conditions and enhancing prey habitat could benefit overall production in neighboring PACs.

*****This PAC should be a survey priority to help ascertain use/occupancy*****



Figure 8. This picture is very representative of most of the habitat within the Knob PAC. There are many pre-settlement pines, but also many small, deformed pines.



Figure 9. Similar to Figure 8, there are many pre-settlement pines, but also many small, deformed pines Much of the PAC is very rocky, and contains alligator juniper with some Gambel oak interspersed throughout.



Figure 10. Area on slope in nest core that could benefit from limited mechanical treatment to enhance key habitat components.

T-Six PAC (#30405016):

Entire PAC, including nest core, is likely a candidate for mechanical and fire treatments. The core area where the historic roosts are located is currently in a state of degradation. Pre-settlement pines and large Gambel oaks occur throughout core area, but many trees of both species are falling over due to stand conditions resulting from very dense regeneration, including many "whips," that limit owl roost habitat value. Nest buffer is very decadent and in need of treatment, but as is, fire would likely kill pre-settlement trees. Mechanical treatments could focus on creating patches of habitat around pre-settlement trees that could be used for roosting by thinning, and in some cases, removal of dense patches of small diameter pine. [Note: Cary described work in Fort Valley where small trees were left around pre-settlement trees and snags to provide perches for fledglings.] Also need to focus treatment on how to maintain Gambel oak on this roost slope. Outside the roost area, the PAC is a mixture of very open, pre-settlement trees where fire alone could meet objectives except for some areas of dense ponderosa pine doghair thickets that could be thinned out to develop future owl habitat. Abundant, large snags exist throughout the rest of the PAC. Some portions of PAC either burned in Birdie Fire or were result of actions taken to suppress Birdie Fire. These areas really do not need additional treatment other than maintenance burning.



Figure 11. Historic roosts located in this area. Note Gambel oaks falling down and density of pine.



Figure 12. Pre-settlement pines are getting out-competed by young and mid-aged trees



Figure 13. Area east of core area on flat. Many pre-settlement pines in this area with dense patches of smaller pines scattered around them.

Foxhole PAC (#30405038):

(Approached PAC from bridge across Bar M canyon). The western PAC area south of Bar M Canyon, sans steep slopes, is a candidate for mechanical treatment. The area consists of dense thickets of ponderosa pine with some oak; the oaks need to be opened up if they are to persist. Abundant large snags exist throughout the area. We saw fewer oak and oak/alligator juniper in the lower slopes and more oak and juniper on the upper slopes. There are natural openings, including at the top of the hill in the SW ¼ of section 5. Parts of this area have large alligator juniper and some of the openings look like they were once open oak areas before the release of pine (from fire exclusion). There is also an extensive network of dispersed camping sites in this section of the PAC. Dwarf mistletoe infection is high in this area and there is currently very little in terms of what we would consider nesting/roosting MSO habitat. Treat mistletoe by strategically placing openings to put space between uninfected and less-infected trees and heavy mistletoe trees. Though we did not walk the portion of the PAC along Bar M Canyon, we did discuss leaving a buffer area along the canyon rim as a wildlife movement corridor.

We walked a loop, coming out Road 9469D. PAC has a mixture of open and closed-canopy conditions. Would need to thin area before burning and reduce VSS 2 ladder fuels. Treatments should:

- Protect snags
- Create groups of 20-60 trees
- Enhance oaks



Figure 14. Dense ponderosa pine in SW ¼ of section 5 in Foxhole PAC



Figure 15. One of many dispersed camping sites off Road 9469D within the Foxhole PAC

Archies and Crawdad PAC Assessments

Attendees: Bill Noble, Neil McCusker, Cary Thompson

Wednesday, June 15, 2011

Archies PAC (#03040534):

This PAC is primarily pine-oak with a strong oak component. We parked along Road 132, near the junction with Road 132D, and walked along the ridge top and overlooked the southwest-facing slope. The slopes were dominated by VSSs 4 and 3 with scattered VSS 5. There were more large trees before and near the nest core and more younger trees as we worked our way towards the northeast. There was a lot of oak larger than 5 inches d.r.c. scattered through the pine, but few large-sized oak.

The ridge top is rocky with open pine-oak, which becomes more of an oak savanna and less rocky as you leave the nest core and follow the ridge top to the northwest. There were pockets of heavy mistletoe infestation and bark beetle outbreaks along the flat ridge and southern slopes. These were more common at the start of the walk than they were at the far end of the ridge. Crowns were reduced, in poor shape and not providing much canopy cover.

There is not much treatment needed on the ridge top other than **removing 5- to 12-inch pine** from within and around clumps of oak. There are opportunities for mechanical treatment along the southwestern slopes. Mechanical and burning treatments could help protect the nest stand located on the northwestern slopes. There are opportunities to release oak and improve sustainability of the stand.



Figure 16. Picture of the southwest ridge taken from the ridge top

We dropped off the northeast slope and walked back along Road 132D. Parts of this were more oak savanna like but there were also pockets of trees with many trees under 9 inches diameter. There were more large oak associated with the smaller pine. “Shelves” or small flat areas associated with the flanks of the ridge were pretty open, lacking large-diameter pine, and supporting small-sized oak. A large herd of elk was bedded down in the oak savanna. Trees along the base of the ridge were in large groups defined by sinuous openings. Some groups were thick with little pine, including a lot of bending whips. Individual trees were in a much healthier condition along the northwestern slopes. Forest on easterly side of road is

similar to the flats between the road and the ridge. **A 9-inch d.b.h. limit would not be a problem** in terms of improving health/habitat with mechanical treatments.

Aspen stand along Road 132 on the lower slopes near Weimer Spring stretches the length of the drainage. Aspen overstory is dying out with no regeneration below. There is opportunity to restore this aspen stand and associated meadow to improve habitat for MSO prey.

Weimer Spring (located immediately adjacent to the PAC): There is a fence around Weimer Tank which Weimer Spring drains into. The fence is down in several places and is in need of repair. The spring is not fenced although meadow habitat could be restored to improve prey habitat. The tank was full of tiger salamander larvae.



Figure 17. Oak provides the vertical heterogeneity in this PAC



Figure 18. Picture of area with many trees under 9 inches diameter



Figure 19. Picture taken along Road 132D facing west



Figure 20. Picture of oak savanna along portions of the ridge top taken by Road 132D.

Crawdad PAC (#03040547):

We walked northwest from the junction of Roads 132 and 133 along the southwestern slope and came around the second knob to the drainage. Headed east above the drainage and then south back to the road junction. Much of the southwestern slopes support dense trees 12-18 inches diameter forming a single story stand with essentially no understory development. Oak was represented by a range of size classes, but not as prevalent in this PAC and is suppressed by the higher densities of pine. Treatments could build gaps around the oak and release individual oak trees amongst the groups. In this area we would likely **need to cut trees larger than 9 inches diameter (even a 12-inch d.b.h. limit would be a challenge to create gaps)**. Bark beetle mortality occurred in groups as did mistletoe. Neil discussed thinning from below until you meet the desired basal area while featuring dominant and co-dominant trees. This would also reduce fire risk to the eastern slope where the majority of roosts are located. Small natural openings were present throughout and could be opened up a little more to enhance habitat for MSO prey.

Further up the slope dominant trees were more VSS 3 than 4 and the forest was a bit more open. Still consistent but scattered oak and some pre-settlement pine. Near the first (main) knob, the forest was dominated by VSS 3 with fewer and smaller oak. A two-track road runs through the area. As we approached the saddle between knobs, there were bigger pine, plus VSS 3 plus successive openings. Oak clumps are largely overgrown with pine. Passed through the saddle and followed the drainage down where we saw a lot of old stumps, indicating an open forest where it's currently relatively dense dominated by "stubby" trees. There is potential to thin here (improve tree health, increase growth rates, open understory for prey). We followed the drainage down and forest opened more with small oak and more yellow pine. Slope was gentle, merging into flats where there was more understory and a young overstory, looking like small opening/meadow encroachment. Moved onto steeper slopes and circled back below ridge top: trees were much denser, bigger (12 to 24 inches and larger d.b.h.), and oak widely scattered.



Figure 21. West hillside showing pre-settlement trees and openings with grass understory



Figure 22. Picture taken at same point facing south with a majority of trees 9 to 18 inches diameter



Figure 23. Picture of Crawdad PAC taken along the northeast slope



Figure 24. Area along the north slope of Crawdad PAC

Sawmill Springs PAC Assessment

Attendee: Cary Thompson

Tuesday, June 28, 2011

Sawmill Springs PAC (#0304070):

This PAC is ponderosa pine with a strong Gambel oak component. Oak is present in all size classes with a large amount of oak regeneration. All size classes of ponderosa pine are also represented in this PAC and are growing in a clumpy, groupy structure in many areas. Treatments could enhance groups of various sizes of pine and oak including younger ages of both species. This PAC has more regeneration than those previously assessed. In addition to oak regeneration Arizona rose and locust are present in the understory. Although there are pockets of dwarf mistletoe the PAC is healthy overall.

This is a structure we would want to maintain and treatments should focus on enhancing growth of young oak and maintaining this diversity of size classes. These areas have moderate levels of dead and down trees with mostly older, decaying large dead trees. Prescribed fire could probably be implemented without thinning.



Figure 25. Clumpy structure with small openings interspersed along Road 683

I walked north to Sawmill Tank, then west to Sawmill Spring and along the drainage and up the slope. The slopes to the west of the spring are thick with pine trees (VSS 4 and VSS 5) and have a northerly aspect while the ridgetops are relatively rocky and open. Treatments to the south should focus on protecting these northerly slopes.

Overall, MSO habitat objectives cannot be met with a 9-inch cutting limit. While there is variability across the PAC, some areas need the flexibility of larger d.b.h. size classes to enhance and maintain owl habitat characteristics.



Figure 26. Northerly slope west of Sawmill Spring

The slopes south of Sawmill Tanks had areas of dense VSS 3 and VSS 4 that did not have as much oak. Treatments in this area should focus on enhancing oak.

I would recommend thinning and burning treatments in the area east of the nest core and south of Sawmill Tank. There are large stands of dense areas of VSS 3 and VSS 4. Treatments should focus on developing larger trees and releasing oak.



Figure 27. Area south of Sawmill Spring with dense VSS 3 and VSS 4

Treatments adjacent to Sawmill Spring should focus on improving spring conditions. The vegetation in the area of the spring and tanks was in good condition and did not appear to have impacts from livestock. No leopard frogs were detected although the tanks and area leading from the spring appeared to be good habitat. No crawfish were found. I counted 6 species of butterflies in the area and 3 species of dragonflies. Monkey flower, watercress and mint edge the spring with a large amount of emergent vegetation and bulrushes along the banks of the tanks. Large amounts of down woody debris blanket the stream. Rocky bluffs west of the spring and large woody debris likely provide additional habitat for MSO prey.



Figure 28. Sawmill Tank (east Tank)



Figure 29. Sawmill Tank (west tank)



Figure 30. Sawmill Tank (west) looking west to Sawmill Spring



Figure 31. Looking east to Sawmill Tanks



Figure 32. Creek leading from spring to tanks



Figure 33. Sawmill Spring

Iris Tank PAC Assessment

Attendee: Cary Thompson

Tuesday, July 12, 2011

From Park Tank I walked south to Iris Tank, walked the area southwest of the nest core. I returned to Iris Tank and walked west to the top of the knob and then north to the second small hill on the west side of the PAC. Much of the PAC consists of dense ponderosa pine. Although oak is present in all size classes there is opportunity to release oak. Recommend treatments throughout the PAC outside of the nest core (I did not have the chance to go into the nest core) to improve habitat for prey, release the oak and to provide protection to the nest core.

Pockets of heavy mistletoe were noted throughout the PAC. Ridge tops are open with snags, dead and down wood, and are rocky. Habitat appears to be good for MSO prey.

The knob west of Iris Tank burned in the Birdie Fire. The burn was patchy and mortality is mainly along the upper third of the slope. Mullein and bull thistle are coming into the understory as are squirrel tail, ceanothus, fescue and oak sprouts.

A small group (about 17 plants) of Arizona Sneezeweed, a Forest Service R3 Sensitive plant was found at Park Tank.



Figure 34. Oak Meadow



Figure 35. Pocket of doghair thickets and mistletoe



Figure 36. Pocket of doghair thickets and mistletoe



Figure 37. Views of Iris PAC forest structure where small and medium-sized trees are competing with large trees



Figure 38. Effects of Birdie fire





Figure 39. Open spacing and open interspace with ground vegetation development and large trees.

Bar-M PAC Assessment

Attendee: Cary Thompson

Thursday, July 14, 2011

The entire PAC burned during the Birdie Fire. Most of the burn was low intensity with small pockets of fire killed trees and some mortality in the oak and large yellow pines. Many of the smaller saplings were killed but are still standing. Oak sprouting is prevalent throughout. Although the burn created nice openings with understory recovery on the ridges there are still dense pockets of ponderosa pine with little oak. Small pockets of toadflax, cheatgrass and mullein are present in areas that burned a little hotter. Most areas would benefit from a thin up to 9 inches; however, there are areas that would require cutting trees larger than 9 inches to reduce competition, release oaks and provide openings for improved foraging. Large snags are present in greater than normal densities although there are few yellow pines scattered

throughout and not many pine trees 16 inches and larger. Drainages provide the best habitat and should be treated differently.

Not sure what happened to the picture I took looking into the nest core from the adjacent knob to the southwest. Overstory trees had been killed in the drainage where the nest core was located. Oak mortality occurred as a result of the fire in this drainage. The adjacent knob burned a little hotter than other areas and toadflax, mullein and bull thistle are present. Oak is sprouting although there is a fair amount of oak mortality. The area south of Road 226 has more yellow pines than the rest of the PAC and groups of dense trees with openings in between groups. Treatments could focus on developing all size classes and releasing oak in dense patches of pine.

Bristow Tank fence needs to be repaired. Good vegetation around tank.



Figure 40. Ridge in northwest corner of PAC



Figure 42. Oaks generally suppresses by dense pine trees



Figure 41. Heavy down fuels in some areas from fire killed trees



Figure 43. Picture taken from knob south of the nest core looking north into the PAC



Figure 44. Area south of Road226 and west of 9470G



Figure 45. Showing dense groups of trees with openings

Clarke PAC Assessment

Attendees: Patty Ringle, Shaula Hedwall, Cary Thompson, Bill Noble

Wednesday, August 10, 2011

Limestone soils make for very high site productivity, but many stands have very little oak. This is not representative of typical MSO habitat, but the birds are here. The owls could be here due to the lush understory supporting larger prey species populations.

Comments:

Leave bigger groups in draws, on north-facing slopes, and smaller groups on south-facing slopes. Suppressed trees under dripline of yellow pine serve as great MSO roosts.

Shaula: Owls don't roost in stands with canopy cover less than 60 percent due to thermoregulation issues; MSO like to roost in smaller trees growing within the crown of larger trees.

Patty: An interspace of 50 feet is not likely to support much regeneration; interspaces of 150 feet may be full of regeneration within 20 years. Openings of 0.5 acre vs. 1 acre or larger are very similar in terms of regeneration; areas that can support regeneration will need retreatment to maintain tree-less space.

Red Hill PAC Assessment

Attendees: Cary Thompson, Mary Lata, Neil McCusker, Mark Nigrelli – 4FRI GIS Specialist, Bill Noble

Friday, April 30, 2013

Route: Parked at main draw that winds through the north central portion of the PAC and empties into Sycamore Canyon (includes Strahan Spring in the canyon, between Red Hill and Geronimo PACs).

Hiked up the east end of stand 000160 – 0004, hooked though 000160 – 0009 at the top of Red Hill, descended through the middle of stand 000160 – 0004, left the core area and hiked across the width and then over 1/3 the length of stand 000160 – 0006 looking down into stand 000160 – 0007 and part of stand 000160 – 00027. Passed through the saddle at the west end of stand 000160 – 0007 and descended further down slope near the boundary of stand 000160 – 00027. Crossed stand 000153 – 0015 and headed up the central draw. We climbed up to the end of an old road bed with grasses and forbs covering much of the bed. Followed it down to the bottom of the stand and bailed off the slope where the road did a sharp bend to the east. We crossed stand 000153 – 0007, the east end of stand 000153 – 0015, and into the bottom of the draw. We followed the drainage back up to the truck, hiking the border of stands 000153 – 0015 and 000160 – 0007, then stands 000153 – 0015 and 000160 – 0006, and finally stands 000153 – 0015 and

000160 – 0004. We then continued past the truck on the boundary of stands 000153 – 0015 and 000160 – 0004 and up into stand 000160 – 0018. We did a loop up into the basin at the head of the draw and back to the vehicle.

Observations: (Saw 2 turkeys not long before reaching the PAC). The top of Red Hill was dry, open, and had scattered cactus. Scattered, small to medium-sized oak was sprouting from rocky outcrops. A few large sized oak (i.e., large enough diameter for owl nesting) were also present. We saw scattered Douglas-fir at the top of the slope along the upper edge of Red Hill. We saw several pockets of *Ips* beetle-killed trees while hiking to the top of Red Hill and down to the flat below the core area. Small diameter tree boles were already down and decomposing. At the edges of the pockets were red-needled trees killed last year, so *Ips* beetles are still active. Also saw successful beetle entries in down wood (tops/parts of trees with green needles broken off during winter). Some areas looked good (large trees, large and medium oak), particularly on the northerly slopes of Red Hill, and some areas were very dense with 12 to 16-inch pine choking out the large pine and overtopping nearly all of the oak. Stand 000160 – 0006 (below the core area) was typical of the latter with a basal area of about 300 square feet per acre. Average tree diameter was a little larger here, ranging 16 to 18 inches d.b.h. for the larger size classes. Still saw active beetle sign, also old bear sign here and on the slopes of Red Hill (rolled rocks, but with needle cast and plants growing in the exposed areas that had been beneath the rocks). Past thinning from maybe 20 or more years ago (boles were decomposing and stumps could be kicked out of the soil). Logs and coarse woody debris were very limited except in scattered pockets.

We saw a MSO! Very light, sandy-colored. Appeared to be a juvenile (2 of 3 visible tail retrices were pointed) roosting in a pre-settlement pine in a large, low mistletoe broom. The tree was in a stand of very open, small diameter trees.

Saw a white tailed (!) doe with 2 yearlings in stand 000153 – 0015. Got into scattered but very large alligator juniper. Drier conditions and cactus reappeared; blue grama replaced Poa. A lot more yellow pine too, but also a lot of very open areas alternating with dense patches of young trees. Fuel loading still patchy across broad areas, but very heavy in the draws. Yellow pine are consistently strung along the bottom of the main draw. The understory was depauperate for nearly the entire hike. Mostly rock, needles, and duff.

Once we passed the vehicle and continued up the drainage, the draw opened up, was much flatter, and supported larger post-settlement trees. Patches of green grass too. Many of the trees had 2 boles and a few had triple boles (cold sink?). Up at the head of the basin was a pocket (about an acre) of aspen amongst thick oak. Aspen regeneration was common, despite all the heavy elk we saw throughout the hike. This little area was bounded by cliffs on two to three sides.

Medium-sized oak was common but typically scattered. Most oak was overtopped and crowded in by young pine. Large oak were widely scattered through area. This was the first PAC visit with stand treatment maps. We discussed the proposed treatments as we hiked and felt that they matched the actual stand conditions well. Using varied d.b.h. limits to match individual stands was an effective approach. In addition, many pockets of steep slopes occurred where harvest would not occur and added to overall habitat diversity. There was no question that MSO habitat would be improved by the proposed treatments.

Lee Butte and Rock Top PAC Assessments

Attendees: Cary Thompson, Mary Lata, Mark Nigrelli, Bill Noble

Friday, June 14, 2013

Lee Butte

Stand 0522-13

We drove Road 9470N most of the way to the "T"-junction in Lee Butte. We walked due north into the stand. It was classified as a 4CSS but it isn't. Maybe a 3ACC. It's very open, scattered opuntia and hedgehog cacti. Also a sensitive *penstemon* species that is rare on the landscape but common here (Cary GPS'd the location). Very limited evidence of pre-settlement trees. Mistletoe present and some VSS 3 trees that look like they are dying have mistletoe. No big trees, very spotty ground fuels, lots of oak and openings. This stand does not appear to need treatment.

Stand 0523-04

We crossed the road heading southwest and entered the stand. It typed the same as the previous stand but looked like a 4CSS! Basal area shortly after entering the stand was 120 square feet per acre. Oak was very small in first stand (seedling-like) but plentiful. Here it's plentiful and ranges from small to medium sized (seedling and sapling sized with some stems reaching 18 inches d.r.c.).

Stand 5 is a very open knob. Rocky, cacti, scattered juniper with dead and dying pine in the VSS 3 range. Cheatgrass and Dalmatian toadflax common.

Stand 6 = Deer beds at the top of the stand. Fire evidence with burned and sculpted remains of old boles (Mary calls "tree art"). More evidence in this of pre-settlement trees than in previous stands. Many huge alligator juniper, consistently scattered evidence of pre-settlement trees, and large snags and some large logs (both have been lacking in previous stands). Overall, 4CSS looks accurate, although it may be approaching a 4B. The stand is dominated by 4s and 3s with widely scattered 5s and 2s. Mostly a VSS 4 with VSS 3 codominants. Mid-sized oak and occasional large oak. Two different stops for basal area yielded 160 and 140 square feet per acre.

We changed our bearing from southwest to east, passing above stand 7. Edge of stand is the top of a rocky bluff looking into a drainage. Lots of huge white wash patches on several of the taller rocks. Don't know what bird, but it must be a large raptor given no water around (i.e., it's heron sized or maybe bigger!). As we hiked, the stand opened and average tree size decreased. By the time we left the stand at least half of it looked more like the VSS 3 CSS we've been seeing and less like the 4B or CSS. Elk sign (churned up trailing) common throughout stand and squirrels and squirrel sign scattered across entire stand. Also patches where rocks were rolled aside like bear foraging. Years of it: some of the exposed areas had piles of needles accumulated and forbs growing, some had some needles, and some looked like this spring.

Stand 11

As we approached Road 9467C that divided stands 6 and 11, the trees increased in size. The border of both stands had denser, larger trees, but as we got further into 11 the trees got smaller and more open. Mistletoe present, but not heavy. Again, we were left wondering how we could improve this PAC with mechanical treatments.

We walked northeast from Road 9467C and crossed a section of the stand as it climbed up toward Road 9470N that we drove in on. We walked back to the truck looking into stand 11 and then stand 18.

Stand 18

As we walked, the right side of the road was core area and the left was proposed mechanical treatment up to 9 inches d.b.h. This was the first stand that looked like cutting could contribute to the development of MSO habitat. Many whips choking yellow pine common. Some big snags scattered about. We returned to the truck, turned around, and headed out the way we came in.

In general, the areas we walked commonly had very large (huge!) alligator junipers. Some of these had young pine in and around them. Saw turkey sign along the edge of the road.

Drive out: Roads 9470N → 127D → 127

On the way in we didn't pay as much attention to the stands. On the way out we looked down at the views and talked about the forest structure. Stand 11 looked about the same as it did on the hike up to the road: trees were dominated by VSS 3 and were more openly grown. While the beginning of the stand (and stand 6) matched the typing, the bulk of it was younger and open. The "C" canopy classification is open, but most of the stand was much more open than the parts that matched the VSS 4 typing. Lots of oak of all different size classes in 11.

Stand 19 – between the road and core area is very similar to stand 18. Both have 9-inch diameter caps that would be effective in removing dog hair groups of little trees competing with the remnant big trees.

Much of the drive out was through stand 052-14 and then 13. The stands are similar; although 13 has smaller average-sized trees. Stand 14 has a 9-inch cap, which won't accomplish much due to average tree size is larger (relatively dense VSS 4) and there are few trees less than 9 inches d.b.h. They're rare enough that we wouldn't need to cut them. A prescribed cutting of 12- to 14-inch d.b.h. trees could make some canopy gaps, allow regeneration, and increase understory development while retaining an overall closed condition. Stand 13 transitions from the dry, open conditions we saw at the start to the more closed canopy conditions we saw at the end of the tour. Still VSS 3 dominated.

At the end of the tour we concluded stands 06 and 11 should be dropped from treatment. This represents a large percentage of the PAC. However, the remaining portions could strongly benefit from the proposed treatments. The small area recommended for treatment may be realistic because of proposed treatments in adjacent stands outside of the PAC. When a contractor is working this area these additional PACs could be treated too as long as this occurs outside the nesting season. In addition, the north end of the PAC abuts Rock Top which will presumably be treated. If the latter is the case then it would be operationally realistic to treat a relatively small portion of Lee Butte.

Rock Top

We didn't have time to hike into Rock Top, but we drove through the middle of the PAC, going the length of the long axis of this oblong-shaped PAC. We noted bends in the road and road junctions to track stands. Overall, the recommended diameter limits matched the conditions we saw across the PAC. The proposed treatments would increase the tree size diversity and there were yellow pine encroached by small to mid-sized trees that would greatly benefit from "daylighting." Same with medium to large-sized oak. Nothing seen while driving suggested classifications or treatments were inappropriate.

A total of 15 PACs were reviewed in the field. One, Clark PAC, is not part of the 4FRI treatment area, but is within the 4FRI analysis area and was marked for treatment under the Elk Park project. We reviewed the Clark PAC to further inform the PAC treatment discussions. The goal of all the PAC reviews was to evaluate potential mechanical and fire treatments. After reviewing the first 6 PACs it became clear that MSO habitat could be improved by treatment and that a 9-inch d.b.h. cap did not make sense in many of

the stands that we hiked. It was not until these initial field efforts (May 6 and 7, 2011) that we realized our PAC evaluation process had essentially identified PACs that were in the worst habitat conditions. PAC reviews conducted in 2013 had the advantage of stand-specific management proposals that could be evaluated while we were hiking the stands. The following is a summary of visits (Table 1) and management-related highlights from the PAC visits.

Table 1. Field reviews for PACs proposed for treatment

PAC Name	Date	Participants
Mayflower Bear Seep Red Raspberry	5/6/2011	Preston Mercer – Mormon Lake AFMO Neil McCusker- 4FRI Silviculturist Mary Lata- 4FRI Fire Ecologist Bill Austin- USFWS Shaula Hedwall-USFWS Bill Noble-4FRI Biologist Cary Thompson- Flagstaff District Biologist Henry Provencio-4FRI Team Leader
Knob T-Six Foxhole	5/9/2011	Linda Wadleigh – Regional Fire Ecologist Bill Austin Shaula Hedwall Bill Noble Cary Thompson John Deluca – Williams/Tusayan District Biologist Roger Joos - Williams/Tusayan Biologist
Archies Crawdad	6/15/2011	Bill Noble, Neil McCusker, Cary Thompson
Sawmill Springs	6/28/2011	Cary Thompson
Iris Tank	7/12/2011	Cary Thompson
Bar-M	7/14/2011	Cary Thompson
*Clark	8/10/2011	Patty Ringle – FS Silviculturist Shaula Hedwall Bill Noble Cary Thomspon
Red Hill	4/30/2013	Mary Lata, Neil McCusker, Mark Nigrelli- $FRI GIS specialist, Bill Noble, Cary Thompson
Lee Butte Rock Top	6/14/2013	Mary Lata, Mark Nigrelli, Bill Noble, Cary Thompson

*The Clark PAC is not included in the 4FRI analysis. The field review was to assess a prescription with a 16-inch cap.

PAC Review Summary

Mayflower:

- Thin from below won't accomplish much due to the lack of small trees;
- Some areas have very heavy fuel loads (estimated at 60 tons/acre);
- Opportunity for aspen restoration which would enhance prey habitat, foraging opportunity, and help with overall aspen ecology.

Bear Seep:

- Flats along Road 132 would benefit from 1- to 2-acre openings (Shaula) for prey/foraging/oak release;
- Some areas are dense in the 12- to 14-inch d.b.h. range and could use thinning and potentially some openings;
- In general, we saw areas that would benefit from changing dense, continuous forest into a more groupy tree distribution with relatively small canopy gaps;
- Small scale aspen and meadow restoration opportunities within PAC;
- Oak and pre-settlement pine encroached and would benefit from release;
- Cannot meet above objectives with a 9-inch d.b.h. cap in this PAC;
- Nest core is mixed conifer, dense, and great owl habitat – don't burn this nest core!

Red Raspberry:

- Lots of small scale topography allows treating dry south slopes heavier to help protect north slopes that could be left dense;
- Enhance openings in pine-oak to benefit oak;
- Yellow pine in drier sites would benefit from an overall basal area reduction to enhance sustainability;
- Opportunities for oak and aspen release and meadow restoration;
- Would require increasing diameter cap to something like 12- to 14-inch d.b.h.;
- Nest core = mixed conifer and should not be burned.

Knob Creek:

- Mechanical treatments recommended for most of the PAC*, including the nest core*;
- Many yellow pine and large oak are currently in dog hair thickets of young trees and would greatly benefit if released from competition;
- This PAC has a lot of pure pine that can be managed as groups and gaps, but make the groups large;
- Can use natural features such as swales for delineating openings;
- Work to retain snags that are abundant in this PAC;
- Many objectives could be met with 9-inch cap, but increasing this limit would allow more ecologically-based treatments.

T-Six:

- Pre-settlement pine and large oak are falling over from competition as these stands unravel – dense regeneration includes many "whips" that limit value of owl habitat;
- **Recommend mechanical treatment in the nest core;**
- Many other stands are open and would not require mechanical treatments;
- Other stands would benefit from thinning or small group removal where pockets of dog hair pine exist.

Foxhole:

- Oak will not persist in overly dense stands of young pine – much of the western portion of the PAC would benefit from mechanical treatment (except, of course, along the steep slopes);
- Need to protect snags and enhance oak;
- Groups of pine could range from 20 to 60 trees.

Archies:

- This PAC has a strong oak component and the pine is dominated by VSS 3 and 4;
- Releasing oak and removing some pine from pockets of oak savanna along ridge top would benefit owl habitat;
- Ridge top also had pockets of mistletoe and bark beetle and pine with reduced canopies; may be able to thin (with a light touch) for general forest health reasons to sustain the stand and speed development of larger trees;
- There are opportunities to release oak, which would require cutting at least up to 12 inches d.b.h.;
- Other side of ridge would do fine with 9-inch d.b.h. limit and thinning pockets of unraveling dog hair pine would improve stand health/sustainability;
- Small areas of aspen and meadow need restoration.

Crawdad:

- Stands needing treatment include single story, dense pine of 12 to 18 inches d.b.h. with no understory and suppressed oak; this needs thinning and creation of gaps to create sustainable owl habitat; 9-inch d.b.h. would preclude meeting these objectives;
- Bark beetle mortality and mistletoe present;
- Small natural openings could be enhanced for tree rooting zone and prey habitat;
- Further up slope forest opens but near top small oak are overtopped by pine;
- A couple other stands looked like historic meadows and open forest that are now encroached by VSS 3-ish pines.

Sawmill Springs:

- Much of the area is in good condition and benefit from a light touch to define tree groups;
- Treatments in other areas could aid in enhancing and retaining oak;
- Opposing slopes of drainage near spring have north and south aspects; treating the south slope could benefit this drier aspect and help protect the denser north slope;
- While much of the PAC is in relatively good shape, owl habitat objectives cannot be met by restricting treatments to 9 inches d.b.h.

Iris Tank

- Much of the PAC consists of dense ponderosa pine. Although oak is present in all size classes there is opportunity to release oak.
- Recommend treatments throughout the PAC outside of the nest core.

Bar-M

- Although the burn created nice openings with understory recovery on the ridges there are still dense pockets of ponderosa pine with little oak.
- There are few yellow pines scattered throughout and not many pines trees 16 inches and larger.
- Most areas would benefit from a thin of trees up to 9 inches d.b.h.; however, there are areas that would require cutting trees larger than 9 inches to reduce competition, release oaks and provide openings for improved foraging.
- The area south of Road 226 has more yellow pines than the rest of the PAC and groups of dense trees with openings in between groups. Treatments could focus on developing all size classes and releasing oak in dense patches of pine.

Clarke

- Limestone soils have high site productivity, but oak is limited in many stands.
- Leave bigger groups in draws, on north slopes, and smaller groups on south-facing slopes.
- Suppressed trees under dripline of yellow pine serve as great MSO roosts.
- Owls don't roost in stands with canopy cover less than 60 percent due to thermoregulation issues.
- An interspace of 50 feet is not likely to support much regeneration; interspaces of 150 feet may be full of regeneration within 20 years.
- Openings of 0.5 acre vs. 1 acre or larger are very similar in terms of regeneration; areas that can support regeneration will need retreatment to maintain tree-less space.

Red Hill

- Logs and coarse woody debris were very limited except in scattered pockets.
- The understory was depauperate for nearly the entire hike, it's mostly rock, needles, and duff.
- Medium-sized oak was common but typically scattered; Most oak was overtopped and crowded in by young pine; Large oak were widely scattered through area.
- We saw several pockets of *Ips* beetle-killed trees, red-needled trees killed last year by *Ips*, and active beetle sign, including successful beetle entries in down wood (tops/parts of trees with green needles) broken-off last winter.
- Some areas looked good (large trees, large and medium oak), particularly on the northerly slopes of Red Hill, and some areas were very dense with 12- to 16-inch pine choking out the large pine and overtopping nearly all of the oak.
- This was the first PAC visit with stand treatment maps: the proposed treatments matched the actual stand conditions well.

Lee Butte

- Some areas do not fit the classification: the trees are younger than expected; both classification and stand conditions are open grown
- Most areas lack pre-settlement trees, large oak, large snags, and large logs.
- Some areas are accurately classified and the proposed treatments fit the stand conditions well.

- Mistletoe pervasive but not heavy
- Some stands are classified accurately and fit the norm seen in other PAC review: very dense young to mid-aged trees with pre-settlement pine and large oak scattered throughout the stand; the big trees are being outcompeted by thickets of small trees and many young trees are already growing as "whips" or have toppled
- The recommendation was to drop at least 3 stands from treatment, which make-up the majority of the PAC, and treat the stands that would clearly benefit (i.e., move towards desired conditions) MSO habitat.

Rock Top

- Based on a road tour of the PAC (we drove the length of the long axis of this oblong-shaped PAC) we evaluated individual stands. Overall, the recommended diameter limits matched the conditions in the PAC.
- Treatments would increase tree size diversity and release pre-settlement pine encroached by small to mid-sized trees; similarly, medium to large-sized oak that are currently vulnerable would be released.

Appendix 5. Smoke Movements in Relation to Mexican Spotted Owls on the 4FRI Landscape

One of the assumptions related to 4FRI is that every acre of active management will include two prescribed fire treatments. Smoke in a fire-adapted ecosystem is a natural event. Smoke should have little to no effect on most wildlife northern Arizona (Abella 2008) and for Mexican spotted owls (MSO) specifically (Horton and Manning 1988) given that smoke is part of the evolutionary environment of this landscape. However, fire has been excluded from most of the project area for over a century. This suggests that at least five fire cycles could have been missed under frequent fire return intervals of 2 to 22 years (Weaver 1951, Cooper 1960, Swetnam 1990, Swetnam and Baison 1990, Fulé et al. 1997, Fulé et al. 2002, Covington et al. 1997, Heinlein et al. 2005). This implies at least 5 times the average fuel loading could have accumulated, depending on the actual time of the last burn in a given site. Therefore, while low severity surface fire is part of the evolutionary environment in southwest ponderosa pine forests, smoke output would be expected to be higher for initial burns in areas that have missed multiple fires. Because uncharacteristically high smoke levels associated with proposed 4FRI burning was identified as potentially affecting spotted owls, smoke behavior was assessed within the 4FRI landscape.

We conducted meetings with representatives from the fire programs from the Coconino NF and the Kaibab NF, the 4FRI fire ecologist, and wildlife biologists from the U.S. Fish and Wildlife Service (FWS) and the 4FRI Project to identify the release and movement of smoke from proposed broadcast burning. The objective was to identify protected activity centers (PACs) vulnerable to settling smoke resulting from prescribed fires associated with the 4FRI Project. Meetings (May 2 and 14, 2012) were conducted to evaluate the susceptibility of every individual PAC within and near the 4FRI treatment area (117 total PACs). At the start of this meeting we were considering the potential of burning in PACs during the owl nesting season when weather and fuel conditions best support “cooler” burns with maximal smoke dispersion. Unlike fall burning, these conditions best meet the objectives of reducing surface fuels while retaining habitat for MSO prey species and minimizing smoke effects to people and to MSOs. The following assumptions where included in the analysis:

- Large canyons (e.g., Oak Creek and Sycamore Canyons) have strong wind patterns that pull the smoke through the canyon rather than resulting in smoke settling in the canyons;
- Smoke will drain out of small canyons that open directly into large canyons;
- Smoke will not typically accumulate in core areas located in the heads of drainages;
- Burning next to PACs will only be done when conditions are such that smoke will lift and dissipate rather than drift or hang in neighboring stands;
- Burning would occur when ventilation is good to excellent to minimize impacts to communities, meet air quality standards, and minimize impacts to owls;
- We clarified that daytime smoke was not the issue because those are the conditions upon which the burn/no burn decision is made, but nighttime is when smoke settles.

Issues discussed included the differences between spring (during the MSO nesting season) and fall burning (after the MSO nesting season). Fire effects are influenced by the time of day ignition occurs, ignition techniques, how much area is ignited at a time, fuel moisture levels, ventilation patterns, etc., and most of these variables are affected by seasonality. The Forest Service strives for conditions that provide good nighttime ventilation to prevent the issue of smoke settling into low-lying areas. A common technique to help generate the initial lift of smoke is mass ignition. The MSO breeding season overlaps

with the spring winds that provide the best ventilation. Mass ignition and large-scale burning are seldom doable in the fall because conditions are drier than spring. For a host of reasons it was agreed that many small fires in the same area, and hence repeated impacts to the same area, was not desirable.

At the end of the meetings the following conclusions were reached:

- 15 PACs were in areas determined to be prone to settling smoke: James and Kelly (south of Kachina), Fisher Point, Walnut, Breezy, Lucida, and Cherry Canyon (all are in Walnut Canyon), Clark and Lake No.1/Seruchos (southeast of Mountain Aire), Rocky Gulch and Jack's Canyon (southeast of Stoneman Lake), Diary Spring and Lockwood (eastern side of Mormon Mountain), Mint Spring (south of Mormon Lake), and Rattlesnake (south of treatment area near I-17);

- The 4FRI subunits 1-1 and 1-3 will require extra attention due to the presence of both MSOs and bald eagles.

However, at the conclusion of the meeting it was decided that all burning within PACs would occur outside of the nesting season. This decision was based on the desire to minimize risk of adverse effects to owls. We also realized that burning adjacent to PACs could have the same results as burning within PACs and that "adjacent" was a relative term.

With the above experience and the concern that smoke effects could result from stands "adjacent to" PACs, we reconvened the above group with the addition of Mark Nigrelli (4FRI GIS specialist), Wesley Hall (Fire Resource Specialist), and Beale Monday (Flagstaff Fuels Specialist) on May 7, 2013. We reexamined the 4FRI treatment area and defined broad polygons where prescribed fire outside of PACs would not occur during the nesting season ("exclusion areas") to minimize the potential for adverse effects to nesting owls. In addition, we identified some areas near PACs and between exclusion polygons where, because of site-specific conditions, there would be opportunities to burn during the nesting season ("opportunity areas"). These area boundaries were predominantly delineated with roads so that a fire could be prevented from entering (or exiting) the defined area without having to build fireline in or near sensitive habitats. A meeting of specialist's from the 4FRI, including Mary Lata, Mark Nigrelli, and Bill Noble, finished this exercise on May 7, 2013.

Assumptions included defining "uncharacteristic" as fire exclusion for 20 or more years. This represents potential accumulations of surface fuels ranging from the high end of a natural fire cycle to conditions resulting from over a century of fuel accumulation (primarily needle cast). This was considered a conservative estimate in terms of biasing towards overestimating effects rather than underestimating potential impacts to MSO. It was assumed that these areas would therefore represent regions of high to uncharacteristically high smoke levels. Proposed 4FRI treatment areas that had previously been broadcast burned or had wildfire within the last 20 years were deemed representative of presettlement conditions. Initial 4FRI burns were considered maintenance burns because smoke levels would be in accord with those typical of the evolutionary environment. Therefore, smoke moving through a PAC during nesting season would not be considered an adverse effect. Initial 4FRI burns in areas where past treatments consisted of mechanical manipulation of vegetation followed by pile burning were discussed and eventually not included as representative of the evolutionary environment. While these treatments represent large areas of reduced fuel loading, there is no guarantee that surface fuels are reduced across entire treatment areas. Therefore, despite an overall reduction in fuels, smoke output could still exceed historical levels. Areas proposed for burning under other recent or ongoing project decisions, and hence have completed NEPA and ESA consultation, were not evaluated as part of the 4FRI. Another assumption was that spring burning outside of PACs would occur when conditions would provide good lift with predominantly southwest winds.

The forest-wide road layers in the 4FRI database were used to designate exclusion or opportunity polygons. We know that many more roads and road beds exist on the landscape. We expect that at implementation there may be boundary adjustments. It is intended that this effort incorporate flexibility to adjust exclusion/opportunity polygons in specific circumstances as long as the adjustment meets the intent of the polygon and either reduces or, at a minimum, does not add to any potential disturbance to nesting MSOs. Any adjustments would be done in coordination with district biologists. For example, near Gash PAC the exclusion boundary was pushed out to follow roads and minimize any risk of disturbance to a non-contiguous portion of the PAC. This excluded a broad meadow area (Broliar Park) that likely could be burned and not affect the PAC (it is below a steep slope east of the PAC). Based on past work, an adequate fireline may already exist at the base of the slope. If this is confirmed at the time of implementation it would be desirable to include Broliar Park to improve the meadow conditions. Enhancing meadow habitat is in accord with the intent of the 4FRI and in line with the goal of the adjacent exclusion polygon. If an adequate fireline does not exist, the exclusion line would remain along the existing road. This assessment also included potential effects to PACs outside the 4FRI boundary.

Once this assessment was completed, PACs identified as vulnerable to settling smoke (identified in May 2012) were individually reviewed. Adjustments were made on a PAC-by-PAC basis to minimize potential risk to owls in these areas. Additional areas were moved into exclusion polygons based on proximity and topography around these PACs (Figure 1).

Simultaneously, areas of opportunity were also reviewed, with adjustments made in and around the exclusion zone boundaries (Figure 1). Areas of opportunity include the following:

- East of Munds Park where the specific location/topography supports good ventilation and lift in the spring – Burning would be done in smaller parcels to ensure smoke would adequately dissipate.
- Mormon Lake Basin (Nestor PAC) area has all been burned, so initial burn characterization does not apply.
- O'Leary (mountain topography) and Bear Jaw PACs (Wilderness boundary) have site-specific features that prevent settling smoke/spring burning.
- Walnut Canyon region (includes an area south of Walnut Canyon along the east boundary of the 4FRI project area and an area between Flagstaff and Walnut Canyon) would include the same design features identified in consultation and incorporated into the Marshall project which covers a larger area immediately to the southwest of Walnut Canyon.
- Smoke from burning in the Howard Pocket area would create minimal impacts because of concerns and necessary design features associated with minimizing smoke impacts to the communities of Sedona and Oak Creek.
- Areas surrounding Sycamore Canyon would have inherent burning limitations related to smoke restrictions in a designated Class 1 Watershed.

Finally, a category was created for maintenance burning among the exclusion polygons. These areas were determined to be unlikely to pose adverse effects to nesting owls because of their location. Delineating this opportunity by location zone was based on local topography; typical wind/smoke patterns, and/or because recent burning (within 20 years) has reduced fuel levels. All non-designated areas outside the new exclusion/opportunity polygon layer and outside of PACs are available for burning during the nesting season (Figure 1).

Sixteen exclusion zones totaling over 86,330 acres were identified outside of PACs. Burning within PACs and within the exclusion polygons will only occur outside the nesting season (September 1 through February 28). Smoke effects to MSOs are expected to be minimal because of the degree of planning and site specificity used in this exercise.

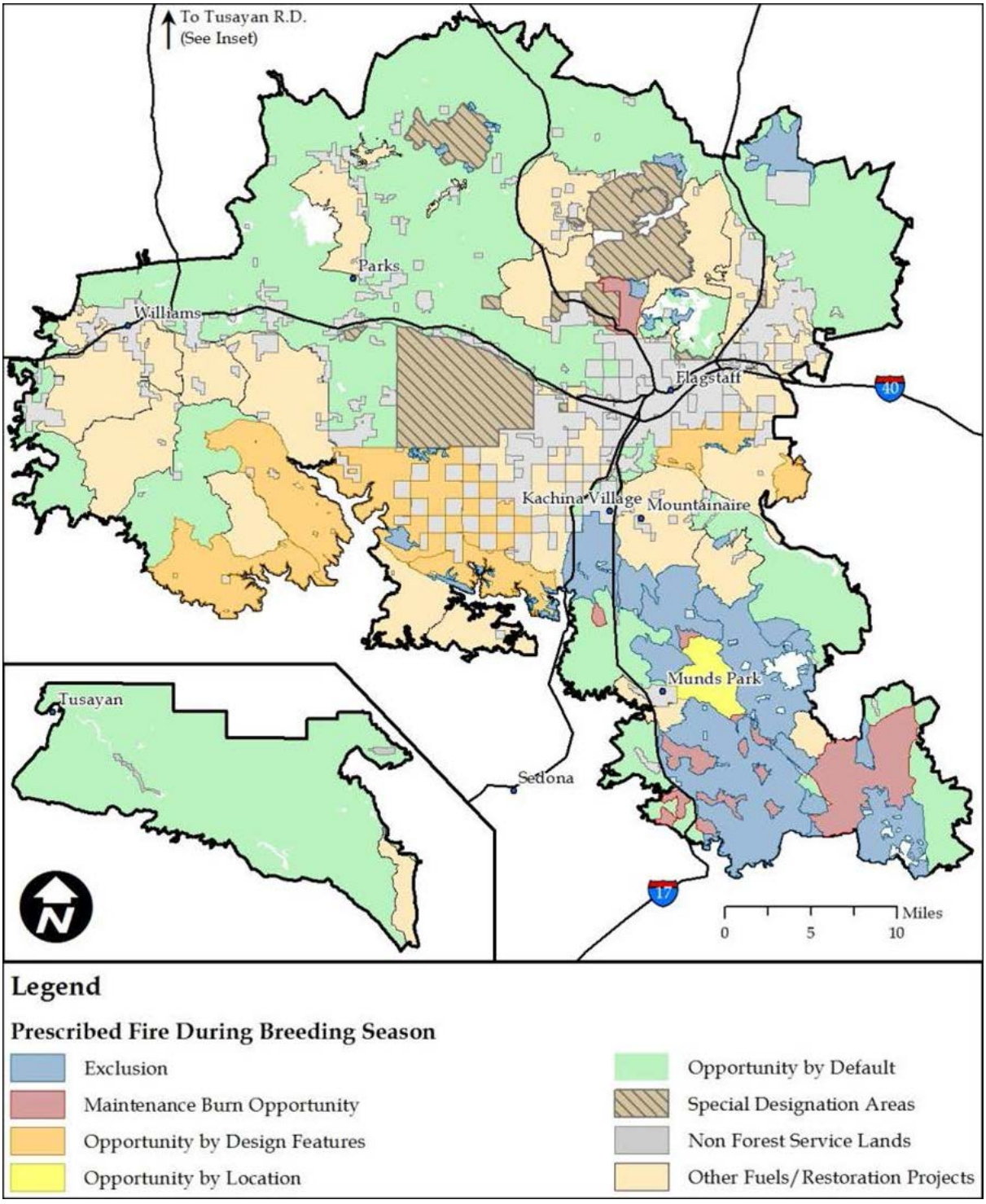


Figure 1. Areas of Fire Exclusion and Fire Opportunity in the MSO Breeding Season

Because burning within exclusion zones and within PACs would occur outside the breeding season, smoke from prescribed fire would not be expected to result in adverse effects to MSO. Owls do not have the same degree of site fidelity outside of the nesting season and if smoke settled into particular areas for extended periods, owls can be mobile without an associated risk to egg viability or nestling's health.

Smoke from prescribed fire would comply with Arizona Department of Environmental Quality requirements (ADEQ). Smoke effects are regulated and permits are required by ADEQ before burning is initiated. Air quality requirements specify that management actions will meet air quality standards. ADEQ considers the cumulative effects of smoke emissions from multiple jurisdictions prior to approving daily prescribed burning activities. This mitigates the potential for severe smoke effects from multiple prescribed fire projects across the entire treatment area.

Appendix 6. Understory and Arthropod Responses to Overstory Cover and Fire: a Literature Review in Support of the Four Forest Restoration Initiative



Bill Noble, 4FRI Wildlife Biologist
April, 2015

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Introduction

One of the most substantial changes to wildlife habitat that could potentially be achieved by the Four Forest Restoration Initiative (4FRI) would be restoration of the ponderosa pine understory. Ponderosa pine forests within the 4FRI project area commonly include up to seven overstory species, including aspen (*Populus tremuloides* Michx.), Gambel oak (*Quercus gambelii* Nutt.), limber pine (*P. flexilis* James), one-seed juniper (*J. monosperma* (Engelm.) Sarg.), alligator juniper (*Juniperus deppeana* Steud.), Rocky Mountain juniper (*Juniperus scopulorum* Sarg.), pinyon pine (*Pinus edulis* Engelm.), and ponderosa pine (*Pinus ponderosa* P. & C. Lawson var. *scopulorum* Engelm.). However, 84 to 95 percent of the overstory is commonly comprised of ponderosa pine trees (4FRI data, Fulé et al. 2002, Bakker and Moore. 2007). In comparison, 300 to 600 plant species occur beneath the canopies of ponderosa pine forests in northern Arizona (Laughlin personal communication 2011). Plot tallies from individual research efforts within the 4FRI area have reported 78 to 271 vascular plant species (Griffis et al. 2001, Abella and Covington 2006, Laughlin et al. 2008, Nyoka 2010, Laughlin et al. 2011, Stoddard et al. 2011).

Ecosystem services, such as climate regulation, air purification, water purification, crop pollination, and so forth are a subset of ecosystem functions (Kremen et al. 2007). The services provided by an ecosystem can often be characterized by the component populations, species, functional groups, food webs, or habitat types that collectively produce the service (Kremen et al. 2007). A productive and diverse understory provides such ecosystem services as protection from soil erosion, forage and cover for wildlife, fuels to carry low-severity surface fires, and is the repository for much of the biodiversity in ponderosa pine ecosystems (Moore et al. 2006).

Understory vegetation defines and supports the arthropod community. Arthropods, including insects, spiders, mites, centipedes, millipedes, isopods, and mollusks (snails and slugs), respond to changes in habitat structure (Pellmyer 1985, Buddle et al. 2006, Stephens Wagner 2006, Moisset and Buchmann. 2011). Arthropods are also key drivers of ecosystem structure and function. They decompose organic material, aerate and enrich soil, release nutrients back into the ecosystem, maintain genetic diversity within plant species, and serve as key prey for birds and small mammals which, in turn, support populations of larger predators (Meyer and Sisk 2001, Waltz and Covington. 2001, Samways 2005, Black 2005, Black et al. 2007, Capinera 2010, Mooney et al. 2010). Environmental factors that alter the spatial and temporal distribution of floral resources influence arthropod community composition (Buddle 2006, Kremen et al. 2007, Moisset and Buchmann 2011). Restoring diversity and connectivity in the herbaceous layer can sustain complex food webs (Meyer and Sisk. 2001, Samways 2005, Huffman et al. 2009, Negrón et al. 2009). These interrelations tie back to wildlife forage, cover, and ecosystem health. Moore et al. (2006) concluded that the herbaceous understory should be a prime focus of land managers involved with forest restoration and conservation biology in southwestern ponderosa pine forests.

Descriptions from the 19th Century

Ponderosa pine forests of northern Arizona, including both overstory structure and pattern and understory pattern and composition, have changed dramatically since the late 1800s. A century ago, the pine forests were dominated by widely spaced large trees with a more open forest floor dominated by herbaceous species (Cooper 1960). Many early expeditions described the natural conditions in what is now the 4FRI area:

- In 1851 navy Lieutenant Edward Fitzgerald Beale received orders from Jefferson Davis, Secretary of War, to survey a wagon route from Fort Defiance (some 30 miles southeast of Canyon de Chelly) to the Colorado River (Davis 2001). When his group approached the San Francisco Mountains, ascending into the ponderosa pine forest on the present day Peaks Ranger District, Coconino National

Forest, he wrote “We traveled rapidly over lovely country of forest and mountain valley, which continually drew exclamations of delight and surprise from every member of the party … we passed successive vales and glades, filled with verdant grass knee high to our mules, dotted with flowers, and the edges skirted by gigantic pines…” (Davis 2001).

- “The country was beautifully undulating, and although we usually associate the idea of barrenness with the pine regions, it was not so in this instance; every foot being covered with the finest grass, and beautiful broad grassy vales extending in every direction. The forest was perfectly open and unencumbered with brush wood, so that the travelling was excellent." (Beale 1858 quoted in Cooper 1960).
- Looking north from Mount Sitgreaves (now the Williams Ranger District, Kaibab National Forest), Beale observed “The fine spring attracts numerous antelopes, which appear and disappear as they glance rapidly through the fine open forest” (Davis 2001).
- Beal later commented that the ponderosa pine forests were "… the most beautiful region I ever remember to have seen in any part of the world. A vast forest of gigantic pines, intersected frequently with open glades, sprinkled all over with mountains, meadows, and wide savannahs, and covered with the richest grasses ..." (quoted by Bell 1870).
- Lt. Joseph C. Ives, commanding an army detachment in 1858, marched to the north base of Bill Williams Mountain (now the Williams Ranger District, Kaibab National Forest). Like previous explorers who passed this way, he was enchanted by the extensive grass growing beneath widely spaced pines (Davis 2001).
- In July 1858, John Udell was preparing to follow Beale’s wagon route along the 35th parallel, bound for California. As his train approached the eastern foothills of the San Francisco Mountain (now the Peaks Ranger District, Coconino National Forest), Udell continued to express delight over the blanket of grass clothing the highland valleys under an open forest of ponderosa pine (Davis 2001).
- C. Hart Merriam based his life zone concept largely on a study of vertical vegetation zones on the San Francisco Mountains. In describing the area he said, "The lava plateau above about 2130 meters (7000 feet) is covered throughout with a beautiful forest of stately pines (*Pinus ponderosa*) which average at least 33 meters [100 feet] in height. There is no undergrowth to obstruct the view, and after the rainy season the grass beneath the trees is knee-deep in places, but the growth is sparse on account of the rocky nature of the surface" (Merriam 1890).

Since this time, heavy tree harvest, fire exclusion, overgrazing, and more recently, climate change, has created a 120-year anomaly in terms of fire behavior which has altered the trajectory of stand development, ecosystem function, and spatial pattern of ponderosa pine in northern Arizona (Pearson 1950, Arnold 1950, Cooper 1960, Covington and Moore 1994, Moore et al. 2004, Roos and Swetnam 2012).

Historical Range of Variation

Historic increases in tree density have led to increased canopy closure, fueled in part by the cessation of frequent, low-severity surface fire that limited survival of tree seedlings (Covington et al. 1997, Fulé et al. 2002, Noss et al. 2006, Sanchez Meador et al. 2010). High seedling establishment rates due to an unusual distribution of moisture in 1919 contributed to today’s forest conditions as did similar, lesser seed crops in 1910, 1914, and 1929 (Arnold 1950). With tree recruitment abnormally high relative to the historical record and an interruption in the fire return interval, an 8 to 21-fold increase in tree density occurred in the ponderosa pine forests within the 4FRI project area (Fulé et al. 2002). Monitoring of long-term exclosures identified a doubling of total tree canopy cover, a tripling of tree density, an increase of 40

percent in tree basal area (square feet per acre), and a predominance of smaller trees between 1941 and 2004 (Bakker and Moore 2007). Forest conditions within the 4FRI project area under the historical range of variation were estimated to have been 23 to 60 trees per acre (Covington et al. 1993, Fulé et al. 1997, Moore et al. 2008). Post-settlement conditions within the project area range from over 400 trees per acre to over 2,470 trees per acre (Fulé et al. 1997, Fulé et al. 2002, Abella and Covington 2006, Moore et al. 2008). Whereas pre-settlement forests were dominated by older and larger trees, today's forests are characterized by relatively small, young trees (USDI 1995, Fulé et al. 1997, Fulé et al. 2002, Moore et al. 2004, Abella and Covington 2006).

Tree group size and shape can be thought of as the building blocks of landscape-scale forest structure in the ponderosa pine system of northern Arizona (Laughlin et al. 2006). The influx of trees since fire exclusion has altered the forest pattern as well as the forest structure. In stark contrast to today's relatively homogeneous forests, pre-settlement forests were relatively open and dominated by groups of trees with larger and more frequent grass openings (Covington et al. 1997, Fulé et al. 2002, Moore et al. 2004). Pre-settlement forest patches in the Gus Pearson Natural Area within the 4FRI project area averaged 0.14 acre (0.055 hectare) in size with a range of 0.05-0.27 acre (0.02–0.11 hectare) (Laughlin et al. 2006). These values are similar to the ranges described by White (0.05-0.72 acre [0.02–0.29 hectare]; 1985) and Cooper (0.15-0.32 acre [0.06–0.13 hectare]; 1960). Individual tree groups ranged from 2 to over 40 trees (White 1985). Rather than a matrix of tree groups defined by an interspersion of grassy, open patches, today's forests consist of small openings within extensive areas of dense pine trees which, in turn, exerts a negative effect on the understory community (Laughlin et al. 2006). Infilling of forests and expansion of trees into openings can affect plant community structure and composition, water and nutrient cycles, understory biomass production, wildlife habitat, biodiversity, and fire patterns across the landscape (Tausch et al. 2009).

Understory Response to Overstory Changes

A strong and inverse relationship exists between understory and overstory production (Cooper 1960 Clary and Ffolliott 1966, Clary 1969, Ffolliott 1983, Hart et al. 2005, Healy 1989, Bojorquez Tapia et al. 1990, Moore et al. 2004, Bakker and Moore 2007, Kennedy et al. 2009, Hodson et al. 2010, Laughlin et al. 2011, Stoddard et al. 2011). In 1901 and 1902 a deficiency in seedlings and saplings was reported by forest managers in what is now the Coconino National Forest, with the forest floor being "more fully occupied by herbaceous species" (Arnold 1950). Successful seed crop years occurred in 1910, 1914, 1929, and most notably in 1919. Afterwards, an abundance of young pine became established across extensive areas of northern Arizona. Young pine trees filtering into virgin timber, extending into natural grassland openings, and restocking cut-over areas created an abundance of young trees across much of what is now the 4FRI project area (Arnold 1950). In contrast to the open forest conditions described above, uncharacteristically dense pine forests began to decrease available sunlight, intercept precipitation and compete for soil nutrients throughout the 1900s (reviewed in Laughlin et al. 2005). Resulting reductions in herbaceous cover were noted by the 1930s (Arnold 1950). Herbaceous understory cover can decrease by four- to five-fold as canopy cover increases from 10 percent to 100 percent (Arnold 1950, Hodson et al. 2010). Under uneven-aged ponderosa pine forests, the relationship between canopy and herbaceous density was linear but variable. In even-aged forests, each 1 percent decrease in ground cover density was equal to a loss of 150 pounds air-dry grass yield (Arnold 1950).

Local research quantified the relationship between understory and overstory basal area. Studies were conducted on different portions of the Coconino National Forest within or adjacent to what is now the 4FRI project area (Clary and Ffolliott 1966, Pearson and Jameson 1967, Bakker and Moore 2007). The Rocky Mountain Forest and Range Experiment Station described relationships between basal area and herbaceous production in both the northern and southern portions of the Coconino National Forest in the

1960s (Clary and Ffolliott 1966, Pearson and Jameson 1967). Researchers working north of Flagstaff found that as basal area increased from 0 to 50 ft^2 per acre, herbaceous production dropped from over 650 pounds per acre to about 100 pounds per acre and when overstory basal area increased above 50 ft^2 per acre, herbaceous production decreased to 45 pounds per acre (Pearson and Jameson 1967).

Clary and Ffolliott (1966) conducted research south of Flagstaff and determined herbaceous production was higher when the overstory basal area was below 95 and was significantly ($p \leq 0.10$) higher when basal area was below 70. Average herbaceous production was higher on thinned plots. However, this trend reversed at levels equal to or higher than 100 square feet per acre basal area. While herbaceous production continued to decrease with increasing basal area, unthinned plots had higher herbaceous production than thinned plots when basal area was 100 ft^2 per acre or greater (Clary and Ffolliott 1966). This may be a result of management selecting for and releasing trees with the best growth potential that subsequently outcompeted the herbaceous layer for available water and nutrients. Another long-term study conducted on the Coconino National Forest found understory plant cover decreased by 21 percent and plot-level understory species richness declined an average of about two species per square yard as ponderosa pine basal area increased from an average of 17 square feet per acre in the early 1900s to 126 square feet per acre in 2007 (Laughlin et al. 2011). Predicted herbaceous production responses to basal area must be regarded as estimates because they cannot account for size-class distribution within a stand (e.g., trees in a northern Arizona ponderosa pine stand had equal basal area in 1876 and 1949, but density was more than 4 times greater in 1949, indicating that there were many small trees (Moore et al. 2004)).

Bakker and Moore (2007) examined understory production relative to increased overstory by using a series of 5 livestock grazing exclosures established in 1912 (see Arnold 1950). All 5 sites were located within about 15 miles of Flagstaff. As overstory increased between 1941 and 2004, understory decreases occurred in shrubs (69 percent), graminoids (39 percent), and forbs (82 percent). Total herbaceous cover decreased by 59 percent. They determined that understory vegetation was more strongly limited by the ponderosa pine overstory than by recent livestock grazing or by differences between years (Bakker and Moore 2007).

As research on the relationship between canopy cover and understory biomass production continued in the latter part of the 20th century, different studies assessed the strength of different variables for evaluating overstory productivity. This work has generated different equations to describe the relationship. Despite the number of studies, the shape and function of the resulting graphs have been the same: an increasing overstory slowly reduces the understory until a threshold in forest canopy is met, and then a sudden plunge in herbaceous production occurs as canopy density continues to increase. While the nature of the equation, slope of the line, and specific threshold values vary, the shape and response function of the curves have remained the same among studies and across decades of study. Forest cover greatly exceeding this threshold is now the normal condition in northern Arizona ponderosa pine forests. As a result, depauperate understories have also become common. Moir commented in 1966 that "Continued tree production unchecked by fire or artificial tree thinning appears to lead towards total or near-total herb suppression." Treatments intended to move forests towards the historical range of variation, but which failed to open forest canopies enough to move below this threshold effect, were identified as limiting understory response by several researchers working in what is now the 4FRI (Bradford et al. 2009, Scudieri 2009, Stoddard et al. 2011).

Forest Floor Conditions

Uncharacteristically dense forests can change herbaceous cover, potentially changing the site ecology. Dense pine canopies can reduce available light to as low as 20 percent of full daylight conditions (Meyer and Sisk 2001, Moir 1966). Limited light can limit plant production and species richness. In graminoids,

decreased solar radiation reduces inflorescence production (Moir 1966). Only high-fidelity understory species can persist beneath dense canopies compared to a much wider range of herbaceous species in more open conditions (Abella and Covington 2006).

Soil organic matter and nitrogen availability affect understory species richness and plant cover (Laughlin et al. 2007). Soils with greater nitrogen content can sustain greater understory plant abundance (Laughlin et al. 2007). However, in a long-term study in what is now the 4FRI project area, the amount of nitrogen stored in the overstory increased 600 percent after tree harvest in 1909 (plot establishment) and 2002; overstory nitrogen was estimated to be 31 percent higher in 2002 than before fire exclusion in 1876 (Moore et al. 2004). Phosphorous and potassium showed similar changes: aboveground phosphorous storage in trees increased by 475 percent and 53 percent since plot establishment and fire exclusion dates, respectively; increases in potassium were 528 percent and 41 percent since plot establishment and fire exclusion, respectively (Moore et al. 2004). Overstory biomass increased when open stands dominated by large trees with proportionally more stem wood converted to closed stands of smaller, younger trees with a high proportion of foliage and leaf area (Moore et al. 2004).

In general, changes in overstory nutrient storage suggest diminished nutrient turnover and decreased nutrient availability to other ecosystem components such as understory plants and non-arboreal herbivores (Moore et al. 2004). Net nitrogen transformation rates and soil microflora activity decreased under dense forests canopies (Moir 1966, Kaye et al. 2005, Boyle et al. 2005). Soil nitrogen is strongly related to understory species richness (Laughlin et al. 2007). Decreasing nutrient concentrations in the mineral soil can lead to less palatable herbaceous plants for wildlife (Mattson 1980). Nutrients occurring in canopy biomass rather than in soil, along with the slow release of nitrogen by pine needles, might be contributing to long-term shifts in the understory plant community (Laughlin et al. 2011).

Increasing canopy cover and density is not only reducing total herbaceous production, but may also be leading to shifts in the plant community. Decreases in available sunlight, precipitation, and soil nutrients select for slower growing, shade- and stress-tolerant plants. Decreases in available sunlight, precipitation, and soil nutrients select for plants that are shorter, flower earlier and contain lower nutritional value for wildlife (Moir 1966, Kaye et al. 2005, Laughlin and Abella 2007, Laughlin et al. 2011). Overstory changes may be selecting for understory species that more slowly acquire and conserve mineral nutrients. Laughlin et al. (2011) observed long-term shifts toward communities dominated by shorter plants with larger seed mass and lower specific root length under dense forest canopies, changing floristic assemblages and reducing the amount and timing of blooms. These changes can affect seed production and availability, lead to reduced plant diversity and reduced functional diversity of understory communities, (Laughlin et al. 2005). Moreover, they directly affect vertebrate wildlife in terms of altered forage and cover, and indirectly through altered arthropod communities.

Increased tree densities and lack of fire in the 4FRI project area have allowed increased accumulation of pine litter (i.e., freshly fallen organic materials). Forest litter depth is estimated to have increased 73.5 percent increase since 1876 (Moore et al. 2004). Alternatives B through E (the action alternatives) would reduce litter depth across the 4FRI treatment area, but the change would be most extensive under alternative C and most restricted in alternative D. The results of research on the effects of litter on understory species in northern Arizona have been varied. Moore et al. (2006) demonstrated that thinning-only treatments (i.e., no reduction in litter) produced equal increases in herbaceous production compared to thinning plus prescribed fire treatments. However, they suggested their study design may have obscured the effects of litter because raking associated with the fire treatment may have affected the soil seed bank in the O horizon. Removal of the upper soil horizons can also remove concentrations of NH^{4+} (ammonium), an important source of nitrogen for many plant species in the O horizon (Gundale et al. 2005). Laughlin et al. (2007) used multivariate modeling to account for species richness and litter depth

and found no significant correlation. Instead, they concluded nitrogen availability and density of the pine overstory primarily drove understory species richness. Abella and Covington (2007) detected no increase in plant cover or richness after two years of pine litter removal. They too cited soil seed bank removal combined with limited pretreatment herbaceous vegetation as potentially preventing a response. In addition, Abella and Covington (2007) described shading, belowground competition for water and nutrients, or other tree-associated factors as more strongly limiting understory communities.

However, other studies in ponderosa pine forests of northern Arizona concluded total plant cover, cover of major grass species, and overall plant species composition were negatively correlated with litter (Laughlin and Abella 2007, Laughlin et al. 2007, Scudieri 2009). Total plant cover and cover of major grass species were positively correlated with bare ground (Scudieri 2009). Laughlin and Abella (2007) concluded plant species appear to respond so strongly to pine litter that variations in litter depth alone could shift community composition. The relationship was found to be so strong that, in another study, litter depth was used as a predictor variable for herbaceous response to overstory changes (Clary 1969). In finding no significant correlation between litter depth and herbaceous species richness, Laughlin et al. (2007) hypothesized plot size may have been a factor (i.e., in ecosystem studies, the effect of litter may be lost at the 1/12-acre scale). Given the varied responses among studies, perhaps site variability as influenced by other variables such as soils or geomorphology, in addition to whether the upper soil horizons are removed, influence the degree to which litter influences understory production. In summary, litter depth appears to exert a strong negative influence on understory productions in several, but not all studies conducted in what is now the 4FRI project area.

An indirect effect of accumulating pine litter is the slowing of soil decomposition rates due to high resin, lignin, and other compounds resistant to chemical breakdown in pine needles (Moir 1966, Laughlin et al. 2011). In addition, dense forest conditions create selection pressure for herbaceous understory species with slower decomposition rates (Laughlin et al. 2010). The relative and total decrease in organic input from grasses and forbs, combined with slower decomposition of herbaceous species, can alter soil properties and impose direct and indirect constraints on understory species diversity (Laughlin et al. 2007). Soil texture and pH constrain growing conditions, limiting sites where plant species might occur (Laughlin and Abella 2007). Decaying pine needles, charred wood, and leachate from needles, wood, and bark significantly reduce germination and growth rates of understory species (Lodhi and Killingbeck 1982, Abella 2006).

Litter thickness and weight are also negatively correlated with seed bank accumulation for both total and native perennial species richness in ponderosa pine forests studied within the 4FRI project area (Black et al. 2007). Seed banks are typically a reflection of the seed rain from existing vegetation, although native graminoids are more common and perennial forbs sparse in the soil seed bank (Buddle et al. 2006, Black et al. 2007, Bradford et al. 2009). Seed banks in general, and specifically for native perennials, have been found to be richer and larger in patches where aboveground understory vegetation is most abundant. This unfortunately indicates they may be less useful for increasing native understory vegetation in dense pine forest where existing understory vegetation is already depauperate (Black et al. 2007). However, soil seed banks also vary across southwestern ponderosa pine forests with little correlation found between the seed bank and above-ground vegetation in other areas (Meyer and Sisk 2001, Buddle et al. 2006,). Patches with open canopies, typically near old trees, support larger and richer soil seed banks than patches of denser canopies containing many closely spaced small trees (Black et al. 2007). Thick duff layers can lead to higher soil temperatures when fire moves through, resulting in increased seed mortality in the soil bank (Buddle et al. 2006, Hart et al. 2005, Blaker personal communication 2011). Dense overstory canopies limit understory species composition and seed production and therefore will continue to reduce or prevent herbaceous recovery, thus hindering recovery of associated habitat elements essential to a host of vertebrate and invertebrate species.

In summary, dense forests dominated by mid-aged pine trees limit sunlight reaching the forest floor, compete for water, and act as strong nitrogen sinks that combine to create unfavorable growing conditions for many understory species. More nutrients are translocated from the soil into forest canopies while slower nitrogen mineralization and nitrification rates are occurring beneath the forest floor. Combined with slower decomposition rates and allelopathic qualities associated with ponderosa pine litter, the current forest floor environment is creating selection pressure altering understory communities compared to pre-settlement conditions. Declines in total cover and species richness resulting from current forest conditions have been documented throughout the 20th century. The decrease in total cover and species richness resulting from current forest conditions includes selection pressures that limit total foliar production, flower production, and seed production and alter the timing of these important functions. The net effects to wildlife are changes in vegetative cover and food quantity and quality, including reduced arthropod availability. In addition to affecting herbivores, negative impacts to the arthropod community can directly influence wildlife by reducing food availability for insectivores and omnivores. In the long-term, reduced arthropod populations can exert secondary limits or selection pressures on the plant community by decreasing the pollinator assemblage; this can further limit the understory diversity, with potential impacts moving up through community trophic levels.

Relationships of Understory Development to Arthropods

Introduction

Invertebrates occupy all forested habitats and have diverse functional roles including detritivores, fungivores, herbivores, predators and parasitoids, and pollinators (Schmidt and Jacobson 2005, Short and Negron 2003). Invertebrates, to which arthropods belong, compose over half the animal diversity in forested landscapes (Schmidt and Jacobson 2005). There are 26 orders of insects within the phylum Arthropoda, but most insects in North America belong to only 8 of these (Stokes 1983). These 8 orders, plus the class Arachnida, are of particular importance to the wildlife species considered under 4FRI. Arthropods are being addressed because they serve as key invertebrate prey items for many birds and mammals (Martin et al. 1961, Capinera 2010). Billions of individuals representing thousands of species may reside in a single northern goshawk territory (Short and Negron 2003). Arthropods are of concern because vegetation composition affects the behavior and structure of arthropod communities (Samways 2005). Current forest conditions in Southwest ponderosa pine forests have been summarized as appearing unfavorable for most insect pollinators (Nyoka 2010).

A healthy herbaceous layer is fundamental to maintaining diverse arthropod communities. Conversely, increased homogeneity of once patchy vegetation leads to loss of specialized habitats. Diversity in arthropod habitats in ponderosa pine forest include diversity of tree species, variable soil conditions, herbaceous and coniferous litter depth, snags, large woody debris, fragmentation or connectivity of arthropod habitats, and herbaceous cover and species richness (Laughlin et al. 2004, Samways 2005, Schmidt and Jacobson 2005, Capinera 2010, Laughlin et al. 2010). Changes in land use and landscape structure influence arthropods, including pollinators, their target plants, and plant/pollinator interactions at individual, population and community scales (Kremen et al. 2007). Effects of thinning, thinning and burning, clearcutting, and wildfire on arthropod populations have been described and in many cases have resulted in entire community shifts (e.g., Strohecker et al. 1968, McIver et al. 1992, Schmidt and Jacobson 2005, Buddle et al. 2006, Coleman and Rieske 2006, Matveinen-Huju and Koivula 2008, Moisset and Buchmann 2011). What is not known is the degree to which current arthropod communities have changed relative to the heterogeneity of habitats found under pre-settlement conditions.

Flowering plants provide foliage, pollen, and nectar and are of significant importance to many families of arthropods (Holland 1984, Capinera 2010, Hedwall personal communication 2011). Pollen is high in

crude protein (10 to 30 percent) and contains fat and minerals; nectar is the principal source of easily digestible carbohydrates for arthropods (Chen et al. 2006, Capinera 2010). Flowering plants must be available both spatially and temporally throughout the growing season to sustain many families of arthropods (Capinera 2010). For example, many arthropods overwinter as adults and require nectar and pollen when they emerge in the early spring while adults of other species emerge in the late summer and require nectar and pollen to mate or feed developing larvae (Stokes 1983, Mooney et al. 2010). A diversity of flowering plants that bloom throughout the spring and summer supports a diverse pollinator assemblage. However, few plant species are capable of flowering throughout the growing season. Therefore, a variety of flowering species ensures food availability for nectar generalists as well as supporting the many insects with host-specific requirements. A diverse community of insect pollinators requires diversity of native flowers and vice versa (Black et al. 2007).

Pollinators

Arthropods have been assisting plant fertilization since the radiation of the Angiospermae during the Cretaceous Period (144-65 million years ago) by allowing these plants to exist in widely separated locations (Capinera 2010). While plants provide required foods for many insects, insects provide the mechanism for cross pollination. Cross pollination, or genetic mixing between plants, requires pollen from one flower reaching the reproductive parts of another flower. Some plants such as grasses and trees use wind to transport pollen, requiring the production of a great deal of pollen and the right circumstance to ensure it reaches other flowers of the same species (Stokes 1983). Conversely, 60 to 90 percent of wild plants require animal pollinators to collect and transport pollen (Stokes 1983, Kremen et al. 2007, Mooney et al. 2010, Nyoka 2010). Insects are the chief pollinators and flowers have evolved hundreds of different strategies designed to lure them in, providing food in exchange for genetic mixing (Stokes 1983). Pollination in the wild is mostly accomplished by bees and wasps, flies, and butterflies and moths (Waltz and Covington 2004, Black et al. 2007, Capinera 2010). Plant pollination by insects is one of the most widespread ecosystem services in terrestrial environments and is essential to maintaining biodiversity (Black et al. 2007). A study in what is now the 4FRI project area found 20 percent of the total sampled arthropods were either pollinators or their diet consisted mainly of flower parts (Huffman et al. 2009). Pollinators have been called a keystone group in terrestrial ecosystems because of the range of ecological services they provide to natural ecosystems (Black et al. 2007). Insect pollinator abundance and species richness are strongly correlated with plant cover availability of floral resources (Nyoka 2010).

The pollinator community affects wildlife directly and indirectly. Pollination of flowering plants concentrates insects, making them easier prey for wildlife (Capinera 2010). Herbaceous response can increase 4- to 5-fold in openings (Arnold 1950, Hodson et al. 2010) and insects can be 25 times more abundant in openings than under forest canopies, providing a primary food source for wildlife, including turkeys and other birds (Healy 1989). The tie between invertebrate prey and their predators is strong enough that butterfly diversity can be a predictor of bird abundance and diversity (Black et al. 2007). Most plants that produce colorful flowers do so to attract insects (Capinera 2010). Each flowering plant species usually has a small guild of pollinators which coevolved with them to ensure their pollination (Mooney et al. 2010). Without pollinators, many plants would decline or disappear; the most highly coevolved mutualistic species are the most at risk (Capinera 2010). Successful pollination results in production of fruits and seeds, providing important wildlife foods (Black et al. 2007, Capinera 2010). The decline or loss of these resources would likely result in declines in the birds and mammals that depend on fruit and seed production (Williams 2011), which in turn can affect higher trophic level predators.

The decline of pollinators and the services they provide has been described for decades, including evidence of declines at local and regional scales and evidence of elevated extinction rates across taxa (Kremen et al. 2007). Habitat loss and fragmentation in the United States has adversely affected pollinator

species, particularly native bees (Mooney et al. 2010). The situation for pollinators caused sufficient concern that the National Research Council of the National Academy of Sciences issued a report titled "Status of Pollinators in North America" in 2006 and again in 2007 [http://dels.nas.edu/Report/Status-Pollinators-North-America]. Landscape structure affects foraging behavior of pollinators: they follow vegetation corridors to reach nectar or pollen sources, avoid edges created by roads, and increase energy expenditure in simplified landscapes where few alternative flower resources occur (reviewed in Kremen et al. 2007). Most pollinators have similar needs: open, sunny areas; high diversity and availability of host plants for food, pollen, and nectar sources; and a variety of microclimates to provide food and shelter under changing weather and climate conditions (McIntyre personal communication). Pollinators respond to habitat restoration as evidenced by restoration of species abundance, species richness, and ecosystem function (Williams 2011). An indication of progress towards restored habitat is less redundancy in pollinators visiting the same plants (Williams 2011).

Connectivity (summarized from Samways 2005 except where noted)

In addition to direct habitat loss, the disruption of the herbaceous layer fragments arthropod habitat. Anthropogenic filters can create a sufficiently large matrix devoid of flowers, creating a barrier to pollinator movement (e.g., decreased sunlight levels that limit plant species richness can create barriers to movement and nesting (Kremen et al. 2007)). Increased anthropogenic filters reduce arthropod movement across the landscape with multiple results. One insect species may be losing the potential to disperse, increasing population isolation, while another species can be losing larval host plants. Population isolation can result in increased mutation/recombination, providing more phenotypic variation and potential adaptability or it can lead to increased risk of extirpation. This loss of habitat connectivity is occurring worldwide and has been described as "devastating." Both area and isolation affect patch occupancy (Ferraz et al. 2007). Avoiding population isolation means maintaining gene flow. Inbreeding depression has been demonstrated to increase extinction risk in some butterflies and may be more widespread in plants and insects than previously thought. Efforts to maintain or create habitat corridors to facilitate movement in fragmented landscapes were demonstrated to be important to invertebrates and plants (Gilbert-Norton et al. 2010).

An emerging strategy in landscape management is to move the transformed landscape back towards something resembling the structure, composition, and function of the original landscape. This encompasses habitat characteristics to which arthropods are sensitive and maintains them in as near natural a state as possible. A range of successional habitats with an emphasis on heterogeneity has been shown to maintain arthropod species richness. Conserving arthropod diversity is heavily dependent on maintaining both large and small patches of high quality habitat. "High quality" refers in part to heterogeneity. Providing both direct habitat connectivity and habitat stepping stones facilitates landscape movement. Managing for habitat stepping stones allows genetic and demographic augmentation of isolated habitat patches by immigrants and facilitates possible recolonization of unoccupied patches (Britten et al. 2003). Currently, patches of non-native invasive species such as Dalmatian toadflax (*Linaria dalmatica*), common mullein (*Verbascum thapsus*), and thistles (*Cirsium spp.*), all of which commonly invade sites after forest management activities, may provide the only substantial islands of pollen and nectar for insect pollinators in ponderosa pine forests undergoing initial treatments (Nyoka 2010).

Ecological Interrelations

Habitat fragmentation can result in non-random extinction of insect populations as influenced by a species' dispersal ability (Fleishman et al. 2002, Samways 2005). Butterfly data has shown that species of intermediate mobility declined most in fragmented landscapes, followed by species of low mobility, whereas species of high mobility were maintained (Samways 2005). Flight-limited species are vulnerable

to local extinction as remnant patches become smaller and more isolated (Samways 2005). Worldwide, an estimated 11,200 insect species have gone extinct, with an estimated 162 species disappearing within the United States (Capinera 2010).

Patch quality is additive upon patch size and isolation (Fleishman et al. 2002, Samways 2005). For many arthropods, the loss of their host plant means they also disappear (Fleishman et al. 2002, Capinera 2010). Diversity of both arthropod predators and herbivores display linear relationships with vascular plant diversity (Samways 2005). Plant species richness, plant functional groups, and most importantly, plant species composition are important determinants of arthropod diversity (Holland 1984; Fleishman et al. 2002; Samways 2005; Matveinen-Huju and Koivula 2008; Hedwall, personal communication 2011). For example, some families of bees are known as "long-tongued" and favor deep flowers while other bee families are short-tongued and only able to take advantage of shallow flowers such as those of the daisy, aster and carrot families (Mooney et al. 2010). Heterogeneity at all levels, from tree groups to landscapes and structurally as well as spatiotemporally, is important to ensure insect diversity (Strohecker et al. 1968, Samways 2005).

Arthropods are key drivers of ecosystem structure and function. They pollinate many flowering plants, decompose organic material, release nutrients back into the ecosystem, and provide the largest food source in almost every ecosystem (Waltz and Covington 2004, Wilson 1987 in Schmidt and Jacobson 2005, Kremen et al. 2007). Arthropods include both hosts and parasites and serve as prey for a variety of animals, including birds, mammals, herpetofauna, and other arthropod species (Black 2005). Arthropod communities interacting with plant communities drive trophic interactions between vertebrate predators and invertebrate prey. For example, recent evidence suggests that predators and parasites strongly influence the population dynamics of bark beetles. Natural enemies can reduce *Ips typographus* reproduction by 83 percent with woodpeckers accounting for 28 percent of mortality of low bark beetle populations, 84 percent during outbreaks, and broods were reduced by 98 percent by woodpeckers on heavily worked trees. Additional mortality was caused by bark removal, thereby increasing access of parasitoids and predators and also increasing solar radiation, thereby drying-out bark beetle larvae (reviewed in Black 2005). In general, the functional importance of an ecosystem service provider depends on both its effectiveness at performing the service and its abundance (Kremen 2005).

Community function and related ecosystem services depend in part on densities, biomass, and interactions of species within the community (Kremen 2005). Diversity confers a stabilizing effect on community structure. More diverse communities provide more stable services than less diverse or simpler communities. These compensatory responses are poorly understood at community levels. In some instances, the importance and contributions of ecosystem service providers has been measured or estimated (Table 1). It is unknown how reduced species abundance, decreasing species richness or local extinctions affect community stability and related services (adapted from Kremen 2005).

Table 1. Networks of ecosystem functions (adapted from Kremen 2005)

Service	Provider/Trophic Level	Unit(s) of Measure	Spatial Scale of Services Provided
Air Purification	Micro-organisms, Plants	Biogeochemical Cycles, Populations, Species, Functional Groups	Regional - Global
Water Purification	Vegetation, Soil micro-organisms, aquatic invertebrates, Aquatic micro-organisms,	Populations, Species, Functional Groups, Communities, Habitats	Local - Regional
Drought Mitigation	Vegetation	Communities, Habitats	Local - Regional

Service	Provider/Trophic Level	Unit(s) of Measure	Spatial Scale of Services Provided
Pollination	Insects, Birds, Mammals	Populations, Species, Functional Groups	Local
Pest Control	Invertebrate parasitoids and predators, and vertebrate predators	Populations, Species, Functional Groups	Local
Detoxification/ Decomposition of Wastes	Leaf litter & soil invertebrates, Soil micro-organisms, Aquatic micro-organisms	Populations, Species, Functional Groups, Communities, Habitats	Local - Regional
Soil generation and fertility	Leaf litter & soil invertebrates, Soil micro-organisms,	Populations, Species, Functional Groups	Local
Seed Dispersal	Ants, Birds, Mammals	Populations, Species, Functional Groups	Local
Climate Stability	Vegetation	Communities, Habitats	Local - Global
Ecosystem Goods	Species Diversity	Populations, Species, Communities, Ecosystems	
Aesthetic/cultural	Biodiversity	Populations, Species, Communities, Ecosystems	Local - Global

Arthropods as Food (summarized from Capinera 2010 except where noted)

An animal's diet has a fundamental influence on its behavior and ecology, including choice of habitat associations, niche selection, foraging and dispersal behaviors, and population structure and dynamics. The potential of 4FRI to restore both the herbaceous and arthropod communities in the understory can benefit a wide range of wildlife. About one-third of the families (33.6 percent) within the class Mammalia eat primarily arthropods while another one-third (32.7 percent) eat vegetation; over 35 percent of families in the class Aves eat arthropods. Arthropods are not only consumed by insectivorous species, but also by omnivores and as alternate prey for carnivores when preferred prey is not available. Arthropods are highly digestible and provide a high yield of metabolizable energy per unit intake, making them a desirable food item for small mammals (Merritt 2010). Nutrition levels of arthropods are typically much higher than most plant-based foods. Based on a review of stomach analyses, key prey items for wildlife (by Order) commonly include: hymenoptera, lepidoptera, coleoptera, orthoptera, diptera, homoptera, and arachnids (Martin et al. 1961). These families represent highly nutritious foods, consisting of 25 to 67 percent protein and 10 to 39 percent fat. In contrast, native grasses are commonly 10 to 15 percent protein (Texas A&M Extension Service). Many birds and mammals select invertebrate prey because of the nutritional advantages they provide for offspring or as foliage losses nutrition in autumn through the seasonal curing process. Arthropods are also an important component in the diets of most amphibians and reptiles. Habitat restoration can potentially redistribute arthropods which, given their importance as food resources, can affect the distribution of vertebrate wildlife populations (Meyer and Sisk 2001). These effects have potential to cascade through the ecosystem and influence food web dynamics (Huffman et al. 2009).

Arthropod Orders

Below is a summary of the habitat relations for key orders of arthropod prey. Each order of arthropod, and many specific families or species within these orders, have particular habitat requirements. Most invertebrates occupy distinctly different habitats during their life cycle (Schmidt and Jacobson 2005). Their habitat needs are influenced by overstory structure, principally tree and canopy density. Edges are

key habitat for many families of insects (Stokes 1983). Links between arthropods and vertebrate species described below principally come from Martin et al. (1961) and Capinera (2010). These authors used data determined directly from stomach analyses, or, in some cases, scat analysis (Capinera 2010) to identify predator/prey relations. This information is included here because these orders represent key prey for a range of vertebrate species. Their habitat relationships tie directly to understory health and proposed treatments proposed in 4FRI. Maintaining the interrelationships between orders of insects are important to ecosystem function and restoration (from Stokes 1983 unless otherwise noted).

Lepidopterans ("scaly-winged," including butterflies and moths):

Both butterflies and moths can require specific plant species as larvae, then become nectar generalists as adults, encompassing a broad range of ecological niches (Waltz and Covington 2004). The female oviposits on or near a specific species or genera of plant and, once the eggs hatch, the plant serves as the species-specific food for the larvae (Stokes 1983, Waltz and Covington 2004). How the female distinguishes between plants in a given forest or meadow is unknown. Examples include the common white and sulphur butterflies (family Pieridae) which usually oviposit on mustards (whites) or legumes (sulphurs). Once the adults emerge, they feed on nectar. Mating behavior includes aerial flights above meadows or lush weeds.

Work with the Nokomis Fritillary (*Speyeria nokomis* sub-species) indicated probability of occupancy increased with increasing larval host-plant abundance and percent cover of adult nectar sources, but decreased as conifer litter reached heavy levels, perhaps as a result of impeded oviposition (Fleishman et al. 2002). The family Nymphalidae includes *S. n. nokomis* and *S. n. nitocris*. *Nokomis* require water flow and violets (Ferris and Fisher 1971). They are nearly always in seep areas with constant water flow surrounded by willow thickets. Larvae require violets as their food plant and typically grow in the understory of the seeps but are sparse in thickets. Surrounding areas can be relatively arid and include sagebrush and juniper. Willow can be associated with this habitat, but it may be because a spurious correlation with other components of the butterflies' immediate environment. The habitat for *S. n. nitocris* is lush Canadian Zone meadows or along mountain streams that feed such meadows. The adults feed upon red thistles of various species and tend to fly at higher elevations than *S. n. nokomis*. Female *nitocris* tend to stay in dense vegetation, including tall grasses and willows along the streams associated with their habitat (Ferris and Fisher 1971).

Adults overwinter under loose bark and feed on sap and early blooming shrubs. Monarch butterflies (family Danaudae) are best known for their long-distance migrations. They feed on milkweed as larvae from which they collect toxins that reduce predation in their adult stage. Adults prefer open habitat with abundant flowers. However, they seek dense vegetation for mating. Because of these habitat associations and their quick response to habitat change, the lepidoptera can be indicators of ecosystem change (Waltz and Covington 2004).

Butterflies preferentially forage on species with bright tubular pink or red flowers and plentiful nectar (Nyoka 2010). In the Southwest, particularly within the 4FRI area, butterflies pollinate catchfly (*Silene, Caryophyllaceae*), honeysuckle (*Lonicera, Caprifoliaceae*), phlox (*Phlox, Polemoniaceae*), cryptantha (*Cryptantha, Boraginaceae*), willows (*Salix* spp.), Gambel oak (*Quercus gambelii Nutt*.), juniper (*Juniperus* spp), buckbrush (*Ceanothus fenderli Gray*), Rumex species, columbines (*Aquilegea* spp.), several beard-tongue (*Penstemon* spp.), paintbrushes (*Castilleja* spp.), cliffrose (*Cowania mexicana* D. Don.), buckwheat (*Eriogonum* spp.), asters (*Asteracea* spp), legumes (*Leguminosae* spp), saltbush (*Atriplex* spp), New Mexico locust (*Robinia neomexicana*), sage (*Artemisia* spp), grasses (graminoids), and milkweed (*Asclepias*, *Asclepiadaceae*) (Holland 1984, Nyoka 2010, McIntyrepersonal communication 2011). Moth-pollinated plants such as evening primrose (*Oenothera*) share similar features with butterfly flowers, but open at night and are generally paler in color (Nyoka 2010).

Presence of a butterfly or moth species indicates presence of the larval host plant, as well as sufficient adult food resources (Waltz and Covington 2004). In addition to the presence of specific species, microclimate conditions have been shown to control foraging rates of many arthropods, including butterflies and moths (Meyer and Sisk 2001, Waltz and Covington 2001). Butterfly species increase proportionally with patch size and butterfly species richness is highest on heterogeneous landscapes (Samways 2005). In order to provide functional habitat so that the full diversity of moths and butterflies is retained, the right plant species need to flower at the right times with a broad enough distribution to account for individual butterflies, populations of butterflies, and their respective meta-populations.

Lepidoptera have many natural predators including frogs and lizards, birds (including hummingbirds), small mammals such as shrews (*Soricidae*) and mice (*Peromycus* spp.), and many species of carnivorous insects and spiders (Capinera 2010). Mexican spotted owls (*Strix occidentalis lucida*) will prey on moths opportunistically (Ganey et al. 2011). Hence, they are an important component of the natural food web. In addition, moths are key food items for bats including some on the Southwestern Regional Forester's Sensitive Species list such as Allen's lappet-browed bat (*Idionycteris phyllotis*), pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*), and spotted bats (*Euderma maculatum*), which feed almost exclusively on lepidopterans (Jones and Rydell 2003, AGFD 2001, Painter et al. 2009).

Hymenoptera ("membrane-winged," including ants, bees, and wasps):

The order Hymenoptera includes a wide variety of species and a wide variety of ecosystem services. Hymenopterids include decomposers, fungivores, herbivores, predators, parasitoids, and pollinators (Short and Negron 2003).

Ants

Ants are in the family Formicidae. Nests are frequently located and sometimes even designed to absorb heat from the sun to warm the colony during the night. The presence of a canopy or lack thereof influences not only the species of ants present, but also the ecological functional groups present within the family Formicidae (Strohecker et al. 1968). Habitat ties can be so strong among ant species that Stephens and Wagner (2006) concluded the maintenance of a diversity of ant functional groups and species in northern Arizona ponderosa pine forests required a diversity of forest conditions. Conversely, forest conditions outside of the range of historical variability will support a diversity of ant species and functional groups also outside the historical range of variability. The loss of functional groups can affect ecological processes (e.g., there is a linear correlation between above ground ant activity measured by the number of species and below ground decomposition processes measured as soil microbial biomass (Samways 2005)).

Bees

Bees descended from wasps and are entirely vegetarian, feeding on pollen and nectar. Globally there are seven families of bees, six of which occur in North America (Hedwall personal communication 2011). The members of the five most common families, Apidae, Halictidae, Andrenidae, Megachilidae, and Colletidae, can be found throughout North America and include 4,000 species of native bees in the United States (Mooney et al. 2010). Over 99 percent of bee species are solitary (Super family Apoidea) and do not form societies like the social bumblebees (native species) or honeybees (introduced from Europe). Bees are the principal pollinators in most ecosystems and are likely to be an important component of the pollinator fauna in restored ponderosa pine forests (Nyoka 2010).

Bees use a diverse range of habitats, requiring components such as herbaceous diversity and density, including grasses, forbs, and shrubs, and a flower bloom succession that lasts from spring until autumn (Hedwall personal communication 2011). The two most common bee families in the ponderosa pine

forests of northern Arizona are Halictidae and Apidae (see below; Smith personal communication 2011). All species within the Halictidae family nest in ground tunnels. Nests seem to be a limiting factor and competition may occur over a suitable site. Suitable nest sites require openings with bare patches of dry, packed earth for their burrows. Females dig burrows in the soil and collect pollen, which they store along with their eggs in the burrow, sealing off the tunnel when they are done. When the eggs hatch, the larvae feed on the stored pollen. They pupate and eventually emerge as adults. In many species of solitary bees, the males may be territorial and patrol areas near flowers, fending off other male bees and even other species of insects that might feed on the flowers. Adults overwinter in underground burrows. When they emerge in early spring they rely on early blooming flowers and catkins that provide pollen and nectar for food.

Leaf-cutter bees (family Megachilidae) use conifer resin, plant hairs, mud, or a mix of the above to build nests in the ground, in hollow stems, or in holes bored in wood (Grigarick and Stange 1968). Ponderosa pine forests provide important nest substrate (snags and logs) for many leaf-cutter bee species. Specimens collected in California have been associated with over 100 different species of flowering plants distributed in 35 different families (Grigarick and Stange 1968).

The family Apidae includes bumblebees (genus *Bombus*). Bumblebees are some of the most common bee species in northern Arizona (Blaker personal communication 2011). Fertilized females overwinter and emerge in early spring when they search for nectar sources and nest sites. The most suitable nest locations are abandoned rodent and mole burrows. It is estimated that about 10 percent of all nests are taken over by other queens. Once a queen has a nest, she collects herbaceous material to line the nest and also to pile around the nest entrance. This is thought to function in part as camouflage because of the typically short supply of preferred nest locations. Camouflaging nest entrances may protect against invading queens of *Bombus* as well as the parasitic subgenus *Psithyrus* (family Apidae).

Bumblebees prefer meadows with high concentration of flowers in the 4FRI area (Blaker personal communication 2011). They commonly forage in meadows near springs, forest edges, and in or adjacent to aspen. Bumblebees commonly visit aspen clones, especially early in the season (Blaker personal communication 2011) where flowers often bloom prior to the trees fully leafing out. They occur in relatively open ponderosa pine forest; dense forest is not good habitat for bumblebees because there are not enough flowers to attract them. Arizona bugbane (*Cimicifuga arizonica*: Ranunculacaea), a plant species managed under a conservation agreement between the Forest Service and the U.S. Fish and Wildlife Service, occurs on the Kaibab and Coconino National Forests. It is pollinated by 3 bumblebee species. The flowering peak for *C. arizonica* coincides with the seasonal maximal colony size of bumblebees. The western bumblebee (*Bombus occidentalis*) depends upon *C. arizonica* as a pollen source (Pilliod et al. 2006). The western bumblebee was once widespread throughout the western states, but has declined in many areas.

Honeybees (*Apis mellifera*) were brought to North America by European settlers in the 1600s, underscoring the importance of pollinators to human crops (Mooney et al. 2010). They have since become naturalized and are likely contributing to the decline of native pollinators. They favor large patches of flowers from which they can make maximize the collection of pollen and nectar with the least amount of energy. While bees from the same hive will visit many different species of flowers, individual bees tend to visit the same species of flowers. This is believed to allow the efficiencies of specialization so that a bee knows how and where to collect nectar and pollen in a given flower. Bees are so flower-specific that only about three percent of an individual bee's pollen load is from more than one type of flower. Having a hive of specialized individual bees that allows for each bee to specialize on a different flower may be part of the reason why honeybees are such effective competitors with our native solitary bee species. Pollination

by bees is required for 15 to 30 percent of U.S. food production, but honey bee populations have been steadily declining for the past 50 years (Kremen et al. 2007).

Nesting and over-wintering habitat are key elements for maintaining bees across a landscape, especially for the many solitary bee species. The availability of nesting sites or materials may be equally as important as foraging resources to solitary bees (Nyoka 2010). Like the floral resources themselves, habitat for ground burrows (i.e., open ground receiving direct solar radiation) can be a limiting factor. Ground-nesting behaviors by bees aerate and enrich soils (Mooney et al. 2010). Similarly, standing dead trees are important nesting habitats for 30 percent of native bees (Mooney et al. 2010). Snags and down wood with holes created by beetles or other insects serve as nests for species in several families, particularly in the family Megachilidae, while carpenter bees can excavate their own tunnels in soft wood (Mooney et al. 2010). As in foraging and pollinating, a diverse array of habitat components provides for diversity in the bee assemblage.

The response of bee individuals, populations and communities to land-use change is largely driven by the spatial and temporal distribution of floral, nesting and over-wintering resources (Kremen et al. 2007). Bees depend exclusively on pollen and nectar for food during both adult and larval stages and preferentially forage on plants that provide both (Nyoka 2010). Herbaceous species important to bees within the 4FRI project area include mule fat (*Baccharis* spp.), milkvetch (*Astragalus*), trefoil (*Lotus*), showy milkweed (*Asclepias speciosa*), all wild buckwheats (Eriognum spp.), goldenrod (Solidago spp.), beardtongue (*Penstemon* spp.), yellow beeplant (*Cleome lutea*), mints (Lamiaceae), figworts (Scrophulariaceae), hyacinth, dandelions, rocky mountain iris, thistle, lavender, blueweed, yellow owl clover, yellow clover, prairie clover, sunflowers, locoweed (*Oxytropis*), silvery lupine (*Lupinus argenteus*), rabbitbrush (*Chrysothamnus* spp.), currents, gooseberries, locust (*Robinia*), and *Cimicifuga arizonica* (Stokes 1983, Pilliod et al. 2006, Hedwall personal communication 2011). There may be some obligate plant-pollinator relationships in ponderosa pine forests as well, such as the bee *Andrena astragali* (Andrenidae) that serves as a pollen specialists for death camas (*Zigadenus*, Liliaceae) and globemallow (*Sphaeralcea*, Malvaceae) (Nyoka 2010).

Wasps

Wasps are different from bees in that they are predaceous while in the larval stage. Adult wasps feed on nectar and are important pollinators. The family Vespidae includes paper wasps and hornets or yellow jackets. They feed primarily on other insects, especially soft-bodies larvae of moths and butterflies. "Paper" nests are full of eggs, larvae, and adults, which provide easily digestible, high protein food for mammals like black bears. Male wasps emerge in late summer or fall and feed on flower pollen.

Numerous wasp families feed on pollen and nectar as adults, but are important parasitoids on many ponderosa pine pests. The family Ichneumonidae is one of the largest families of all insects. They and the closely related family Braconidae make up the majority of parasitoid insects. Parasitoid species differ from parasitic species in that they eventually kill their hosts, while parasites may weaken, but typically do not kill their host species. Species from both families lay their eggs on or in other insects. The larvae develop inside their hosts and emerge when they are ready to pupate. Ichneumons use edge habitat and are important parasitoids of pest species such as ponderosa pine tip moth (*Rhyacionia zozana*), pandora moth (*Cloradia pandora*), and ponderosa pine budworm (*Choristongura lambertiana*). They also commonly select caterpillars like tussock moths (family Liparidae) and tent caterpillars (moth family Lasiocampidae), other butterflies, and aphids. The mechanism for locating their host is unknown. Tent caterpillars can defoliate extensive areas of aspen within the ponderosa pine zone and ichneumon wasps are an important parasitoid of the pupal stage (Batzer et al. 1995). There are thousands of species of Braconids and each species usually seeks a specific host species. Adult braconids feed on the nectar of flowers or the honeydew secreted by aphids or treehoppers. Braconid larvae are important parasitoids on

ponderosa pine beetle pests such as *Ips* sp. and *Dendroctonus* sp. Other important wasp families that prey on forest pests include Specidae and Chalcidoidae.

Hymenopterans are prey items for some management indicator species of the Coconino National Forests as well as many of the migratory birds that occur on both forests. Management indicator species include red-naped sapsuckers, hairy woodpeckers, pygmy nuthatches, and turkeys; migratory birds include Lewis' woodpecker, purple martins, and olive-sided flycatchers for which hymenopterans are the primary prey item. Another pollinator group, the hummingbirds, also consume hymenoptera. Hymenopterans are food for least chipmunks (*Eutamias minimus*) and northern flickers, both of which are key prey items for northern goshawks (Reynolds et al. 1992), another management indicator species. Northern flickers prey on ants in the understory and nocturnal swarms of winged ants are preyed on by bats (Jones and Rydell 2003).

Homoptera ("same winged", including cicadas [Cicadudae], leafhoppers [Cicadellidae] and aphids [Aphidae]):

Homopterans are primarily herbivores (Short and Negron 2003) and, in general, prefer open country like meadows, savannas, and grasslands and overwinter at the base of grasses. They represent key prey items for other arthropods, especially Hymenopterans, Coleopterans, and Arachnids. Aphids are an important food for hairy woodpeckers and leafhoppers are eaten by shrews.

Coleoptera ("sheath-winged"):

Beetles are the most specious and often the most abundant insects (Capinera 2010). Coleopterans perform multiple ecosystem services, including predators of other arthropods (Carabids), scavengers and detritivores that are instrumental in decomposition and nutrient cycling (Scarabaeinae and Tenebrionids), fungivores that assist in distributing fungal spores (Curculionidae), herbivores (Scarabaeinae), and bark beetles that contribute to the creation of snags and woody debris (e.g., the families Curculionidae and Scolytinae are common within the 4FRI project area) (Short and Negron 2003, Schmidt and Jacobson 2005). Many species of ground nester bees (e.g., the families Apidae, Andrenidae, Halictidae, Megachilidae, and Colletidae) use holes in dead wood made by beetles for their nest locations (Mooney et al. 2010). Holes drilled in tree boles by beetles can provide nest sites for other species, including native bees occurring within the ponderosa pine forests of the 4FRI area (Laughlin et al. 2007). Because of the diversity in the order Coleoptera, no single forest condition can be labeled as optimum in providing beetle habitat. Beetle species richness is highest on heterogeneous landscapes (Samways 2005, Moisset and Buchmann 2011).

Both larvae and adults in the Family Cicindelidae are predators and prefer open habitat warmed by the sun. They feed on ants, caterpillars, flies, and aphids. Members of the families Cerambycidae (longhorned beetle), Cantharidae (soldier beetle), and Bupresidae (flat-headed borers) lay eggs in either live or dead wood. Their larvae feed on other insects in the soil or under bark and some species may take two to three years to mature. Adults feed on aphids, other insects, pollen, and nectar. Some species can specialize on certain species of moths including some that are considered agricultural pests. Particular species of flowers can function as both food and mating sites for some beetles. One species of longhorned beetle and related species in the family Buprestidae live in forested habitat and burrow into dead wood. The females seek out trees that have recently been cut or recently died and deposits their eggs in bark crevices. The larvae feed under the bark and once they pupate, the adults overwinter under the bark.

Bark beetles (family Scolytidae) spend most of their life inside the wood. The adults emerge to find new trees, mate, and lay eggs under the bark of living trees. Some species tunnel in the cambium of the wood and some species tunnel in the bark. Within the 4FRI, the primary bark beetle species associated with ponderosa pine mortality are a complex of *Ips* beetles including: the Arizona five-spined *Ips*, *Ips lecontei*

(Swaine), the pine engraver beetle, *Ips pini* (Say), *Ips calligraphus* (Germar), *Ips latidens* (LeConte), *Ips knausi* Swaine and *Ips integer* (Eichhoff) (Laughlin and Moore 2008). The probability of ponderosa pine mortality caused by bark beetles was positively correlated with tree density (Laughlin and Moore 2008). They are capable of killing trees if enough adults successfully burrow under the bark and the resulting tunnels girdle the tree. Once they are successful the adult emits a pheromone that attracts more beetles that lay their eggs in the weakened tree. At this point it is unlikely the tree will live much longer. Once beetles successfully hatch and emerge from host trees their numbers are such that even healthy trees succumb to the onslaught of successive attacks. While the resulting snags serve as wildlife habitat, they do not persist long (Chambers and Mast 2014).

Beetles are relatively ineffective pollinators, yet they remain an important group owing to their sheer abundance on flowers. A study of soft-winged flower beetles (Melyridae, subfamily Dasytinae) in western North America suggests that species in this group contribute to the pollination of numerous plant genera common to ponderosa pine forests, including forbs such as cinquefoil (*Potentilla*, Rosaceae), yarrow (*Achillea*, Asteraceae), and fleabane (*Erigeron*, Asteraceae), as well as several shrubs, including rose (*Rosa*, Rosaceae), currant (*Ribes*, Grossulariaceae), buckbrush (*Ceanothus*, Rhamnaceae), and snakeweed (*Gutierrezia*, Asteraceae) (Mawdsley 2003).

Coleopterans are an important food for woodpeckers (including red-naped and hairy), bark foraging birds (including pygmy nuthatches), grassland birds, olive-sided flycatchers, purple martins, turkeys, hummingbirds, and northern leopard frogs (Martin et al. 1961, Kennedy et al. 2009, Capinera 2010). All life stages of some beetles provide food for woodpeckers and bark gleaners such as nuthatches, chickadees, and creepers. Beetles are an especially important prey item for small mammals, including shrews, mice, and chipmunks (Capinera 2010). Large bats with more powerful jaws will eat beetles, including big brown bats (*Eptesicus fuscus*) and the greater western mastiff-bat (*Eumops perotis*; Jones and Rydell 2003), a sensitive species for the Southwestern Region of the U.S. Forest Service. In addition, large mammals like foxes and bears also select for beetles. Mexican spotted owls feed on beetles with relatively high frequency (USDI 1995).

Diptera ("two wings," includes flies):

Dipterans serve in a wide range of ecosystem roles, including detritivores, fungivores, herbivores, predators, and pollinators (Short and Negron 2003). In general, fly species from this order tend to be generalist pollinators (Nyoka 2010). Kearns (1992) found 20 different fly families that visited flowers. The most abundant flower-visiting flies were hover flies (Family Syrphidae; Kearns 1992). Flies are more effective pollinators than butterflies (Waltz and Covington 2004) but less efficient pollinators than bees (Nyoka 2010). However, they replace bees as dominant pollinators at higher elevations (Kearns 1992), which may include ponderosa pine forest. Their effectiveness as pollinators is due to high visitation rates and the fact they preferentially forage on open, bowl-shaped flowers or short-tubed members of the Asteraceae family (Nyoka 2010). Flies are important pollinators of some understory species such as Lewis flax (*Linum lewisii*), sandmat (*Chamaesyce, Euphorbiaceae*), buckwheat (*Eriogonum, Polygonaceae*), and some lilies (*Liliaceae*), such as death camas (*Zigadenus*) and mariposa lily (*Calochortus*) (Nyoka 2010).

Flies in the family Tachinidae are the most important parasitoids of forest pests, particularly moth larvae (Stireman 2005). Adult Tachinid flies lay eggs on moth larvae, including ponderosa pine pests such as Pandora moths and ponderosa pine tip moths. The young flies hatch, then feed upon and kill their host.

An unusual family within this order is the robber fly (Asilidae). Adult robber flies prey on nearly all other flying insects. They are common and are often beneficial in controlling insect pests. Adults intercept prey in midair, launching from perches on leaves or twigs in edge habitat. Only about 15 percent of all flights

result in capture of prey and if they are unsuccessful from a particular perch, they move to a new location. While hunting, they too become the hunted and are consumed by a variety of bird species and mice, including hummingbirds and purple martins. Robber flies are one of the main foods for purple martins. Interestingly, flies made up less than 1 percent of the diet of olive-sided flycatchers (Capinera 2010). Dipterans are among the most abundant nocturnal insects in temperate climates, making them important prey for many smaller bats, including western pipistrelle (*Pipistrellus hesperus*) and various myotis (*Myotis* spp.) (Jones and Rydell 2003).

Orthoptera ("straight wings", including grasshoppers, crickets, and katydids):

Orthopterans are typically relatively large herbivores and as such, provide prey for a variety of vertebrate wildlife. The life cycles of crickets and grasshoppers are similar. Most overwinter in the egg stage and nymphs hatch from the eggs between late spring and late summer. They prefer open areas with dense vegetation. Turkeys, woodpeckers, flycatchers, martins and grassland birds feed on orthopterans. Additionally, shrews, chipmunks, and spiders feed on them too.

Class Arachnida (includes hunting spiders and web-building; from Steele (2011) unless otherwise noted):

Arachnids are one of the most species-rich and numerous taxa in the arthropod community (Buddle et al. 2006). Spiders may dwell in the ground, under rocks, among grasses, on plants, in tree branches, in caves, and on water. All of these habitats are present in the ponderosa pine forests of the 4FRI analysis area, as influenced by topography, geology, and microclimate. Hunting spiders include jumping spiders, wolf spiders, and crab spiders. They rely on stealth, quickness, and relatively acute eyesight to stalk, ambush, or directly attack their quarry. They tend to be more ground-dwelling and mobile. Web-building spiders include widow, cob web, and orb spiders and tarantulas. They typically produce silken structures (sheet, tangle, or flat radiating orb) in locations most likely to passively intercept prey. Web-building spiders tend not to travel as extensively as the hunting spiders and usually take advantage of the higher portions of the forest understory to deploy their webs. Most spiders live either one to two seasons. The diversity in spider species relates to diversity in habitat requirements. In general, relatively small changes in habitat structure can have profound effects on spider species composition and relative abundances (McIver et al. 1992). Maintaining a broad array of spider species requires a heterogeneous landscape.

Similar to herbaceous species, spiders respond to overstory-induced changes in understory structure and microclimate (McIver et al. 1992, Stephens and Wagner 2006). Prey and microenvironment are largely influenced by canopy closure, moisture, and litter depth (McIver et al. 1992, Stephens and Wagner 2006). Hunting spiders are more common in open habitats and web builders dominate dense forest habitats (McIver et al. 1992, Stephens and Wagner 2006). One reason mobile hunting spiders may be more common in open-canopy habitat is in response to ant densities, another mobile predator that is more common in open habitats (McIver et al. 1992). Grasshoppers are an abundant and common prey in open habitats (McIver et al. 1992). Hairy woodpeckers, red-naped sapsuckers, pygmy nuthatches, and turkeys, all management indicator species, prey on spiders. Shrews (Merriam's and the least) and least chipmunks (a goshawk prey item) also eat spiders.

Summary

Arthropods play multiple ecological roles, including: crucial roles in decomposition and energy and nutrient cycling; inoculating litter with fungal spores and indirectly affecting plant productivity; modifying vegetation architecture, nutrient uptake, and plant growth rates; snag creation; and they exert a tremendous influence on sympatric arthropod populations through predation and parasitism on their prey species (Short and Negron 2003, Capinera 2010). Decreases in understory biomass and shifts in plant assemblages directly affect arthropod communities. Forest overstory changes such as the loss of host

plants for specific arthropod species, decrease in sunlight reaching the ground, changes in forest floor moisture and litter depth, reduced herbaceous cover, loss of edge and meadow habitat, and fragmentation of understory connectivity all affect the arthropod community. These changes can further influence ecosystem function on many trophic levels. The arthropod community in Southwest ponderosa pine forests has surely changed in association with forest habitat changes (Short and Negron 2003).

Human impacts have modified the landscape through fragmentation, degradation and destruction of natural habitats and the creation of new anthropogenic habitats (Kremen et al. 2007). Locally, the degree of understory habitat loss and fragmentation is extreme and extensive and further loss through attrition continues to occur. The arthropod community is tied to plant species richness, total ground cover of the understory, and changes in microhabitat. Therefore, it is reasonable to assume that environmental changes that alter the spatial and temporal distribution of floral resources have led to declines in abundance and composition of arthropod populations as well. Managing for mobile organisms and the services they provide requires considering not only the local scale where services are delivered, but also a landscape scale that reflects both the spatial distribution of resources and the foraging and dispersal movements of the organisms themselves (Kremen et al. 2007). Changes in arthropod populations may be directly affecting vertebrate wildlife species, including threatened species, management indicator species, sensitive species, migratory birds, and key vertebrate prey species.

Effects of Management Treatments

Proposed Actions of the 4FRI

Proposed treatments of the 4FRI largely include combinations of thinning and prescribed burning. Currently, large stands of relatively closed canopy, homogeneous, young to mid-aged forest are common across the landscape. Thinning objectives include moving forests dominated by even-aged and evenly sized trees to uneven-aged conditions defined by small groups of trees and interspersed forest gaps. Forest gaps or interspaces are not intended to regenerate trees, but are rooting zones to support tree groups. Silvicultural prescriptions include meadow, savanna, and grassland restoration, aspen restoration, spring and ephemeral channel restoration, and retaining and enhancing Gambel oak. Under the proposed action alternatives, alternative B proposes to treat 384,966 acres with mechanical treatments and 583,330 acres with prescribed fire treatments; alternative C proposes to treat 431,049 acres with mechanical and 586,110 acres with prescribed fire treatments; alternative D proposes to treat 384,966 acres with mechanical 178,441 acres with prescribed fire treatment; and alternative E proposes to treat 403,500 acres with mechanical and 581,301 acres with prescribed fire treatments. Goals for prescribed burning include reducing surface fuels and raising canopy base height to reduce the threat of future crown fire. One of the primary project objectives is to restore conditions that allow frequent fire to return to the landscape as a relatively quickly moving, low-severity surface fire.

Several metrics are commonly used in the scientific literature to describe understory response to overstory changes, including plant biomass, plant cover, species richness, and community composition. The literature summary below is from studies comparing current forest conditions, thinned forests, thinned and burned forests, and post-wildfire stands.

Understory Response to Thinning and Burning (all studies occurred in northern Arizona ponderosa pine unless otherwise noted)

Understory response to overstory removal varies considerably, largely depending on the amount of residual overstory left after treatment. Clary and Ffolliott (1966) found that ground flora biomass was higher in thinned stands compared to unthinned stands with residual basal area values of 22 to78 square

feet per acre, but there was no significant difference among treatments when post-thinning basal area exceeded 78. This threshold effect is reflected in the myriad equations used to predict understory response that display similar patterns when graphed (see Bojorquez-Tapia et al. 1990 and Moore and Deiter 1989). Sabo et al. (1990) concluded that thinning basal area to less than 43.5 square feet per acre results in understory standing crop levels consisting of mostly native late successional plants. In addition to post-treatment basal area, other factors affecting understory response were the number of trees per acre, time since treatment, and annual precipitation.

Light commercial thinning, with or without prescribed burning, did not significantly increase the proportion of herbaceous colonizers moving into stand understories compared to unmanaged control areas (Sabo et al. 2009). This is in agreement with other studies that concluded minimal treatments that retain high tree densities have little impact on plant community production or composition (reviewed in Abella 2004 and Sabo et al. 2009). Unmanaged stands in this study were characterized by high tree density, low disturbance, and few colonizing plant species (Sabo et al. 2009).

Research on changes in species richness or diversity after treatment has reached mixed conclusions. Thinning and burning in Arizona ponderosa pine increases some ground flora species, has no apparent impact on others, and negatively affects some species (reviewed in Abella 2004). Abella and Covington (2006) found that total mean species richness did not differ significantly among control, low-, and medium-intensity thinning treatments, but high-intensity thinning (reducing density 85 percent to 56.7 trees per acre) increased richness by about twice as much as the other treatments. Griffis et al. (2001) reported mean native forb species richness was similar across treatments, including control stands (mean basal area equaled 139 ft^2 per acre), thinned stands (residual mean basal area equaled 83), and in thinned and burned stands (residual basal area equaled 65). They concluded remaining basal area may have been too high to affect species richness. Another study examining the effects of 30 years of repeated prescribed fires at varying frequencies on understory abundance and composition concluded a weak treatment response was primarily due to high overstory basal area at the study sites Scudieri (2009).

Covington et al. (1997) reported that ground flora biomass in thinning-only treatments was almost four times greater than in thin and prescribed burn treatments in patches dominated by post-settlement trees. However, measurements were taken about a year after burning and the O-horizon was raked away as part of site preparation before burning (Covington et al. 1997), potentially affecting the soil seed bank. Andariese and Covington (1986) found that ground flora biomass in mature stands did not differ significantly between burn and control plots at sites burned two and five years before sampling, but did differ at a site burned 7 years previously. Stoddard et al. (2011) had similar findings, concluding plant community changes were likely still occurring 6 years after treatments. In a rare long-term study on overstory manipulation, species richness did not differ among treatments for 10 years (Laughlin et al. 2008). Thinning alone did not increase species richness, but thinning plus repeated burning increased species richness 11 and 12 years after initial treatment (Laughlin et al. 2008). Fifteen new species were present in years 12 and 13 that were not present at the beginning of the study (Laughlin et al. 2008).

Stoddard et al. (2011) tracked understory species richness and cover across three levels of thinning intensity plus a control. They found results were highly variable among experimental blocks, but observed strong trends of increasing richness and cover in treated stands. Plant community composition was still in flux by the sixth year after treatment (Stoddard et al. 2011). Species richness was positively related to both the percent change in canopy cover ($r^2 = 0.27$, $P < 0.0001$) and basal area ($r^2 = 0.38$, $P < 0.0001$) as a result of tree removal. Total plant cover more than doubled in the low-intensity units and more than quadrupled in the high-intensity units as compared to the control units. Plant cover was positively correlated to both the percent change in canopy cover ($r^2 = 0.24$, $P < 0.0001$) and tree basal area ($r^2 = 0.28$, $P < 0.0001$; Stoddard et al. 2011). In summary, thinning the overstory can increase species richness

if treatments allow enough sunlight to reach the forest floor and if conditions are monitored long enough through time.

Total biomass of herbaceous standing crop increased rapidly and was significantly higher after treatment in another long-term ecosystem experiment. Moore et al. (2006) evaluated responses to three restoration treatments: 1) thinning from below, 2) thinning from below plus prescribed burning, and 3) an untreated control (Moore et al 2006). While treatments yielded a significant increase in total biomass of herbaceous vegetation over the control throughout the entire post-treatment period, total biomass did not differ between thinning and thinning-and-burning treatments (Moore et al. 2006).

Abella and Covington (2006) evaluated community compositional differences (i.e., species presence and abundance) among treatments. They reported subtle but positive native species compositional differences between control plots and thin and burn plots 3 years after treatment. In another study, community composition diverged among treatments 5 years after initial treatment, and compositional changes were again greatest in the thin and burn treatment (Laughlin et al. 2008). Fire is a factor because it decreases accumulated litter and resulting smoke at ground level provides a cue for initiating seed germination in some species (Buddle et al. 2006).

Thinning indirectly affects ground flora through other interrelated ecosystem components such as soil nutrients and plant-mycorrhizae associations (Abella 2004). Arbuscular mycorrhizae are generally associated with herbaceous understory plants in pine forests and are different from the ectomycorrhizae generally associated with trees and woody shrubs (Hart et al. 2005). In a review of tree thinning and prescribed burning on understory vegetation, Abella (2004) reported arbuscular mycorrhizae more abundant on thinned and burned plots than on control plots. Abella (2004) also described the negative correlation between soil O-horizon thickness (a mix of leaf litter, minerals, and organic matter; The Cooperative Soil Survey 2001) and ground flora biomass. O-horizon thickness in ponderosa pine has increased during the past century because of fire suppression and increased tree densities; prescribed burning therefore benefits ground flora by reducing O-horizons (Covington and Sackett 1984).

Available soil nutrients often increase following burning (Covington and Sackett 1992). In Abella's (2004) review of thinning and burning in ponderosa pine forests, he concluded that availability of greater concentrations of nitrogen (N) and potassium leads to higher foliage nutrient concentrations in plants that is available for grazers. In another study, net N mineralization, nitrification, and nitrate ($NO_{3)}$ concentrations were significantly greater in the thin-and-burn treatments than other treatments during year 1 and soil ammonium remained elevated through year 3 in ponderosa pine forests (Gundale et al. 2005). Differences in N- cycling and availability among treatments can influence the composition of the biotic community that establishes following treatment.

Results from plant community modeling suggest that net nitrification was indirectly related to plant species richness via a positive relationship between species richness and nitrifier abundance (Laughlin et al. 2010). Graminoids using C3 photosynthetic pathways dominated herbaceous response after both thinning and thinning-and-burning treatments (Moore et al. 2006). Laughlin et al. (2010) indicated species-rich plant communities dominated by C3 graminoids and legumes were associated with soils with a high abundance of nitrifiers, again indicating the benefits of prescribed fire after mechanical treatments. Many herbivores selectively feed on C3 plants over C4 plants, including Mogollon voles (Chambers and Doucett 2008), because C3 plants have higher nutritional content and digestibility (Gannes et al. 1998). Conversely, plants with C4 photosynthetic pathways are less palatable to wildlife (Gannes et al. 1998).

Actinomycetes are a broad group of bacteria that consume soil organic matter, plant litter, and simple carbon compounds, releasing the nutrients in these substances for use by living plants. Actinomycetes are particularly effective at breaking down tough substances like cell walls of plants, even under harsh soil

conditions (USDI 2011b). Lignin, a component of cell walls, is often the most difficult portion of plant biomass to degrade (DeAngelis et al. 2011). Thin-and-burn treatments can lead to increased actinomycete activity (Gundale et al. 2005).

Fire suppression activities over the past 120 years in ponderosa pine-dominated forests have resulted in large increases in pine and other conifer litter input and a concurrent reduction in herbaceous litter inputs both above and below-ground (Kaye et al. 2005). These changes in litter quality have apparently altered the mutually dependent soil microflora (Hart et al. 2005). Over the long-term, fire exclusion may have modified soil communities, including mutually dependent soil microflora, via plant-induced changes in the soil environment (Hart et al. 2005). Management activities that change soil nutrients can shift dominance of decomposers from bacterial to fungal, leading to subsequent changes in ground flora species assemblages (USDI 2011b). These differences in soil characteristics may influence stand productivity and understory species composition in the future (Gundale et al. 2005). Understanding the interactions between microbial and macroscopic components of a given ecosystem function could be critical for managing for these services (Kremen et al. 2007).

The importance of N as a structuring component of plant communities should be particularly strong in systems limited by N such as ponderosa pine ecosystems (Gundale et al. 2005). The native grass species that reportedly dominated the understory of historical ponderosa pine forests likely relied on rapid nitrogen cycling promoted by the frequent return of surface fire. Ponderosa pine-dominated forests have some of the shortest historical fire-return intervals of any forest type, and thus the evolutionary role of fire in shaping these forests is likely strong (Hart et al. 2005). Plant-soil feedbacks such as those described above may be even more fundamental to the long-term maintenance and stability of fire-adapted forests than direct nutrient mineralizing effects (Hart et al. 2005). Correlation analysis revealed that variation in fine fuel consumed was tightly correlated with net N mineralization and net nitrification (Gundale et al. 2005). Thinning and prescribed burning can affect microbial communities by increasing solar penetration to the forest floor, causing chemical alteration of the forest floor and associated changes in the mineral soil microclimate (Meyer and Sisk 2001, Hart et al. 2005). Two cycles of burning in thin-and-burn treatments reduced leaf N concentration of trees compared with the thin alone treatment (Wallin et al. 2004), suggesting more N was absorbed at or below ground level.

Soils under trees established in the last century have retained the biological, chemical, and physical imprints of the grass vegetation that occupied these areas before the pine invasion (Covington et al. 1997). The fact that pine invasion has not yet fundamentally altered the functional capabilities of the soil microbial community increases the chances that microbial communities that establish in restored grass openings following tree removal will be within the historical range of variation (Boyle et al. 2005).

Response by Taxa

While understory response to management is largely determined by the species present before treatments, effects to understory vegetation can vary by taxa. Native graminoids, especially bunchgrasses, commonly dominate the herbaceous layer under dense ponderosa pine forests in northern Arizona (Griffis et al. 2001, Stoddard et al. 2011). This is true for unmanaged, thinned, and thinned-and-burned stands (Griffis et al. 2001, Stoddard et al. 2011). However, biomass response of graminoids varies by treatment intensity with one study reporting more than a 470 percent increase in graminoid cover in high-intensity treatment units compared to a 53 percent increase in control units as compared to pretreatment measurements (Stoddard et al. 2011). In this study, all three levels of thinning intensity were also treated with broadcast prescribed burning. Griffis et al. (2001) also found abundance of native graminoids increased significantly with treatment intensity in stands thinned and burned, but abundance decreased significantly in stands that experienced high-severity wildfire (Table 2).

Waltz and Covington (2004) found little difference between treated and control forests two years after thinning and burning treatments in terms of species richness of forbs serving as host and nectar plants for butterflies. Plant communities did shift from an annual forb community 1 year after treatment to more perennial forbs and grasses 3 years after treatment. There was an overall increase in diversity of flowering species (Waltz 2001). Griffis et al. (2001) reported thinning-and-burning yielded the greatest species richness value for native forbs and higher native forb abundance than either unmanaged or thinned-only stands. Reintroducing fire into northern Arizona pine forest systems was reported to increase species richness and abundance of native annuals by others as well (Laughlin et al. 2004, 2005, 2006; Moore et al. 2006; Table 2). About half of the new species colonizing the area after thinning and burning were native annuals (Laughlin et al. 2008). Legumes and forbs exhibited a 4- to 5-year lag before responding to the thinning and thinning-and-burning treatments (Moore et al 2006). Annual and biennial plants showed a large biomass increase approximately 5 years after implementation of the composite treatment (Moore et al. 2006). Native forbs constituted between 12 and 30 percent of the total standing crop across all treatment types 10 or more years after treatment, with higher percentages of forbs related to higher treatment intensities (Sabo et al. 2009).

In general, shrubs respond negatively to fire (Table 2). Many native shrub species decreased significantly with treatment intensity, although shrub response to fire intensity can vary by species (Griffis et al. 2001). In one study, prescribed fire resulted in 17 to 32 percent mortality of shrubs whereas 0 to 5 percent of shrubs died on unburned plots (Huffman and Moore 2004). Mortality of burned plants was positively related to amount of forest floor consumed during prescribed fires. One growing season after fire, surviving burned plants responded by producing long resprouts. Current-year branches were consistently longer on burned than unburned plants only where plots were protected from mule deer and elk (Huffman and Moore 2004). Unburned plants had more current-year branches and greater biomass than burned plants. However, no seedlings emerged on unburned plots but were found on 44 percent of burned plots (Huffman and Moore 2004). Decreasing tree density was positively correlated with Fendler ceanothus (*Ceanothus fendleri Gray*) current-year branch length, biomass, and leaf area (Huffman and Moore 2004).

Response of non-native forbs varies by disturbance (Table 2). High-severity wildfire tends to favor exotic species (Griffis et al. 2001). Non-native forbs constituted 3 percent of the total standing crop on plots thinned to a low basal area and prescribed burned compared to 26 percent on wildfire stands (Sabo et al. 2009). Nonetheless, this response may be ameliorated through time. Immediately following thinning and burning treatments, nonnative species cover comprised 6 percent of the total cover where treatment-induced disturbances were the greatest (Stoddard et al. 2011). However, the initial increase in nonnative species did not persist and was reduced by half six years after treatment (Stoddard et al. 2011).

Table 2. Understory response to forest disturbance

	Changes Relative To Control Plots			
Understory Characteristic	Thinning	Thinning & Burning	High Severity Wildfire	Citation(s)
Plant Species Richness	Increase	Increase	Increase (but includes a higher percentage of exotic species)	Stoddard et al. 2011
Total Biomass	Increase	Increase	Increase (but includes a higher percentage of exotic species)	Moore et al. 2006
Graminoids	Increase	Greatest Increase	Decrease	Griffis et al. 2001; Stoddart et al. 2011

	Changes Relative To Control Plots			
Forbs	Increase	Greatest Increase	Increase	Griffis et al. 2001; Laughlin et al. 2004, 2005, 2006; Moore et al. 2006
Shrubs	Increase	Increase/ Decrease	Decrease	Huffman and Moore 2004; Griffis et al. 2001
Gambel Oak	Increase	Decrease in small diameter oak followed by sprouting/increase in large diameter growth rates	Decrease	Abella and Fulé 2008
Soil Nutrients	Increase	Greatest Increase	Increase (greater pulse in magnitude, but with lower potential to affect plant growth over time)	Meyerand Sisk 2001; Gundale et al. 2005; Hart et al. 2005; Covington and Sackett 1992; Abella 2004
Actinomycete	Increase (after herbaceous vegetation increases)	Increase	Decrease (patchy response depends on site-specific severity)	Gundale et al. 2005; Hart et al. 2005
Arbuscular Mycorrhizae	Increase (after herbaceous vegetation increases)	Increase	Decrease (patchy response depends on site-specific severity)	Covington and Sackett 1984; Abella 2004
Community Composition	Increase	Increase	Increase	Covington and Sackett 1992; Abella 2004; Laughlin et al. 2008
Litter	Decreased Rate of Accumulation	Decrease	Decrease	Scudieri 2009
Native Plant Species	Increase	Increase	Increase (in the long-term)	Griffis et al. 2001; Laughlin et al. 2004, 2005, 2006; Moore et al. 2006
Exotic Plant Species	Increase?	Increase (in short-term)	Greatest Increase	Griffis et al. 2001; Sabo et al. 2009; Stoddard et al. 2011

Prescribed fire without mechanical alteration of the overstory reduces surface fuels, but does not appear to affect much change in understory vegetation. Only minimal effects on understory abundance and composition were detected after 30 years of repeated prescribed fires at varying time frequencies at two ponderosa pine sites in northern Arizona (Scudieri 2009). The weak treatment response was primarily due to high overstory basal area that occurred at monitored sites (Scudieri 2009). In another study, direct effects of prescribed burning included significant reductions in leaf-litter cover and depth, but no differences were significant for herbaceous cover or shrub cover the following year (Coleman and Rieske 2006).

Gambel Oak Response

Frequent fire is part of Gambel oak's evolutionary environment. Historical fire return intervals often averaged less than 19 years in pine-oak forests and multiple growth forms of the species persisted in frequently burned forests (Abella and Fulé 2008). Densities of small-diameter oaks have sharply increased in the 140 years since fire exclusion following Euro-American settlement (Abella 2008a). Gambel oak densities in northern Arizona increased from 32 per acre in 1883 to 191 per acre in 1994 (summarized in Abella 2008a).

Trees affect soil moisture, nutrients, microclimates, and other environmental variables at the forest floor. Openings in oak canopies support more plant cover, more herbaceous species, and greater frequencies of some grasses compared to openings in pine forests (summarized in Abella 2009). Unlike needle-cast beneath pine, oak litter is looser, less resinous, and moister, which may result in decreased fire intensities (Abella and Fulé 2008). Oak clumps containing multiple, widely spaced stems appear optimal for maintaining relatively high understory species richness by facilitating the coexistence of plant species requiring either open or closed-canopy environments (Abella 2008b).

Thinning relatively homogeneous stands of ponderosa pine into groups of trees with adjacent interspaces can stimulate oak regeneration, creating highly variable patches of Gambel oak sprouts (Fulé et al. 2002). Thinning pine trees likely produces the largest and most persistent enhancement of oak diameter growth compared to thinning or prescribed burning of oak (summarized in Abella 2008b). Fire can be used to manage Gambel oak densities and growth forms while maintaining large oaks during low-intensity burning (Table 2). More than 66 percent of oak greater than 6 inches in diameter were alive at least 5 years after two prescribed fires. Survival was low (less than 20 percent) for small diameter Gambel oak (less than 2 inches diameter) after prescribed fire (Abella and Fulé 2008). Waltz and Covington (2004) documented a loss of Gambel oak after restoration-based thinning and burning treatments, but variability in response across treated units prevented statistically significant results. Top-killed oaks resprout prolifically, suggesting that fire can maintain oak browse and cover for wildlife. Burning and thinning oak can temporarily reduce densities, but these treatments may result in longer term increases because of oak's prolific sprouting ability. Elevated oak density could constitute key intermediary tree structure after thinning to mediate impacts of rapid forest structure alteration to some wildlife species, especially during the time required to reestablish large-tree pine structure. There also is less evidence that elevated oak densities represent a negative ecosystem-level effect as compared to high densities of ponderosa pine.

While acorn production is cyclic, oaks 10 to 15 inches in diameter, with 80 to 100 percent live crown, yield the most acorns. Oaks less than 5 inches or greater than 18 inches in diameter produced few acorns. Management strategies that promote large oaks with vigorous crowns, such as thinning pine trees, likely will increase acorn production (summarized in Abella 2008b).

Gambel oak communities provide a diverse array of habitats. Gambel oak provides food, cover, and nesting and fawning habitat (Moir et al. 1997). Managing for low-growing forms of oak, particularly shrub thickets, will produce the greatest amount of accessible forage for ungulates. Gambel oak foliage comprised 8 to 77 percent of whitetail deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), and elk (*Cervus canadensis*) diets in pine-oak forests (Reynolds et al. 1970 in Abella 2008a). Brushy oak forms can provide fawning cover for deer (Moir et al. 1997). Densities of invertebrates and song birds are higher in Gambel oak communities. Gambel oak is used by both foliage and cavity nesters and provides roost habitat for bat species (Moir et al. 1997, Chambers personal communication 2009). Gambel oak is host for at least four species of butterfly larvae (McIntyre personal communication 2011). One butterfly species, the Arizona Sister (*Limenitis bredowii*), relies on Gambel oak foliage as a caterpillar host and oak tree sap for adult nectaring. Waltz & Covington (2004) reported decreases in the Arizona Sister after

restoration treatments. Gambel oak was not thinned with the restoration treatment, but mortality occurred with prescribed fire.

Forest Resiliency

Precipitation and drought appear to be the primary factors affecting total herbaceous biomass (Moore et al. 2006). Drought can overwhelm understory response to overstory thinning and prescribed fire (Huffman personal communication 2011). Fulé et al. (2002) reported sharp declines in understory plant cover and species richness across a spectrum of treatment intensities, including control stands, when precipitation was only 61 percent of average after treatment. They concluded that drought counteracted any detectable treatment effects. Several years later, Moore et al. (2006) described precipitation levels 75 percent below average that again reduced herbaceous biomass. In general, graminoids had been increasing several years since treatment and continued to increase until a series of severe droughts reduced standing crop to pretreatment levels (Moore et al 2006). Drought years have been common since the late 1990s (Figure 5 through Figure 7) and seem to favor graminoids with C4 photosynthetic pathways that are more efficient in their water-use (reviewed in Moore et al. 2006).

Drought affects forest structure directly in terms of potential tree mortality and indirectly through other pathways, including changes in arthropod populations. In general, ponderosa pine mortality in the Southwest has increased as a result of drought and more frequent bark beetle attacks (Kolb et al. 2007, Ganey and Vojta 2011). Severe drought from 2001 to 2004 led to increases in bark beetle populations (Negrón et al. 2009). Mortality was pervasive in ponderosa pine across northern Arizona, with a 74 percent increase of pine trees dying from 2002 to 2007 compared to the number dying from 1997 to 2002 (Ganey and Vojta 2011). A severe bark beetle outbreak represents a strong ‘‘thinning from above’’ disturbance (Klenner and Arsenault 2009). Mortality rates tend to be lower for smaller diameter trees and higher for larger trees (Klenner and Arsenault 2009, Ganey and Vojta 2011). Outbreaks can be extensive and have long-term consequences for canopy closure and overstory structure and significantly alter fuel complexes and fire behavior over time (Klenner and Arsenault 2009, Negrón et al. 2009). Forests with diverse tree species and age classes are less likely to develop large insect outbreaks (Black 2005). Ganey and Vojta (2011) concluded that the forests of northern Arizona are not resilient to climate change, and that treatments to increase resilience to climate change may be appropriate.

In a review of research conducted at the G.A. Pearson Natural Area, Fort Valley Experimental Forest outside Flagstaff, Moore et al. (2008) described trees older than 140 years responding with greater water uptake, stomatal conductance, net photosynthetic rate, and leaf nitrogen concentration in the first year after thinning. These physiological changes persisted through at least the seventh year following treatment (Moore et al. 2008). In another study, thinning consistently increased bole basal area increment starting in the second post-treatment year and continued for the next 10 years, except in the severe drought of 2002 (Kolb et al. 2007). Thinning also reduced crown dieback over the first 10 years after treatment (Kolb et al. 2007). While growth was similar for trees in both thin-only and thin-and-burn treatments in most post-treatment years (Kolb et al. 2007), resin flow defense against bark beetles was consistently stimulated by only the thin-and-burn treatment (Wallin et al. 2004). Thinning and prescribed burning in ponderosa pine forests are expected to enhance understory vegetation directly and indirectly improve understory conditions by increasing old tree resiliency to drought and thus move elements of overstory structure back towards the historical range of variation.

Drought affects arthropod populations as well. While these changes are not often detected and the ramifications to forest health are not always understood, fundamental ecosystem pathways are affected. From 2003 to 2004, carabid ground beetle abundance decreased to only about one-third of the levels measured from 1998 to 2000 (Chen et al. 2006). This plummet in the population was ascribed to changes in annual precipitation in northern Arizona. In the extreme drought of 2002 no carabids were found within

ponderosa pine sample plots (Chen et al. 2006). In dry years, small forest openings may provide cooler and moister microclimates than those in larger, more exposed meadows. These microclimates appear to maintain flowering plants required by nectar feeding butterflies and other pollinating insects that, in some years, may be limited or absent in larger, drier meadows (Julie McIntyre personal communication 2011). These islands of nectar flowers within the forest matrix may act as stepping stones, providing population connectivity and promoting dispersal and genetic exchange of pollinating insects (McIntyre personal communication 2011).

Arthropod Response to Management Treatments

Bark Beetles

Changes in forest structure over the last century as a result of anthropogenic influences are likely to increase susceptibility to *Ips*-caused ponderosa pine mortality in the Southwest (Negrón et al. 2009). These changes in forest structure have implications for species dependent on mature overstory trees and large snags for foraging and nesting, particularly in pure stands of ponderosa pine dominated by trees in larger size classes (Klenner and Arsenault 2009). Current forests that exceed the historical range of variation are at greater risks of uncharacteristic mortality levels resulting from beetle attacks (Lynch et al. 2008). In combination with past harvesting of ponderosa pine forests over the last century, this may further compromise the ability to provide future habitat conditions for wildlife associated with large trees, snags, and logs (Klenner and Arsenault 2009, Ganey and Vojta 2011). Silvicultural prescriptions can facilitate the development of mature conditions in ponderosa pine stands impacted by beetles (Klenner and Arsenault 2009, Ganey and Vojta 2011). Thinning forests to decrease tree competition can also benefit pollinating parasitoid wasps and flies, which attack pine beetles and moth larvae to feed their own larvae (Smith, personal communication 2011).

Ground Beetles

Tenebrionid beetles, which are forest floor scavengers, were found at higher richness and diversity in ponderosa pine stands of northern Arizona 13 to 14 years after fuel reduction treatments (thinning alone and thinning with prescribed burning) compared to untreated stands (Chen et al. 2006). Villa-Castillo and Wagner (2002) found diversity of ground beetle species increased as the level of stand disturbance increased (unmanaged, thinned, thinned and burned, and wildfire). However, thin-only stands did not significantly vary from unmanaged stands in overall species assemblage and both had the lowest species richness values. Although species richness was low in unmanaged and thin-only stands, abundance was generally high. However, the higher abundance on unmanaged and thinned treatments was accounted for by a single species. Similarly, Chen et al. (2006) described thin-only stands as having the highest species evenness. Fuel reduction treatments consistently increased species richness and Shannon diversity measurements for carabids, but did not cause a pronounced shift in their community assemblage (Chen et al. 2006).

Stands that were thinned with a similar intensity, but with a prescribed burn applied 3 to 4 years after thinning, had significantly different ground beetle assemblages. Species richness for ground beetle species assemblages was higher on thinned-and-burned and high-severity wildfire-burned stands than either unmanaged or thin-only stands (Villa-Castillo and Wagner 2002). Chen et al. (2006) found that community assemblages of both carabids and tenebrionids had the highest species richness and diversity in high-severity wildfire-burned stands. Villa-Castillo and Wagner (2002) found a shift toward an assemblage dominated by open-area species in stands created by high-severity wildfire (Villa-Castillo and Wagner 2002). Ordinations of carabid and tenebrionid community assemblages at two-dimensional scales showed that wildfire stands (greater than 90 percent basal area consumed during wildfire in 1996) were clearly separated from all other stand types for both taxa (Chen et al. 2006). Villa-Castillo and Wagner

(2002) concluded a mosaic of forest conditions likely provides refugia for recolonizing beetles and prevents competitively dominant species from monopolizing resources. Chen et al. (2006) concluded mechanical fuel reduction treatments are an important management strategy to maintain high invertebrate species diversity in southwestern ponderosa pine forest ecosystems. Heterogeneity is important to species richness of all taxa although different taxa are related to different measures of heterogeneity such as structure and composition. No single forest condition can be labeled as optimum in providing habitat (Chen et al. 2006).

Spiders

Relatively small changes in habitat structure can have profound effects on spider species composition, in part because wandering spiders are largely replaced by web-building species as litter composition changes (reviewed in McIver et al. 1992). A study in Finland looked at the effects of a range of logging intensities on spider assemblages (Matveinen-Huju and Koivula 2008). Gap felling preserved some forest species while also supporting colonization of open-habitat species and thinning treatments preserve forest-floor spider assemblages found in unlogged control stands (Matveinen-Huju and Koivula 2008). Work in western Oregon documented a succession of spider species present in association with different ages of forest stands (McIver et al. 1992). Some species are present in areas without a forest canopy and others reside in old-growth stands. A mosaic of age-classes and structural characteristics supports the most diverse spider communities.

A study in Alberta looked at aspen-dominated stands within coniferous forests that were either clearcut or burned in high-severity wildfire (Buddle et al. 2006). Species abundance and species richness was greater in cut versus burned stands for almost three decades following a disturbance (Buddle et al. 2006). This is probably due, in part, to the complete or partial reduction of the organic horizon that occurs following most wildfires (Buddle et al. 2006). Spiders and other generalist predators may be recolonizing the wildfire landscape from refugia missed by the fire. However, there is evidence that wildfire is crucial to some unique elements of litter-dwelling arthropods in young aspen forests (Buddle et al. 2006). Spiders apparently mostly recover to pre-disturbance assemblages after clearcutting in about 30 years (McIver et al. 1992). The post-disturbance assemblage continued developing 70 years after logging (Buddle et al. 2006) and it is not known how long full recovery takes (Matveinen-Huju and Koivula 2008).

Ants

Stephens and Wagner (2006) assessed changes occurring in ground foraging ant functional groups with four treatments (unmanaged, thinned, thinned and broadcast burned, and high-severity wildfire) in northern Arizona ponderosa pine-bunchgrass ecosystems. Ant functional groups and individual species differed significantly by treatment. Different functional groups were dominant under different levels of disturbance severity and suppressed or excluded other functional groups that were less suited to the particular disturbance intensity. Unmanaged forest stands were characterized by high tree densities, high basal area, and dominated by the opportunist functional group. Thinned stands, also dominated by the opportunist functional group, had a similar ant assemblage as the unmanaged stands, but the coarse woody debris functional group was more abundant in thinned stands. The generalist group was up to 25 percent more abundant in the wildfire areas than any other treatment condition. They occurred at very low (less than 5 percent) abundance in the thinned stands for both years. Conversely, relative abundance of coarse woody debris specialists was highest in thinned sites and lowest in wildfire sites, being at least 10 percent more abundant on thinned sites than wildfire sites. Specialized slave makers were most abundant in unmanaged and thinned sites and were rarely or not observed in thinned-and-burned or wildfire sites (Stephens and Wagner 2006). The variety in ant functional groups among treatment types underscores how different the ecosystem composition may be in today's forests relative to the historical range of variation. Stephens and Wagner (2006) concluded that in order to maintain a diversity of ant functional

groups and species in northern Arizona ponderosa pine forests, a diversity of forest conditions should be maintained. McIver et al. (2006) concluded that several species of ants made up the majority of invertebrate predator biomass in clearcuts. Only one species was present in old-growth forests (McIver et al. 2006). Maintaining a diversity of habitat types should support ecologically diverse ant functional groups (Stephens and Wagner 2006).

Butterflies

The primary threat to many butterfly species is habitat loss (Black et al. 2007, Selby 2007). In general, increased light to the forest floor increases the overall butterfly population. In addition, as specific host and nectar plants become more established in opened areas, more specialized butterfly species are also likely to move into restored forest areas (reviewed in Meyer et al. 2001; Julie McIntyre, personal communication 2011). Butterflies associated with open habitats are likely to be attracted to restoration treatments in Southwest ponderosa pine systems (Meyer et al. 2001).

After restoration-based treatments were implemented in ponderosa pine forest in northern Arizona, butterfly species richness and abundance were 2 and 3 times greater, respectively, in treated units than in paired control forests 1 year after treatment, and 1.5 and 3.5 times greater, respectively, 2 years after treatment (Waltz and Covington 2004). Ordination of butterfly assemblages in control and treatment units showed significant separation after restoration treatments. Waltz and Covington (2004) also reported insolation (light intensity) was significantly greater in treated forests after restoration.

Species such as *Speyeria nokomis nokomis* and *S. n. nitocris* may benefit from meadow restoration and restoration of ephemeral drainages. *S. n. nitocris* fly in open, sunny habitats but females also search out host plants in edge habitats. Their host plant, *Violoa nephrophylla* Greene, is typically found in moist or spring-fed meadows (Julie McIntyre, personal communication 2011). Maintaining habitat supporting the host plant along with a diversity of flowering nectar sources (especially purple and yellow flowers), will help support this species (Julie McIntyre, personal communication 2011). Work with the Nokomis Fritillary (*Speyeria nokomis apacheana*) indicated probability of occupancy increased with increasing larval host-plant abundance and percent cover of adult nectar sources (Fleishman et al. 2002). Occupancy decreased as litter reached heavy levels, perhaps as a result of impeded ovipositing (Fleishman et al. 2002), suggesting prescribed burning could maintain their habitat. Butterflies should benefit from management that provides key micro-habitat components such as increased understory, particularly flowering forbs, and higher light intensity and higher temperatures at the forest floor (Meyers et al. 2001, Selby 2007).

Pollinators

Ponderosa pine forest conditions across the Intermountain West appear to be increasingly unfavorable for most insect pollinators (Nyoka 2010). Most pollinators have similar needs: open, sunny areas, high herbaceous diversity, and availability of host plants and nectar sources. Some early-successional disturbance-based forb communities, with a variety of microclimates, may provide refugia under changing conditions (Julie McIntyre personal communication 2011.). Overstory thinning and prescribed burning have the potential to improve habitat for pollinating taxa (Nyoka 2010; Table 3). Overstory thinning and prescribed burning can increase nest site availability, solar radiation at ground level, and the abundance and diversity of flowering plant resources, resulting in improved habitat for most pollinating insects (Black et al. 2007, Nyoka 2010).

Response to High-Severity Fire

Vegetation Response

Species richness and abundance of native graminoids both decreased significantly in stands that experienced high-severity wildfire (Griffis 2001). Wildfire produced the greatest abundance of forbs, but also the greatest abundance of exotic forbs (Griffis 2001). In 1996, the Hochderffer fire (north of Flagstaff) killed over 95 percent of the trees (Sabo et al. 2009). Following the fire, nearly half of the total native graminoid biomass occurring on wildfire plots comprised colonizing species (Sabo et al. 2009). Nonnative forbs were not detected on unmanaged, thinned, or thinned and burned stands 8 years later, but constituted 7 percent of the total vegetative biomass on wildfire stands. In the ninth year following fire, 22 percent of total vegetative biomass was contributed by nonnative forbs (Sabo et al. 2009). This pronounced presence of non-native forbs on wildfire sites was largely attributed to common mullein (*Verbascum thapsus* L.). In addition to mullein, other nonnative forbs, in decreasing order, were: Dalmatian toadflax (*Linaria dalmatica* L.) P. Mill.), yellow salsify (*Tragopogon dubius* Scop.), Russian thistle (*Salsola kali* L.), prickly lettuce (*Lactuca serriola* L.), common dandelion (*Taraxacum officinale* G.H. Weber ex Wiggers), lambsquarters (*Chenopodium album* L. var. album), and bull thistle (*Cirsium vulgare* (Savi) Ten.). The most severely disturbed wildfire site supported the greatest standing crop of native and non-native colonizing species (Sabo et al. 2009).

Fire creates a nutrient pulse that can enrich the soil. As the time between fires lengthens, the pulse of nutrients released from the fire increases in magnitude. However, the extended time between fire/pulses means there is a less potential to affect plant growth during the fire-free period (Hart et al. 2005). In contrast, higher frequency and lower severity fire, like those managed in prescribed fires, produces a lower magnitude nutrient pulse but does so more frequently and thereby enhances soil nutrient balances and aids herbaceous vegetation more consistently.

Arthropods and Fire

Prescribed burning primarily affects the arthropod community by changing understory conditions. In southeastern pine-oak forest, arthropod abundance in the leaf-litter remained low the year following an early-season, low-intensity prescribed fire (Coleman and Rieske 2006). Recovery of leaf-litter arthropods was evident two-growing seasons after the burn. While this was low-intensity fire, it was also a first entry burn. In a paired site that had been burned 3 years previously, no long-term effects of multiple burning on leaf-litter arthropods were detected. Leaf-litter arthropod diversity was not affected by either burn regime, but abundance was greater at sites with multiple fires. Prescribed burning that created a mosaic (i.e., pockets of less intense or incomplete fires as well as hotter burn areas) retained higher leaf litter and supported a greater abundance of arthropods (Coleman and Rieske 2006). Three years between prescribed burns appeared adequate to replenish leaf-litter habitat and allow arthropod abundance to rebound to comparable unburned levels (Coleman and Rieske 2006).

A study in a California oak woodland habitat that tracked wildfire effects on a flowering forb concluded plants growing in burned environments were taller and their pollen-tubes grew faster than plants growing in unburned sites (Travers 1999). There is a positive relationship between pollen-tube growth and pollen production, suggesting plants in burned environments better support pollinators and that they would have a competitive advantage in the fertilization of ovules (Travers 1999). Pollen performance appears to depend on both the genetic background of pollen recipient plants and the growth environment of pollen donors (Travers 1999). If pollen performance is limited by nutrient availability, then post-fire increases in soil nutrient content should lead to improved rates of pollen-tube growth in individuals growing after the fire (Travers 1999). If these results can be extrapolated to other flowering plants, then prescribed fire should benefit pollinators by enhancing pollen production. Overall diversity and abundance of nectar or

pollen-feeding arthropods may increase in response to increased nectar resources (Waltz and Covington 2004). A 50-year chronosequence of a Mediterranean pine-shrub community regenerating following fire found bee community composition closely tracked floral composition and associated rewards (Potts et al. 2003b cited in Kremen et al. 2007).

Arthropod response to forest removal varies depending on the disturbance source (Table 3). Fewer arthropods were detected in deciduous-dominated stands (*Populus* sp.) originating from wildfire than in those developing after clearcutting (Buddle et al. 2006). This pattern was maintained for almost 3 decades after disturbance and was probably due in part to complete or partial reductions of the O-horizon following most wildfires (Buddle et al. 2006). Landscape-scale high-severity fires can create extensive areas of powdery soil substrates unsuitable for ground-nesting bees and, in the short-term, result in widely scattered patches of floral resources dominated by low-reward annual species (Nyoka 2010). The probable outcome of continued fire suppression is an increase in high-severity, stand-replacing wildfires (Covington and Moore 1994, Covington et al. 1997) as seen in the Rodeo-Chediski Fire of 2002 (464,556 acres) and the Wallow Fire in 2011 (538,049 acres).

Table 3. Arthropod response to forest disturbance

	Changes Relative To Untreated Plots			
Arthropod Species	**Thinning**	**Thinning and Burning**	**High Severity Wildfire**	**Citations**
Bark Beetles	Decrease	Decrease	Increase (surviving trees weakened by fire are more vulnerable)	Lynch et al. 2008; Negrón et al. 2009
Ground Beetles	Increase	Increase	Increase (but dominated by open-habitat species)	Villa-Castillo and Wagner 2002; Chen et al. 2006
Spiders	Increase	Increase	Mixed (depends on burn patterns and severity)	McIver et al. 1992; Buddle et al. 2006; Matveinen-Huju and Koivula 2008
Ants	Increase	Mixed	Mixed	Stephens and Wagner 2006
Butterflies	Increase	Increase	Decrease	Meyers et al. 2001; Waltz and Covington 2004; Selby 2007
Pollinators	Increase	Greatest Increase	Decrease in the short-term; increase in long-term	Travers 1999; Kremen et al. 2007; Nyoka 2010

Understory Conditions in the 4FRI Analysis Area

Historic Conditions

Research was initiated in ponderosa pine forests on the Coconino National Forest by Gus Pearson in 1909 and these data were incorporated into recent research by Moore et al. (2004). Based on detailed stand information and management history, a model was built to predict forest characteristics before logging and fire exclusion altered stand conditions. Basal area was used to estimate understory biomass from

1876, the year of the last wildfire and before any logging occurred, to present. Moore et al. (2004) also used models from other areas within the proposed 4FRI treatment area and from the Beaver Creek watershed adjacent to the 4FRI treatment area boundary to estimate historic understory biomass. Overall, they estimated a decrease in understory biomass of over 50 percent since 1876.

Current Conditions

Range managers monitored forage production with a survey technique known as the Parker 3-Step. Each "step" represents a different data-collection method performed at fixed points and transects designed to be reread through time. A Parker cluster typically consisted of three 100-foot-long transects, and plants were recorded every foot along each transect (step 1). Range conditions were evaluated (step 2) and photographs taken at permanent photo points (step 3). Originally, any perennial plant encountered every foot along permanent transects were tallied ("hits"). After transects had been read for years it was felt the data was not sensitive enough to accurately represent range conditions. Surveys were modified to include plant hits and "dots." If no plant occurred at any of the 1-foot marks, the closest plant within a 180° arc off transect was included. Dots expanded the dataset, but lack of a spatial component associated with dots made analysis difficult. While the data is not suited for rigorous investigation, they preserve a record of plant species occurring on the landscape and the frequency in which they occurred. This method was considered state-of-the-art, but in recent years it has been replaced with more ecologically sensitive measures. Nevertheless, the Parker dataset represents the most comprehensive herbaceous vegetation dataset with repeat measures in northern Arizona. Most Parker 3-Step clusters date back to the 1950s and 60s. Parker transects were intended to be read every decade and readings within the 4FRI treatment area occurred as recently as 2010.

There are 121 Parker clusters within the soil types occurring in the 4FRI area. Data from the original surveys for these transects were put into an electronic format (Dave Brewer, Ecological Restoration Institute). Data summaries for hits (Figure 1) show deceases in herbaceous cover since the 1980s. An obvious increase in trees occurred along transects since the 1960s, but even trees declined since the 1980s. Dots provide higher frequencies and indicate grasses and trees have increased while other plant taxa decreased during this same time period (Figure 2).

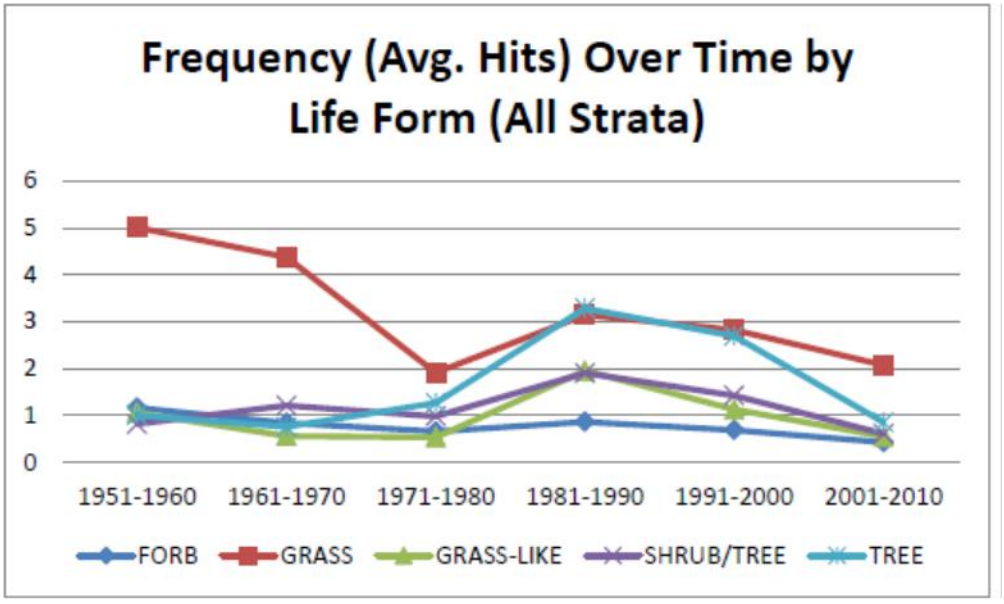


Figure 1. Plant frequency trends along Parker transects (hits) occurring in soil strata within the 4FRI area

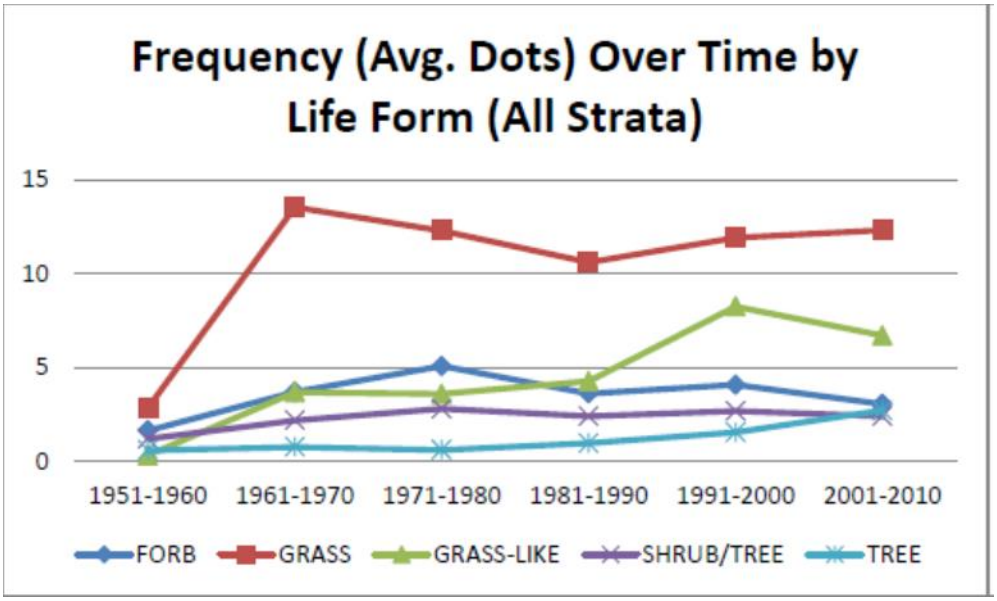


Figure 2. Plant frequency trends adjacent to Parker transects (dots) occurring in soil strata within the 4FRI area

Figure 3 displays changes in hits on C_3 ("cool season") and C_4 ("warm season") plants over time. Increases for both groups occurred in the 1970s and both have had decreasing trends since the 1980s. Warm season plants, primarily blue grama grass, have been dominant on the landscape, but the degree of dominance has decreased through time. Cool season plants have been decreasing at a faster rate than warm season plants since the post-1980s decline. The pattern changes when dots are used, with warm season plants continuing to increase since the 1980s and cool season plants only decreasing since the 1990s (Figure 4).

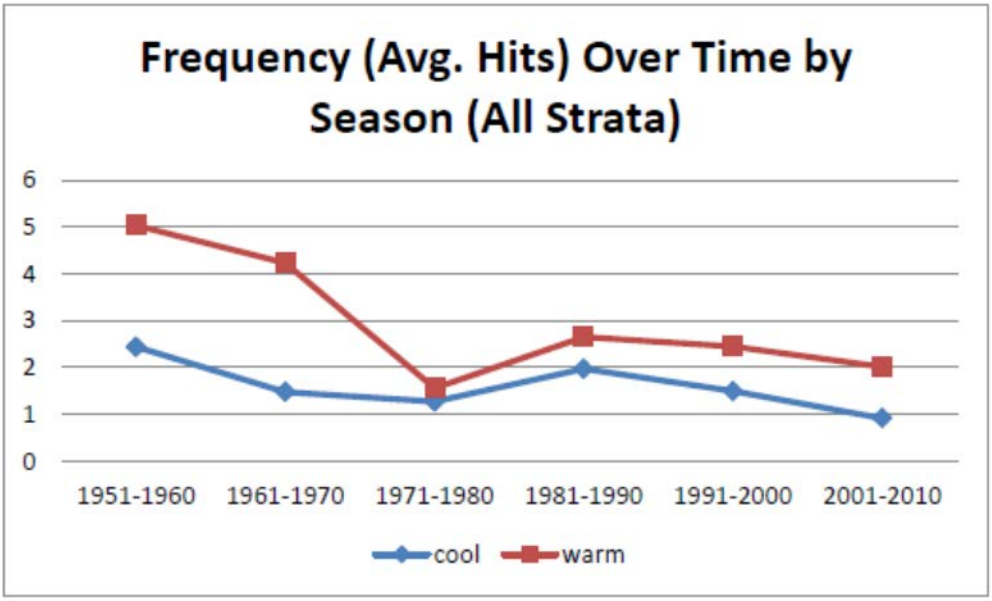


Figure 3. Plant frequency trends along Parker transects (hits) occurring in soil strata within the 4FRI area

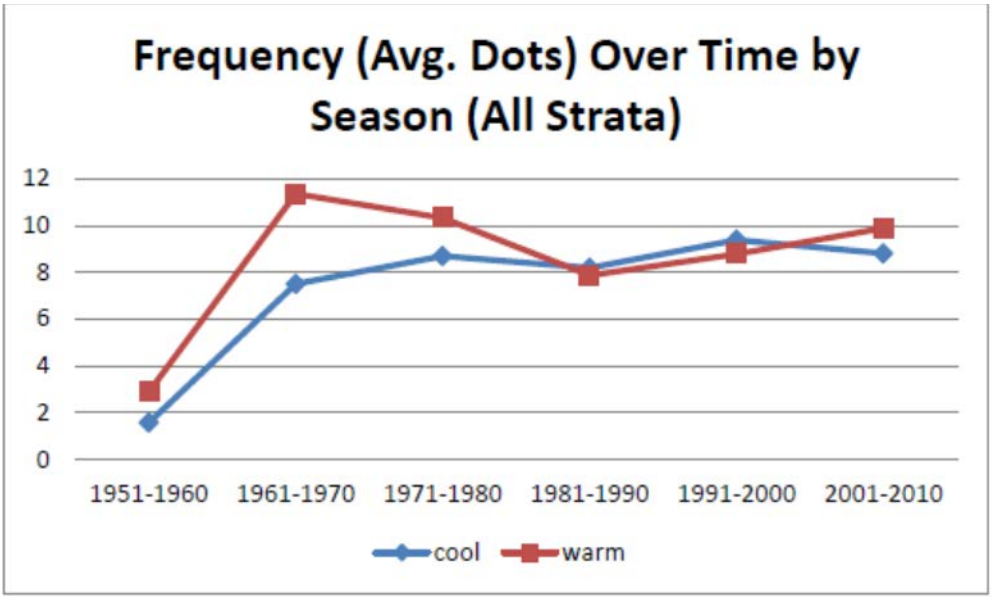


Figure 4. Trends for cool (C_3 pathways) and warm (C_4 pathways) season plants adjacent to Parker transects (dots) occurring in soil strata within the 4FRI area

Key to trends in vegetation is precipitation patterns. Flagstaff is relatively centrally located in the 4FRI treatment area, and precipitation history for Flagstaff shows that, with exception, annual precipitation has exceeded the 10-year average (Figure 5). A clear exception is the drought of the early 2000s. Annual precipitation in northern Arizona is bimodal, principally occurring as winter snow or summer (monsoon) rain. Winter precipitation is key for maintaining cool season plants while warm season plants are tied more strongly to monsoon rains. An examination of winter precipitation illustrates the number of years with below average snowfall (Figure 6). Monsoon rains more often occurred at or above the 10-year average (Figure 7). Note that the drought that started in 2000 affected both summer and winter precipitation.

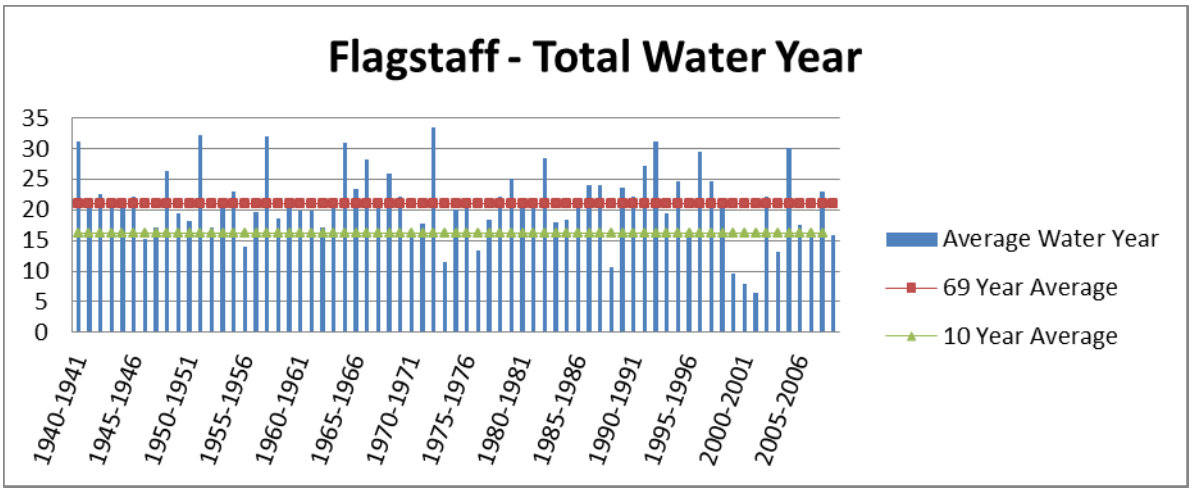


Figure 5. Annual precipitation patterns for Flagstaff, Arizona, 1940 to 2009

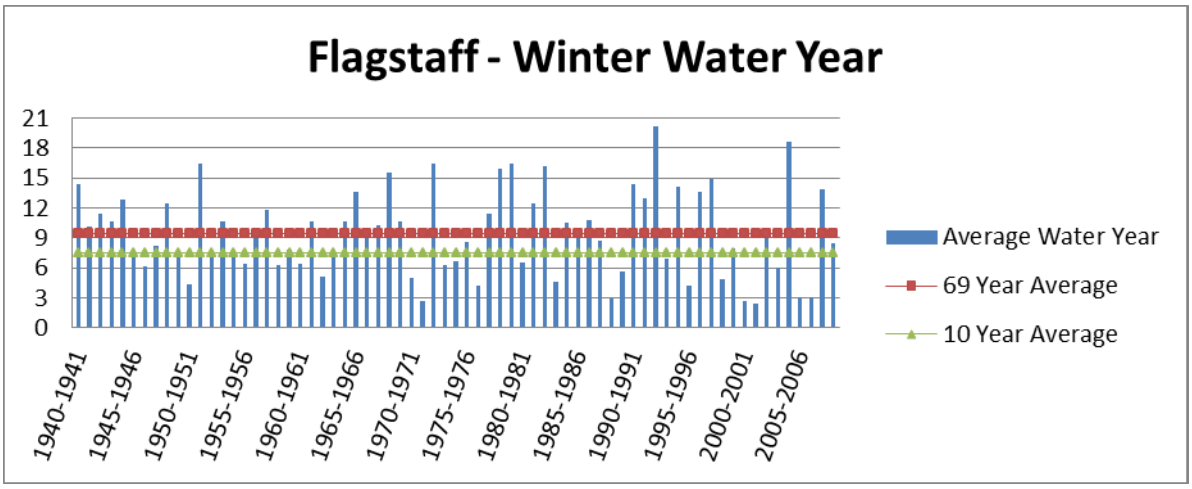


Figure 6. Winter precipitation for Flagstaff, Arizona, 1940 to 2009

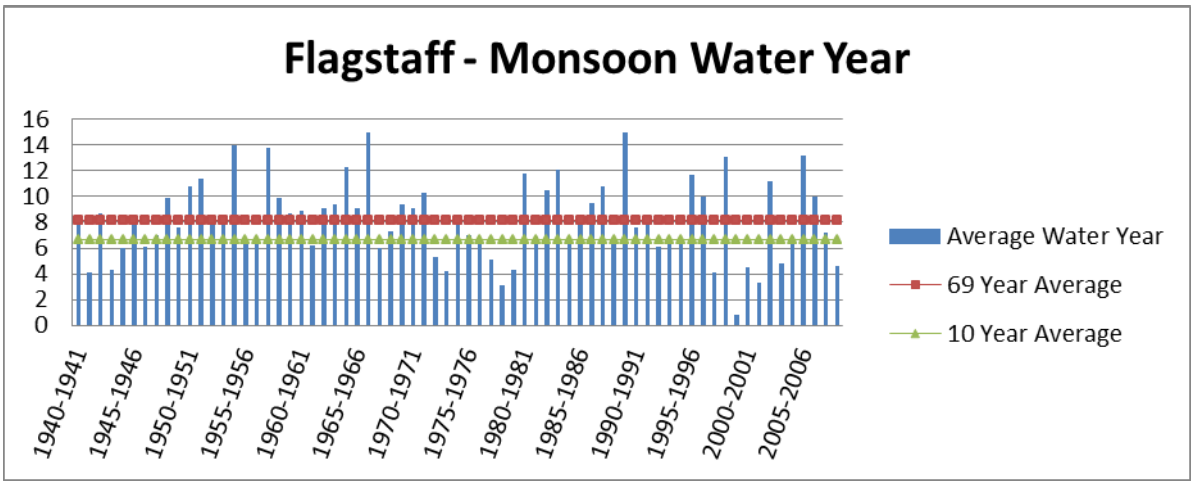


Figure 7. Summer precipitation for Flagstaff, Arizona, 1940 to 2009

Predicting Future Conditions

As described above, there is a strong and predictable relationship between overstory canopy closure, tree density, and understory production. Decades of research using local vegetation data across the ponderosa pine forests of northern Arizona have resulted in many models for predicting understory response. While the associated Y-intercepts and coefficients vary among models, the resulting response functions are the same: the relationship between the input (forest structure) and the output (understory biomass) is inversely related and curvilinear. As forest density increases, understory development decreases. The reduction in herbaceous biomass is small at first and then rapidly declines. At a certain level of forest development, the rate of decrease in herbaceous production levels off, becoming nearly asymptotic in dense, closed canopy conditions as the understory response approaches zero.

Understory biomass predictions vary by soil type (Bennet et al. 1987, Ffolliott 1983, Laughlin and Abella 2007). At broad scales, most soil series within the 4FRI project area are dominated by basalt or limestone parent materials. Soil chemistry, texture, and topography all affect biomass production (Clary and Ffolliott 1966, Covington and Sackett 1992, Abella and Covington 2006, McGlone et al. 2009). However, under dense canopy cover, understory is similar between soil types (Clary and Ffolliott 1966, Bennett et

al. 1987). Differences in biomass yield between different soil types is more fully expressed under open canopy cover (Bennett et al. 1987).

A variety of approaches have evolved to classify landscapes or ecosystems. One approach uses terrestrial ecosystems, which have been defined as the conceptual representation of the obligatory relationship between soil, vegetation, and climate (Robertson et al. 2003). A terrestrial ecosystem survey consists of the systematic examination, description, and classification of soil, vegetation, and climate which are integrated with other ecosystem components, such as landform, geology, and geomorphology (Robertson et al. 2003). The unique combination of terrestrial ecosystems and appropriate phase criteria (i.e., slope, texture of the surface layer, soil depth, etc.) define an ecological map unit. Terrestrial ecosystem survey meets the requirements of the National Hierarchal Framework of Ecological Units, a land classification system for classifying and mapping of the Earth into progressively smaller areas of increasingly uniform ecological potentials. Terrestrial ecosystem survey mapping is done at the landscape scale with a resolution of 40 acres. Identification of the soil component meets the standards and follows the policies and procedures outlined in the National Cooperative Soil Survey program. The description and classification of soils meets the criteria established in *Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys* (2nd edition, 1999), the *Soil Survey Manual,* and the "National Soil Survey Handbook" (Robertson et al. 2003). A terrestrial ecosystem survey was completed for both the Coconino and Kaibab National Forests (Brewer et al. 1991, Miller et al. 1995).

Bojorquez Tapia et al. (1990) developed and statistically analyzed 18 herbage production/forest overstory regression equations based on more than 20 years of data from the Beaver Creek drainage, a subwatershed adjacent to the 4FRI project boundary on the Coconino National Forest. The area was dominated by ponderosa pine forest occurring on soils with basaltic parent material. The authors reported associated statistical measures for the equations, including the coefficient of determination, to compare how well the predictive models matched the actual data. In this application, a coefficient of determination (r^2) is the proportion of variability in a data set accounted for by the model. It reflects the goodness of fit, or how well the model prediction matches the actual data values. An r^2 of 0.0 indicates none of the variability in the dataset is explained by the model and a value of 1.0 occurs when a model perfectly fits the data. An r^2 of 0.4 can indicate a reasonable fit in natural resource models. Through a series of statistical evaluations, Bojorquez Tapia et al. (1990) concluded 16 of the 18 equations did not meet their evaluation criteria. The top model was logarithmic using basal area as the measure of overstory with an r^2 of 0.70 (Table 3). The authors clarified that the intent of the model development was for long-term planning purposes and not for predicting herbage production in a particular year (Bojorquez Tapia et al. 1990).

In a similar effort, Deiter (1989) evaluated eight models for predicting understory biomass using a variety of overstory stand density measures on stands from the North Kaibab Ranger District of the Kaibab National Forest. This work was done in ponderosa pine forest on limestone soils. One of the equations was a nonlinear regression model using basal area. This equation represented a comparable approach to Bojorquez Tapia et al. (1990) using the same overstory variable. Deiter's (1989) equation for limestone soils had an r^2 of 0.67 (Table 4).

Table 4. Selected models for relating understory production to overstory basal area in ponderosa pine forests of northern Arizona. The response variable Y equals understory production.

Regression Equation	Parent Soil	r^2	Study
$\text{Log (Y)} = 2.794 - 0.348 \times 10^{-1} \text{ (BA)}$	Basalt	0.703	Bojorquez Tapia et al. 1990
$\text{Square root (Y)} = 6.5894 + 32.488 \times \ln^{(-0.0511*BA)}$	Limestone	0.671	Deiter 1989

The equations described above were developed from data within their respective study areas. In order to predict actual herbaceous biomass yield in other areas, site specific data should be collected to calculate new coefficient values (i.e., it is not valid to use models with coefficients from one watershed to predict understory biomass yield from other watersheds). Additional measures such as litter depth, topography, interactions of soil nutrients and microflora, and other factors could affect the accuracy of the predictions. Nevertheless, the models in Table 3 were used to create a **relative index** of herbaceous response to overstory manipulations across the 4FRI treatment area.

The yield values are not intended to represent actual predictions of expected pounds per acre of biomass. Rather, the output (biomass yield) represents a relative measure of change based on a consistent measure before and after treatment across the ponderosa pine forest within the 4FRI treatment area. The models identified by Bojorquez Tapia et al. (1990) for basalt and Deiter (1989) for limestone soils were used as a means to uniformly compare understory response to changes in overstory structure. This approach was pursued because of the consistently similar response function from a variety of models developed over the last several decades within the ponderosa pine forests of northern Arizona. The strong link between overstory, as assessed by basal area, and understory has been demonstrated by a variety of authors. This approach allows an objective comparison of management actions based on stand-by-stand treatment outputs to evaluate this fundamental aspect of wildlife habitat. These estimates of understory response display relative changes in biomass yield under different treatment scenarios. The relative change in understory was generated for each individual ponderosa pine stand across the treatment area based on modeled changes resulting from proposed fire and/or mechanical treatments.

Abella and Covington (2006) examined geomorphology, soils and vegetation in ponderosa pine stands on the Coconino National Forest. They classified 10 different ecosystem types using diagnostic environmental features and characteristic herbaceous species. Black cinder soils with purplefringe (*Phacelia sericea* Graham) common in the understory had the driest surface soils, lowest plant cover, and fewest understory species of any of the classified ecosystems; next on this gradient were red cinders with yellow ragleaf (*Bahia dissecta*) (Abella and Covington 2006). Soil texture can affect herbaceous production in ponderosa pine forest (Clary et al. 1966, Clary 1969) and surface movement of cinders may further impede understory development (Abella and Covington 2006). The black cinder system, with gravelly, surficial volcanic cinders typically had more open grown forest, but with low ground-flora cover. Surface soils in the black cinders were deemed “inhospitable” with harsh growing conditions favoring annual versus perennial understory plants. Ponderosa pine growth rates were variable but, on average, rapid diameter growth occurred once a tree became established. The red cinder system had sandy loam soils, slow tree growth, and moderate ground-flora cover. Growth rates of ponderosa pine were slowest in red cinders. Both systems principally occur around the San Francisco Peaks, although cinder inclusions can be found across the 4FRI treatment area. While no models exist for relating understory response to overstory conditions in cinder communities, we expect a limited response because of the growing conditions. Abella and Covington (2006) noted that the red cinder systems were rare historically, but over 30 percent of their area has been burned by crown fires since 1950, indicating a need for ecologically-based treatments despite the limited response in understory vegetation. No relative indices for understory were developed for cinder soils.

There are 96 terrestrial ecosystem survey units across the 4FRI project area. These were grouped by dominant parent material and each soil survey was combined into one of three categories: basalt, limestone, or cinder (Rory Steinke, Coconino NF and Christopher MacDonald, Kaibab NF, personal communication). This greatly simplifies site-based variation found in the project area. The Bojorquez Tapia et al. (1990) and Deiter (1989) equations for basalt and limestone parent material, respectively, were included in the database calculations and a relative understory response value was generated for each stand, for each reporting year, for each alternative. For the purposes of forest simulation modeling,

the following assumptions were made: the year 2010 represents existing conditions; all mechanical treatments would occur in the year 2012; first-entry burning treatments would happen in 2015; maintenance burns would follow in 2019; and 2020 is the first year following treatment (see the Silviculture and Fire Ecology reports for details). Modeling out to the years 2030 and 2050 was conducted to track forest changes through time. Modeling assumes no further treatments or reductions in overstory after 2019. This assumption omits potential effects of any future management actions, including prescribed or wildfires. This assumption means unrestricted canopy development resulting in understory biomass declines over time.

Another limit to using the index approach is that output is based on basal area. Basal area values in the database are stand averages and do not address tree density. Deiter (1989) provides an example of two 1-acre stands with the same basal area. One stand has trees averaging 6 inches d.b.h. and the other has trees averaging 24 inches d.b.h. If the basal area in both stands was 44 ft^2 per acre, the first stand would have 229 trees and the second stand 14 trees. If a stand was mostly open grown, the predicted biomass yield would be biased low. Overall, this bias is likely slight for existing stand conditions in the 4FRI treatment area; most of the mechanical treatments are designed to create openings among currently homogeneous stand structure. However, after treatment many of the stands would have groups of trees with intervening gaps. The index value would increasingly underrepresent actual response values in the future.

Fire effects on herbaceous response are not captured in the understory response model. While the silviculture model adds a mortality factor for prescribed fire, thereby increasing the understory response, it does not account for the other influences fire has on herbaceous growth. Neither the post-fire nutrient pulse, reduction in pine litter, exposure of soil seed banks to smoke, nor the alteration of the relative contribution of conifer input into soil chemistry processes and secondary effects on soil microflora and fauna are included in estimating post-treatment herbaceous biomass. All these factors would likely increase the actual response of herbaceous species after opening the canopy. Effects to the O-horizon are also not included here. The resulting bias could be neutral, negative, or positive. Overall, not having fire effects factored in would represent a negative bias in that the estimated biomass response would be lower than actual values.

Finally, model results only show differences in potential post-treatment responses. They do not include effects of grazing after 4FRI-related activities are completed. Domestic grazing and grazing by wild ungulates may increase or decrease through time, depending on management decisions by the Forest Service for domestic ungulates and by the Arizona Game and Fish Department for managing wild ungulates, primarily elk. Management of large ungulate grazers, domestic or wild, could have direct effects on understory response. Should overall grazing pressure increase, there may be no benefits realized in understory communities, associated arthropod communities, and their effects on vertebrate wildlife.

Nevertheless, the model was consistently applied to all stands under all alternatives across all time periods. Therefore, results still display relative change based on individual stand treatments.

Modeled Effects by Alternative

NOTE: These model runs were based on the treatment area defined in the 4FRI Draft Environmental Impact Statement. Total acres are very similar in the Final Environmental Impact Statement, but adjustments occurred in several restoration units. Because the changes were small in scale and scattered across multiple subunits, new understory index model runs for this report were not conducted. The graphs displayed here would not change, given the changes in treatment area relative to the scale of analysis. These graphs do not include alternative E, which did not exist at the time of the DEIS. Understory values

are presented for Mexican spotted owl (MSO) and northern goshawk habitats in the body of the wildlife report. Alternative E consistently ranks above alternative D and below alternatives B and C in terms of understory response. See the EIS or specialist reports for treatment differences between alternatives.

The number of proposed treatments multiplied by the number of alternatives multiplied by the number of time periods equals a lot of individual values. Summary graphs are presented by subunit to capture the differences between alternatives in a spatial manner across the treatment area. At the landscape level, the results of the modeling effort in terms of response function match expectations based on the scientific literature (Figure 8). The no action alternative (alternative A) results in a continued decline in herbaceous biomass. Also expected was the similar pattern for each of the action alternatives. This is the same response function described in the literature. The year 2020 shows the response to reductions in canopy and, to a limited extent (i.e., as reflected in the stand averages), the creation of interspaces and canopy openings. The rate of decline in understory development increases through time as trees continue to grow. The number of acres treated varies between alternatives. Alternative C treats the most acres and elicits the greatest response in understory. Alternatives B and D treat the same number of acres mechanically, but alternative D does not include broadcast burning across all the mechanical treatments as alternative B does and there are about 20,640 fewer acres of prescribed-burn-only treatments. Alternative D treats the fewest acres of the action alternatives and generates the least response in understory biomass.

Understory response consistently varies by treatment intensity in the literature. Treatment response is more nuanced across the 4FRI landscape. While group selection consistently produced a three- to four-fold increase in understory response, other patterns were not as obvious. Treatment designs were based on individual stand conditions. More open stands were modeled with lighter treatments and closed stands were modeled with heavier treatments, except in specific management areas like MSO habitat. Management direction for MSO habitat followed direction in the original MSO Recovery Plan (USDI 1995). Like treatment intensity, existing herbaceous biomass is correlated with existing overstory conditions. Stands designated for higher intensity mechanical treatments tend to have higher tree densities and so support low levels of understory development. Stands designated for lower intensity mechanical treatment levels are already more open and so currently support relatively higher levels of understory development. Similar post-treatment results occurred in terms of total yield and percent increase of the herbaceous response because of the correlation that both management prescriptions and existing understory conditions have with overstory. This validates the assumption that overstory conditions in stands identified for heavier tree removal have canopy conditions that are more closed. Stands that are more open are, in turn, getting lighter treatments. This relationship between existing conditions and treatment intensity ameliorates the output. Stands identified for savanna and grassland restoration currently support higher levels of understory biomass than the forest treatments, indicating these treatments are also well placed.

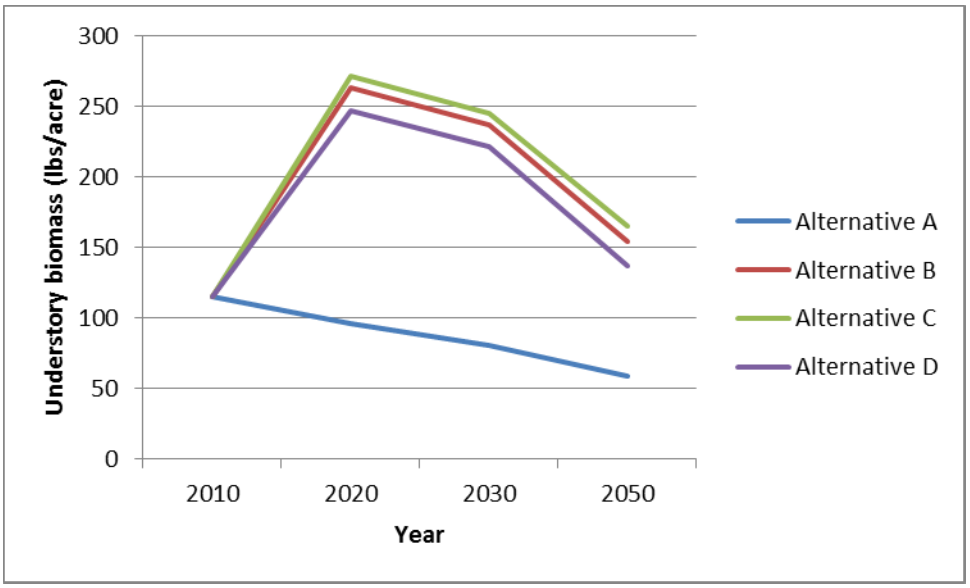


Figure 8. Average per-acre understory biomass yield by alternative based on modeled changes in basal area under the 4FRI (see Affected Environment section for alternative descriptions)

Restoration Unit 1

Results below present total yield by subunit (i.e., average per-acre yield multiplied by the number of acres). Individual subunits vary by size, total acres treated, kinds of treatments, and the mix of soil types within them. This leads to marked variation across the landscape (e.g., subunits within restoration units 1 and 3 have more acres of grassland and savanna treatment; subunits 4-3 and 4-4 have most of the loose cinder soils; restoration unit 6 is limestone; and subunits with extensive areas of Mexican spotted owl habitat have management objectives that stress closed canopy conditions). Rather than display the average response per acre, as shown in Figure 8, the values below represent total yield or the relative biomass response multiplied by the number of acres per subunit. Values are reported in units of 1000 (i.e., five thousand thousands equals 5 million pounds of biomass). All graphs are scaled the same to facilitate comparisons between subunits.

Restoration Unit 1 is east of Flagstaff and south of I-40 (see Figure 2 of the 4FRI wildlife report for map of subunits). Subunits 1-1, 1-2, and 1-4 show a similar response for action alternatives B through E (Figure 9 through Figure 13). However, the tables beneath the graphs (Table 5 through Table 9) show a consistent doubling to tripling of forage values, potentially totaling millions of additional pounds of herbaceous biomass (i.e., increases in food and cover for wildlife). Subunits 1-3 and 1-5 mirror the scale of change indicated in Figure 8, but show more separation between alternatives. These two subunits have significantly more savanna treatments than the other subunits in Restoration 1. On average, alternative D leaves denser forest conditions, producing lower values in understory biomass production.

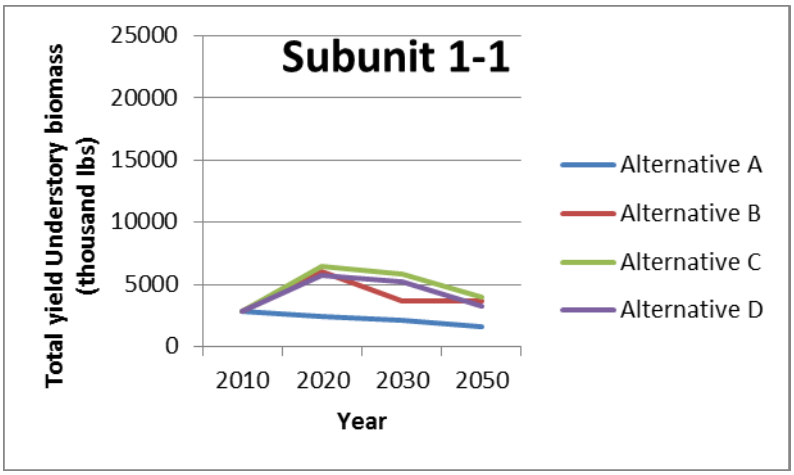


Figure 9. Total biomass yield in Subunit 1-1, based on modeled changes in basal area

Table 5. Subunit 1-1 (10,169 acres) total yield by decade (thousand pounds)

Treatments	2010	2020	2030	2050
Alternative A	2,878	2,451	2,085	1,556
Alternative B	2,878	6,071	3,630	3,630
Alternative C	2,878	6,396	5,857	4,017
Alternative D	2,878	5,725	5,166	3,254

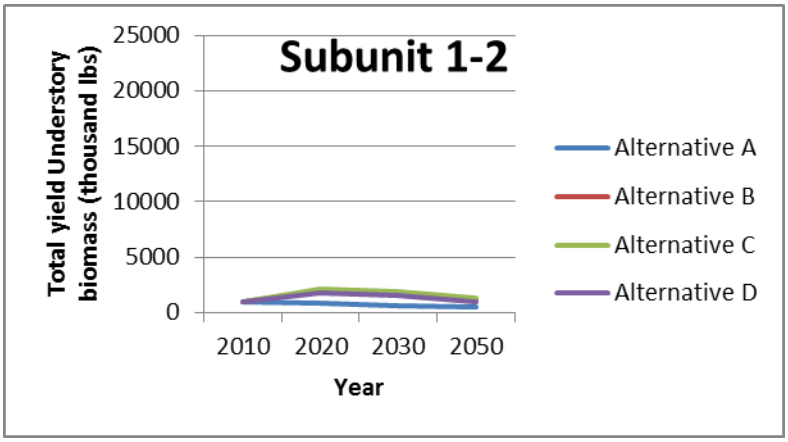


Figure 10. Total biomass yield in Subunit 1-2, based on modeled changes in basal area

Table 6. Subunit 1-2 (8,054 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	1006.75	821.508	676.536	459.078
Alternative B	1006.75	1965.176	1763.826	1191.992
Alternative C	1006.75	2085.986	1892.69	1336.964
Alternative D	1006.75	1812.15	1610.8	1030.912

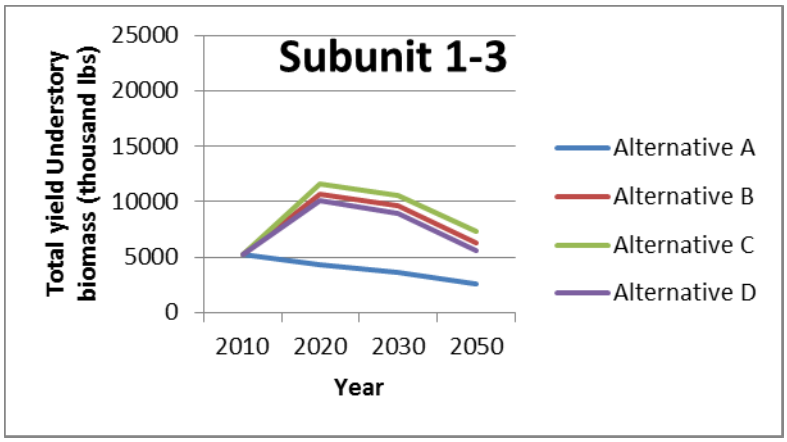


Figure 11. Total biomass yield in Subunit 1-2, based on modeled changes in basal area

Table 7. Subunit 1-3 (41,577 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	5,197	4,366	3,659	2,578
Alternative B	5,197	10,727	9,687	6,320
Alternative C	5,197	11,558	10,519	7,318
Alternative D	5,197	10,062	8,981	5,572

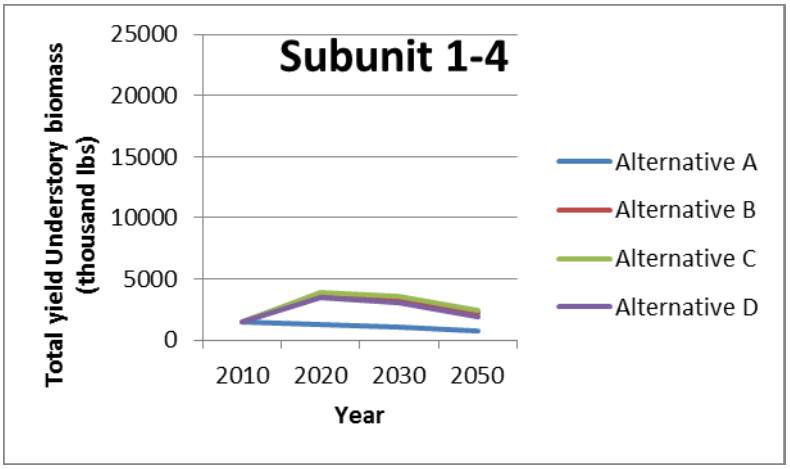


Figure 12. Total biomass yield in Subunit 1-4, based on modeled changes in basal area

Table 8. Subunit 1-4 (18,326 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	1,521	1,246	1,026	733
Alternative B	1,521	3,775	3,372	2,199
Alternative C	1,521	3,958	3,555	2,401
Alternative D	1,521	3,482	3,079	1,906

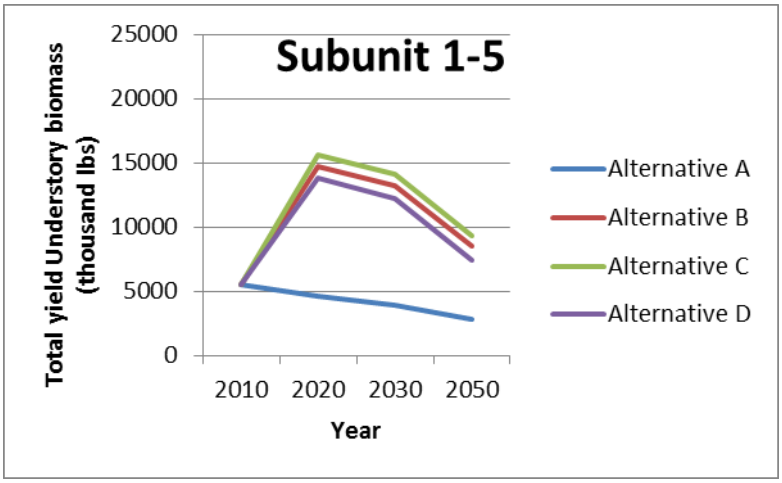


Figure 13. Total biomass yield in Subunit 1-5, based on modeled changes in basal area

Table 9. Subunit 1-5 (79,098 acres) Total Yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	5,536	4,588	3,876	2,848
Alternative B	5,536	14,712	13,209	8,464
Alternative C	5,536	15,582	14,079	9,334
Alternative D	5,536	13,763	12,181	7,435

Restoration Unit 3

Restoration Unit 2 was designated early in the project formulation, primarily encompassing the Red Rock Ranger District. No management treatments were proposed for Restoration Unit 2. Restoration Unit 3 is west of Interstate 17 and south of Interstate 40. Biomass production is consistently much higher in each subunit in this restoration unit as a result of higher intensity mechanical treatments including more acres of grassland and savanna restoration and a higher ratio of 40 to 55 percent openness (Figure 14 through Figure 18 and associated Table 10 through Table 14). This restoration unit includes work in and around Garland Prairie and an east-west open canopy corridor designed by the Arizona Game and Fish Department to facilitate seasonal pronghorn movement across much of the width of the Williams Ranger District. The corridor follows known movements of pronghorn and includes areas of currently young, dense forest.

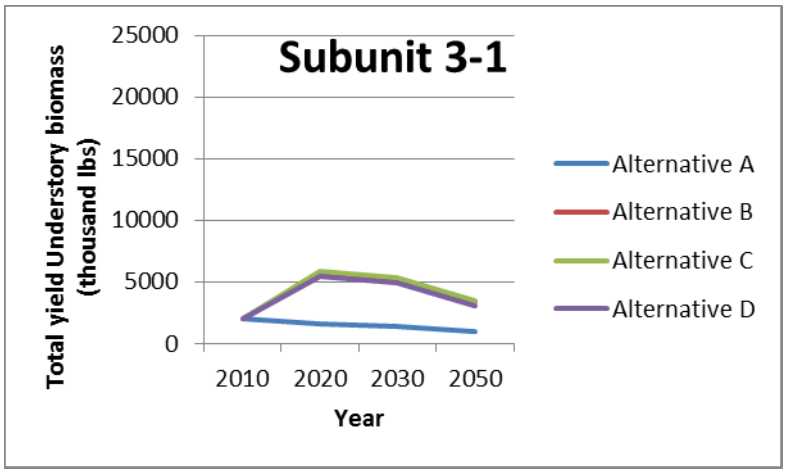


Figure 14. Total biomass yield in Subunit 3-1, based on modeled changes in basal area

Table 10. Subunit 3-1 (23,178 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	1,993	1,646	1,368	997
Alternative B	1,993	5,795	5,261	3,361
Alternative C	1,993	5,864	5,331	3,454
Alternative D	1,993	5,424	4,914	3,013

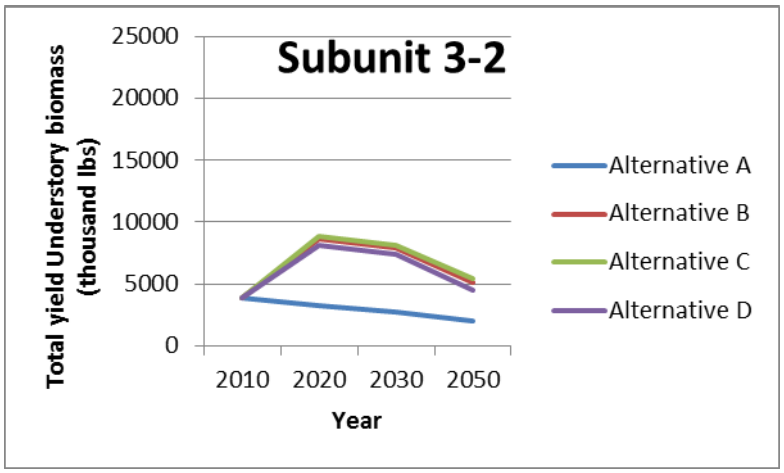


Figure 15. Total biomass yield in Subunit 3-2, based on modeled changes in basal area

Table 11. Subunit 3-2 (32,826 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	3,906	3,283	2,757	2,035
Alternative B	3,906	8,633	7,878	5,088
Alternative C	3,906	8,863	8,108	5,449
Alternative D	3,906	8,141	7,386	4,530

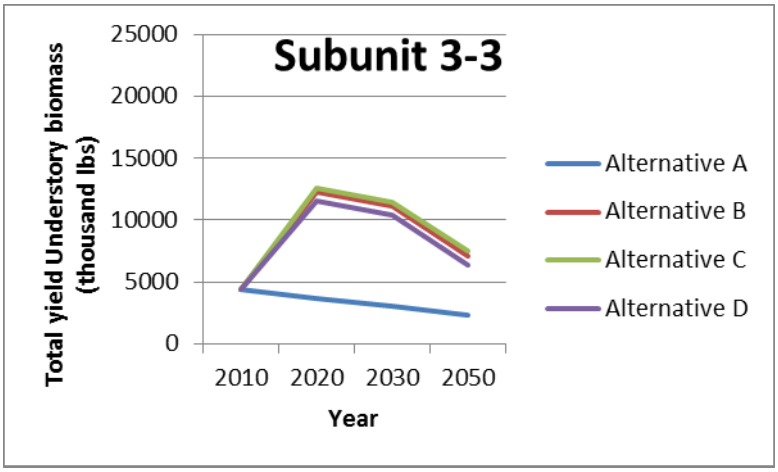


Figure 16. Total biomass yield (pounds) in Subunit 3-3, based on modeled changes in basal area

Table 12. Subunit 3-3 (48,462 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	4,410	3,683	3,102	2,326
Alternative B	4,410	12,309	11,146	7,124
Alternative C	4,410	12,552	11,437	7,463
Alternative D	4,410	11,534	10,419	6,349

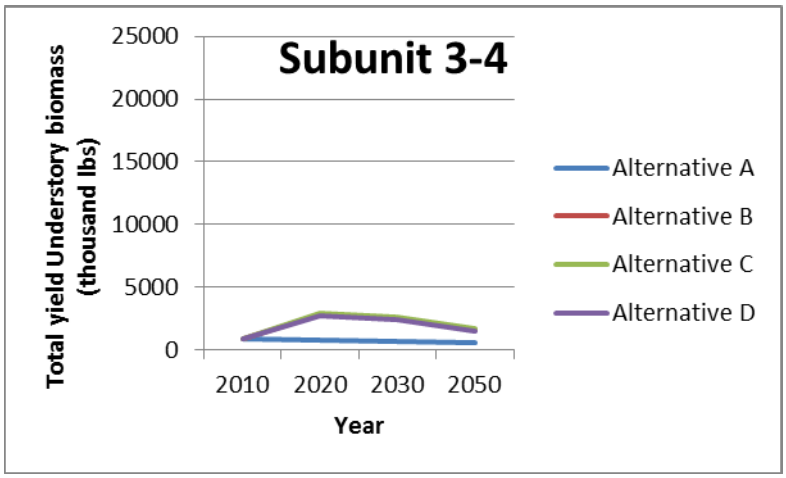


Figure 17. Total biomass yield in Subunit 3-4, based on modeled changes in basal area

Table 13. Subunit 3-4 (9,019 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	893	776	685	559
Alternative B	893	2832	2,561	1,641
Alternative C	893	2,904	2,634	1,714
Alternative D	893	2,679	2,417	1,470

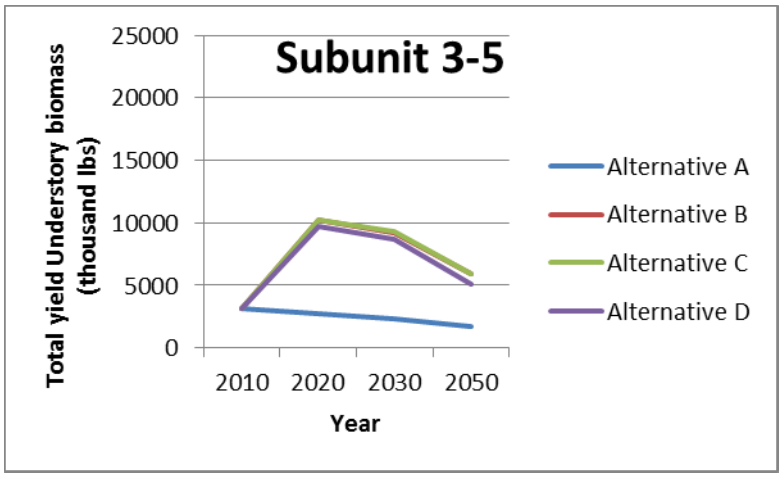


Figure 18. Total biomass yield in Subunit 3-5, based on modeled changes in basal area

Table 14. Subunit 3-5 (36,392 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	3,166	2,693	2,293	1,747
Alternative B	3,166	10,263	9,244	5,968
Alternative C	3,166	10,263	9,280	5,968
Alternative D	3,166	9,680	8,661	5,131

Restoration Unit 4

Restoration Unit 4 is north of Interstate 40 and mostly northwest of Flagstaff, including part of the Peaks Ranger District and much of the Williams Ranger District. There is little limestone in this unit and it includes most of the cinder soils. Government Prairie is in this restoration unit as is a north-south pronghorn movement corridor developed by the Arizona Game and Fish Department. Subunits 4-3 and 4-4 are about 67,000 and 81,500 acres, respectively, and Subunits 4-2 and 4-5 are about 10,200 and 7,000 acres, respectively. Subunit size is reflected in the biomass yield given this value is the result of multiplying yield by acres (Figure 19 through Figure 22 and associated Table 15 through Table 18). However, the intent of the understory index is to identify relative differences between alternatives. In Restoration Unit 4, differences in understory response between alternative A and alternatives B through E seems minimal in Subunit 4-5 but represents a 2- to 3-fold improvement. Alternative D again produces the lowest response of alternatives B through E.

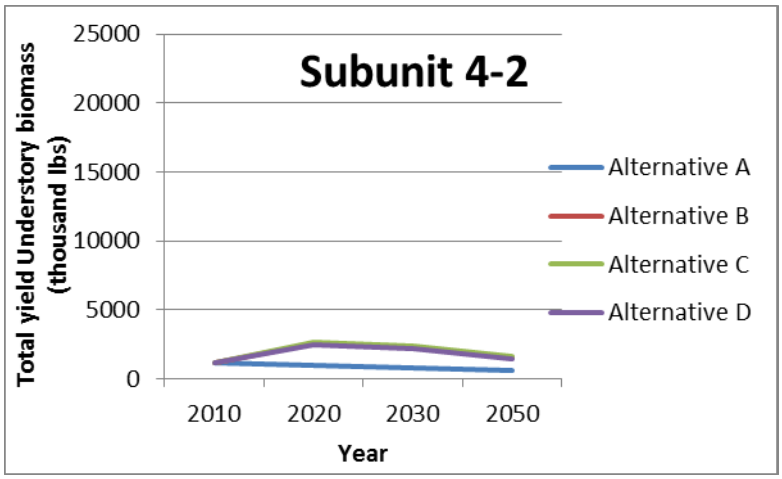


Figure 19. Total biomass yield in Subunit 4-2, based on modeled changes in basal area

Table 15. Subunit 4-2 (10,231 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	1,146	951	788	563
Alternative B	1,146	2,568	2,312	1,545
Alternative C	1,146	2,619	2,363	1,606
Alternative D	1,146	2,425	2,169	1,391

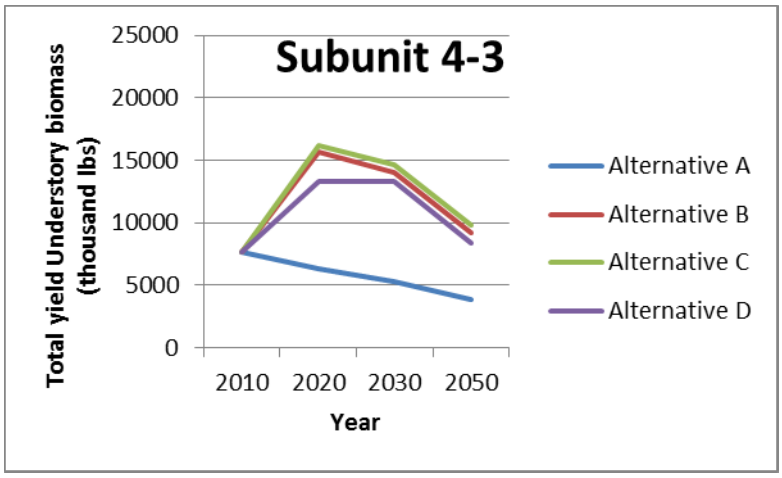


Figure 20. Total biomass yield in Subunit 4-3, based on modeled changes in basal area

Table 16. Subunit 4-3 (67,047 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	7,643	6,370	5,297	3,822
Alternative B	7,643	15,689	14,080	9,253
Alternative C	7,643	16,225	14,616	9,856
Alternative D	7,643	13,275	13,275	8,381

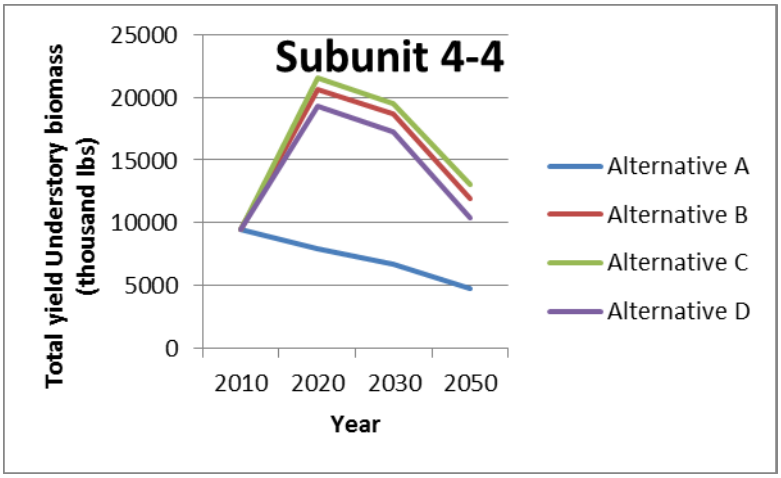


Figure 21. Total biomass yield in Subunit 4-4, based on modeled changes in basal area

Table 17. Subunit 4-4 (81,541 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	9,459	7,909	6,686	4,811
Alternative B	9,459	20,630	18,673	1,191
Alternative C	9,459	21,527	19,488	13,047
Alternative D	9,459	19,325	17,287	10,437

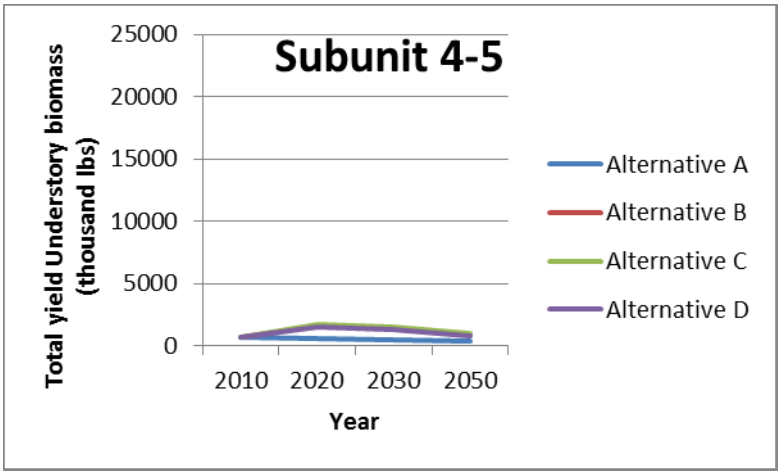


Figure 22. Total biomass yield in Subunit 4-5, based on modeled changes in basal area

Table 18. Subunit 4-5 (6,985 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	671	552	454	321
Alternative B	671	1,586	1,411	859
Alternative C	671	1,683	1,509	978
Alternative D	671	1,481	1,306	754

Restoration Unit 5

Restoration Unit 5 is north of I-40and north and northeast of Flagstaff. Limestone is nearly absent from the Unit and subunit 5-2 has over 3,000 acres of loose cinders not included in yield calculations. In addition, subunit 5-2 has nearly 34,000 acres of proposed burn-only treatment in each of the action alternatives. Differences in biomass response are still apparent between most alternatives in this subunit despite the acres of burn only and loose cinders, (Figure 23, Figure 24, and associated Table 19 and Table 20). Alternative C includes over 1,700 acres of grassland restoration in subunit 5-2.

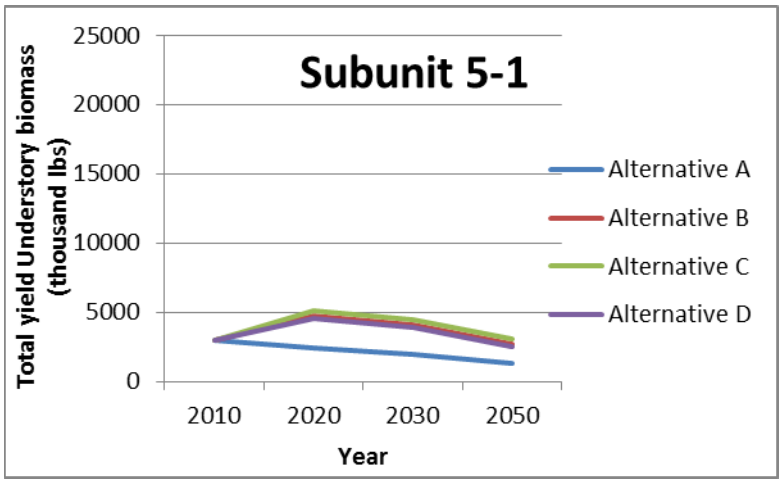


Figure 23. Total biomass yield in Subunit 5-1 based on modeled changes in basal area

Table 19. Subunit 5-1 (24,210 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	2,929	2,373	1,937	1,332
Alternative B	2,929	4,745	4,116	2,712
Alternative C	2,929	5,084	4,479	3,075
Alternative D	2,929	4,527	3,922	2,494

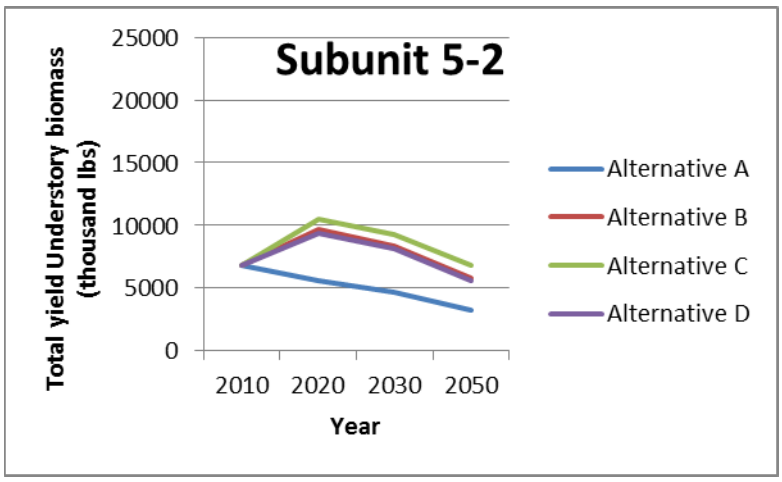


Figure 24. Total biomass yield in Subunit 5-2, based on modeled changes in basal area

Table 20. Subunit 5-2 (53,520 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	6,851	5,620	4,656	3,211
Alternative B	6,851	9,634	8,349	5,834
Alternative C	6,851	10,543	9,313	6,797
Alternative D	6,851	9,366	8,135	5,620

Restoration Unit 6

Restoration Unit 6 is on the Tusayan Ranger District south of the Grand Canyon National Park. The subunits are all limestone soil and subunit 6-2 includes pine-sage treatments. The largest biomass response for this restoration unit occurs in subunit 6-3. The line for alternative B is hidden by alternative C because of nearly identical understory responses. Alternative D again has the lowest response identified for any action alternative (Figure 25, Figure 26, Figure 27, and associated Table 21, Table 22, and Table 23). Subunit 6-4 has one of the most muted responses with over 80 percent of the treatment consisting of burn-only treatments. As noted above, this analysis does not account for ecosystem contributions of prescribed fire.

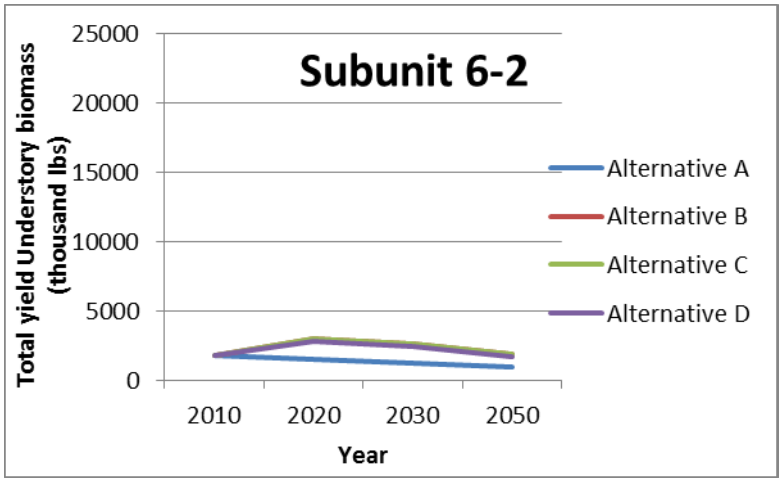


Figure 25. Total biomass yield in Subunit 6-2, based on modeled changes in basal area

Table 21. Subunit 6-2 (5,552 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	1,766	1,444	1,194	888
Alternative B	1,766	2,993	2,632	1,860
Alternative C	1,766	2,993	2,632	1,860
Alternative D	1,766	2,748	2,399	1,655

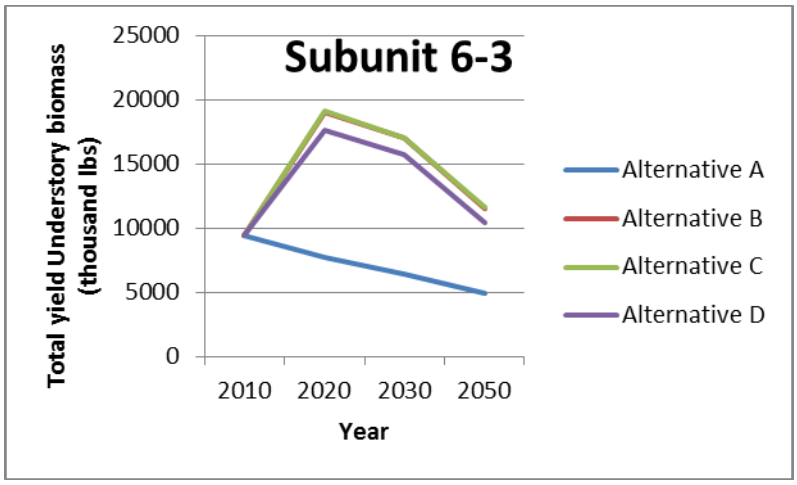


Figure 26. Total biomass yield in Subunit 6-3, based on modeled changes in basal area

Table 22. Subunit 6-3 (34,156 acres) total yield (thousand pounds)

Treatments	2010	2020	2030	2050
Alternative A	9,461	7,719	6,421	4,919
Alternative B	9,461	19,025	17,010	1,155
Alternative C	9,461	19,093	17,044	11,579
Alternative D	9,461	17,590	15,712	10,418

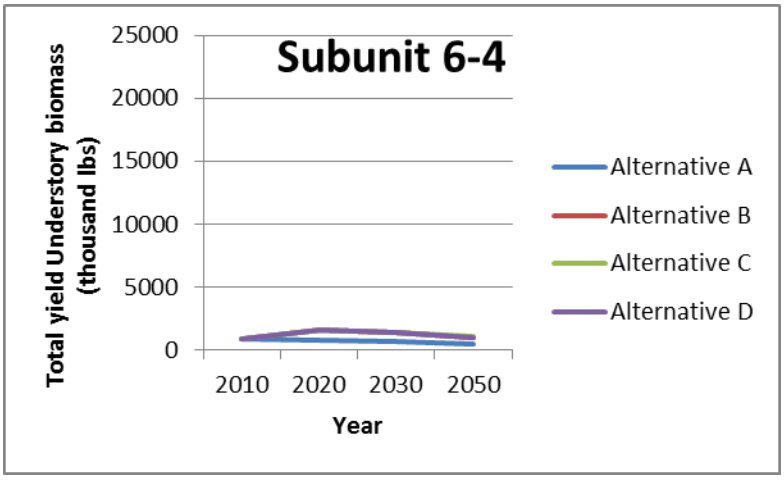


Figure 27. Total biomass yield (pounds) in Subunit 6-4, based on modeled changes in basal area

Table 23. Subunit 6-4 (3,870 acres) total yield (thousand pounds by decade)

Treatments	2010	2020	2030	2050
Alternative A	902	762	654	523
Alternative B	902	1,629	1,420	1,037
Alternative C	902	1,645	1,436	1,053
Alternative D	902	1,575	1,374	995

Summary and Effects to Wildlife

Understory biomass would consistently continue to decline across all subunits under alternative A. Alternative C consistently provides the greatest response in herbaceous biomass compared to all other alternatives. Alternative B is similar to alternative C, but with fewer acres treated. Alternative D does the least to move understory conditions back towards the historical range of variation. Alternative D also lacks much of the associated benefits of low-severity fire because of the limited number of acres identified for burning in this alternative. Where subunit graphs apparently display overlapping lines for each of the alternatives, the actual yield values in the tables can show differences of millions of pounds of grasses and forbs that provide food and cover for a wide range of wildlife species; from ground dwelling arthropods to mammalian and avian species. The herbaceous response would also affect soil chemistry by rebalancing the ratios of organic input and affecting soil microflora, including mycorrhiza. Fire cannot be successfully returned to the landscape without fuels to carry it. Restricting total acres treated or using only mechanical or fire treatments limits the amount of area where soil improvements could be expected.

Moore and Deiter (1992) concluded overstory density effects on understory production were most predictable for grasses, sedges, and forbs while shrubs showed only a slight response to changing overstory density. Cool-season plants showed a much stronger relationship with overstory density than did warm-season plants regardless of plant type (Moore and Deiter 1992). Implementation of the 4FRI could potentially reverse or slow the declining trend in C_3 plants, particularly under alternative C.

Increasing the understory should directly benefit the arthropod community. Changes in the understory are expected to include more flowering forbs and the plants should be more widely distributed. Thinning and creating canopy gaps under currently homogeneous forest cover would contribute towards reconnecting isolated pockets of herbaceous cover, reversing the trend of increasing fragmentation of pollinator habitat. Increasing herbaceous productivity, including leaf, root, fruit, and seed development, improves bird and mammal forage directly (plants) and indirectly (arthropods as both food and pollinators). Upper trophic-level species like raptors and terrestrial carnivores should benefit from improvements to prey species habitat.

The most abundant foods on earth are plants and insects and so it is no surprise that the most abundant small mammals are rodents (largely herbivores/granivores) and bats (largely insectivores) (Merritt 2010). Mice and mouse-like rodents have been labeled the most important small mammals in terms of their effect on the environment and as a staple food for predators (Merritt 2010). In general, small mammal communities can benefit from thinning treatments in fire-prone ecosystems, particularly when heterogeneity of forest structure is retained (Converse et al. 2006a, Noss et al. 2006, Kalies et al. 2012). Kalies et al. (2012) found five of eight small mammal species responded positively in terms of occupancy to forest thinning treatments (Mogollon vole, deer mouse, golden-mantled ground squirrel, gray-collared chipmunk, rock squirrel). One of three species that responded negatively, Botta's pocket gopher, responded positively to open forest structural conditions, but negatively to treatments that reduced tree BA and density. The two remaining species, tassel-eared squirrels and Mexican woodrats, responded negatively to treatment unless specific habitat features were retained (Kalies et al. 2012). All but the latter two species had inverse relationships in terms of occupancy to pine basal area and responded positively to understory cover. Kalies et al. (2012) concluded that all eight small mammal species can benefit from restoration treatments. Kalies et al. (2012) and Converse et al. (2006b) determined thinning treatments have positive effects on small mammal biomass; but Bagne and Finch (2009) found thinning did not change total small mammal abundance. Converse et al. (2006b) stated response of small mammal populations to thinning would be greatest in areas where tree densities are especially high. While reestablishing the understory herbaceous layer can benefit many small mammals, small fossorial mammals can, in turn, be important agents in maintaining the ecology of grassland and savanna systems

(Yoshihara et al. 2009, Ganey and Chambers 2011). Table 24 lists expected impacts of proposed treatments to key mammal and bird species within the 4FRI treatment area.

Understory restoration is expected to enhance cover for ground-nesting birds and increase forage for insectivores, frugivores, and granivores. While studies rarely correlate avian response to understory development directly, work has been done relating thinning and burning to bird communities. George et al. (2005) compared bird communities between an old-growth stand of ponderosa pine containing a relatively open canopy, large snags, and developed understory, with a dense second-growth ponderosa pine forest in California. Overall bird species composition was similar between sites; most of the species detected at only one site were rare at the site where they were detected. Woodpeckers, bark gleaners, and flycatchers were more abundant in old-growth forest. Foliage gleaners were more abundant in second-growth (George et al. 2005). While the connection between foliage gleaners and younger forest was not clear, mid-age pine trees tend to have more foliage volume than older trees. In addition, foliage gleaners are cup-nesters (George et al. 2005) and may prefer the denser crowns of younger trees. The presence of flying arthropods was greater in old growth and positively associated with ground vegetation, down wood, shrubs, and saplings (George et al. 2005).

Hurteau et al. (2008) looked at effects of thinning and prescribed burning treatments on birds in ponderosa pine forests on the Kaibab and Coconino National Forests. They did not find effects to species richness or evenness. Although some individual species increased (e.g., western bluebirds) and some decreased (e.g., mountain chickadees) they determined the modest effects treatments had on the avian community warranted implementing prescribed surface fire after thinning projects. Thinning and burning effects were evaluated specifically for western bluebirds in northwestern Arizona and the authors described increased herbaceous ground cover and Gambel oak density as likely improving invertebrate assemblages and thus improving forage abundance for nesting bluebirds (Wightman and Germaine 2006). A project in the Black Hills, South Dakota, reported overall species richness was generally lower in ponderosa pine forest with overstory canopy cover greater than 40 percent compared to ponderosa pine forest with less than 40 percent canopy cover (Mills et al. 2000). Most changes in forest structure will benefit some species and negatively impact others. Creating a mosaic of forest conditions following treatments may be the most suitable approach for a wide range of forest passerines (Hurteau et al. 2008).

Table 24 presents a list of birds and mammals identified as threatened, sensitive, management indicator species, migratory birds, or primary prey of goshawks in the Southwest (Reynolds et al. 1992) and occurring in the 4FRI treatment area. Included in the table are expected responses to understory changes resulting from overstory treatments.

Table 24. Short-term (10 years) effects of increased understory production on selected wildlife species; see text for detail

Species Status	Species	Habitat Link(s)	Nature of Link	Species Response
Threatened and Endangered Species	Mexican Spotted Owl	Vertebrate Prey	Indirect through effects to small mammals, birds, and key arthropod species	Positive
Management Indicator Species	Abert's Squirrel	Canopy Connectivity	Indirect through interruption of tree canopy; decrease in mycorrhiza fruiting bodies	Negative
Management Indicator Species	Northern Goshawk	Vertebrate Prey	Indirect through birds and small mammals	Positive

Species Status	Species	Habitat Link(s)	Nature of Link	Species Response
Management Indicator Species	Pygmy Nuthatch	Invertebrate Prey and Nesting and Foraging Habitat	Direct through increase in invertebrates; Indirect through promotion of large trees and snags	Positive
Management Indicator Species	Turkey	Invertebrate Prey, Hard Mast, and Cover	Direct through increase in understory, improvements to oak, and invertebrates	Positive
Management Indicator Species	Elk	Herbaceous Food and Calving Cover	Direct through understory growth	Positive
Management Indicator Species	Hairy Woodpecker	Overstory Manipulation	Indirect through promotion of large trees and snags	Positive
Management Indicator Species	Red-naped Sapsucker	Invertebrate Prey (especially ants)	Direct through increase in invertebrates; Indirect through promotion of large trees, aspen, and snags	Positive
Management Indicator Species	Mule Deer	Herbaceous Food and Fawning Cover	Direct through understory growth	Positive
Management Indicator Species	Juniper Titmouse	Hard Mast and Cover	Indirect through promotion of large, open grown trees in the pinyon-juniper woodlands	Positive
Management Indicator Species	Pronghorn	Herbaceous Food and Fawning Cover	Direct through understory growth and grassland restoration	Positive
Sensitive Species	Ferruginous Hawk	Vertebrate Prey and open habitat	Indirect through increase in habitat for small mammals and birds and direct through grassland restoration	Positive
Sensitive Species	American Peregrine Falcon	Vertebrate Prey and open habitat	Indirect through increase in prey habitat (food and cover)	Positive
Sensitive Species	Baird's Sparrow	Herbaceous Food and Cover	Direct through increase in understory and invertebrates	Positive
Sensitive Species	Merriam's Shrew	Invertebrate Prey	Direct through increase in invertebrates	Positive
Sensitive Species	Dwarf Shrew	Invertebrate Prey	Direct through increase in invertebrates	Positive
Sensitive Species	Western Red Bat	Invertebrate Prey	Direct through increase in invertebrates	Positive
Sensitive Species	Spotted Bat	Invertebrate Prey	Direct through increase in invertebrates	Positive
Sensitive Species	Allen's Lappet-Browed Bat	Invertebrate Prey	Direct through increase in invertebrates	Positive
Sensitive Species	Pale Townsend's Big-Eared Bat	Invertebrate Prey	Direct through increase in invertebrates	Positive
Sensitive Species	Greater Western Mastiff Bat	Invertebrate Prey	Direct through increase in invertebrates	Positive
Sensitive Species	Mogollon Vole	Invertebrate Prey and Cover	Direct through increase in understory and invertebrates	Positive
Sensitive Species	Long-Tailed Vole	Invertebrate Prey and Cover	Direct through increase in understory and invertebrates	Positive

Species Status	Species	Habitat Link(s)	Nature of Link	Species Response
Migratory Birds	Bark Gleaners	Invertebrate Prey	Indirect through promotion of large trees	Positive
Migratory Birds	Foliage Gleaners	Dense Mid-aged forest (Food & Cover?)	Direct through Overstory Habitat Changes	Negative
Migratory Birds	Insectivores	Invertebrate Prey	Direct through increase in invertebrates	Positive
Selected Goshawk Prey	American Robin	Invertebrate Prey	Direct through increase in invertebrates	Positive
Selected Goshawk Prey	Band-tailed Pidgeon	Hard and Soft Mast	Direct through increase in foraging habitat	Positive
Selected Goshawk Prey	Cottontail	Herbaceous Food and Cover	Direct through increase in understory and invertebrates	Positive
Selected Goshawk Prey	Golden-Mantled Ground Squirrel	Herbaceous Food and Cover	Direct through increase in understory and invertebrates	Positive
Selected Goshawk Prey	Mourning Dove	Forage (especially graminoid production) and Nest Site Structure	Direct through increase in foraging habitat; Indirect through improved nest structure	Positive
Selected Goshawk Prey	Northern Flicker	Invertebrate Prey	Direct through increase in invertebrates (especially ants)	Positive
Selected Goshawk Prey	Steller's Jay	Invertebrate Prey and Mast Production	Direct through increase in invertebrates (especially beetles, grasshoppers, and wasps)	Positive
Selected Goshawk Prey	Williamson's Sapsucker	Forest Structure, Invertebrate Prey, and Mast Production	Indirect: Nests in aspen and dense forest. Direct: feeds on Invertebrates, sap, and mast.	Positive

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Appendix 7. Bridge Habitat for Canopy-Dependent Wildlife



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Introduction

Because much of the 4FRI landscape is dominated by mid-aged trees, the 4FRI project would not achieve desired conditions on all treatment acres immediately after treatment. It would take time for the largely even-aged forests to develop uneven-aged structure, for trees to mature into larger diameter classes, and for tree canopies within tree groups to reach the desired interlocking crown condition. Because of this time lag, some stakeholders are concerned that post-treatment conditions within the 4FRI project area would not provide sufficient habitat for canopy-dependent wildlife in the short term.

The wildlife species of concern identified by the public, relative to the delay in achieving desired conditions, include northern goshawks, Mexican spotted owls (MSOs), Abert's squirrels, turkeys, mule deer, black bears, and some songbird species. The information provided in this appendix clarifies how post-treatment conditions within the 4FRI project area would provide habitat for canopy-dependent wildlife in the short term. We are referring to those areas as "bridge habitat," suggesting that these more densely forested areas would be available to wildlife to bridge the time between treatment and the attainment of desired conditions across the broader landscape.

Bridge Habitat at the Landscape Scale

For purposes of this discussion, the landscape is considered to be the 988,764-acre 4FRI Coconino and Kaibab NFs analysis area. All treatment area acreages are calculated based on alternative C because it has the most comprehensive set of potential treatments that could impact canopy-dependent wildlife and it is the preferred alternative. To determine how much bridge habitat would be available to canopy-dependent wildlife after treatment at the landscape scale, it is important to review the acres of treatment and exclusion categories within the project area (Table 1). About 40 percent of the project area was excluded from management consideration under this EIS.

Table 1. Acres of Treatment and Non-treatment Areas within the 4FRI Project Area

Area	Description	Acres
Project Area	Total area within 4FRI project boundary	988,764
Exclusions	Other projects	213,090
	Special management areas (wilderness, research natural areas, inventoried roadless areas, Camp Navajo, and experimental forests)	30,668
	Non-FS lands	145,156
	Miscellaneous (other cover types, no-treatment protected activity center (PAC) core areas, inaccessible areas, etc.)	11,138
	Total excluded areas within 4FRI project boundary	**400,052**
Treatment Area	Ponderosa pine treatment area	507,839
	Other cover types treatment area	80,876
	Area within the proposed treatment boundary (includes mechanical treatment and prescribed burning)	**588,716**

Two bridge habitat categories ("other projects" and "wilderness, slopes, PACs") were analyzed at the scale of the total project area to demonstrate the patch-mosaic of deferrals versus treated areas across the larger landscape. The remainder of the bridge habitat categories analyzed were within the ponderosa pine treatment area (507,839 acres) scale. This scale was used to demonstrate how bridge habitat would persist where mechanical treatments and prescribed fire are proposed. The percentages provided for each category are not necessarily additive. Some categories are merely subsets of other categories but they provide several different ways of looking at how we account for closed-canopy species through project design. As Table 1 demonstrated, there is a highly diverse mosaic of forest structure that would vary in terms of overall density and openness after treatment at the landscape scale.

Other Projects

Excluded fuels reduction and forest restoration projects account for 213,090 acres (22 percent) of the total project area (988,764 acres). We can assume that some proportion of these projects would retain closed-canopy conditions after treatment, or remain untreated. On average, about 37 percent of a given project on the Coconino and Kaibab NFs is untreated after implementation (Hampton et al. 2008, page 17). Untreated areas are a result of site-scale factors such as archaeological and historical sites, wildlife deferrals, funding issues, steep or rocky terrain, and areas with insufficient road access. Using the 37 percent estimate for untreated acres after project completion, we concluded about 78,843 acres would remain in deferral (i.e., untreated) due to site-scale logistics in the total 4FRI project area. There is no data to accurately estimate acres of closed-canopy conditions in excluded projects. However, we can assume that some proportion of this area would contribute habitat for canopy-dependent species.

Wilderness Areas, Slopes >40 percent, and Mexican Spotted Owl Protected Activity Centers not Identified for Mechanical Treatment

These areas have not been identified for mechanical treatment and are generally characterized by dense forest conditions used by canopy-dependent wildlife. These areas account for 8 percent (79,699 acres) of the total project area, including 81 of 99 MSO protected activity centers (PACs). The 18 PACs with mechanical treatments were not included here, but little change in canopy conditions are expected in those PACs (see "Affected Environment" section of the wildlife report).

Ponderosa Pine Treatment Area Scale (507,839 acres)

Although the 4FRI proposes to treat over ½ million acres, treatment intensities are highly variable (Table 2 and Figure 1). Very open treatments include grasslands and savannas. The most common treatment in the open category would range from 40 to 55 percent open.

Table 2. Acres of Proposed Treatment in terms of Post-treatment Openness

Post-treatment Openness Category	Acres	Percent of Ponderosa Pine Treatment Area
Very Open	67,553	13
Open	228,860	45
Moderately Closed	141,530	28
Closed	69,897	14
Total	**507,839**	**100**

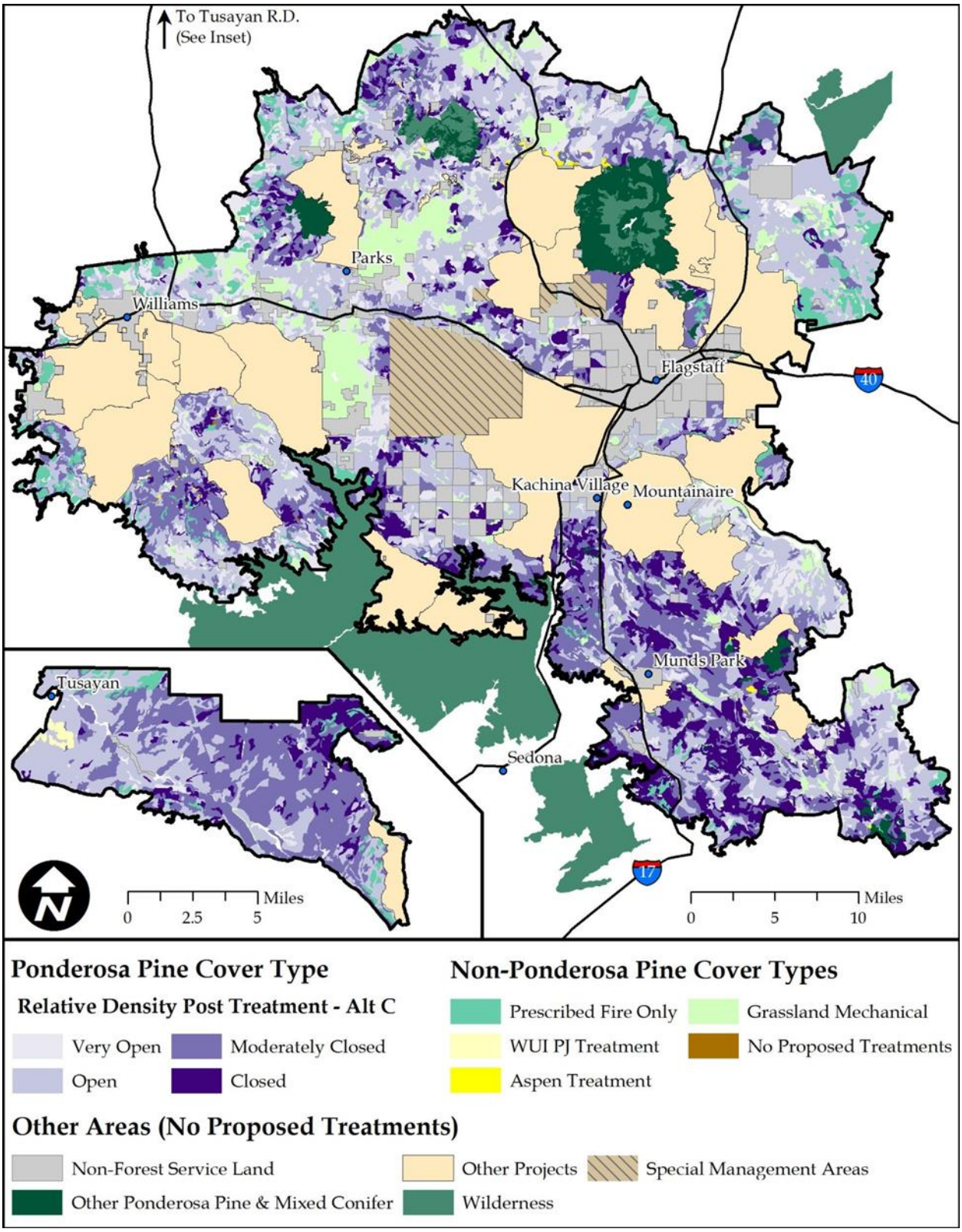


Figure 1. Relative, Post-treatment Forest Density Across the 4FRI Project Area, Alternative C

Closed and Moderately Closed Conditions

This category includes mechanically treated and prescribed fire only areas where post-treatment conditions maintain 60 to 90 percent forested cover. Included in this category were some MSO and northern goshawk habitats. Post-treatment openness would range from 10 to 25 percent and 25 to 40 percent open. MSO restricted and target/threshold habitats, and 18 MSO PACs proposed for mechanical treatment would also be in this openness category. About 211,427 acres (42 percent) of the ponderosa pine treatment area would be in this category. About 69,897 acres (14 percent) of the ponderosa pine treatment area would remain in closed condition (75 to 90 percent forested) after treatment. This percentage includes all those areas listed above, but excludes areas in the 25 to 40 percent open category and areas that are not currently in a closed condition.

Mexican Spotted Owl Protected, Target and Threshold, and Restricted Habitats

These habitat designations have specific guidelines per the MSO Recovery Plan to ensure denser forest conditions selected for by the owl. Within the 4FRI Project, these designations could be ranked in terms of their forest density, and therefore their provision for other closed-canopy species. Protected habitat is generally densely forested, target and threshold habitats are similar to protected habitat, and restricted habitat is less dense than protected but more densely forested relative to areas outside MSO designations. In regards to 4FRI, habitat definitions are specific to pine-oak forest.

- Protected owl habitat accounts for roughly 35,262 acres, which is about 7 percent of the ponderosa pine treatment area (Table 3 see the "MSO PAC Mechanical" and "Protected Prescribed Fire Only" row in the "Post-treatment Density" column). Of this total, 26,120 acres are currently in a closed condition. This includes 70 PACs (18 of which are proposed for some mechanical thinning) and slopes >40 percent (proposed for prescribed fire only). Protected owl habitat is designed to provide a multi-layered, more closed canopy condition relative to the other habitats in the ponderosa pine treatment area, with an emphasis on managing for large trees (18-inch dbh or greater). The average basal area for protected habitat, based on modeled projections for the year 2020, is 155 square feet per acre.
- Target and threshold habitats include those areas that meet or are approaching nesting and roosting habitat conditions. These areas account for about 2 percent (8,692 acres) of the ponderosa pine treatment area (see MSO target and MSO threshold rows in Table 3). Of this total, about 7,489 acres are currently in a closed canopy condition. Per the 1995 MSO Recovery Plan, target and threshold habitats are to be managed for ≥15 percent of total stand density index (SDI) in each of the three defined ponderosa pine tree size classes (12- to18-inch dbh, 18- to 24-inch, and >24-inch). The revised Recovery Plan (USDI 2012) addressed the misinterpretation of nest stand data, recommending a stand average of 110 square feet per acre or greater basal area with a preponderance of large trees (18-inches dbh and larger).
- Restricted habitat accounts for 66,419 acres (Table 3), which is 13 percent of the ponderosa pine treatment area. Of this total, 42,538 acres (about 64 percent) are currently in a closed condition and another 17,179 acres (about 26 percent) are currently in a moderately closed condition. The guidelines for restricted habitat are less specific in order to meet multiple objectives and operate in conjunction with ecosystem management and existing management guidelines. Objectives for the 4FRI include managing for an abundance of ponderosa pine trees 18-inches dbh and greater, maintaining tree form oak, and managing for a stand average of 70 to 90 square feet per acre basal area at the stand level.

Northern Goshawk Habitat

Closed canopy conditions would also be realized within areas managed according to the northern goshawk guidelines. Higher tree density, canopy cover, and larger group sizes would be retained in post-fledging family areas (PFAs) and lands outside post-fledging family areas (LOPFAs) where the current condition and proposed treatments are for 10 to 25 percent interspace (14,933 acres). Denser forest structure would also be retained in northern goshawk nest areas that currently have closed conditions (3,234acres). Areas within (post-family fledging areas) (PFAs) and lands outside PFAs (LOPFAs) that are proposed for prescribed fire only treatments or no treatments that are currently in a closed condition would retain higher tree densities and canopy cover after treatment (16,310 acres). Together, these categories account for about 7 percent of the ponderosa pine treatment area (about 34,477 acres). In addition, PFAs and LOPFAs currently in a moderate closed or closed condition and proposed for moderately dense treatments (25 to 40 percent interspace) account for about another 8 percent of the ponderosa pine treatment area. Areas within PFAs, LOPFAs and goshawk nest areas that are proposed for prescribed fire only treatments or no treatments account for 22,312 acres, which is about 4 percent of the ponderosa pine treatment area. Together these two categories account for nearly 13 percent [8 percent + 4 percent] of the ponderosa pine treatment area and would remain in a moderately closed condition after treatment.

About 41 percent of the ponderosa pine treatment area is LOPFA and PFA goshawk habitat proposed for low-density condition (savanna/grassland restoration and 40 to 55 percent interspace) (Table 3).

Wildlife Movement Corridors

Efforts were taken to ensure habitat connectivity for canopy-dependent wildlife at the landscape scale. Data from known wildlife movement corridors for black bear, turkey, mule deer, and tassel-eared squirrels were incorporated into treatment development for the 4FRI (AGFD 2011, figure 51). While tassel-eared squirrels are dependent on sufficient areas with connected canopies, black bears and mule deer are habitat generalists that seek cover, but largely use habitat elements independent of forest canopy closure. Closed canopy forest corridors would provide hiding cover for these species. Landscape-scale movement corridors were examined on a stand-by-stand basis. Where closed canopy wildlife corridors overlapped with proposed mechanical treatments, treatment intensities were adjusted to provide closed or moderately-closed canopy conditions post-treatment. In addition to treatment areas that would remain in closed or moderately closed conditions, roughly 4,169 acres were actively changed from more open to more closed treatments. Treatments were adjusted in five different wildlife movement corridors within the project area. The expected result is the retention of thermal and hiding cover in addition to closed-canopy conditions to facilitate movement across the landscape for a suite of species.

In summary, there are four key considerations with regard to bridge habitat for closed-canopy species at the landscape and treatment scales:

- A patch-mosaic of bridge habitat would remain available for canopy-dependent wildlife. At a minimum, 8 percent of the project area would be in deferral due to wilderness, slope, and untreated MSO PACs. Potentially another 8 percent of the project area would be in deferral as part of other excluded projects.
- About 1 in 5 acres (nearly 22 percent of the ponderosa pine treatment area) would be managed as MSO habitat, creating conditions that also provide habitat for other canopy-dependent wildlife.
- Bridge habitat would be maintained across 42 percent of the ponderosa pine treatment area.
- Connectivity for closed-canopy species was specifically built into treatment designs separately from MSO and northern goshawk guidelines.

Table 3 provides a detailed summary of acreages and percentages for each treatment category within the ponderosa pine treatment area in terms of post-treatment density and contributions to bridge habitat. Figure 1 illustrates the patch-mosaic of post-treatment forest density relative.

Table 3. Post-treatment Contributions to Bridge Habitat Provided by Each Treatment Designation

Treatment	Post-treatment Density	Landscape Scale Bridge Habitat	Mid-scale Bridge Habitat	Total Acres	Percent (%) of Ponderosa Pine Treatment Area
Mechanical Treatment					
Low Density	Savanna/Grassland Restoration	X	X	56,372	11
	LOPFA 40–55% Interspace	X	Some	141,267	28
	PFA 40–55% Interspace	X	Some	12,834	3
Low Density Total				210,472	41
Moderate Density	LOPFA 25–40% Interspace	X	X	52,574	10
	MSO Restricted	X	X	62,785	12
	PFA 25–40% Interspace	X	X	4,406	1
Moderate Density Total				119,766	24
High Density	LOPFA 10–25% Interspace	X	X	29,511	6
	PFA 10–25% Interspace	X	X	2,670	1
High Density Total				32,181	6
Very High Density	MSO Threshold	X	X	1,892	< 1
	MSO Target	X	X	6,495	1
	MSO PAC Mechanical	X	X	10,284	2
Very High Density Total				18,672	4
Prescribed Fire Only Areas and Areas with No Proposed Treatments					
Low Density	LOPFA Prescribed Fire Only	Some	Some	86,869	17
	LOPFA No Proposed Treatments	Some	Some	858	< 1
Low Density Total				87,728	17
Moderate Density	PFA Prescribed Fire Only	X	X	3,216	1
	PFA No Proposed Treatments	X	X	92	< 1
	Restricted Prescribed Fire Only	X	X	4,187	< 1
	Restricted No Proposed Treatments	X	X	1,280	< 1
Moderate Density Total				6,898	1

Treatment	Post-treatment Density	Landscape Scale Bridge Habitat	Mid-scale Bridge Habitat	Total Acres	Percent (%) of Ponderosa Pine Treatment Area
High/Very High Density	PFA Nest Area Prescribed Fire Only	X	X	6,836	1
	PFA Nest Area No Proposed Treatments	X	X	4	< 1
	Threshold Prescribed Fire Only	X	X	217	< 1
	Threshold No Proposed Treatments	X	X	1	< 1
	Target Prescribed Fire Only	X	X	84	< 1
	Target No Proposed Treatments	X	X	2	< 1
	Protected Prescribed Fire Only	X	X	25,714	5
	Protected No Proposed Treatments	X	X	244	< 1
High/Very High Density Total				32,122	6
Grand Total				**507,839**	**100**

Bridge Habitat at the Restoration Unit (RU) Scale

At the RU scale (Figure 2), there are additional ways of accounting for bridge habitat. Factors contributing to bridge habitat at the RU scale include the area remaining in closed and moderately closed condition after treatment and areas allocated for old growth.

Closed (<25 % Interspace) to Moderately-Closed (25 to 40 % Interspace) Canopy Conditions

Table 4 summarizes the range of post-treatment openness by RU under alternative C. (Also, see table 64 in the silviculture specialist's report). The overall range in openness indicates a variety of conditions within RUs post-treatment. Most of the area within each RU would range from open to moderately closed canopy conditions. Very open and closed conditions would also be represented in each RU, ranging from 2 to 20 percent and from 4 to 21 percent respectively. RU 1 has the highest percentage of post-treatment habitat in a closed condition, due in large part to ecological conditions such as soil, climate, and site quality that result in a denser reference condition relative to the other restoration units. RU 1 also contains the highest proportion of MSO habitat relative to the other RUs. Note that RU 3, 4, and 6 include large areas of savanna, grassland, and pine/sage habitats (e.g., Garland Prairie in RU 3, Government Prairie in RU 4, and pine-sage in RU 6). Savanna and grassland restoration is based on soil characteristics, and would total 56,372 acres of very open treatment. While maintaining adequate closed canopy conditions has been a topic of concern for some stakeholders, the lack of grassland and savanna habitat is a more significant issue ecologically (Merola-Zwartjes 2005, North American Bird Conservation Initiative 2011, Brown and Makings 2014).

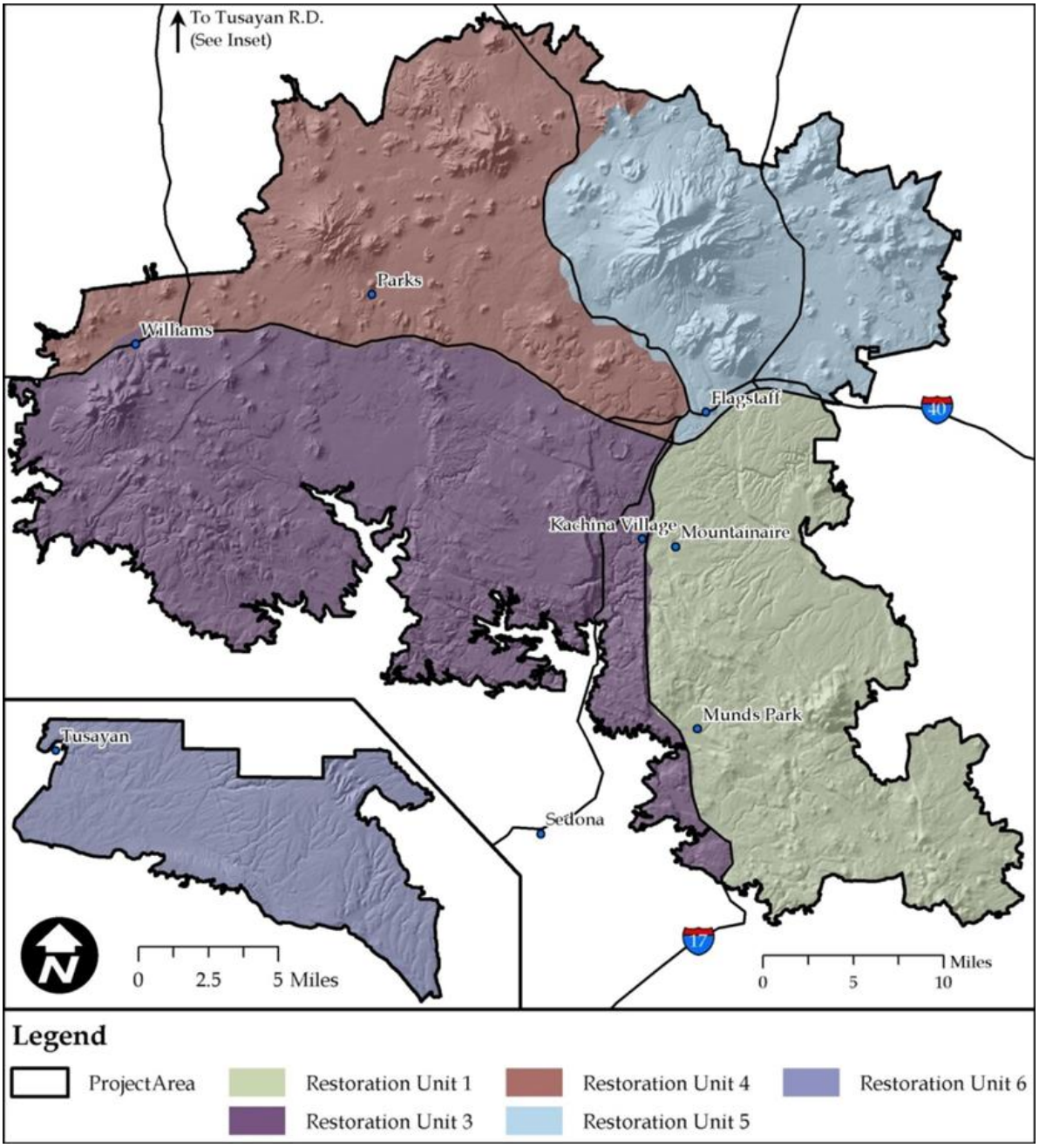


Figure 2. RU Boundaries within the 4FRI Treatment Area

Table 4. Proposed Post-treatment Openness Condition (Percent) by RU

RU	Very Open	Open	Moderately Closed	Closed
1	11%	40%	29%	21%
3	13%	40%	32%	15%
4	20%	52%	18%	10%
5	14%	58%	24%	4%
6	2%	41%	47%	11%

Old-growth Allocations

Desired conditions for old growth in ponderosa pine under the Coconino forest plan direction:

- 20 trees per acre at 18-inch dbh and greater and at least 180 years old,
- one snag per acre at least 14-inch dbh and 25 feet tall,
- two down dead tree pieces 12 inches in diameter and 15 feet long,
- basal area at least 90 square feet, and
- canopy cover of at least 50 percent.

Guidelines from the Kaibab forest plan include:

> Multi layered canopy, interlocking canopy and old growth.
>
> Ponderosa Pine Desired Conditions: Fine-scale: 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. Where Gambel oak comprises more than 10% of the basal area, it is not uncommon for canopy cover to be greater than 40%. Mid-scale: 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. Forest conditions in some areas contain 10 to 20% 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). Landscape: 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. Denser tree conditions exist in some locations such as north facing slopes, canyons, and drainage bottoms. 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, dead trees (snags), downed wood (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).
>
> 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. On suitable timberlands, projects should retain somewhat higher frequencies of trees across broad diameter classes to allow for future tree harvest. Project design should manage for replacement structural stages to assure continuous representation of old growth over time.
>
> The microhabitat diversity provided by the old trees, multi-storied canopies, snags, and downed logs within old growth areas are rare across the landscape. Functional MSO habitat and portions of northern goshawk habitat are comprised of old-growth forest (see chapter 1, existing and desired conditions for more details). The Coconino forest plan direction is to allocate and maintain at least 20 percent old growth forest within each ecosystem management unit (EMU). For the purposes of the 4FRI project, an EMU resembles the 4FRI RUs, therefore old growth was allocated by RU (see table 38 in the silviculture specialist report).
>
> Forty percent of the ponderosa pine treatment area on the Coconino NF (127,009 acres) and 35 percent (65,810 acres) of the Kaibab NF are allocated for old growth. Old-growth conditions do not currently occur in sufficient quantity on the Coconino and Kaibab NFs. Areas selected for old-growth

allocation represent current conditions that most closely resemble old growth. The 4FRI has incorporated a large tree retention policy and alternative C (the preferred alternative) would also include an old tree protection strategy. It is the intent of the 4FRI project to manage allocated areas according to old growth standards to move them towards mature, diverse forests over time. Similar provisions were made for pinyon-juniper habitats. A portion of these areas currently support closed canopy conditions and will continue to do so. More closed canopy conditions will develop in these areas over time, contributing further to closed canopy habitat.

Bridge Habitat at the Mid-Scale

Bridge habitat for canopy-dependent wildlife would also occur at the mid-scale in the 4FRI project. Some densely forested areas would be deferred simply due to the vagaries of implementation. The 4FRI project also intentionally plans for bridge habitat at the mid-scale through its desired conditions, design features/best management practices/mitigation, the old and large tree implementation plans, and the silvicultural design and implementation guide. These factors are described below.

Desired Conditions for Bridge Habitat

The 4FRI EIS describes treatments intended to meet the described desired conditions. During implementation of the 4FRI project, site-specific prescriptions would be developed to implement the treatments and they too would be based on meeting desired conditions. The following subset of desired conditions would help ensure bridge habitat is maintained in the proposed project area (see chapter 1 purpose and need for the full set of desired conditions):

- The desired condition is to restore tree density and pattern to the natural range of variability, while meeting forest plan requirements for MSO protected, target, threshold, and restricted habitats and goshawk nest areas.
- At the fine scale, the desired condition is a ponderosa pine ecosystem consisting of groups of trees that typically range in size from 0.1 acre to 1.0 acre. Tree groups would exceed 1-acre in size as needed to respond to site-specific conditions such as the presence of pre-settlement trees or mature trees that are developing old-tree characteristics.
- Tree groups in the mid-age and older vegetation structural stage (VSS) classes would have canopies that provide moderate-to-closed conditions and connectivity for wildlife that are dependent on this type of habitat. These conditions are widely distributed on the landscape. At the landscape scale (extent of ponderosa pine vegetation), all canopy density conditions exist and provide for heterogeneity.
- Moderate-to-closed canopy conditions (and the connectivity between groups supporting these conditions) are met in a variety of ways: habitat for goshawk and MSO, steep slopes, buffers for several resources including bald eagle roosts, other raptor nests, heron rookeries, caves, sink holes, and special designations that would not be treated (including wilderness and most research natural areas).
- There is a need to use management strategies that: (1) promote tree regeneration and understory vegetation, (2) move tree canopy density, tree group pattern and interspaces towards the historic range of variability, and (3) provide a mix of open, moderately closed, and closed-canopy conditions at the fine (group) to landscape (ponderosa pine vegetation) scale.
- There is a need to implement uneven-aged management strategies and manage for high-density, relatively uneven-aged stands in MSO restricted habitat, including target and threshold habitats to meet forest plan and MSO Recovery Plan requirements.

Wildlife Design Features, Best Management Practices, and Mitigation Measures

Design features, best management practices, and mitigation measures are intended to avoid or minimize adverse effects of management actions on natural resources. They provide safeguards for wildlife and other resources during the implementation phase. Some of these actions would result in a well-distributed network of bridge habitat for wildlife across the larger landscape (Table 5). A more complete list of design features, best management practices, and mitigation can be found in appendix C and appendix D of the EIS (the silvicultural design and implementation guide). Selected silvicultural design features that contribute to bridge habitat are described in greater detail below.

Table 5. Design Features, Best Management Practices and Mitigation Measures Contributing to Bridge Habitat

Species/Resource	Description
Bald Eagle Nests	No mechanical treatments would occur within a 300-foot radius of bald eagle nest trees (about a 6 acre patch for each nest).
Bald Eagle Roosts	No mechanical treatments will occur around confirmed bald eagle roost sites (300-foot radius around roosts on the Coconino NF and a 10-chain radius on the Kaibab NF).
Vegetation Structural Stages 4, 5, and 6	Within group density – Manage mid-aged tree groups for a range of density and structural characteristics by thinning approximately 50 percent of the mid-aged groups to the lower range of desired stocking conditions, approximately 20 percent each to the middle and upper range of desired stocking conditions, and approximately 10 percent would not be thinned. Within group structure – Enhance and maintain mid-aged, mature, or old group structure by retaining individual and clumps of vigorous ponderosa pine seedlings, saplings, and poles within the larger group.
Caves and Sinkholes	A 300-foot no mechanical treatment buffer would be designated around 34 cave entrances (about 6.5 acres each) and around an undetermined number of sink holes (i.e., karst) to protect cave ecosystems from siltation, protect human health and safety, and reduce potential disturbance to roosting bats. Existing roads could be used for mechanical harvest but no new skid trails would be created.
Dependable Waters	Hiding cover would be maintained near dependable waters by not targeting drainages for interspaces and openings and through implementation of watershed BMPs.
Great Blue Herons	No dominant or co-dominant trees would be cut in rookeries. Nest trees will be prepped prior to implementing prescribed fire.
MSO	Trees greater than 24-inch dbh would not be harvested.
Mixed Conifer	4FRI activities would not include mechanical or fire treatments in the mixed conifer inclusions within the ponderosa pine forest (e.g., MSO core areas in treated PACs). Similarly, islands of ponderosa pine within mixed conifer forest would not be treated as part of this project.
Northern Leopard Frogs	A no-treatment buffer (no thinning, no direct ignition) would extend ¼-mile from tanks with known northern leopard frog sites, or be designated along logical topographic breaks. In some cases, the district wildlife biologist could work with implementation teams to determine the habitat protection buffer boundary.
Northern Leopard Frogs	A 200-foot protection zone (100 feet either side of streamcourse) would be established around designated stream courses for northern leopard frogs. There would be no thinning and no direct ignition of prescribed burning within the protection zones. Designated skid trail crossings through the buffer zones are allowed.

Species/Resource	Description
Raptor Nests	No mechanical treatment buffers would be designated around raptor nests. Sharp-shinned hawk nests = 10 acres, Cooper's hawk nests = 15 acres, osprey nests = 20 acres, other raptors = no mechanical treatment buffers within a 50-foot radius (about 0.2 of an acre).
Snags	Emphasize retention of snags ≥18-inch dbh.
Snags	Retain trees ≥18-inch dbh with dead tops, cavities, and lightning strikes wherever possible to provide cavity nesting/foraging habitat (i.e., the living dead).
Streamside Management Zones	On areas to be prescribed burned, establish filter strips (also known as streamside management zones). Applies to riparian and non-riparian streamcourses. Deferral widths range from 35 to 120 feet on each side of the streamcourse.
Turkeys	Retain medium to high canopy cover in pine stringers in the pinyon-juniper transition zone and target low-severity burns to retain yellow pine and roosting cover.
Wildlife Cover	Gambel oak, juniper, and pinyon species may only be cut as necessary to facilitate logging operations (skid trails and landings) and by design as follows: Within UEA, IT, SI, and WUI treatments, pinyon/juniper seedling/sapling and young/mid-aged trees may be cut within a 40-foot radius of individual or groups of old ponderosa pine (as defined in the old tree implementation strategy). Within savanna and WUI PJ mechanical treatment areas, pinyon/juniper seedling/sapling and young/mid-aged trees may be cut.
Habitat Heterogeneity	Manage mid-aged tree groups for a range of density and structural characteristics by thinning approximately 50 percent of the mid-aged groups to the lower range of desired stocking conditions, approximately 20 percent each to the middle and upper range of desired stocking conditions and approximately 10 percent remain unthinned.
Canopy Cover/ Habitat Heterogeneity	Enhance and maintain mid-aged, mature and old group structure by retaining individual and clumps of vigorous ponderosa pine seedlings, sapling and poles within the larger group.

UEA =uneven aged; IT = intermediate thin; SI = stand initiation; WUI = wildland-urban interface

Old and Large Tree Implementation Plans

In response to public input from several stakeholders requesting a design feature that included no cutting of pre-settlement old-growth trees, the 4FRI project would implement an Old Tree Protection Strategy. Old trees (approximately 150 years and older) would be retained regardless of their diameter within the 4FRI project area. 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 (e.g., moving a road out of stream channel). However, exceptions are not expected. Retention of old trees as individuals and groups will contribute significantly to bridge habitat, providing old growth structure for wildlife in the short term.

In response to input from some stakeholders, alternative C includes a Large Tree Retention Strategy. The strategy identifies areas where post-settlement trees 16 inches dbh and larger would be retained and exceptions where removal of trees 16 inches dbh and larger would be necessary to move toward ecological desired conditions. Elsewhere, those trees would be retained, adding to the mid-scale provision of bridge habitat for canopy-dependent wildlife.

Silvicultural Design and Implementation Guide

Vertical and horizontal heterogeneity are important components of wildlife habitat in ponderosa pine forests. Restoring variability and diversity to forest structure and pattern is a central desired condition of the 4FRI project. The silvicultural design and implementation guide (hereafter "implementation guide"; appendix D, attachment 1) is intended to translate desired conditions, management direction, and design features into guidance for the district silviculturists responsible for writing site-specific prescriptions in the implementation phase. The intent is to balance the need for flexibility to adapt to on-the-ground realities while ensuring adequate sideboards to minimize or avoid impacts to important resources. Below are examples of how maintenance of bridge habitat would be ensured through the implementation guide.

Implementation Guide—Mexican Spotted Owls

Several features of the implementation guide treatment design for the Mexican spotted owl (MSO) would serve as a proxy for other canopy-dependent wildlife. Design features for the owl are too numerous to list here, but those listed below serve to illustrate specifically how bridge habitat would be maintained at the mid-scale:

- Each PAC has a 100-acre (or greater) core area that would not have mechanical treatments.
- Each PAC to be thinned would have an upper diameter limit of trees that may be cut.
- Manage for 110 to 150 square feet of basal area (depending on alternative) in protected, target, and threshold habitats; basal area in restricted other habitat would range from 70 to 90 square feet.
- Individual trees and tree groups would occupy approximately 60 to 75 percent of the area within restricted other habitat.
- Treatments are designed to manage for old age trees and to sustain as much old forest structure as possible across the landscape. Treatments would follow the Old Tree Protection Plan.
- No trees larger than 18-inches dbh would be cut in protected habitat and no trees larger than 24-inches dbh would be cut in restricted habitats.
- In restricted other habitat, tree groups would, on average, range in size from 0.1 to 1 acre; northerly aspects and highly productive microsites would have larger average group sizes.
- In restricted other habitat, manage for tree groups with different age classes by retaining individual and clumps of vigorous ponderosa pine seedlings, saplings and poles within the larger mid-aged, mature or old tree groups.
- In restricted other habitat, interspace width between tree groups would average from 25 to 60 feet with a maximum width of 200 feet.
- Manage for large oak and pine snags.
- Retain non-ponderosa pine species in the canopy.
- Retain young trees growing within the dripline of old trees in PACs to maximize roosting potential.

Implementation Guide—Northern Goshawks

Several features of the treatment design for the northern goshawk would serve as a proxy for other canopy-dependent wildlife. Design features that would contribute towards this goal are numerous, but a few key features are highlighted to illustrate maintenance of bridge habitat. Relevant design features from Table 5 are not repeated below.

- Treatments are designed to manage for old age trees, following the Old Tree Protection Plan.

- Treatments would strive to attain an overall stand average density ranging from 40 to 90 square feet of basal area and 15 to 40 percent of maximum SDI. Density would vary within this range depending on treatment type, intensity, existing stand structure, and site conditions.
- Tree group density would be managed to meet the canopy cover requirement of 40 plus percent within mid-aged forest (VSS 4), mature forest (VSS 5), and old forest (VSS 6) 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 achieve overall stand average density targets, basal area and SDI within tree groups would often need to exceed average target values. Table 6 illustrates how this could work for basal area (see the implementation guide for greater detail). For example, a treatment intensity of 10 to 25 should result in 10 to 25 percent of a stand open and 75 to 90 percent treed. If the objective for a specific stand was 20 percent interspace and 80 percent trees, including 10 percent regeneration, then 70 percent of the treed area would be groups and individual trees. If the overall target basal area was 60, tree groups in the 70 percent treed area would have to average a basal area of 86.
- Within-group structure specific to mid-aged to old tree classes (VSS 4 to 6) would include open understories, interlocking tree crowns, abundant large limbs, and shade.
- Tree groups, on average, would range in size from 0.1 to 1 acre. Overall average group size would vary within this range depending on existing stand structure, and pre-settlement tree evidence.
- Maximum interspace width of 200 feet.
- Maximum regeneration opening size of 4 acres or 200 feet wide.
- One group of reserve trees, three to five trees per group, would be left in created regeneration openings larger than 1 acre in size.
- Manage for large oaks.
- Within the proposed ADGF research areas, tree group size is dependent on experimental design and would range in size from 1 to 15 acres.

Table 6. Excerpt from Section D of the 4FRI Implementation Guidelines

Treatment Intensity	Percent Area		Percent Area with Tree Cover		Average Group Basal Area to Achieve Overall Basal Area					
	Interspace	Tree	Groups & 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	

Treatment Intensity	Percent Area		Percent Area with Tree Cover		Average Group Basal Area to Achieve Overall Basal Area					
	Interspace	Tree	Groups & Individuals	Regeneration	40	50	60	70	80	90
			70	10		71	86	100	114	
			65	15		77	92	108	123	
			60	20		83	100	117	133	

Conclusions about Bridge Habitat in the 4FRI Project

Closed-canopy, high-density, mid-aged forest conditions are currently common in the 4FRI project area. To achieve ecological objectives (e.g., achieve or move towards the natural range of variability, increase forest resiliency to continuing climate change, maintain existing large and old trees, and increase large tree growth rates) and modify landscape-scale fire behavior, continuity of canopy connectedness and overall forest density must be significantly reduced. Given the evolutionary history of canopy-dependent wildlife on this landscape, we can assume that closed-canopy conditions were present within the natural range of variability. The question of how much of the pre-settlement landscape was in this condition remains unanswered, but the literature, including historic stand inventories, stand reconstructions, and site descriptions, combined with soil mapping and photo documentation, consistently concludes that this was not the predominant condition. Nevertheless, the 4FRI project proposes to maintain more closed canopy conditions than likely occurred historically. Some closed canopy forest areas are proposed for long-term management (e.g., MSO habitats) and others could change the next time a management planning analysis is conducted on this landscape (e.g., nest and roost sites for other raptor species that might not be in use in the future). Together, they would provide bridge habitat for canopy-dependent wildlife to span the time between restoration treatments and achievement of desired conditions.

In summary, bridge habitat would be managed for at the mid-scale in four key ways:

- Desired conditions that strive to attain the full range of natural variability which includes areas for canopy-dependent wildlife,
- Design features/BMPs/mitigation measures would result in a well-distributed mosaic of small-scale deferrals in a landscape dominated by prescribed fire and mechanical treatments,
- Implementation guidance for MSO habitat that retains higher forest density and canopy cover relative to the surrounding landscape, and
- Implementation guidance for northern goshawks that allows for higher density within tree groups given the contribution of interspaces and openings to overall stand averages.

About 40 percent of the landscape within the 4FRI project boundary would be deferred from treatment (Table 1). Of those acres treated, about 42 percent would remain in a moderately closed to closed condition after treatment. Landscape-scaled movement corridors that were independent of site-specific treatment assessments were included in the project design. Old growth allocations account for 38 percent of the ponderosa pine treatment area and are well-distributed across the landscape and would be managed for closed canopy conditions in the long-term. A patch-mosaic of small deferrals would be created all across the 4FRI project area to maintain wildlife-related features such as sinkholes and hiding cover. Implementation guidance in MSO and northern goshawk habitats includes provisions for higher tree densities and canopy cover relative to the surrounding landscape. All of these measures would provide bridge habitat for canopy-dependent wildlife. It is our assumption that by providing more closed-canopy conditions than likely occurred historically, adequate habitat will be provided habitat for canopy-

dependent wildlife. Monitoring would be an important test of this assumption, and adaptive management would be employed if outcomes prove otherwise.

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Appendix 8. Wildlife Corridors for Habitat Connectivity

Wildlife corridors were developed by the AGFD and include the pronghorn migration route from Garland Prairie to the west boundary of the treatment area, passing south of Bill Williams Mountain. Also see the Arizona Game and Fish Department 2011 report: The Coconino County Wildlife Connectivity Assessment: Report on Stakeholder Input (52 pages).

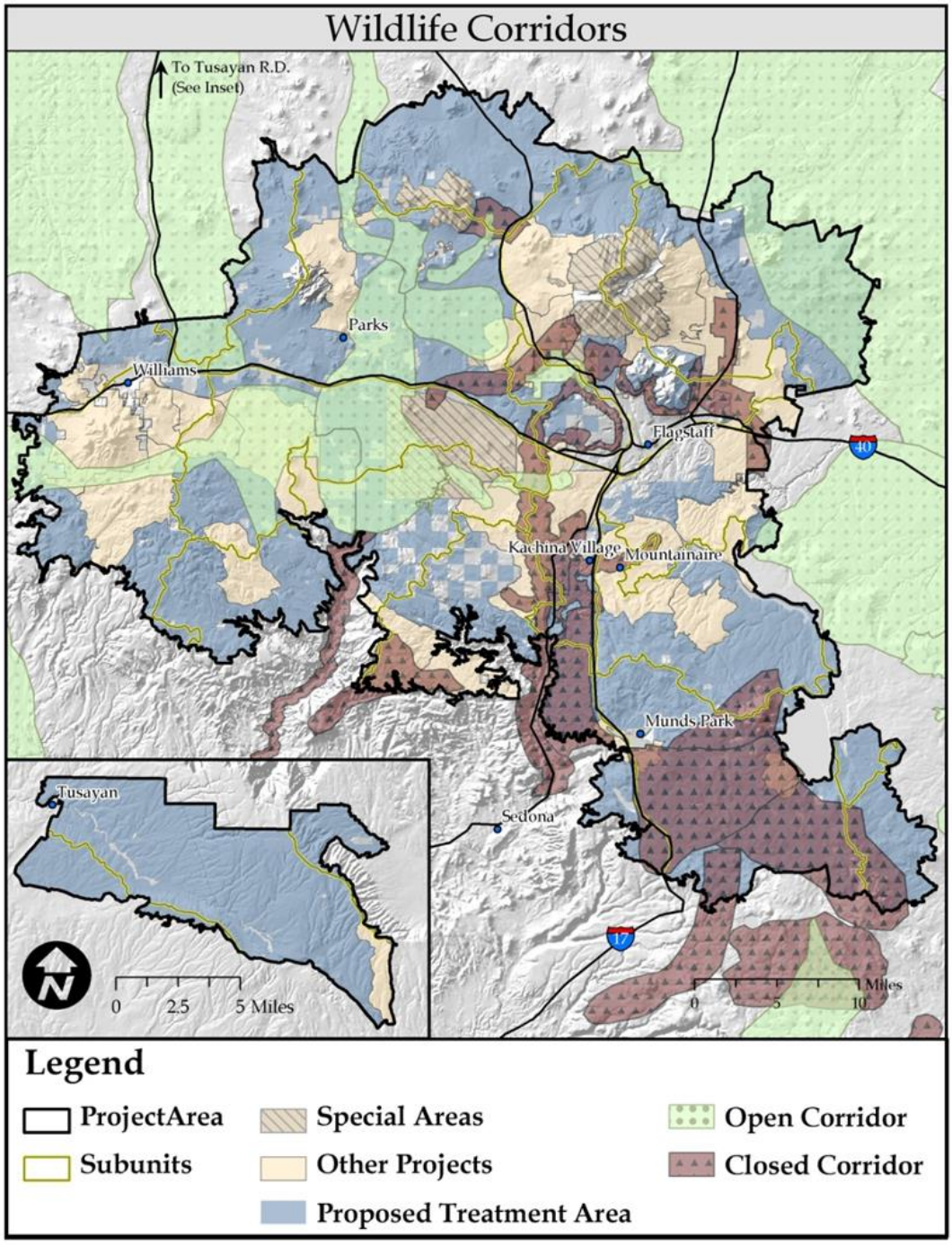


Figure 1. Proposed wildlife habitat and corridors for the 4 Forest Restoration Initiative

Appendix 9. Hiding and Thermal Cover Values by Subunit for All Alternatives

Table 1. Alternative A 1
Table 2. Alternative B 3
Table 3. Alternative C 6
Table 4. Alternative D 8

Table 1. Alternative A

Alternative A		2010 Hiding/Thermal				2020 Hiding/Thermal				2050 Hiding/Thermal			
Subunit	**Total Acres**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**
Pine-Oak	**112,546**	**52,678**	**59,196**		**671**	**46,561**	**62,743**	**2,885**	**356**	**14,472**	**84,967**	**12,883**	**223**
COF	**85,482**	**37,664**	**47,329**		**490**	**33,990**	**48,432**	**2,885**	**175**	**2,992**	**69,562**	**12,883**	**45**
1	61,231	27,485	33,453		293	24,133	35,060	1,907	130	2,496	48,479	10,256	
1-1	1,434	961	391		82	776	635	24		148	1,287		
1-2	588	423	165			423	165				588		
1-3	15,957	7,056	8,901			5,698	9,978	281		430	13,716	1,811	
1-4	3,598	1,601	1,996		0	1,598	1,990	11		58	2,753	787	
1-5	39,653	17,444	21,999		210	15,638	22,292	1,591	130	1,859	30,135	7,658	
3	21,678	8,973	12,659		46	8,709	12,126	798	45	204	19,583	1,847	45
3-3	3,493	1,294	2,153		46	1,145	2,014	289	45	121	2,821	507	45
3-4	4,722	2,317	2,405			2,053	2,495	174			3,965	757	
3-5	13,463	5,362	8,101			5,510	7,617	335		84	12,797	582	
4	547	257	290			149	367	31			439	108	
4-3	277	140	137			62	214				200	77	
4-4	82	82				51		31			51	31	
4-5	188	36	153			36	153				188		
5	2,026	948	927		151	999	880	148		292	1,061	673	
5-1	1,166	653	513			593	425	148		141	758	267	
5-2	861	295	414		151	407	454			151	303	406	

Alternative A		2010 Hiding/Thermal				2020 Hiding/Thermal				2050 Hiding/Thermal			
Subunit	**Total Acres**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**
KNF	**27,063**	**15,015**	**11,868**		**181**	**12,571**	**14,311**		**181**	**11,480**	**15,405**		**178**
3	25,476	14,274	11,203			12,035	13,441			10,993	14,484		
3-1	7,600	4,463	3,137			3,952	3,647			3,680	3,920		
3-2	5,745	3,090	2,655			2,349	3,396			2,056	3,689		
3-3	12,132	6,721	5,411			5,733	6,398			5,256	6,875		
4	1,587	741	665		181	536	870		181	488	921		178
4-3	116	116					116				116		
4-4	1,471	625	665		181	536	754		181	488	805		178
Pine	**399,633**	**147,677**	**129,961**	**27,098**	**94,897**	**150,633**	**176,271**	**53,441**	**19,288**	**41,141**	**201,327**	**152,364**	**4,801**
COF	**237,289**	**71,291**	**78,515**	**17,152**	**70,332**	**85,175**	**102,005**	**42,091**	**8,019**	**24,915**	**101,111**	**111,263**	
1	84,562	31,820	30,685	5,818	16,240	35,069	37,639	8,002	3,852	8,199	43,390	32,974	
1-1	7,480	2,675	2,984	294	1,527	2,743	3,738	941	58	1,262	2,700	3,519	
1-2	5,928	2,091	1,528	424	1,885	2,327	2,926	448	227	396	3,023	2,509	
1-3	22,279	7,705	7,292	1,279	6,003	9,134	9,347	1,687	2,112	2,953	11,401	7,926	
1-4	13,687	7,229	3,479	266	2,712	7,816	5,004	444	424	981	7,970	4,736	
1-5	35,188	12,119	15,401	3,555	4,113	13,049	16,625	4,483	1,032	2,608	18,297	14,283	
3	36,649	11,793	19,341	1,967	3,548	12,544	19,970	2,881	1,253	2,829	22,190	11,630	
3-2	165	60	70	3	33	81	70	3	12	23	73	70	
3-3	11,559	3,603	6,345	324	1,286	3,840	6,429	840	450	622	7,694	3,243	
3-4	4,198	973	2,237	589	399	898	2,398	807	95	210	1,880	2,107	
3-5	20,727	7,157	10,689	1,051	1,830	7,726	11,073	1,232	697	1,974	12,542	6,211	
4	56,434	17,296	20,970	4,953	13,215	19,884	27,107	7,121	2,323	5,709	22,975	27,750	
4-3	24,954	5,707	9,452	1,904	7,891	7,358	12,310	3,498	1,788	3,138	7,395	14,421	
4-4	25,064	9,752	8,762	2,566	3,984	10,318	11,176	3,086	485	1,768	12,423	10,873	
4-5	6,417	1,837	2,755	483	1,341	2,208	3,622	537	50	803	3,158	2,457	
5	59,644	10,383	7,519	4,414	37,328	17,679	17,288	24,087	590	8,179	12,557	38,909	
5-1	19,449	5,046	4,418	1,309	8,677	9,339	6,413	3,375	322	5,262	5,924	8,263	
5-2	40,195	5,338	3,101	3,104	28,651	8,340	10,875	20,712	268	2,917	6,632	30,646	

Alternative A		2010 Hiding/Thermal				2020 Hiding/Thermal				2050 Hiding/Thermal			
Subunit	**Total Acres**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**
KNF	**162,344**	**76,386**	**51,447**	**9,946**	**24,565**	**65,458**	**74,267**	**11,350**	**11,269**	**16,226**	**100,216**	**41,101**	**4,801**
3	45,422	14,529	17,113	5,215	8,565	11,620	23,293	6,129	4,380	2,343	23,920	17,441	1,718
3-1	11,205	4,506	4,268	1,034	1,397	3,640	5,544	1,113	907	1,153	6,403	3,271	378
3-2	16,975	2,737	7,129	2,816	4,293	2,157	9,300	3,523	1,994	606	6,844	8,994	530
3-3	17,242	7,287	5,716	1,366	2,874	5,822	8,449	1,492	1,479	584	10,672	5,176	811
4	75,733	29,026	28,647	4,731	13,329	22,420	41,203	5,221	6,889	3,776	45,934	22,940	3,083
4-2	7,381	2,836	1,759	833	1,953	1,871	3,404	1,222	884	319	4,275	2,587	201
4-3	29,965	14,327	9,047	1,375	5,217	11,432	14,252	1,201	3,080	1,491	20,146	6,731	1,598
4-4	38,386	11,862	17,841	2,523	6,160	9,116	23,546	2,799	2,925	1,966	21,514	13,622	1,284
6	41,188	32,831	5,687		2,671	31,418	9,771			10,107	30,362	720	
6-2	5,069	4,198	539		332	3,290	1,779			677	4,392	0	
6-3	32,635	25,844	4,526		2,265	25,285	7,351			7,270	24,646	719	
6-4	3,484	2,789	622		74	2,843	641			2,160	1,325		
Total	**512,178**	**200,355**	**189,158**	**27,098**	**95,568**	**197,194**	**239,015**	**56,325**	**19,644**	**55,614**	**286,294**	**165,247**	**5,024**

Table 2. Alternative B

Alternative B		2010 Hiding/Thermal				2020 Hiding/Thermal				2050 Hiding/Thermal			
Subunit	**Total Acres**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**
Pine-Oak	**112,546**	**52,678**	**59,196**		**671**	**40,466**	**57,679**	**4,220**	**10,181**	**13,824**	**73,292**	**15,311**	**10,119**
COF	**85,482**	**37,664**	**47,329**		**490**	**28,468**	**46,237**	**4,220**	**6,557**	**6,226**	**57,447**	**15,311**	**6,498**
1	61,231	27,485	33,453		293	20,593	33,230	3,243	4,164	4,755	39,853	12,516	4,105
1-1	1,434	961	391		82	874	358	24	179	126	1,130	0	179
1-2	588	423	165			329	171	0	88	92	408	0	88
1-3	15,957	7,056	8,901			4,622	9,699	466	1,170	869	11,791	2,127	1,170
1-4	3,598	1,601	1,996		0	1,298	2,073	95	132	55	2,536	874	132
1-5	39,653	17,444	21,999		210	13,470	20,929	2,658	2,595	3,613	23,988	9,516	2,536
3	21,678	8,973	12,659		46	6,914	11,697	798	2,269	1,201	16,194	2,013	2,269

Alternative B		2010 Hiding/Thermal				2020 Hiding/Thermal				2050 Hiding/Thermal			
Subunit	**Total Acres**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**
3-3	3,493	1,294	2,153		46	726	2,243	289	235	159	2,446	654	235
3-4	4,722	2,317	2,405			1,510	2,671	174	367	143	3,455	757	367
3-5	13,463	5,362	8,101			4,677	6,783	335	1,667	899	10,294	603	1,667
4	547	257	290			187	300	31	28	0	410	108	28
4-3	277	140	137			62	214	0	0	0	200	77	0
4-4	82	82				51	0	31	0	0	51	31	0
4-5	188	36	153			74	86	0	28	0	160	0	28
5	2,026	948	927		151	774	1,010	148	95	270	989	673	95
5-1	1,166	653	513			528	456	148	35	141	723	267	35
5-2	861	295	414		151	247	554	0	60	129	266	406	60
KNF	**27,063**	**15,015**	**11,868**		**181**	**11,998**	**11,442**	**0**	**3,624**	**7,597**	**15,845**	**0**	**3,621**
3	25,476	14,274	11,203			11,468	10,769	0	3,239	7,203	15,035	0	3,239
3-1	7,600	4,463	3,137			3,495	3,015	0	1,090	2,356	4,154	0	1,090
3-2	5,745	3,090	2,655			2,266	2,778	0	700	1,239	3,806	0	700
3-3	12,132	6,721	5,411			5,707	4,976	0	1,449	3,608	7,075	0	1,449
4	1,587	741	665		181	530	672	0	385	395	810	0	382
4-3	116	116				74	29	0	13	0	103	0	13
4-4	1,471	625	665		181	456	644	0	372	395	708	0	369
Pine	**399,633**	**147,622**	**129,885**	**27,098**	**95,027**	**87,944**	**73,716**	**42,140**	**195,833**	**17,608**	**107,796**	**115,777**	**158,452**
COF	**237,289**	**71,291**	**78,515**	**17,152**	**70,332**	**37,572**	**48,084**	**37,249**	**114,384**	**1,624**	**49,771**	**86,479**	**99,415**
1	84,562	31,820	30,685	5,818	16,240	8,710	13,153	13,877	48,822	1,173	13,020	28,711	41,657
1-1	7,480	2,675	2,984	294	1,527	1,258	951	1,204	4,067	236	1,614	2,826	2,803
1-2	5,928	2,091	1,528	424	1,885	317	853	386	4,373	70	728	1,329	3,801
1-3	22,279	7,705	7,292	1,279	6,003	2,058	1,281	3,189	15,751	494	2,333	5,980	13,472
1-4	13,687	7,229	3,479	266	2,712	1,294	2,597	1,460	8,336	112	2,765	3,873	6,937
1-5	35,188	12,119	15,401	3,555	4,113	3,784	7,470	7,639	16,295	262	5,580	14,703	14,644
3	36,649	11,793	19,341	1,967	3,548	4,996	8,866	5,296	17,491	90	8,231	13,447	14,880
3-2	165	60	70	3	33	10	78	5	73	0	52	40	73

Alternative B		2010 Hiding/Thermal				2020 Hiding/Thermal				2050 Hiding/Thermal			
Subunit	**Total Acres**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**
3-3	11,559	3,603	6,345	324	1,286	1,160	1,725	1,965	6,708	2	2,162	3,819	5,576
3-4	4,198	973	2,237	589	399	196	669	1,057	2,276	15	285	1,860	2,037
3-5	20,727	7,157	10,689	1,051	1,830	3,630	6,394	2,269	8,434	73	5,731	7,728	7,194
4	56,434	17,296	20,970	4,953	13,215	8,016	12,022	7,660	28,736	330	11,163	20,277	24,665
4-3	24,954	5,707	9,452	1,904	7,891	4,261	4,976	2,766	12,952	126	5,389	8,698	10,741
4-4	25,064	9,752	8,762	2,566	3,984	2,400	5,057	4,090	13,517	204	3,986	9,059	11,816
4-5	6,417	1,837	2,755	483	1,341	1,355	1,989	804	2,268	0	1,788	2,520	2,109
5	59,644	10,383	7,519	4,414	37,328	15,850	14,043	10,416	19,334	32	17,357	24,043	18,212
5-1	19,449	5,046	4,418	1,309	8,677	8,347	4,266	2,844	3,992	7	8,934	7,187	3,321
5-2	40,195	5,338	3,101	3,104	28,651	7,503	9,777	7,572	15,342	25	8,422	16,856	14,892
KNF	**162,344**	**76,331**	**51,371**	**9,946**	**24,696**	**50,372**	**25,631**	**4,891**	**81,449**	**15,984**	**58,025**	**29,299**	**59,037**
3	45,422	14,474	17,037	5,215	8,696	7,489	6,432	2,277	29,224	4,657	6,425	9,849	24,490
3-1	11,205	4,506	4,268	1,034	1,397	2,970	1,586	557	6,092	1,939	2,224	2,327	4,715
3-2	16,975	2,682	7,054	2,816	4,424	2,009	2,126	1,014	11,826	1,207	1,827	4,375	9,565
3-3	17,242	7,287	5,716	1,366	2,874	2,511	2,720	706	11,305	1,511	2,374	3,148	10,209
4	75,733	29,026	28,647	4,731	13,329	13,317	13,484	2,559	46,374	5,709	20,631	18,768	30,625
4-2	7,381	2,836	1,759	833	1,953	1,563	583	238	4,997	860	1,422	1,332	3,767
4-3	29,965	14,327	9,047	1,375	5,217	6,780	6,237	764	16,185	1,973	12,970	6,337	8,685
4-4	38,386	11,862	17,841	2,523	6,160	4,974	6,663	1,557	25,192	2,876	6,238	11,100	18,172
6	41,188	32,831	5,687		2,671	29,566	5,716	55	5,851	5,617	30,969	681	3,922
6-2	5,069	4,198	539		332	4,338	151	0	580	578	4,049	0	442
6-3	32,635	25,844	4,526		2,265	22,640	5,374	55	4,566	4,986	23,546	681	3,422
6-4	3,484	2,789	622		74	2,588	191	0	705	53	3,373	0	58
Grand Total	**512,178**	**200,300**	**189,082**	**27,098**	**95,698**	**128,410**	**131,394**	**46,361**	**206,013**	**31,432**	**181,088**	**131,088**	**168,571**

Table 3. Alternative C

Alternative C		2010 Hiding/Thermal				2020 Hiding/Thermal				2050 Hiding/Thermal			
Subunit	**Total Acres**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**
Pine-Oak	**112,546**	**52,678**	**59,196**		**671**	**42,641**	**55,314**	**4,685**	**9,906**	**16,731**	**70,038**	**15,932**	**9,844**
COF	**85,482**	**37,664**	**47,329**		**490**	**30,606**	**43,794**	**4,685**	**6,397**	**8,067**	**55,145**	**15,932**	**6,338**
1	61,231	27,485	33,453		293	22,312	31,137	3,708	4,074	6,173	37,959	13,084	4,015
1-1	1,434	961	391		82	874	358	24	179	126	1,130	0	179
1-2	588	423	165			329	171	0	88	92	408	0	88
1-3	15,957	7,056	8,901			5,142	9,079	655	1,081	1,469	11,124	2,283	1,081
1-4	3,598	1,601	1,996		0	1,298	2,073	95	132	55	2,536	874	132
1-5	39,653	17,444	21,999		210	14,669	19,456	2,934	2,594	4,431	22,760	9,927	2,535
3	21,678	8,973	12,659		46	7,333	11,347	798	2,199	1,625	15,787	2,067	2,199
3-3	3,493	1,294	2,153		46	888	2,081	289	235	332	2,219	707	235
3-4	4,722	2,317	2,405			1,726	2,455	174	367	360	3,238	757	367
3-5	13,463	5,362	8,101			4,719	6,811	335	1,597	933	10,330	603	1,597
4	547	257	290			187	300	31	28	0	410	108	28
4-3	277	140	137			62	214	0	0	0	200	77	0
4-4	82	82				51	0	31	0	0	51	31	0
4-5	188	36	153			74	86	0	28	0	160	0	28
5	2,026	948	927		151	774	1,010	148	95	270	989	673	95
5-1	1,166	653	513			528	456	148	35	141	723	267	35
5-2	861	295	414		151	247	554	0	60	129	266	406	60
KNF	**27,063**	**15,015**	**11,868**		**181**	**12,035**	**11,520**	**0**	**3,509**	**8,664**	**14,893**	**0**	**3,506**
3	25,476	14,274	11,203			11,505	10,847	0	3,124	8,270	14,083	0	3,124
3-1	7,600	4,463	3,137			3,495	3,015	0	1,090	2,356	4,154	0	1,090
3-2	5,745	3,090	2,655			2,305	2,810	0	630	1,674	3,441	0	630
3-3	12,132	6,721	5,411			5,706	5,023	0	1,404	4,240	6,489	0	1,404
4	1,587	741	665		181	530	672	0	385	395	810	0	382
4-3	116	116				74	29	0	13	0	103	0	13
4-4	1,471	625	665		181	456	644	0	372	395	708	0	369

Alternative C		2010 Hiding/Thermal				2020 Hiding/Thermal				2050 Hiding/Thermal			
Subunit	**Total Acres**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**
Pine	**399,633**	**147,677**	**129,961**	**27,098**	**94,897**	**77,063**	**76,521**	**42,216**	**203,833**	**6,775**	**109,473**	**116,688**	**166,696**
COF	**237,289**	**71,291**	**78,515**	**17,152**	**70,332**	**36,188**	**50,409**	**37,399**	**113,292**	**0**	**51,022**	**87,137**	**99,131**
1	84,562	31,820	30,685	5,818	16,240	7,537	13,203	13,858	49,964	0	13,025	28,736	42,801
1-1	7,480	2,675	2,984	294	1,527	1,022	951	1,204	4,303	0	1,614	2,826	3,039
1-2	5,928	2,091	1,528	424	1,885	246	853	386	4,443	0	728	1,329	3,871
1-3	22,279	7,705	7,292	1,279	6,003	1,564	1,332	3,170	16,214	0	2,338	6,005	13,937
1-4	13,687	7,229	3,479	266	2,712	1,182	2,597	1,460	8,448	0	2,765	3,873	7,049
1-5	35,188	12,119	15,401	3,555	4,113	3,522	7,470	7,639	16,557	0	5,580	14,703	14,905
3	36,649	11,793	19,341	1,967	3,548	4,923	10,012	5,179	16,535	0	8,636	13,783	14,230
3-2	165	60	70	3	33	10	78	5	73	0	52	40	73
3-3	11,559	3,603	6,345	324	1,286	1,158	2,188	1,906	6,307	0	2,507	3,812	5,240
3-4	4,198	973	2,237	589	399	181	669	1,057	2,290	0	285	1,860	2,052
3-5	20,727	7,157	10,689	1,051	1,830	3,574	7,077	2,211	7,865	0	5,792	8,070	6,865
4	56,434	17,296	20,970	4,953	13,215	7,910	13,151	7,946	27,428	0	12,004	20,575	23,855
4-3	24,954	5,707	9,452	1,904	7,891	4,223	5,351	2,839	12,541	0	5,668	8,774	10,512
4-4	25,064	9,752	8,762	2,566	3,984	2,332	5,810	4,303	12,619	0	4,548	9,282	11,234
4-5	6,417	1,837	2,755	483	1,341	1,355	1,989	804	2,268	0	1,788	2,520	2,109
5	59,644	10,383	7,519	4,414	37,328	15,818	14,043	10,416	19,366	0	17,357	24,043	18,244
5-1	19,449	5,046	4,418	1,309	8,677	8,340	4,266	2,844	3,999	0	8,934	7,187	3,328
5-2	40,195	5,338	3,101	3,104	28,651	7,478	9,777	7,572	15,367	0	8,422	16,856	14,916
KNF	**162,344**	**76,386**	**51,447**	**9,946**	**24,565**	**40,874**	**26,112**	**4,817**	**90,540**	**6,775**	**58,451**	**29,551**	**67,566**
3	45,422	14,529	17,113	5,215	8,565	3,553	6,565	2,234	33,071	747	6,719	9,841	28,116
3-1	11,205	4,506	4,268	1,034	1,397	1,516	1,586	557	7,546	379	2,224	2,327	6,275
3-2	16,975	2,737	7,129	2,816	4,293	1,075	2,211	1,001	12,687	176	2,012	4,356	10,431
3-3	17,242	7,287	5,716	1,366	2,874	962	2,768	675	12,838	192	2,483	3,158	11,409
4	75,733	29,026	28,647	4,731	13,329	9,223	13,831	2,528	50,150	1,470	20,764	19,030	34,470
4-2	7,381	2,836	1,759	833	1,953	893	583	238	5,667	132	1,422	1,332	4,496
4-3	29,965	14,327	9,047	1,375	5,217	5,483	6,237	764	17,481	708	12,970	6,337	9,950

Alternative C		2010 Hiding/Thermal				2020 Hiding/Thermal				2050 Hiding/Thermal			
Subunit	**Total Acres**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**
4-4	38,386	11,862	17,841	2,523	6,160	2,846	7,011	1,527	27,002	630	6,371	11,361	20,024
6	41,188	32,831	5,687		2,671	28,098	5,716	55	7,319	4,559	30,969	681	4,980
6-2	5,069	4,198	539		332	4,086	151	0	832	457	4,049	0	563
6-3	32,635	25,844	4,526		2,265	21,462	5,374	55	5,744	4,084	23,546	681	4,324
6-4	3,484	2,789	622		74	2,550	191	0	743	18	3,373	0	93
Grand Total	**512,178**	**200,355**	**189,158**	**27,098**	**95,568**	**119,704**	**131,835**	**46,901**	**213,739**	**23,506**	**179,511**	**132,620**	**176,541**

Table 4. Alternative D

Alternative D		2010 Hiding/Thermal				2020 Hiding/Thermal				2050 Hiding/Thermal			
Subunit	**Total Acres**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**
Pine-Oak	**112,546**	**52,678**	**59,196**		**671**	**38,144**	**60,164**	**4,024**	**10,213**	**16,841**	**70,437**	**15,234**	**10,033**
COF	**85,482**	**37,664**	**47,329**		**490**	**27,186**	**47,683**	**4,024**	**6,589**	**7,470**	**56,366**	**15,234**	**6,412**
1	61,231	27,485	33,453		293	19,944	34,043	3,047	4,197	5,530	39,242	12,439	4,020
1-1	1,434	961	391		82	615	616	24	179	186	1,069	0	179
1-2	588	423	165			360	141	0	88	92	408	0	88
1-3	15,957	7,056	8,901			4,564	9,757	466	1,170	1,180	11,480	2,127	1,170
1-4	3,598	1,601	1,996		0	1,399	2,035	32	132	163	2,429	874	132
1-5	39,653	17,444	21,999		210	13,006	21,495	2,525	2,627	3,908	23,856	9,439	2,450
3	21,678	8,973	12,659		46	6,258	12,353	798	2,269	1,587	15,808	2,013	2,269
3-3	3,493	1,294	2,153		46	752	2,216	289	235	159	2,446	654	235
3-4	4,722	2,317	2,405			1,763	2,418	174	367	252	3,346	757	367
3-5	13,463	5,362	8,101			3,742	7,719	335	1,667	1,177	10,016	603	1,667
4	547	257	290			129	359	31	28	15	396	108	28
4-3	277	140	137			62	214	0	0	0	200	77	0
4-4	82	82				51	0	31	0	0	51	31	0
4-5	188	36	153			16	145	0	28	15	145	0	28

Alternative D		2010 Hiding/Thermal				2020 Hiding/Thermal				2050 Hiding/Thermal			
Subunit	**Total Acres**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**
5	2,026	948	927		151	856	928	148	95	338	920	673	95
5-1	1,166	653	513			502	481	148	35	210	654	267	35
5-2	861	295	414		151	354	447	0	60	129	266	406	60
KNF	**27,063**	**15,015**	**11,868**		**181**	**10,958**	**12,481**	**0**	**3,624**	**9,371**	**14,072**	**0**	**3,621**
3	25,476	14,274	11,203			10,503	11,735	0	3,239	8,956	13,282	0	3,239
3-1	7,600	4,463	3,137			3,386	3,124	0	1,090	3,152	3,358	0	1,090
3-2	5,745	3,090	2,655			2,051	2,994	0	700	1,636	3,409	0	700
3-3	12,132	6,721	5,411			5,066	5,617	0	1,449	4,168	6,516	0	1,449
4	1,587	741	665		181	456	746	0	385	415	790	0	382
4-3	116	116				0	103	0	13	0	103	0	13
4-4	1,471	625	665		181	456	644	0	372	415	687	0	369
Pine	**399,633**	**147,622**	**129,885**	**27,098**	**95,027**	**109,689**	**84,746**	**39,174**	**166,023**	**41,329**	**106,210**	**105,651**	**146,442**
COF	**237,289**	**71,291**	**78,515**	**17,152**	**70,332**	**51,868**	**53,374**	**33,642**	**98,405**	**15,833**	**48,063**	**81,561**	**91,833**
1	84,562	31,820	30,685	5,818	16,240	17,531	15,720	11,254	40,058	10,158	13,040	25,182	36,183
1-1	7,480	2,675	2,984	294	1,527	1,973	1,116	1,364	3,027	1,233	1,041	2,787	2,419
1-2	5,928	2,091	1,528	424	1,885	1,135	775	376	3,642	543	892	1,096	3,399
1-3	22,279	7,705	7,292	1,279	6,003	3,963	1,672	3,135	13,509	3,212	2,082	5,115	11,870
1-4	13,687	7,229	3,479	266	2,712	3,660	3,114	556	6,356	2,127	3,552	2,641	5,367
1-5	35,188	12,119	15,401	3,555	4,113	6,800	9,042	5,822	13,524	3,043	5,473	13,544	13,128
3	36,649	11,793	19,341	1,967	3,548	6,654	9,246	5,780	14,968	1,946	7,991	12,536	14,177
3-2	165	60	70	3	33	10	80	3	73	10	42	40	73
3-3	11,559	3,603	6,345	324	1,286	1,827	1,629	2,457	5,646	254	2,065	3,819	5,422
3-4	4,198	973	2,237	589	399	349	836	1,000	2,013	276	349	1,690	1,883
3-5	20,727	7,157	10,689	1,051	1,830	4,468	6,702	2,321	7,237	1,406	5,535	6,987	6,799
4	56,434	17,296	20,970	4,953	13,215	10,906	13,092	7,332	25,104	3,132	10,133	19,825	23,345
4-3	24,954	5,707	9,452	1,904	7,891	5,241	5,311	3,165	11,236	1,173	4,966	8,582	10,233
4-4	25,064	9,752	8,762	2,566	3,984	3,972	5,967	3,360	11,765	1,707	3,508	8,739	11,109
4-5	6,417	1,837	2,755	483	1,341	1,692	1,815	807	2,103	252	1,658	2,504	2,003

Alternative D		2010 Hiding/Thermal				2020 Hiding/Thermal				2050 Hiding/Thermal			
Subunit	**Total Acres**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**	**Hiding Only**	**Hiding/ Thermal**	**Thermal Only**	**Not Cover**
5	59,644	10,383	7,519	4,414	37,328	16,777	15,316	9,276	18,275	597	16,900	24,018	18,129
5-1	19,449	5,046	4,418	1,309	8,677	8,755	5,368	2,009	3,317	464	8,503	7,187	3,295
5-2	40,195	5,338	3,101	3,104	28,651	8,022	9,948	7,267	14,957	133	8,397	16,831	14,834
KNF	**162,344**	**76,331**	**51,371**	**9,946**	**24,696**	**57,820**	**31,372**	**5,533**	**67,618**	**25,496**	**58,147**	**24,091**	**54,610**
3	45,422	14,474	17,037	5,215	8,696	9,348	8,906	2,712	24,456	7,698	7,134	8,052	22,539
3-1	11,205	4,506	4,268	1,034	1,397	3,403	2,397	610	4,795	2,759	2,323	1,850	4,273
3-2	16,975	2,682	7,054	2,816	4,424	2,393	3,608	1,375	9,600	1,901	2,101	3,857	9,117
3-3	17,242	7,287	5,716	1,366	2,874	3,552	2,901	728	10,062	3,038	2,710	2,345	9,149
4	75,733	29,026	28,647	4,731	13,329	17,672	17,930	2,820	37,311	9,539	22,208	15,427	28,559
4-2	7,381	2,836	1,759	833	1,953	1,857	1,173	263	4,088	1,369	1,462	1,074	3,477
4-3	29,965	14,327	9,047	1,375	5,217	8,730	6,795	789	13,652	3,254	13,512	5,084	8,116
4-4	38,386	11,862	17,841	2,523	6,160	7,085	9,962	1,768	19,571	4,916	7,234	9,270	16,966
6	41,188	32,831	5,687		2,671	30,801	4,537	0	5,851	8,259	28,806	612	3,512
6-2	5,069	4,198	539		332	4,221	267	0	580	764	3,994	0	311
6-3	32,635	25,844	4,526		2,265	23,960	4,109	0	4,566	7,291	21,586	612	3,146
6-4	3,484	2,789	622		74	2,619	161	0	705	204	3,226	0	55
Grand Total	**512,178**	**200,300**	**189,082**	**27,098**	**95,698**	**147,833**	**144,911**	**43,198**	**176,236**	**58,170**	**176,648**	**120,885**	**156,476**

Appendix 10. Status of Game Species and Their Potential Response to Treatments within the Four Forest Restoration Initiative

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Overview

The Arizona Game and Fish Department (AGFD) requested the opportunity to work as a member of the planning team for the Four Forest Restoration Initiative (4FRI). Their contributions included updating population trends for game species that serve as Management Indicator Species on the Coconino and Kaibab National Forests. Summaries on species biology, ecology, and population trends were created by Sara Reif, AGFD Region 2 Habitat Program Manager (Flagstaff, Arizona) in 2012.

Tassel-eared squirrels



Tassel-eared squirrels (*Sciurus aberti*, also known as Abert's squirrel) are an indicator of early seral ponderosa pine habitat in both the Coconino and Kaibab Forest Plans. Preferred habitat structure is composed of intermediate to older aged forest (trees 9-22+ inches dbh; Dodd et al. 1998, Elson 1999). The tassel-eared squirrel is considered a ponderosa pine "obligate" species. It relies on ponderosa pine and associated hypogenous fungi (Keith 1965, Stephenson 1975, States et al. 1988, Austin 1990, Snyder 1992) for most of its diet, and its nests are placed almost exclusively in these pines (Halloran and Bekoff 1994, Snyder and Linhart 1994), which also provide escape cover from predators and movement corridors created by interlocking tree canopies (Stephenson and Brown 1980). Additional information on tassel-eared squirrels is available in the forestwide management indicator species (MIS) status reports for both the Coconino NF (USDA FS 2002) and the Kaibab NF (USDA FS 2010).

Population Trend

Population estimates have not been directly measured for tassel-eared squirrels on the Coconino or Kaibab NFs. Squirrel feeding sign data were collected during songbird surveys by the Kaibab NF and the Rocky Mountain Bird Observatory, but sample size was limited (see below). Global heritage rating is G5, indicating populations are demonstrably secure, although isolated sub-species could be rare. Heritage rating in Arizona is S5, indicating a secure population in the state (NatureServe 2002). AGFD data of statewide tree squirrel harvest indicate inherently variable but stable trends in hunter harvest from 1995–2004, and from 2004–2009 (AGFD 2011a; **Error! Reference source not found.**). Methodologies were different between the time periods and so harvest rates are not directly comparable. Harvest rates do not include junior harvest and therefore likely underestimate total annual harvest of tree squirrels. These data include all species of tree squirrels in Arizona, not just tassel-eared squirrels, and so better represent the popularity of squirrel hunting than a density index. AGFD biologists postulate that, because tree densities, basal area, and canopy cover are higher than the historical range of variability, current tassel-eared squirrels numbers are likely inflated relative to levels before Euro-settlement. Although these forest metrics were not well documented, the hypothesis is supported by Brown and Davis (1998).

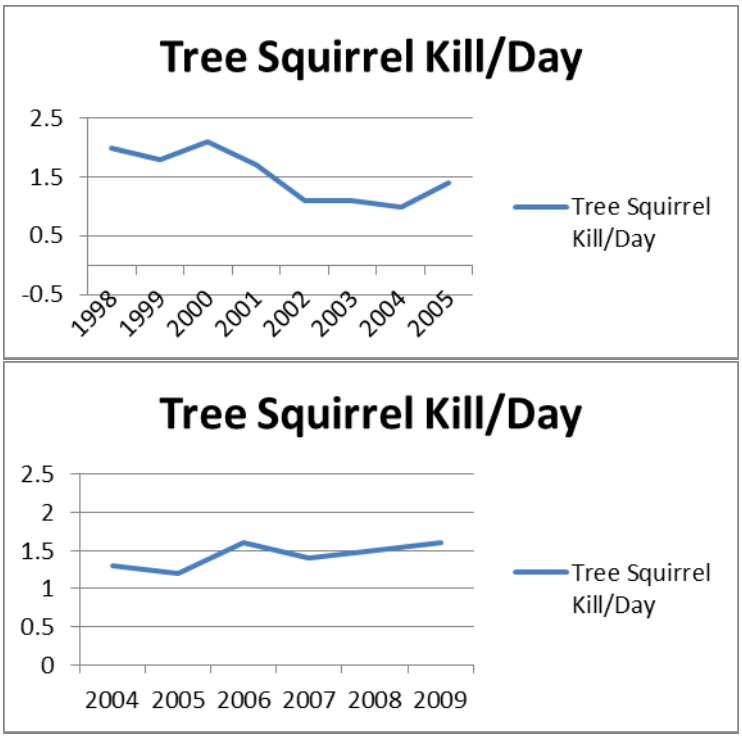


Figure 1. Tree squirrel harvest per day in Arizona from 1998–2004, and from 2004–2009. Note: harvest rates between the two time periods are not directly comparable because different survey methodologies were used beginning in 2004 (though both methodologies were conducted simultaneously 2004–2005). Harvest rates do not include junior harvest and therefore likely underestimate annual harvest of tree squirrels.

Additional population trend information is available for the Coconino NF, where AGFD feeding sign surveys were conducted from 2005 - 2010 in association with FS vegetation management projects in the Flagstaff wildland-urban interface (Yarborough et al. 2010). Feeding sign survey results indicate a stable trend in tassel-eared squirrel abundance on the Forest (Figure 2). Treated areas received recent fuels reduction treatment in the form of mechanical thinning and/or prescribed fire. Untreated areas had no recent fuels reduction treatments.

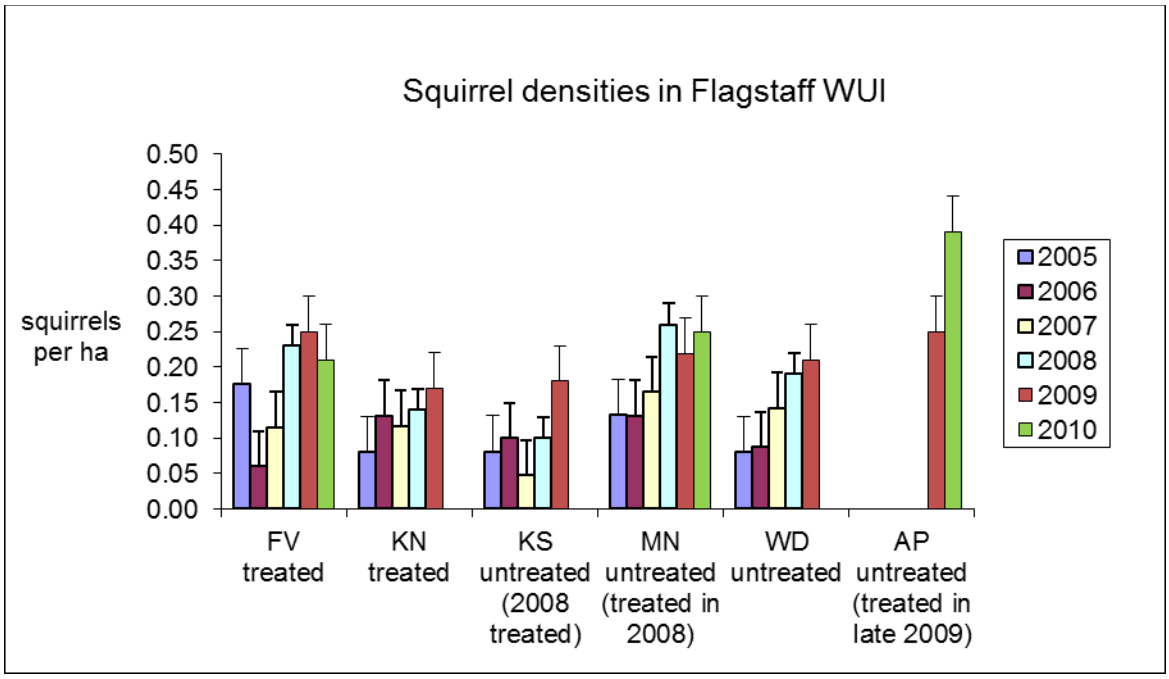


Figure 2. Feeding sign survey results from 2005- 2010 in Fort Valley (FV), Kachina North (KN), Kachina South (KS), Mountainaire (MN), Woody Ridge (WD), and Airport (AP) study sites in the Flagstaff Wildland-Urban Interface. There is no statistical difference between error bars in this graph.

Limited squirrel data were also available for the Kaibab NF. The Kaibab and the Rocky Mountain Bird Observatory collected observations of squirrels and their feeding sign during songbird surveys on the forest from 2005 – 2009 (Pavlacky 2011). This was during the initiation and development of both bird and squirrel surveys at the forest level. Trend data were summarized by year, limiting total data points to $n = 5$. The Rocky Mountain Bird Observatory found an increasing trend in squirrel feeding sign (Figure 3). However, inferences are limited by variance and sample size. Study design and methodology were changed for both song birds and squirrels in 2012 to better meet monitoring objectives.

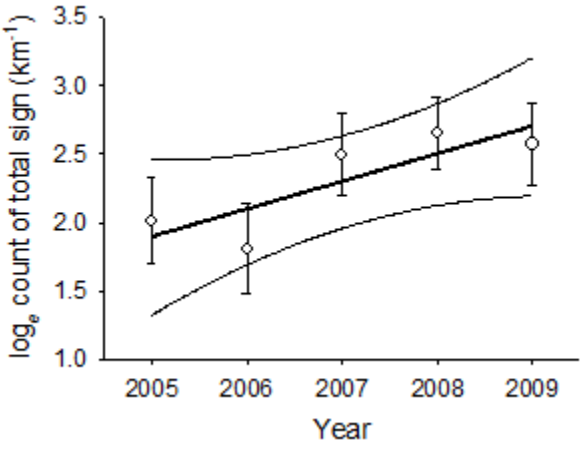


Figure 3. The temporal trend for total tassel-eared squirrel sign (km^{-1}) from 2005 to 2009 (Pavlacky 2011). The bold trend line is the estimated count of total sign (km^{-1}) and the upper and lower lines are 95% confidence limits. The open circles are the mean count of total sign (km^{-1}) by year with error bars of 1 standard error. Data were transformed using the natural log of total counts.

Habitat Use and Trend

Tassel-eared squirrels select for groups of older, larger ponderosa pine trees with high canopy density. They are not wide-ranging species; their home ranges vary from 4 ha up to 70 ha, with juvenile dispersal distances ranging between 0.5 – 0.89 miles (Farentinos 1979).

Areas with higher basal area and canopy cover as well as interlocking canopies contain the highest densities of squirrels based on feeding sign survey data (Yarborough et al. 2010). The squirrel's ability to access the growing pine shoots it depends on for food, as well as its ability to escape predators, is dependent on interlocking tree canopies especially during winter when snow accumulation can impede ground travel (Stephenson and Brown 1980). When snow is absent, tassel-eared squirrels will forage on the forest floor primarily for mycorrhizal fungi ("truffles") associated with pine tree roots (States et al. 1988). Tassel-eared squirrels also depend on ponderosa pine seeds to meet their nutritional demands.

Nest trees are generally taller and larger than surrounding trees (62 ± 9 feet versus 44 ± 16 feet tall and 15 inches dbh ± 3 inches versus 11 ± 7 inches dbh; Halloran and Beckoff 1994). Prather et al. (2006) found that local basal area explained squirrel density in 9 northern Arizona studies, and Dodd et al. (1998) estimated optimal basal area for squirrels to be greater than 150 ft^2 per acre. Stand-level canopy cover of 40-50% probably represents a threshold for optimal tree squirrel habitat and is particularly important for recruitment (Dodd et al. 1998; Prather et al. 2006; Loberger et al. 2011). At the scale of the stand and the restoration unit, a continuously dense forest is not required for squirrels as long as denser patches of forest are retained for foraging, nesting, and escaping predators. Dodd et al. (2006) postulated that up to 75% of a forested landscape could be treated and still provide suitable squirrel habitat if treatments were applied as a mosaic of patches and areas of optimal habitat were retained.

Potential Effects

Effects of Thinning

Forest tree thinning under the goshawk guidelines should result in a mosaic of vegetative structural stages, interrupt canopy closure, and allow more sunlight to reach the forest floor. In the moderate- to high-intensity treatments, the reduction in canopy connectedness will reduce safe travel routes for tassel-eared squirrels and expose them to higher rates of predation. These higher-intensity treatments will also expose more of the forest floor to direct sunlight which could remove the microsite habitat for mycorrhizal fungi production, thereby reducing an important food source for squirrels. Tassel-eared squirrels may shift their patterns of nesting and foraging in response to restoration treatments because there will be a patch mosaic that includes untreated or lightly-treated areas. A ratio of optimal to sub-optimal patches that is skewed toward a more open condition will be less desirable to the squirrel and could lead to a short-term reduction in current squirrel populations. Post-treatment conditions would also stimulate tree growth and increase canopy connectedness, which should have a positive long-term impact to squirrel populations.

Despite the proposed reduction in dense forest conditions, sustainable forests that include large, cone-bearing trees (either as individual legacy trees or in groups of mature and old-growth trees interspersed with patches suitable for fungi production) would provide squirrel habitat. Canopy connectivity would be retained in groups rather than across whole landscapes. In the long term this should provide for more sustainable squirrel habitat over time because the risk of stand-replacing fire, bark beetles, and disease, and therefore long-term degradation or loss of squirrel habitat, would be significantly reduced (USDA FS 2010). The long-term benefit is particularly important in light of predicted climate changes (see "Climate Change in All Alternatives" in the Affected Environment section of the wildlife report).

Proposed thinning treatments may cause visual or auditory disturbance to individual squirrels, although these effects would be short-term and limited in scope. Best management practices will direct operators to avoid removal of trees containing squirrel nests.

The inclusion of the Large Tree Retention Strategy (LTRS) and the incorporation of wildlife research will allow for higher basal area and canopy cover contributions from large-diameter trees, which should benefit tassel-eared squirrels for nesting and for winter cover. The larger forest patches created in the wildlife research project will increase the amount of optimal squirrel habitat available as well.

Effects of Prescribed Burning

Disruption of normal behavioral patterns could occur to tassel-eared squirrels during burning activities, particularly since the proposed action calls for burning up to 40,000 acres annually. Effects would likely be due to direct disturbance by human presence during burning activities as well as smoke inhalation. However, human disturbance and smoke effects should be transitory in nature and short-term. Prescribed fire treatments are expected to be implemented twice in the next 10 years, which would increase the frequency of fire disturbance to tassel-eared squirrels. However, squirrels evolved with a frequent fire return interval so prescribed fire effects should not result in dramatic shifts in squirrel behavior or habitat use.

Pile burning on steep slopes could disrupt normal behavioral patterns. Effects would likely be due to direct disturbance by human presence during burning activities as well as smoke inhalation. However, human disturbance and smoke effects should be transitory in nature and short-term and only in isolated patches across the project area.

Effects of Aspen Treatments

Tassel-eared squirrel associations with aspen are not well-documented. Aspen treatments are not expected to impact this species.

Effects of Grassland and Savanna Treatments

Grasslands are not selected for by tassel-eared squirrels; therefore, direct and indirect effects of burning in these open habitats are expected to be minimal for squirrels.

Effects of Stream/Spring Restoration

Tassel-eared squirrel associations with ephemeral streams and springs are not well-documented. Stream and spring restoration is not expected to impact this species.

Effects of Road Closure/Obliteration

Little documentation exists to demonstrate that tassel-eared squirrels avoid or select for roads, so the effect of closures is unknown but assumed to be of benefit to the species since road-killed squirrels are commonly observed on both Forests.

Elk



Elk (*Cervus elaphus*) are an indicator of early-seral ponderosa pine for the Coconino and Kaibab NFs, and are an economically and socially important species. Elk are habitat generalists. In addition to occupying ponderosa pine forests, they graze grassland and woodland habitats as well as aspen and riparian areas. On both the Kaibab and Coconino NFs, elk occupy mountain meadows and forests in summer and move to lower-elevation pinyon-juniper woodland, conifer forest, and grasslands in winter (Hoffmeister 1986, USDA FS 2002, USDA FS 2010). Elk prefer grasses, and they also eat forbs, shrubs, and trees such as Gambel oak and quaking aspen (Boyd 1978, Burt and Grossenheider 1976, Hoffmeister 1986, NatureServe 2001). They are a wide-ranging species; a recent study of elk movements on Camp Navajo indicates minimum convex polygon home range sizes for elk between 61.8 and 169.8 square miles, with average daily movements of 3.1 miles (Partridge and Ingraldi 2007). Therefore, individuals will likely respond to changes in forest management at the scale of the restoration unit and the project area.

According to the AGFD, the 4FRI project area includes portions of four elk herds (Figure 4; McCall, personal communication 2011). One herd includes Game Management Unit (GMU) 5A/5B/6A and occurs on the Coconino NF. The second herd includes 6B, 8, and Camp Navajo, which overlaps with both the Coconino and Kaibab NFs. The third is contained within GMU 7, which overlaps with both Forests. GMU 7 has some population exchange with the fourth herd in GMU 9, which occurs primarily on the Tusayan Ranger District of the Kaibab NF. It is important to note that elk that intermix among herds do not always go back to their respective GMU after winter, which complicates interpretation of both population- and habitat-utilization data for this species.

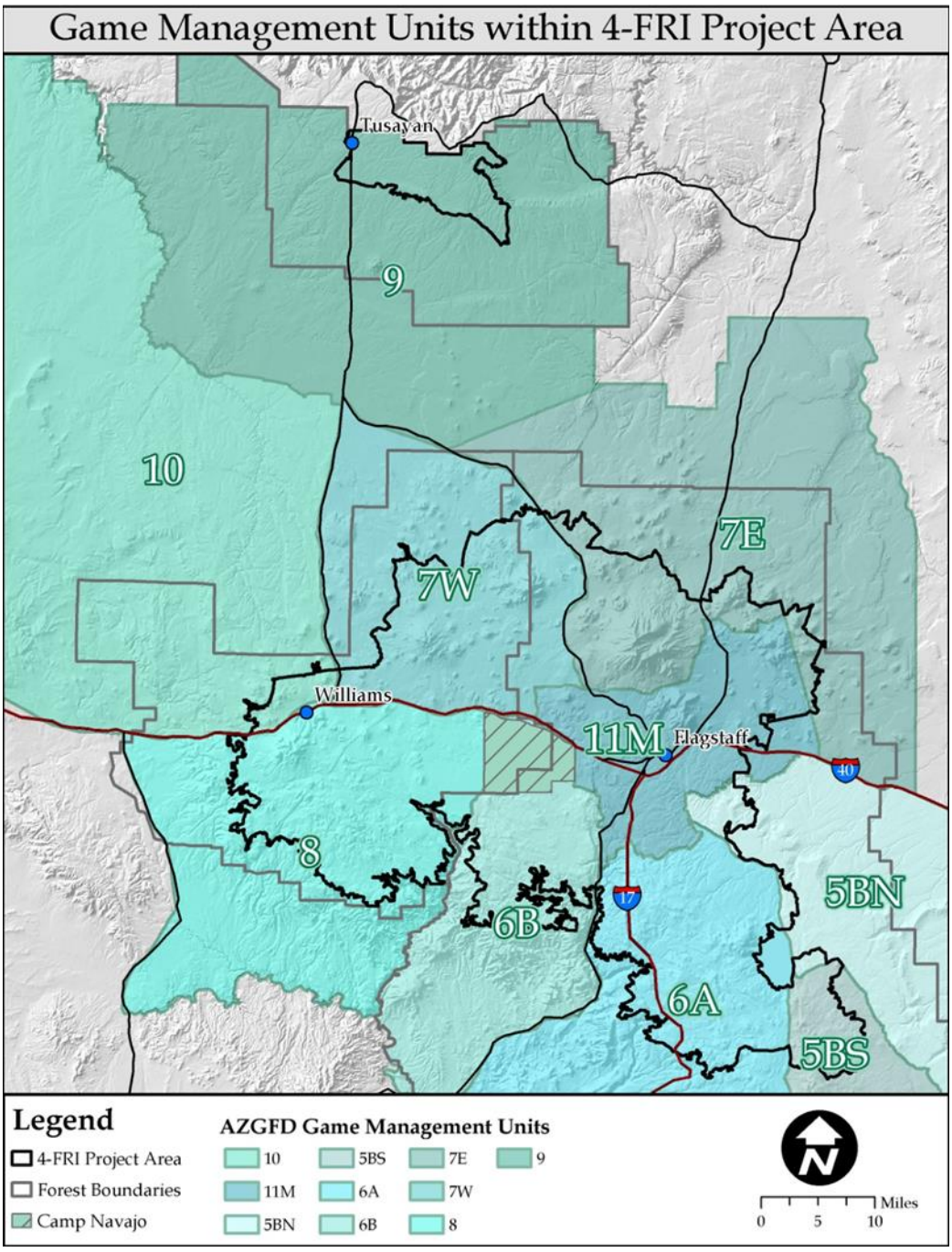


Figure 4. Arizona Game and Fish Department Game Management Units within the 4FRI Project Area

Population Trend

Because of their primary responsibilities for managing wildlife, the main data source for elk population trend comes from AGFD survey and hunt data, which shows a stable to decreasing trend in elk populations. Data used in this analysis were collected by game managers using aerial (fixed-wing aircraft and helicopter) and ground-based (driving and horseback) survey methods. Survey methods vary across GMUs, and some methods vary across years for certain GMUs. The lack of consistency in survey methods is due in large part to the difficulty in detecting elk in heavy forested cover and because patterns

of elk distribution shift in response to precipitation patterns over time. This inconsistency makes interpretation of population data more difficult than if methodologies and effort were consistent across GMUs and across years.

AGFD evaluates trends in elk populations based on 1) annual surveys (Figure 5), and 2) population estimates derived from a model that takes cow:calf ratios, bull:cow ratios, harvest, and estimated annual background mortality into consideration (Figure 6). Modeled mortality rates are based on limited available data from Brown (1994) and J. Gagnon unpublished data (AGFD files 2010). One limitation of this model is that it requires modelers to select a beginning population size for bulls and cows for which reliable data are lacking. Modelers must set beginning population size using anecdotal inference from earliest known survey numbers. For this reason, AGFD recommends greater emphasis on trends rather than absolute numbers. Population trend estimates are available from 1988 through 2009.

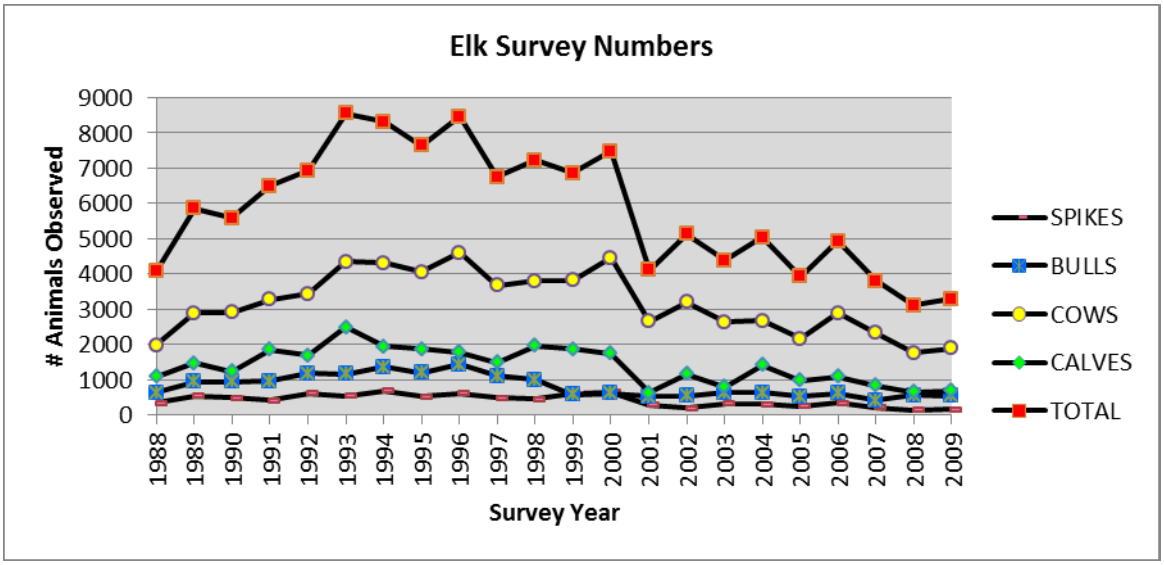


Figure 5. Elk survey trends on the Coconino and Kaibab National Forests. Numbers are collected during annual surveys. Data are unpublished but available from AGFD Flagstaff Regional Office (Lutch, personal communication, November 2011).

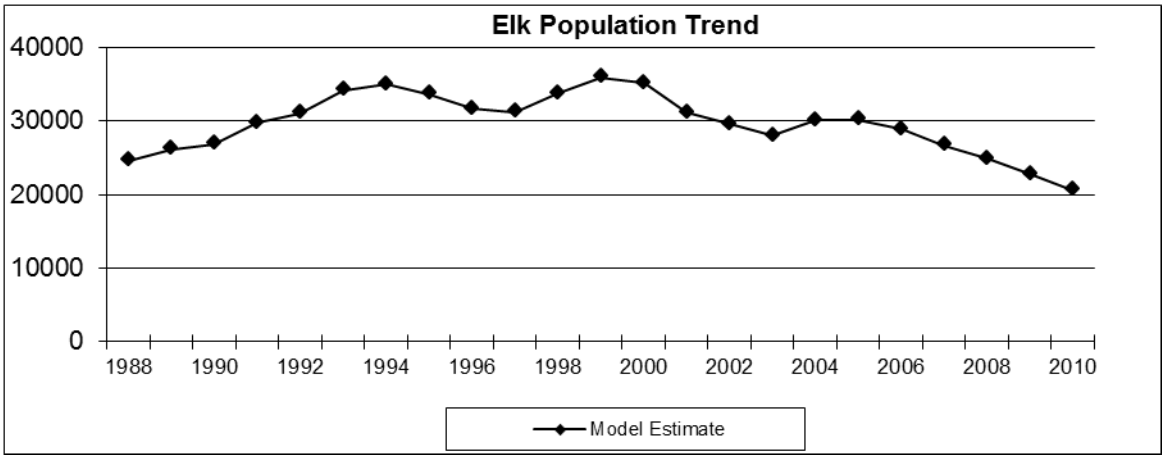


Figure 6. Trend in estimates elk populations for the Coconino and Kaibab National Forests from 1988-2009. Includes Game Management Units 5A, 5B, 6A, 6B, Camp Navajo, 7, 8, and 9. Data are unpublished but available from the AGFD Flagstaff Regional Office (Lutch, personal communication, November 2011).

Figure 5 and Figure 6 show a stable to decreasing trend in elk numbers over time on the Coconino and Kaibab National Forests, with a peak in the mid-1990s. From 1988 to 2008 elk populations increased by 9%; however, more recent efforts to reduce populations in response to declines in habitat quality have led to a 33% decline in estimated elk numbers during the years 2000–2011 (with the last two years based on projected trend).

Habitat Use

Elk select their habitat based on a relatively even ratio of forest (cover) to openings (forage) (Dealy 1985, Brown 1994). Forested cover is thought to be important for elk to protect against changes above and below critical temperature tolerances (Dealy 1985), and to provide places for elk to hide from human disturbance, particularly along roadways or in areas of timber harvest (Ward 1975). Elk typically select hiding and thermal cover in areas with high canopy density (70%) and a low canopy-base height (6.5 feet) (Brown 1994). Tree size class is less important to elk as long canopy requirements are met, though elk bedding sites are often found in early seral forests with a high percentage of vegetation structural stage (VSS) 2 and 3 tree groups (Brown 1994). However, recent studies postulate thermal cover is not as important for elk as forage availability in terms of maintaining good body condition (Cook et al. 2004). Foraging areas are primarily openings in the forest canopy where perennial grasses and forbs are more readily available (Reynolds 1966). Elk also forage in areas dominated by Gambel oak and quaking aspen where they feed on sprouts and ramets. Forest management practices that create an interspersion of forest tree groups and openings tend to improve habitat conditions for elk by increasing understory primary productivity while still providing cover nearby (Johnson and Matchett 2001, Van Dyke and Darragh 2007).

High levels of elk utilization can have negative impacts on sensitive areas within the project area, particularly in aspen clones (Fairweather et al. 2008) and montane riparian areas such as springs and ephemeral stream channels (Neary and Medina 1996). Elk utilization contributes to the overall lack of aspen recruitment from the young sucker stage into larger size classes. In springs, wet meadows, and stream channels, trampling and vegetation removal by elk contributes to geomorphic changes, causing erosion, channel widening, and overall degradation of riparian systems (Neary and Medina 1996).

Current trends in elk habitat on both forests are stable to increasing, due in large part to the increase in fuels reduction projects aimed at opening forest canopies which increases elk forage availability (USDA FS 2002, 2010). AGFD contemporary efforts to reduce elk populations have helped ameliorate habitat changes, contributing towards stabilizing population trends with the exception of aspen areas where browse pressure remains high (Fairweather et al. 2008).

Habitat Changes

Continuing the current forest growth trajectory would continue to provide large patches of trees with higher basal area, canopy density, and interlocking crowns, which would provide thermal and hiding cover for elk. However, pine encroachment into grassy openings and meadows will continue to limit foraging habitat for elk. The current unnatural stand densities will threaten sustainability of elk habitat over time by limiting understory production and creating risk for uncharacteristic, high-severity fire.

Potential Effects

Effects of Mechanical Thinning

Thinning small-diameter trees and using prescribed fire in ponderosa pine would open the canopy and decrease fine fuels on the forest floor. The result would be increased growth of herbaceous and shrub-level vegetation, which would provide increased forage in the long term, with expected benefits as soon

as 1-2 years following prescribed fire (Canon et al. 1987 *in* Pilliod et al. 2006). Reducing tree densities and ladder fuels would reduce available thermal and hiding cover for elk. However, thermal protection for elk would continue to be available in areas maintained for higher BA and canopy density including MSO nesting and restricted habitat, northern goshawk nest stands, bald eagle roosts, buffers around caves and sinkholes, and areas excluded from mechanical treatment such as wilderness and slopes >40%.

Thinning small-diameter trees and burning in Gambel oak could also reduce hiding and thermal cover for elk in the short term. This risk, however, must be weighed against the risk of stand-replacing fire events. Project design criteria for both habitats include tree thinning under the goshawk guidelines. This should result in a mosaic of interspersed vegetation structural stages including early-seral habitat, and would provide necessary habitat characteristics, such as bedding sites and open areas with increased forage for elk in the long term.

The inclusion of the LTRS and the incorporation of watershed and wildlife research areas under alternative C would benefit elk for thermal cover. Design features intended to maintain variable size-class trees and variable tree densities within groups would contribute towards hiding and thermal cover.

Since elk also select for grasslands where increased herbaceous productivity provides foraging opportunities, the grassland treatments proposed in Alternative C would likely benefit elk.

Proposed thinning treatments may cause visual or auditory disturbance to individual elk, although these effects would be short-term. Best management practices would place seasonal restrictions on logging activities in known elk calving areas to reduce the likelihood of direct impacts.

Effects of Prescribed Fire

Disruption of normal behavioral patterns could occur to elk during burning activities. Prescribed fire treatments would increase the frequency of fire disturbance to elk. Effects would likely be due to direct disturbance by human presence during burning activities as well as spatial displacement by fire and smoke. However, human disturbance and smoke displacement should be transitory in nature and short-term. Since elk are capable of moving several miles in any given day, it is likely they will be able to move out of fire and smoke paths in the event of prescribed burns. Although the 4FRI Project includes noxious weed control, the risk of cheatgrass invasion following restoration treatments has the potential to negatively impact mule deer habitats in the long term (McGlone et al. 2009).

Effects of Aspen, Spring, and Ephemeral Channel Restoration

Exclusion of elk from aspen, springs, and ephemeral channels will limit their ability to access those forage and water resources. However, the increased herbaceous productivity resulting from forest thinning is likely to offset elk utilization of aspen and riparian areas. Springs and ephemeral channels do not represent reliable water sources for elk and exclusion of these areas should not have an impact given the relatively high availability of permanent, artificial water sources across the project area.

Effects of Road Closure/Obliteration

Closure and obliteration of unauthorized roads will positively impact elk. Elk are known to avoid roads and heavily used recreational areas (Ward 1975).

Mule deer

Mule deer (*Odocoileus hemionus*) are an indicator of early-seral aspen and pinyon-juniper for the Coconino and Kaibab NFs, and is an economically and socially important species. Mule deer typically summer at higher elevations in aspen, mixed conifer, and ponderosa pine forests, and transition to winter in pinyon-juniper woodlands found at lower elevations (Hoffmeister 1986). Mule deer are browsers and prefer leaves and twigs from shrubs and trees over grasses. Home range size varies, depending upon availability of forage and cover. Mule deer in the vicinity of the Tusayan and Williams Ranger Districts (Kaibab NF) have an estimated home range 141.1 square miles (±48.3) (Dodd et al. 2010). Since mule deer are a relatively wide-ranging species, they are likely to respond to changes in forest management at small and large spatial scales.

Population Trend

Mule deer are currently listed as G5, N5, and S5 (NatureServe 2010a). The species is considered to be demonstrably widespread, abundant, and secure, globally, nationally (USA), and statewide (AZ).

Mule deer populations have fluctuated throughout history due to influences of precipitation, habitat quality, predation, and hunting pressure (Heffelfinger and Messmer 2003). Annual statewide survey data from 1946 – 2008 demonstrate this fluctuation in mule deer abundance, and show a contemporary decline in mule deer surveyed that began in the mid-1990s but has stabilized since 2004 (Appendix 6, Figure 7). This is consistent with the forest-wide population trend determinations for both forests (Coconino NF – decreasing (USDA FS 2002); Kaibab NF – stable to decreasing (USDA FS 2010)).

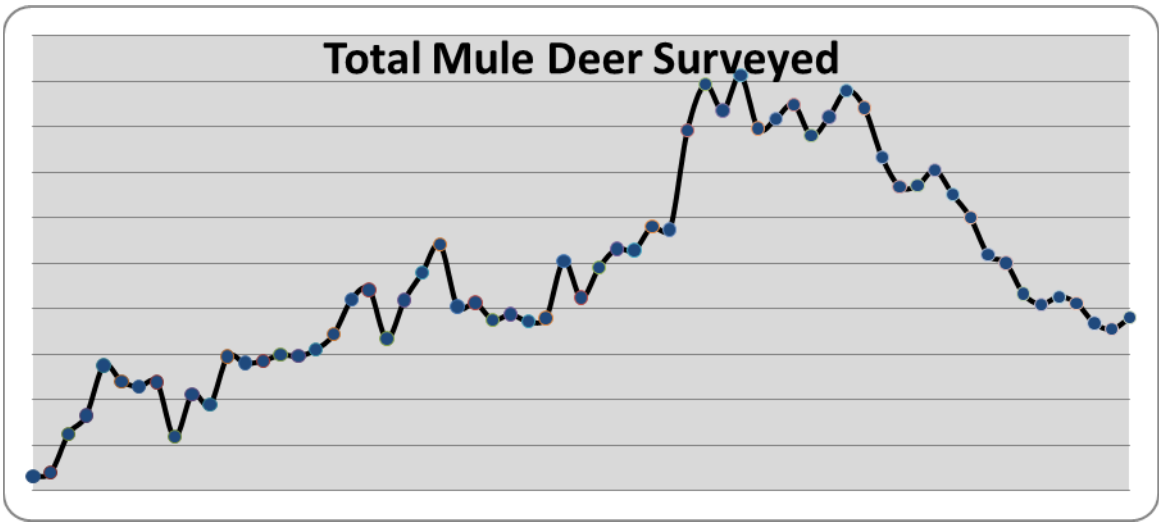


Figure 7. Results of annual statewide mule deer surveys 1946 – 2010 (Appendix 6)

For the purpose of this analysis, data were compiled from files at the Flagstaff Regional Office of the AGFD in order to determine population trends on the Coconino and Kaibab NFs (McCall, AGFD, unpublished files, November 2011). The two best indicators for mule deer population trend are 1) the number of mule deer observed during annual surveys, and 2) number of fawns per 100 does. These two indicators are used because they are more reliable than population modeling estimations for mule deer. Given the inconsistency of survey methodologies, population model outputs and deer observed/hour of survey are less reliable than actual survey numbers (McCall, personal communication, November 2011). Data are displayed by Game Management Unit (GMU; Figure 8, Figure 9, and Figure 10). For the

Coconino NF, data are relevant from GMUs 5A and 5B (combined only for mule deer analysis), 6A, 6B, 7, and 8. For the Kaibab NF, data are relevant from GMUs 6B, 7, 8, and 9. There is some intermingling of mule deer across the two forests, primarily between GMUs 7 and 9. All GMUs are relevant to the 4FRI project area.

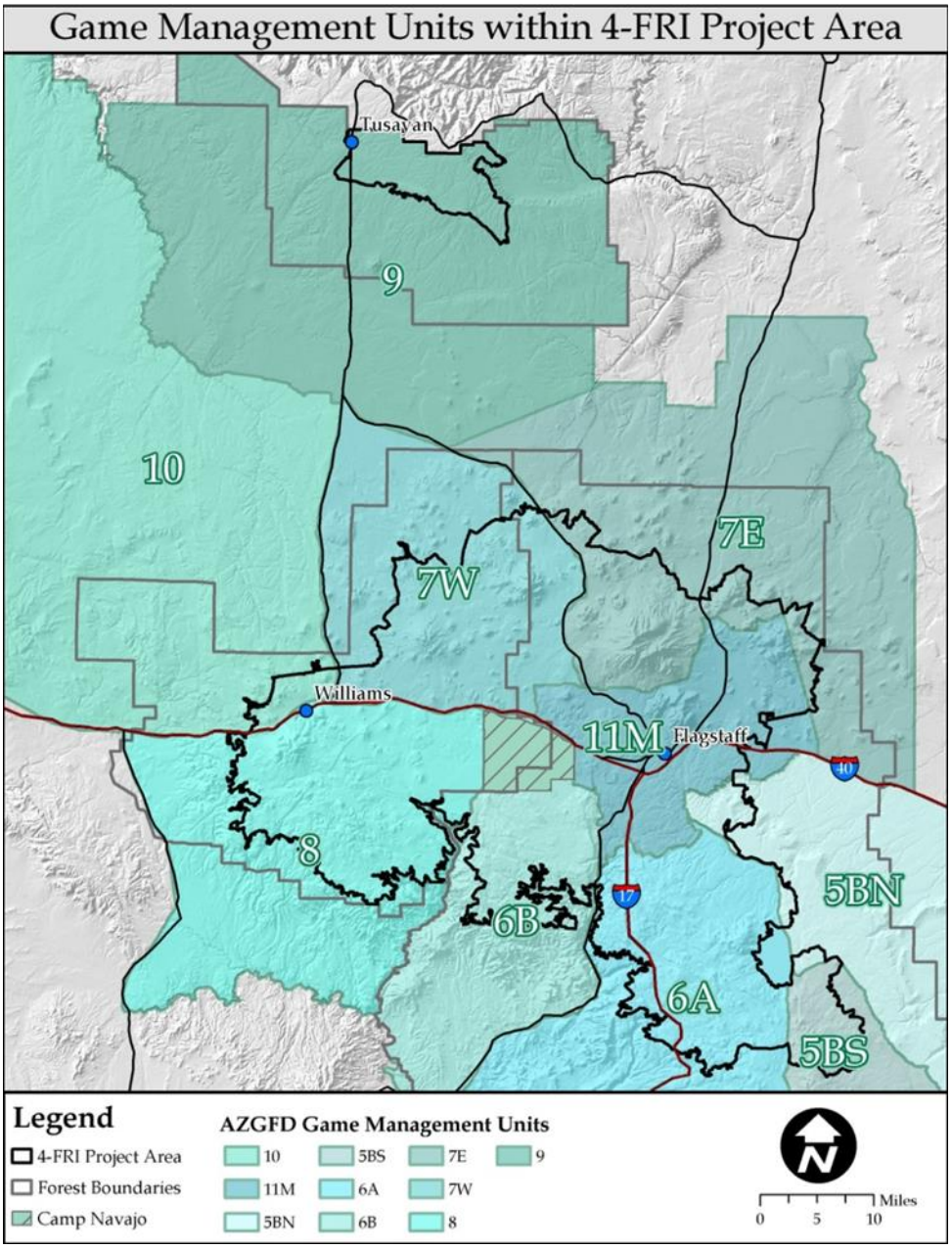


Figure 8. Arizona Game and Fish Department Game Management Units within the 4FRI Project Area

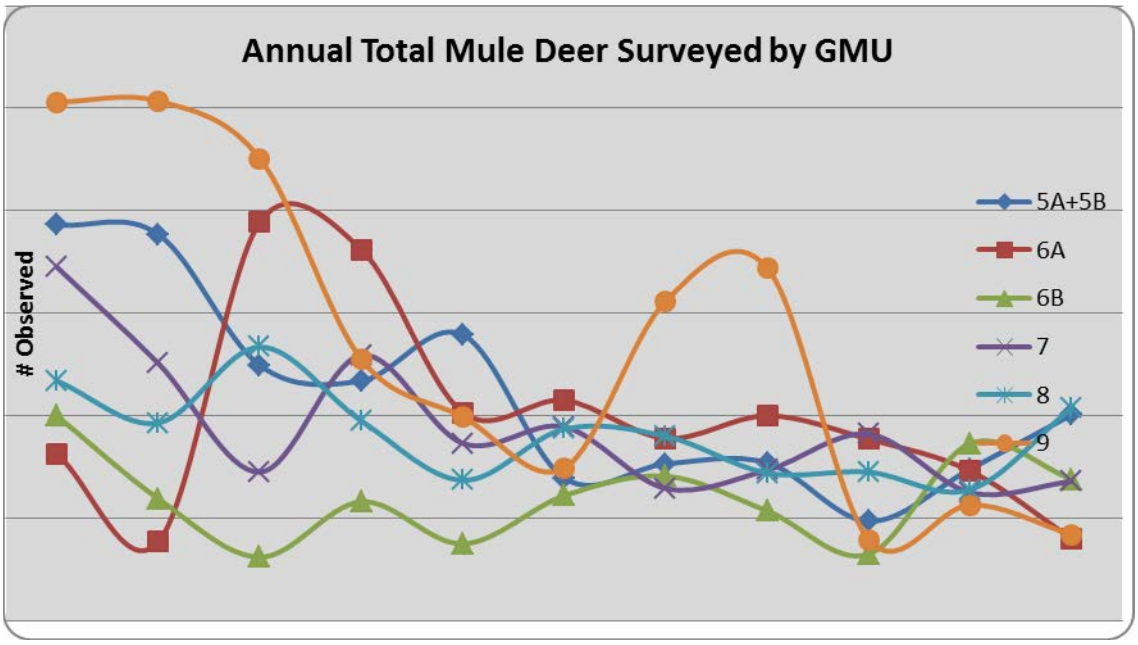


Figure 9. Total number of mule deer surveyed by GMU, 2000 – 2010

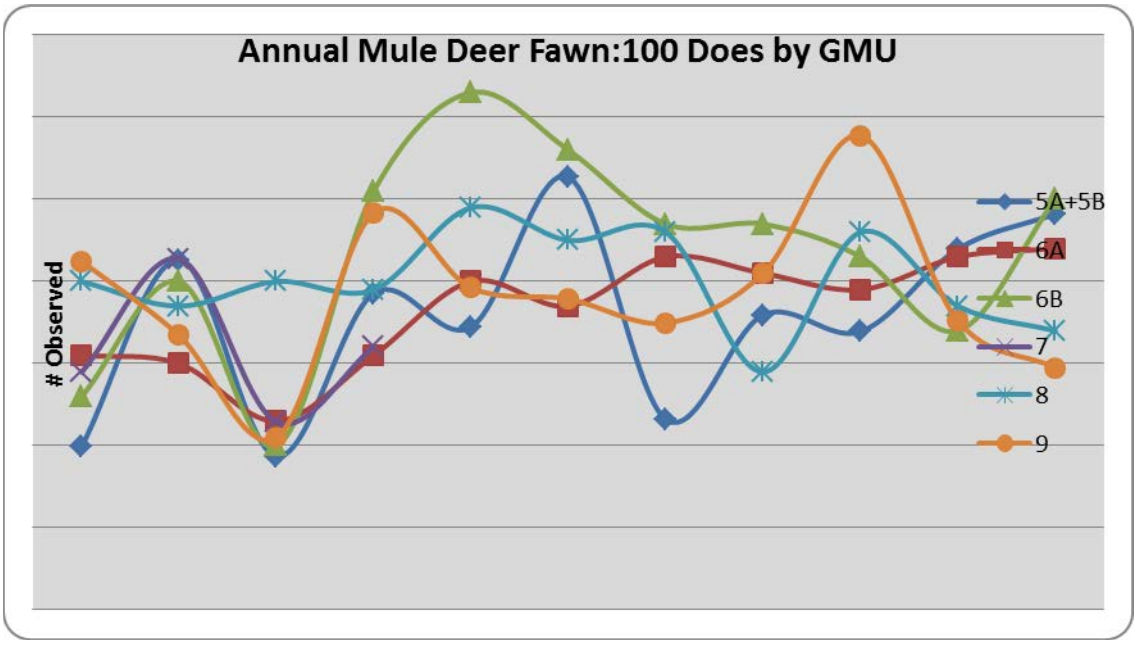


Figure 10. Ratio of mule deer fawns per 100 does by GMU, 2000 – 2010

The declining to stable trend in mule deer surveyed over the last decade on the Coconino and Kaibab NFs is consistent with the statewide trend. The fawn:doe ratios indicate relatively stable trends in doe productivity over time across both national forests. Though currently stable, survey data suggest that overall mule deer populations are lower than they were a decade ago. Regional experts have attributed contemporary mule deer population decline to declines in the quality of their habitat.

Habitat Use and Trend

Unlike cattle and elk, mule deer are not adapted to digest a diet high in grass; instead they rely primarily upon browse and forbs to meet their nutritional needs, particularly on their winter range when snow limits access to herbaceous ground cover (Wallmo and Regelin 1981). Important plants in a mule deer's diet include sagebrush (*Artemisia spp.*), cliffrose (*Cowania mexicana*), mountain-mahogany (*Cercocarpus ledifolius*), buckbrush (*Ceanothus cuneatus*), buckthorn (*Rhamnus spp.*), quaking aspen (*Populus tremuloides*), juniper (*Juniperus spp.),* and Gambel oak mast (*Quercus gambelii*). High diversity and productivity of shrubs and young trees are important habitat components for mule deer, best represented within early-successional forests and maintained by natural disturbances such as fire (Mule Deer Working Group 2004).

Carrying capacity of winter range habitats is often the limiting factor for mule deer populations (Wallmo et al. 1977). Winter range for mule deer occurs primarily in pinyon-juniper communities which are largely outside the scope of the 4FRI project. However, summer range for mule deer occurs throughout the project in areas of ponderosa pine, pine-oak, pine-sage, aspen, and at springs and ephemeral channels particularly when water is available.

High levels of interspersion of forested cover and openings are favored by mule deer, particularly when a shrub, oak, or aspen component is present (Germaine et al. 2004, Wightman and Yarborough 2005). When openings or low-density forests are present in a matrix of higher-density forest patches, mule deer will forage in open and sparsely-treed areas at night but spend the majority of their daylight hours on bedsites located within denser hiding and thermal cover (Wightman and Yarborough 2005). In addition, mule deer prefer smaller openings and show higher fidelity to forested edges relative to elk and cattle (Dealy 1985). As such, landscape-scale forest restoration practices that favor heterogeneity, promoting forest with openings, oak, sage, and aspen, should improve habitat for mule deer in the short and long terms.

Mule deer commonly browse on aspen within the 4FRI project area. Aspen are declining on both national forests, due to a combination of factors including drought, heavy frost events, disease and pathogens, ungulate herbivory, and fire suppression (Fairweather et al. 2008). Aspen continues to be lost as successional processes result in pine and other conifers overtopping many of the clones. Some early-seral stage aspen are being created through wildfire and management activities, which should benefit mule deer. However, management activities have not been implemented to a level, or over enough area, to prevent loss of aspen patches in the landscape and provide for adequate aspen recruitment.

Current conditions on both forests do not provide optimal cover and foraging conditions for mule deer. Fire suppression over the last century has led to increased tree densities and canopy closure, reducing forest openings, meadows, and grasslands. These changes have reduced both groundcover and the shrub layer, likely decreasing the carrying capacity of lands on both forests. Deer may also be negatively affected by competition with elk and livestock for shared forage species if widespread hedging (e.g., shrubs on the Tusayan Ranger District) or actual elimination of forage occurs (e.g., aspen regeneration on the Peaks Ranger District (Coconino NF) and Williams Ranger District (Kaibab NF)).

Potential Effects

Maintaining current conditions would continue to provide large patches of trees with higher basal area, canopy density, and interlocking crowns thereby providing thermal and hiding cover for mule deer. However, overstory suppression of browse diversity and productivity will continue to limit forage habitat for mule deer. Tree encroachment into openings and meadows will also limit mule deer foraging habitat, simplifying forest structure and reducing habitat heterogeneity. Early-seral aspen will continue to decline in the absence of natural disturbances such as fire and without management intervention. The current

unnatural stand densities would threaten sustainability of mule deer habitat by creating risk for uncharacteristic, high-severity fire.

Effects of Mechanical Thinning

Weather patterns such as precipitation are the primary driver of deer populations in the short term, but landscape scale habitat improvements such as 4FRI would make long-term gains in deer abundance over time (appendix 6).

Thinning under the goshawk guidelines would result in a mosaic of interspersed vegetation structural stages that provide both bedding sites and foraging areas for mule deer. Cutting in early-seral pinyon-juniper on the Tusayan Ranger District would positively influence forage abundance by opening up the tree canopy and allowing sunlight to reach the forest floor. Thinning and burning in the pine-sage, pine-oak, and pure pine stands would also provide opportunities for browse increase, which should positively influence mule deer populations over time. Not targeting sage, oak, or juniper for removal would improve forage in the short- and long-term, particularly after thinning ponderosa pine trees.

Reducing tree densities and ladder fuels would reduce available thermal and hiding cover for mule deer. However, thermal protection would continue to be available in areas maintained for higher basal area and canopy density, including MSO nesting and restricted habitat, northern goshawk nest stands, bald eagle roosts, sinkholes and caves, and areas excluded from mechanical treatment such as wilderness and where slope >40%. Thinning small-diameter trees and burning in Gambel oak could also reduce hiding and thermal cover for mule deer in the short term. This risk however, must be weighed against the increased likelihood for stand-replacing fire events and mass habitat loss over larger areas.

Fencing around aspen will allow for recruitment of new ramets and creation of early-seral conditions but will preclude foraging mule deer unless fences are removed. Reduction in aspen forage will have localized impacts on deer but is not expected to have impacts at the population level given that other understory forage plants will likely increase following overstory reductions.

The inclusion of the LTRS and the incorporation of watershed and wildlife research areas under alternative C would retain higher basal area, higher canopy cover, and larger forest patches because of the combined contributions from large-diameter trees. Design features intended to maintain variable size-class trees and variable tree densities within groups would contribute toward hiding and thermal cover. These should benefit mule deer in terms of cover and additional areas for mule deer daybeds.

Since mule deer also select for the forested edges of grasslands where increased herbaceous productivity provides foraging opportunities, grassland treatments should benefit mule deer.

Proposed thinning treatments may cause visual or auditory disturbance to individual mule deer, although these effects would be short-term. Best management practices will place seasonal restrictions on logging activities in known fawning areas to reduce the likelihood of direct impacts.

Effects of Prescribed Fire

Landscape-scale application of prescribed fire would more closely simulate historic fire regimes, restoring disturbances that work to create patches of early seral forest, particularly enhancing areas of aspen. Enhancement of these features across the landscape would benefit mule deer.

Mule deer evolved in southwestern ponderosa pine forests that were characterized by frequent, low-severity fire. This frequent fire helped maintain herbaceous openings and meadows, which are important for mule deer foraging. Disruption of normal behavioral patterns could occur to mule deer during burning

activities, and prescribed fire maintenance treatments would increase the frequency of fire disturbance on mule deer. Effects would likely be due to direct disturbance by human presence during burning activities as well as smoke inhalation. However, human disturbance and smoke effects should be transitory in nature and short-term. Since mule deer are capable of moving several miles in any given day, it is likely they will be able to move out of smoke paths in the event of prescribed burns.

Cheatgrass has a profound negative impact on mule deer habitat quality through a process of invasion, competition with, and eventual elimination of shrubs through unnatural acceleration of fire frequencies in pinyon-juniper and ponderosa pine systems. Although the 4FRI Project includes noxious weed control, the risk of cheatgrass invasion following restoration treatments has the potential to negatively impact mule deer habitats in the long term (McGlone et al. 2009).

Effects of Aspen, Spring, and Ephemeral Channel Restoration

Exclusion of mule deer from aspen, springs, and ephemeral channels will limit their ability to access those forage and water resources. However, the increased shrub and herbaceous productivity resulting from forest thinning is likely to offset mule deer utilization of aspen and riparian areas. Springs and ephemeral channels do not represent reliable water sources for mule deer and exclusion of these areas should not have an impact given the relatively high availability of permanent, artificial water sources across the project area.

Effects of Road Closure/Obliteration

Closure and obliteration of unauthorized roads will positively impact mule deer. Mule deer are known to avoid roads and heavily used recreational areas (Mule Deer Working Group 2004).

Wild turkeys



Wild turkeys (*Meleagris gallopavo*) are an indicator of late-seral ponderosa pine forests, and are an economically and socially important species. Turkey roosts and nests are associated with groups of large pine trees on steep slopes, and they select foraging and loafing habitats within a mix of meadows, oak, and juniper. Turkeys are migratory in parts of their range, moving between lower elevations for wintering to higher elevations for breeding. Timing of movements can differ annually, depending upon snowfall and tree mast production (Wakeling 1991, Hoffman et al. 1993). Forage includes cone crops produced by mature ponderosa pine trees, hard mast from oak trees, juniper berries, seeds from grasses and forbs in early seral habitat, and invertebrates. Pine-oak habitats are particularly important for turkeys in the winter (Wakeling and Rogers 1995). Core home range size for turkeys is roughly 26-30 square miles (Wakeling 1991). Since turkeys are a relatively wide-ranging species, they are likely to respond to changes in forest management at small and large spatial scales.

Population Trend

Wild turkeys are currently listed as G5, N5, and S5 (NatureServe 2010b). The species is considered to be demonstrably widespread, abundant, and secure, globally, nationally (USA), and statewide (AZ).

Turkey populations in Arizona were fairly robust in the 1960s, but have been in steady decline since that time. Current estimates number the population between 15,000 and 20,000 birds, depending on climatic conditions (AGFD 2011a). Factors contributing to this decline include logging practices, increased human

recreational use, fall hunting, disease, grazing, and long-term changes in climatic patterns (Wakeling 1991). Annual statewide survey data from 1960 to 2010 demonstrate a fluctuation in numbers with an overall declining trend (Figure 11; AGFD 2011a). The Coconino and Kaibab NFs represent the core of the turkey's distribution in Arizona, and unlike the statewide declining trend, populations on the two forests have been stable to increasing for the last several years (USDA FS 2002, 2010).

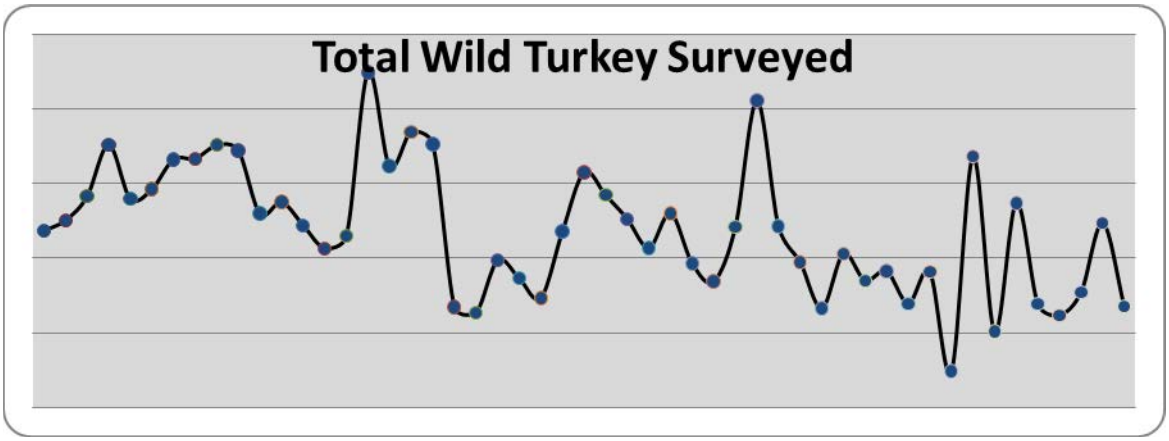


Figure 11. Results of annual statewide turkey surveys 1946 – 2010 (AGFD 2011)

Because of their primary responsibilities for managing wildlife, the main data source for turkey population trend comes from AGFD survey and hunt data. Up until the late 1960s, AGFD conducted standardized driving surveys for turkey. When turkey densities began decreasing, standard survey procedures did not provide good data because of the low number of observations along survey routes (Wakeling 1991). Since that time, AGFD has gotten more consistent and reliable information by using 1) the percent of archery hunters seeing turkeys during archery elk hunts, and 2) the number of turkeys harvested during the spring (T. McCall, personal communication 2011). Data on percent hunters observing turkey and harvest data are available for 1997 – 2010 (Figure 12, Figure 13, Figure 14, and Figure 15). Both indicators for turkey suggest a variable yet stable population trend within the 4FRI project area, on both National Forests.

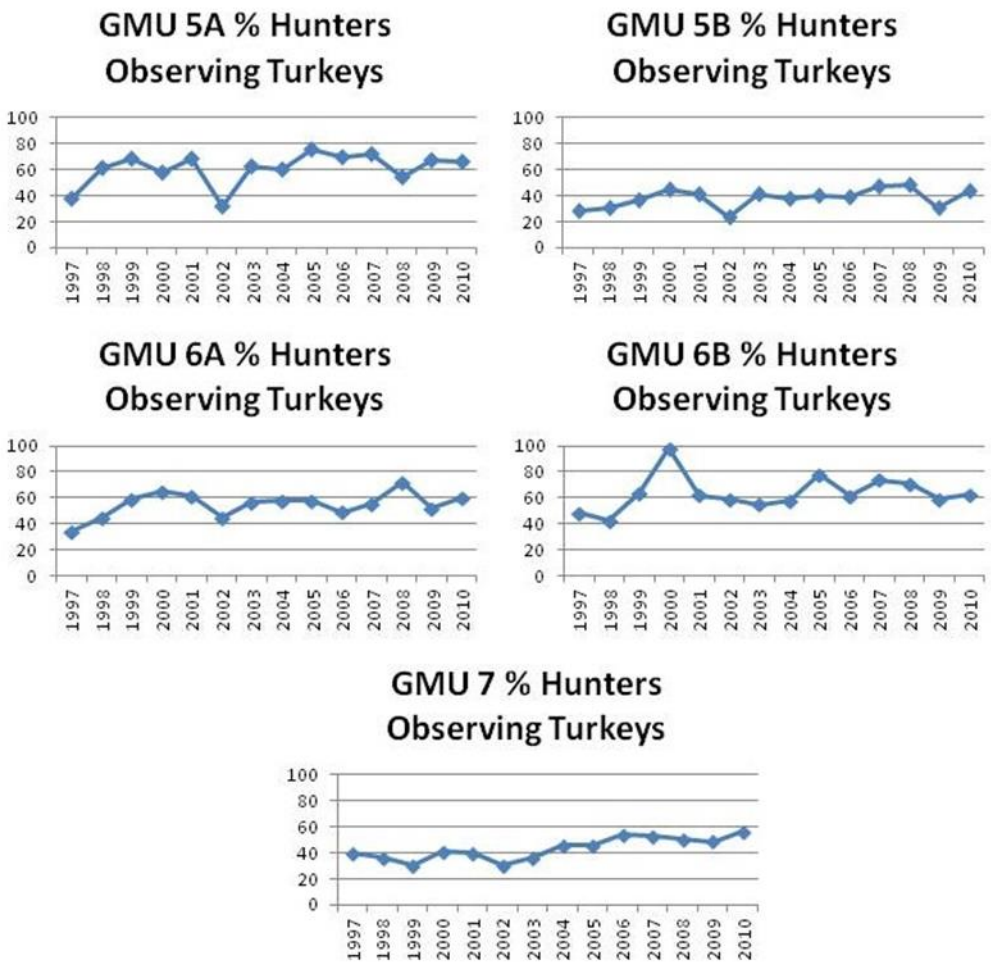


Figure 12. Annual percentage of archery hunters observing wild turkey (1997–2010). Coconino National Forest, including Game Management Units 5A, 5B, 6A, 6B, and 7.

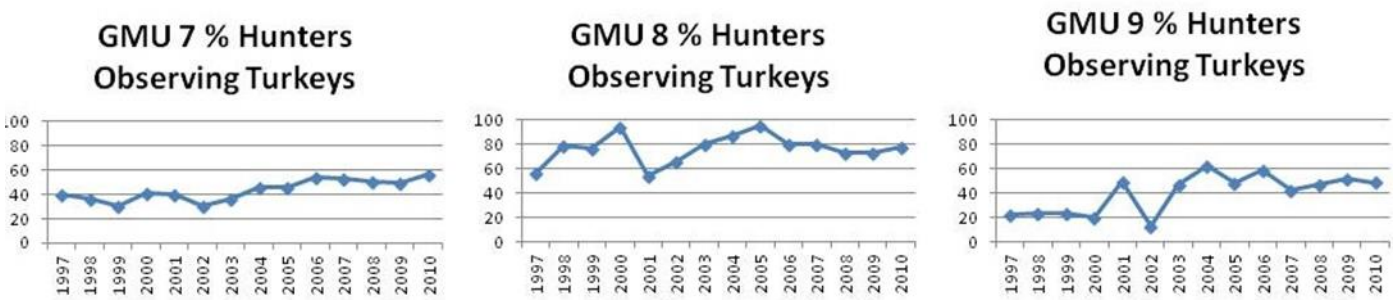


Figure 13. Annual percentage of archery hunters observing wild turkey (1997–2010). Kaibab National Forest, including Game Management Units 7, 8, and 9.

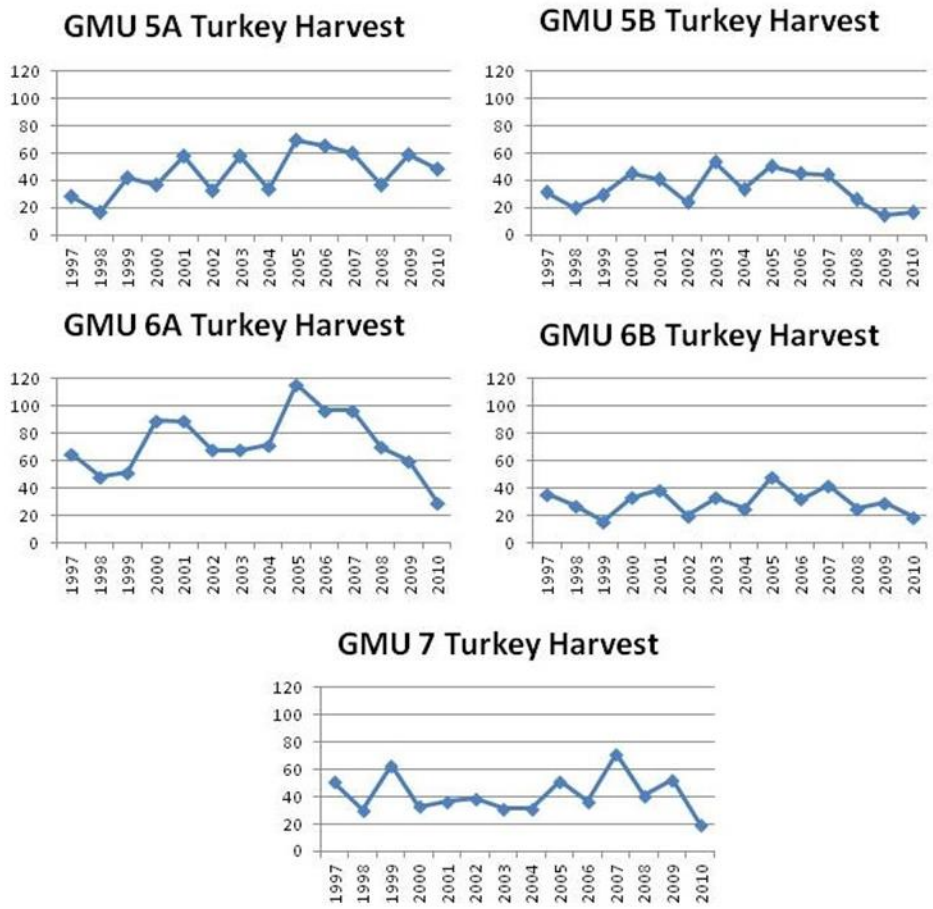


Figure 14. Annual harvest rates for wild turkey (1997–2010). Coconino National Forest, including Game Management Units 5A, 5B, 6A, 6B, and 7.

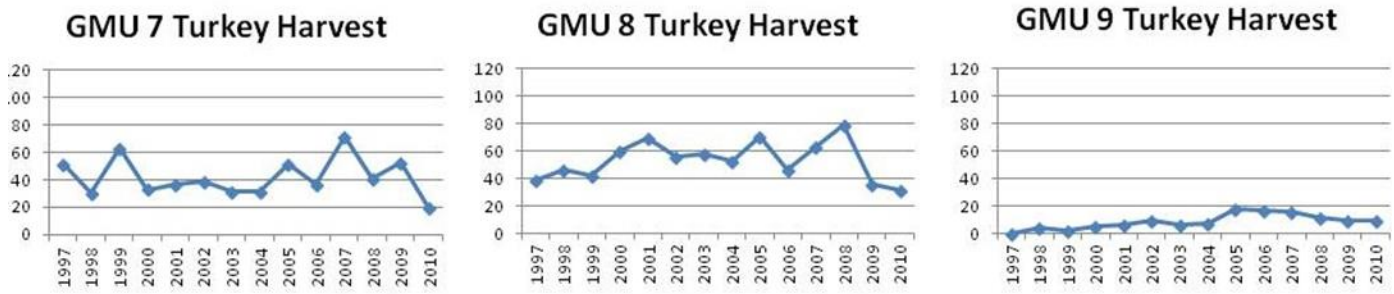


Figure 15. Annual harvest rates for wild turkey (1997–2010). Kaibab National Forest, including Game Management Units 7, 8, and 9.

Habitat Use and Trend

Turkey habitat is typically described relative to four behaviors: nesting, roosting, foraging, and loafing. There have been several studies examining turkey habitat selection in ponderosa pine on the Mogollon Rim, primarily just east of the 4FRI project area within Arizona Game Management Unit 4A on the

Apache-Sitgreaves National Forest (Wakeling 1991, Mollohan et al. 1995, Wakeling and Rogers 1995). The habitat description below is based on these references.

Nesting habitat is best characterized by steep slopes (>40%), with a clumpy-groupy forest structure dominated by trees in the VSS 5 and 6 size class. Turkeys nest on the ground up against rock cliffs, on the uphill side of large trees, or in slash. Canopy cover is typically high (50%) within 0.1 acres of the nest, with dense horizontal cover in the form of a low tree canopy base height, shrubs, or slash.

Roosting habitat is similar to nesting habitat in terms of steep slopes (again >40%), typically in the upper strata of canyons and drainages. Turkeys roost in tree groups that average 36 trees with dbh > 16 inches, where the roost tree is often >24 inches dbh. The high tree and canopy density within roosts is important for thermal protection, particularly in the winter. Uneven-aged canopy structure also helps provide thermal protection. Unlike nesting habitat, turkeys select for a higher canopy base height (>24 feet) when roosting.

Clumpy-groupy forest structure is also important for turkeys in their foraging habitats, where they select for small forest openings (0.28–0.31 acres) for feeding. Openings can be natural meadows or early seral forests created by logging or natural disturbance, typically located on flatter terrain relative to nesting and roosting habitats. Turkeys select areas with a higher percent cover of forbs and grasses for feeding, and they select for areas of higher plant species richness (and higher invertebrate richness) during the poult-rearing phase. Acorn mast from Gambel oak can increase the probability of overwinter survival and is connected to productivity in the following year.

Loafing is a behavior common among gallinaceous birds; it is a time when turkeys rest, preen, and take dust baths. Turkey loafing occurs in small (<1 acre) forested patches, adjacent to openings (within 100 feet), dominated by sapling and pole-sized trees, with higher numbers of trees per acre and basal area relative to feeding or nesting sites. Course woody debris and fallen snags are commonly used in loafing habitats. Turkeys will also loaf in recently thinned areas with broadcasted slash, as long as the residual tree density remains high.

Potential Effects

Weather patterns such as precipitation are a driver of turkey populations in the short term, but landscape-scale habitat improvements such as 4FRI would make long-term gains in turkey abundance over time. Continuing on the current trajectory, forests would continue to provide large patches of trees with higher basal area, canopy density, and interlocking crowns, thereby providing thermal and hiding cover for turkey. However, overstory suppression of oak, grass, and forb diversity and productivity and similar impacts to the arthropod community would continue to limit forage habitat for turkey. Tree encroachment into openings and meadows would also limit turkey foraging habitat. Late-seral ponderosa pine will continue to be threatened by unnatural stand densities, creating risk for uncharacteristic, high-severity fire.

Effects of Mechanical Thinning

Avoidance of mechanical thinning on slopes >40% would allow for maintenance of turkey nesting and roosting habitat. Prescribed fire would decrease the risk of future surface fire transitioning into crown fire. Turkey roosting habitat characteristics overlap with MSO protected activity center (PAC) characteristics, and the proposed thinning and prescribed fire within the proposed PACs would improve turkey roosting habitat by raising canopy-base height and protecting larger trees from loss from fire. Treatments within goshawk nest stands on steeper slopes would also improve roosting habitat for turkeys. Areas with a high density of sapling and pole-sized trees would be thinned in order to meet desired conditions, decreasing loafing habitat. However, loafing sites would still be provided in deferral areas and when site-specific

conditions indicate appropriate designation of large groups of VSS 2 and 3 trees. Coarse woody debris requirements set forth in the forest plans would continue to provide substrates for turkey use in nesting and loafing areas.

Thinning under the goshawk guidelines would result in a mosaic of interspersed vegetation structural stages and openings that would provide increased understory production and therefore increased foraging habitat quality for turkey. The emphasis on creation of groupy forest structure would improve a key component of nesting, roosting, and foraging habitat.

Mechanical thinning would be used to reduce overstory competition with Gambel oak, where appropriate. This action is expected to help increase acorn mast production (Okonburi 1999), a critically important food source for overwintering turkeys.

The use of AGFD connectivity data has been used to inform spatial arrangement of mechanical thinning treatments that favor late-seral forest dwelling species such as turkey (AGFD 2011b). This treatment design, used in combination with soils information and historic evidence, will enhance connectivity for turkey populations.

Proposed thinning treatments may cause visual or auditory disturbance to individual turkeys, although these effects would be short-term. Best management practices would place seasonal restrictions on logging activities in known nesting and roosting areas to reduce the likelihood of direct impacts.

The inclusion of the LTRS and the incorporation of watershed and wildlife research areas under alternative C would retain higher basal area, higher canopy cover, and larger forest patches because of the combined contributions from large-diameter trees. Design features intended to maintain variable size-class trees and variable tree densities within tree groups would contribute to hiding and thermal cover. Combined, these activities would provide additional areas for turkey loafing, nesting, and roosting.

Since turkeys select for forested edges of grasslands where increased herbaceous productivity provides foraging opportunities, grassland treatments would likely benefit turkeys.

Effects of Prescribed Fire

Landscape-scale application of prescribed fire would simulate historic fire regimes, restoring disturbances that work to create openings, and increase resiliency in late-seral ponderosa pine forests. This is expected to benefit turkeys.

Burning shrubs, slash, and understory vegetation would reduce hiding and nesting cover for turkeys in the short-term. Thinning and burning in Gambel oak could reduce nesting and foraging habitat for turkeys in the short-term. However, low-severity fire can increase diversity and productivity in grasses and forbs, in turn increasing the likelihood of higher invertebrate diversity, which would benefit turkeys, especially during the poult-rearing phase. Benefits could be expected within 1-2 years following prescribed fire (Canon et al. 1987 *in* Pilliod et al. 2006).

Less prescribed fire would reduce the direct impacts of burning and smoke. However, turkeys evolved in southwestern ponderosa pine forests that were characterized by frequent, low-severity fire. This frequent fire helped maintain herbaceous openings and meadows, which are important for turkey foraging. Reduced burning would also limit the quality of turkey habitat within the project area.

Disruption of normal behavioral patterns could occur to turkeys during burning activities. Prescribed fire treatments are expected to be implemented twice in the next 10 years, which would increase the frequency of fire disturbance on turkey. Effects would likely be due to direct disturbance by human

presence during burning activities as well as smoke inhalation. However, human disturbance and smoke effects should be transitory in nature and short-term. Because turkeys are capable of moving several miles in any given day, it is likely they would be able to move out of smoke paths in the event of prescribed fires. Best management practices would place seasonal restrictions on burning activities in known nesting and roosting areas to reduce the likelihood of direct impacts.

Effects of Aspen, Spring, and Ephemeral Channel Restoration

Fencing aspen, springs, and ephemeral channels would allow for recruitment of new aspen and creation of early-seral conditions. Turkeys could likely fly over fences when the protected area is large enough to allow them to negotiate the barrier, as in aspen. Fences would likely present barriers in small areas, such as spring exclosures. Ephemeral channels may be a mix of both. Reduction in forage will have localized impacts on turkey that would use those areas for foraging, but this is not expected to have impacts at the population level. Exclusion of turkey from springs and ephemeral channels would limit their ability to access those forage and water resources. However, the increased herbaceous and tree mast productivity resulting from forest thinning is likely to offset turkey utilization of riparian areas. Springs and ephemeral channels are less reliable water sources for turkey and exclusion of these areas should not have an impact on given the relatively high availability of permanent, artificial water sources across the project area.

Effect of Road Closures/Obliteration

Closure and obliteration of unauthorized roads will positively impact turkeys. Turkeys are known to avoid roads and heavily used recreational areas (Wakeling 1991).

Pronghorn



Pronghorn (*Antilocapra americana*) are an indicator of grassland habitats and an economically and socially important species. Pronghorn are associated with grasslands, meadows, and savannas on the Coconino and Kaibab NF and are typically found in flat or rolling areas, along foothills, in mountain valleys, and on plateaus. Pronghorn prefer ecosystems with a mixture of grasses, forbs, and shrubs to provide for forage requirements and fawning areas (Yoakum 2004). They evolved to avoid predation through sight and flight; habitats with low-growing vegetation and/or sparse tree density are important for pronghorn. Pronghorn avoidance of areas with high tree density and cover differs markedly from deer and elk habitat selection within the 4FRI project area. Home ranges have been measured in the vicinity of Wupatki and Sunset Crater National Monuments, which are adjacent to the Coconino NF, and were estimated between 22.8 and 50.2 square miles for females and males, respectively (Ockenfels et al. 1997). Since pronghorn are a relatively wide-ranging species, they are likely to respond to changes in forest management at small and large spatial scales.

Population Trend

Pronghorn are currently listed as G5, N5, and S5 (NatureServe 2010c). The species is considered to be demonstrably widespread, abundant, and secure, globally, nationally (USA), and statewide (AZ).

A number of factors have been identified that affect pronghorn populations including severe weather, amount and timing of precipitation, habitat fragmentation, diet overlap with other grazers, reductions in

fawn hiding cover, woody vegetation encroachment, predation, and nutritional concerns (Neff 1986, Ockenfels 1996). Annual statewide survey data from 1946–2010 demonstrate fluctuations in pronghorn abundance. There was an expansive increase in pronghorn numbers during the 1970s and 1980s followed by a decline that began in the mid-1990s. Populations have appeared to have stabilized since 2005 (Figure 16, AGFD 2011a). Both forest-wide MIS reports indicate variable to decreasing population trends (USDA FS 2002, 2010).

Locally, there has been substantial focus on declining pronghorn populations on Anderson Mesa, an area which is included in GMUs 5A and 5B (Yoakum 2002). Pronghorn populations and productivity on Anderson Mesa have been declining significantly since the 1940s (Yoakum 2002). However, significant efforts have been taken to restore higher quality habitat for pronghorn in this area since 2002. The 4FRI project includes a portion of Anderson Mesa.

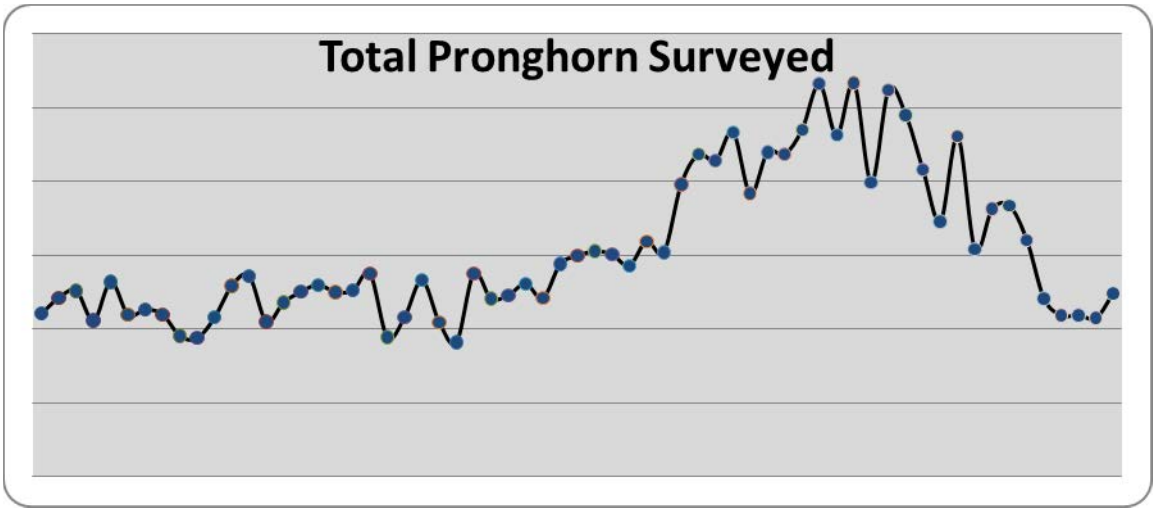


Figure 16. Results of annual statewide pronghorn surveys 1946 – 2010 (AGFD 2011)

Because of their primary responsibilities for managing wildlife, the main data source for pronghorn population trends comes from AGFD survey and hunt data. Data used in this analysis were collected by game managers using fixed-wing aerial surveys. Detection rates for pronghorn are highly variable across years depending on weather, annual green-up (affects surveyor's ability to see animals against an otherwise brown back-drop), and how pronghorn move in response to localized precipitation patterns. This inconsistency makes interpretation of population data difficult and uncertain (McCall personal communication 2011).

AGFD evaluates trends in pronghorn populations based on 1) annual surveys, and 2) model-derived population estimates. Data are displayed by Game Management Unit (GMU; Figure 17). The two best indicators for pronghorn population trend are 1) the number of pronghorn observed during annual surveys (Figure 18), and 2) number of fawns per 100 does observed during annual surveys (Figure 19). These two indicators are more reliable than population modeling estimations for pronghorn because of the uncertainty in certain model parameters such as starting population size and annual mortality rates (McCall personal communication 2011). For the Coconino NF, data are relevant from GMUs 5A, 5B, 6A, 6B, and 7. For the Kaibab NF, data are relevant from GMUs 7, 8, and 9. There is some intermingling of pronghorn herds across the two forests, primarily between GMUs 6B and 8 as well as GMUs 7 and 9. All GMUs are relevant to the 4FRI project area.

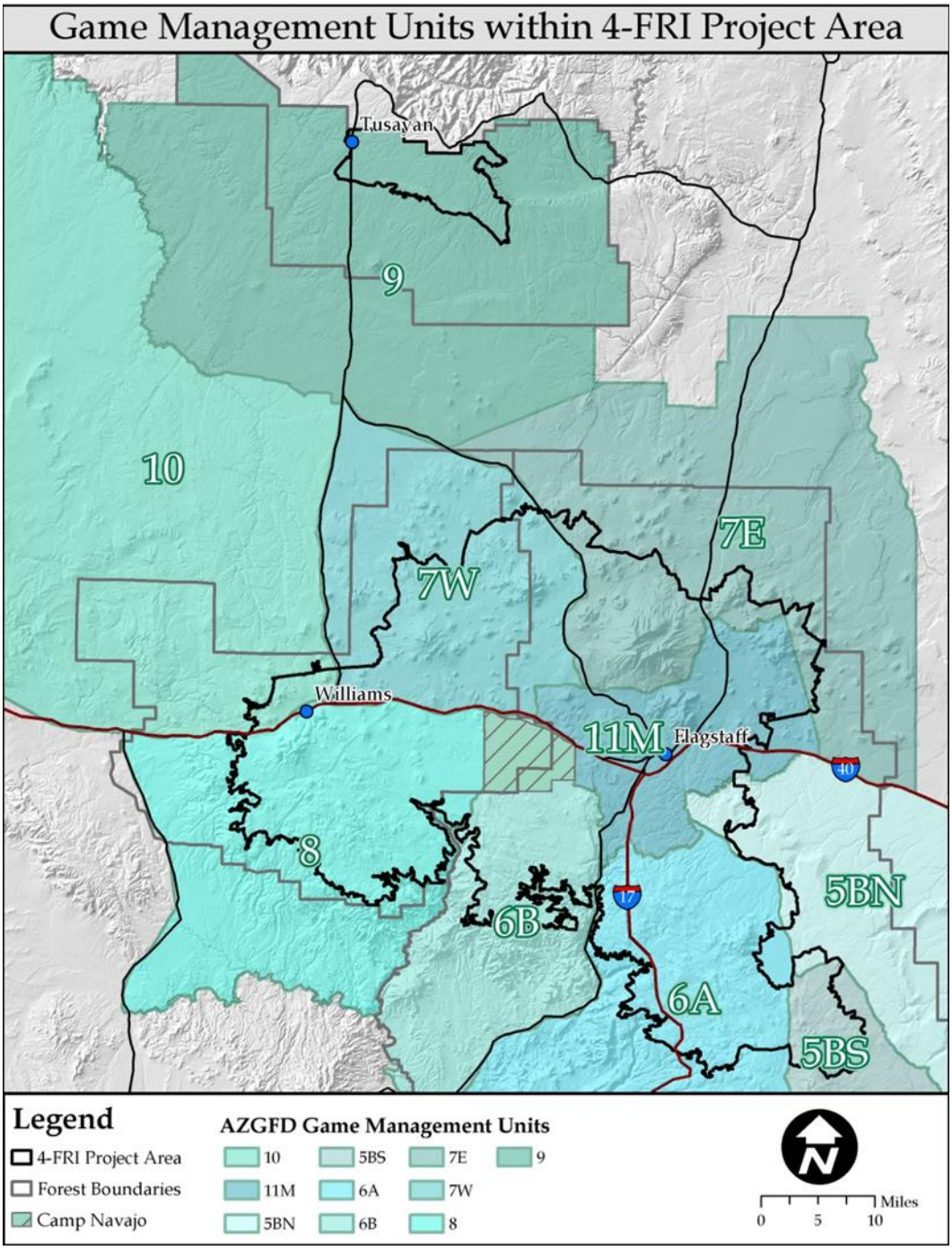


Figure 17. Arizona Game and Fish Department Game Management Units within the 4FRI Project Area

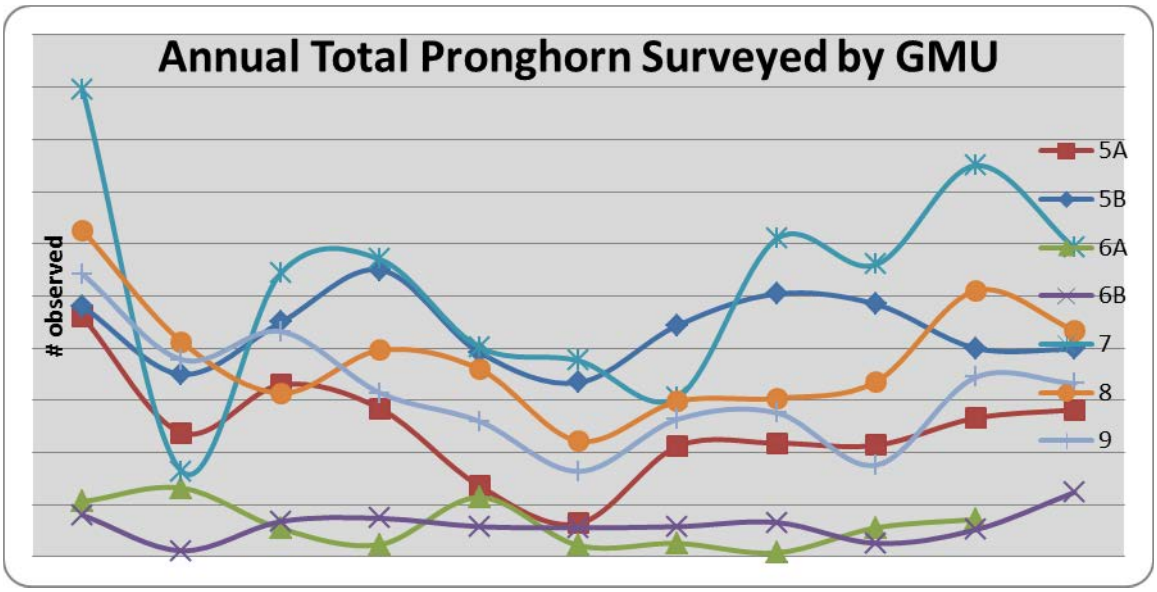


Figure 18. Total number of pronghorn surveyed by Game Management Units within the 4FRI Project Area, 2001–2011

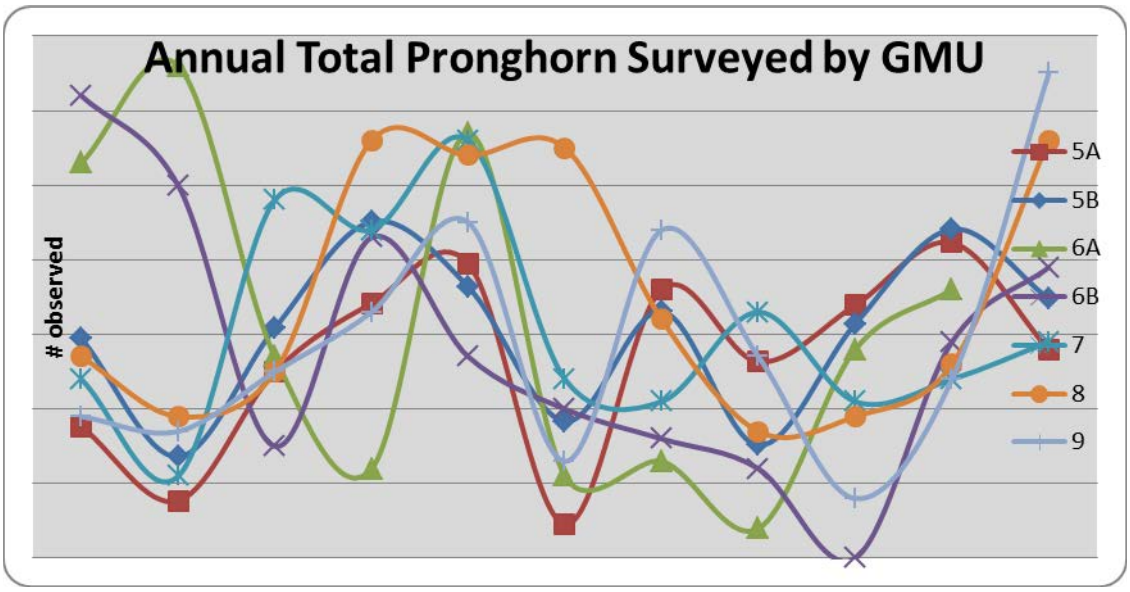


Figure 19. Fawn:100 Does ratios for pronghorn surveyed by Game Management Units within the 4FRI Project Area, 2001–2011. Fawn:doe ratios are an indicator of annual productivity, which is considered to be the limiting factor for pronghorn populations within the 4FRI project area.

AGFD population estimates are then derived from a model that takes annual surveys, fawn:doe ratios, buck:doe ratios, harvest, and estimated annual background mortality into consideration. Modeled mortality rates are based on limited available data from AGFD. One limitation of this model is that it requires modelers to select a beginning population size for bucks and does for which reliable data are lacking. Modelers must set beginning population size using anecdotal inference from earliest known survey numbers. For this reason, AGFD recommends greater emphasis on trends rather than absolute numbers. Population trend estimates are available from 2002 through 2011 for both forests (Figure 20 and Figure 21).

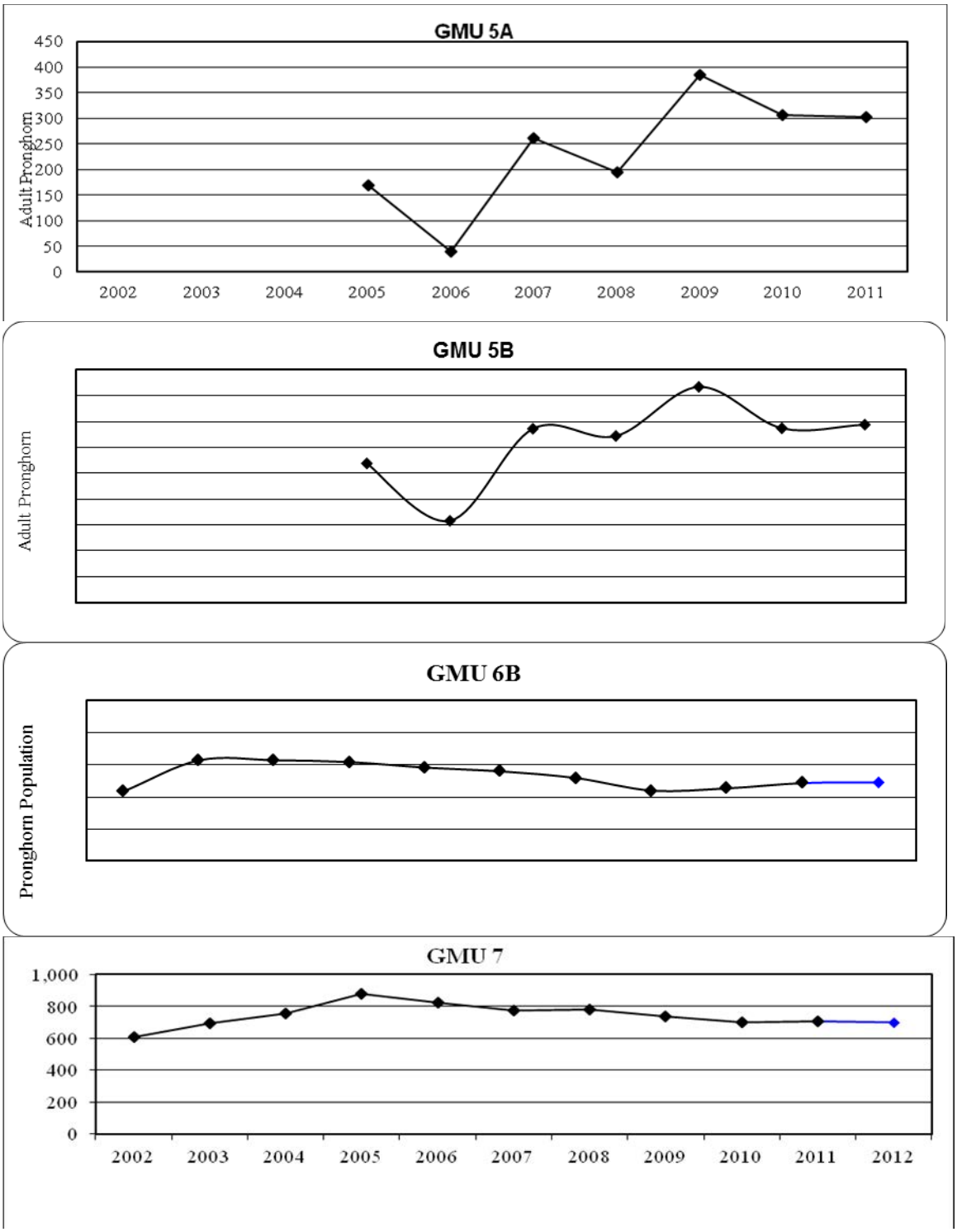


Figure 20. Estimated population trends for pronghorn, 2002-2011, on the Peaks Ranger District of the Coconino National Forest, including Game Management Units 5A, 5B, 6B, and 7. (6A data were unavailable). Blue lines are from unpublished data available from the AGFD Flagstaff Regional Office (McCall, personal communication October 2011).

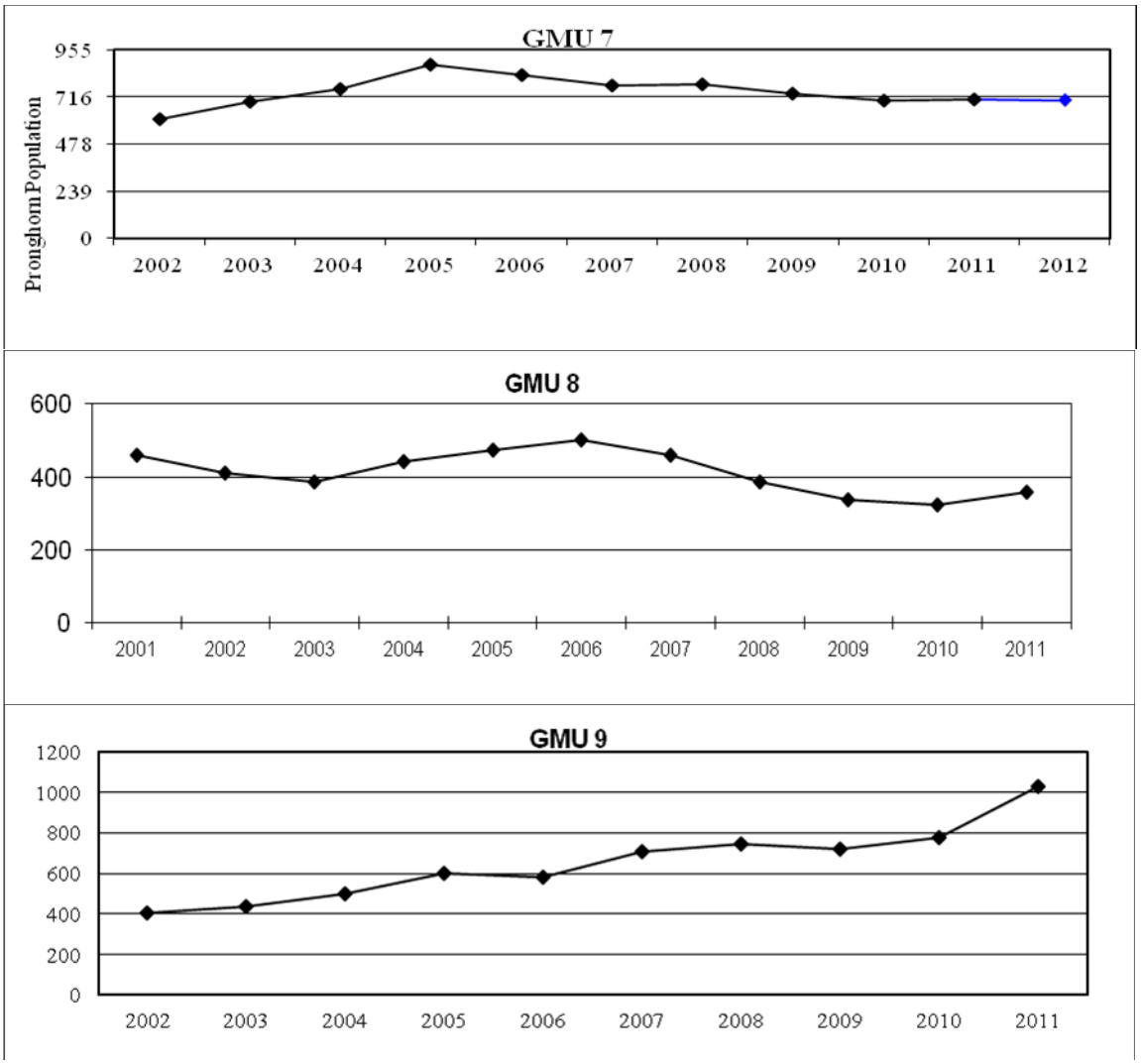


Figure 21. Estimated population trends for pronghorn, 2002-2011, on the Kaibab National Forest, including Game Management Units 7 and 8 for the Williams Ranger District and Unit 9 for the Tusayan Ranger District. Data are unpublished but available from the AGFD Flagstaff Regional Office (McCall, personal communication, October 2011).

Overall, population models for all GMUs within the 4FRI project area indicate a stable trend over the last decade.

Habitat Use and Trend

Pronghorn are adapted for sight and flight; visibility and an ability to run at full speed in open, gentle terrain are crucial for predator avoidance. Pronghorn avoid areas of high tree and/or tall shrub density, preferring areas with <30 percent tree/shrub cover and where vegetation height is less than 2 feet tall (Ockenfels et al. 1994). Woody plant invasion into grasslands and meadows has been identified as one of the leading factors reducing habitat quality for pronghorn, sometimes leading to isolation of populations when combined with other sources of habitat fragmentation such as fences and roads (Neff 1986, Ockenfels et al. 1994, Ockenfels et al. 1996, AGFD 2002, Waddell et al. 2005). A recent study of habitat quality in and around Camp Navajo Army National Guard, which is centrally located within the 4FRI project area, found that pronghorn habitat quality was significantly limited by high ponderosa pine

densities and encroachment into meadows and grasslands (Waddell et al. 2005). Of particular note was the encroachment of pine trees into Garland Prairie; a critically important grassland used for pronghorn fawning.

Tree and shrub cover are occasionally used by pronghorn, indicating some selection for savanna conditions as well as grasslands. Isolated, large trees will receive some use by pronghorn for shade during hot summer months (Ockenfels et al. 1994). Low shrubs can play a key role as hiding cover for fawns (AGFD 2002).

Several local studies and plans have recognized the importance of grass, forb, and shrub diversity for sustaining pronghorn nutritional needs throughout the year as well as providing hiding cover for fawns (Ockenfels et al. 1994, Ockenfels et al. 1996, AGFD 2002, Yoakum 2002, Waddell et al. 2005). These studies recommend removal of encroaching woody tree species from grasslands and savannas as well as prescribed burning to reinvigorate production and diversity of understory forbs which have the highest nutritional value during fawning. Availability of water is also important for pronghorn, particularly for lactating females (Ockenfels et al. 1994).

Potential Effects

Effects of Mechanical Thinning

Availability of grasslands, meadows and savannas would continue to be limited for pronghorn use under current conditions. Tree density and canopy cover within historic meadows and grasslands continue to limit sight distances and suppress productivity of grasses and forbs for foraging and fawn hiding cover. Connectivity of pronghorn habitat would continue to decline under current conditions. Grassland habitats would continue to decline in the absence of natural disturbances such as fire and without management intervention.

The restoration of historic grasslands and meadows and savanna by thinning encroaching pines would benefit pronghorn habitat connectivity and invigorate productivity of grasses and forbs. Specifically, grassland restoration activities in the vicinity of Garland Prairie would be beneficial for pronghorn because of the crucial role Garland Prairie serves as fawning habitat. Thinning would improve sight distances and grass-forb abundance. Grass-forb cover is expected to increase within 1–2 years after treatment, which should improve pronghorn foraging and fawning habitats. Restoring large areas to open conditions preferred by pronghorn (<30 percent in forested cover) would significantly contribute to increases in pronghorn habitat and decreases in habitat fragmentation.

The AGFD connectivity data can inform spatial arrangement of mechanical thinning treatments that favor grassland wildlife such as pronghorn (AGFD 2011b). This treatment design, used in combination with soils information and historic evidences, would enhance connectivity for pronghorn populations.

Proposed thinning treatments may cause visual or auditory disturbance to individual pronghorn, although these effects would be short-term.

Effects of Prescribed Fire

Landscape-scale application of prescribed fire would more closely simulate historic fire regimes, restoring disturbances that work to maintain grasslands, meadows, and savannas. Low-intensity fire is expected to increase growth and diversity of herbaceous vegetation, which would provide increased forage in the long term, with expected benefits as soon as 1–2 years following prescribed fire (Canon et al. 1987 *in* Pilliod et al. 2006). These actions would benefit pronghorn.

Reducing acres of prescribed fire would reduce the direct impacts of burning and smoke. However, pronghorn in the Southwest evolved on grasslands and savannas that were characterized by frequent fire. Fire helped maintain grassland boundaries, herbaceous openings, and the inherent connectivity of these habitats.

Disruption of normal behavioral patterns could occur to pronghorn during prescribed fire activities. Prescribed fire treatments would increase the frequency of fire disturbance on pronghorn. Effects would likely be direct disturbance by human activity during burning activities as well as displacement by fire and smoke. However, disturbance should be transitory in nature and short-term. Since pronghorn are capable of moving several miles in a given day, it is likely they will be able to move out of smoke paths in the event of prescribed fires. Burning in known fawning areas between April 15 and June 15 could impact young, less-mobile fawns. Burn schedules will be adjusted where AGFD has data on fawning use (e.g., Garland Prairie).

Non-native, invasive plants can negatively impact pronghorn habitat quality through a process of invasion, competition, and eventual elimination of native grasses and forbs through unnatural acceleration of fire frequencies in pinyon-juniper and ponderosa pine systems. The risk of non-native plant invasion following restoration treatments has the potential to negatively impact pronghorn habitats in the long term. Following Best Management Practices for noxious weed prevention should mitigate this threat.

Effects of Aspen, Spring, and Ephemeral Channel Restoration

Pronghorn do not select for aspen habitats and would therefore not be affected by aspen restoration. Since pronghorn are highly mobile and relatively wide ranging, the small size of fence projects for aspen, spring, and ephemeral channel restoration activities would not impact pronghorn movement. Spring restoration, if located adjacent to grassland or savanna, is expected to improve habitat quality for pronghorn by improving available water sources in the long term.

Effects of Road Closure/Obliteration

Closure and obliteration of unauthorized roads will positively impact pronghorn. Pronghorn are known to avoid roads and heavily used recreational areas (Ockenfels et al. 1996).

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Appendix 11. Mexican Spotted Owl Biology and Ecology in Relation to the 4 Forest Restoration Initiative





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April 2012

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Figure 1. Recovery Units within the United States recognized in the Mexican spotted owl Recovery Plan (USDI 1995). 2

Introduction

This report summarizes the current status and ecology of the Mexican spotted owl (MSO) within the Upper Gila Mountains Recovery Unit (UGM RU). The 4FRI occurs entirely within the UGM. The UGM supports over half of the known population of MSOs. The owls appear to be more continuously distributed in the UGM, relative to other RUs, and the central location of the UGM within the overall range of the MSO facilitates gene flow across their range. Therefore the UGM is important to the overall range-wide stability of MSOs. Effects of management and effects from a lack of management within the UGM can impact MSO recovery. Consequently, the 4FRI team met with the USDA Forest Service Rocky Mountain Research Station (RMRS) and requested a summary and synthesis of existing knowledge on the status and ecology of MSOs within this RU. Dr. William Block, Program Manager and Supervisory Research Wildlife Biologist at the RMRS and also senior author of the Recovery Plan for the MSO, and Dr. Joseph Ganey, Research Wildlife Biologist at the RMRS, member of the MSO recovery team, and lead scientist on multiple MSO research projects, agreed to our request. Dr. Ganey and other MSO experts published the "Status and ecology of Mexican spotted owls in the Upper Gila Mountains Recovery Unit, Arizona and New Mexico" in 2011 (Ganey et al. 2011; General Technical Report RMRS-GTR-256). The intent of this report is to aid planners in evaluating potential benefits or impacts of management actions for MSOs and their habitat.

Existing Conditions

The Forest Service (FS) is the primary administrator of lands supporting Mexican spotted owls in the Southwest. Most Mexican spotted owls have been found on national forest lands of Arizona and New Mexico (the Southwestern Region of the FS).

The Mexican spotted owl is widespread and the threats facing the owl vary by location. Their densities, food habits, degree of isolation, and other aspects of their biology and ecology differ in different locations. For these reasons, the U.S. Fish and Wildlife Service (FWS) described six separate recovery units within the Southwest United States (Figure 1). Recovery units were delineated based on the following information, presented in order of importance: (1) physiographic provinces, (2) biotic regimes, (3) perceived threats to owls or their habitat, (4) administrative boundaries, and (5) known patterns of owl distribution (USDI 1995).

Mexican Spotted Owl Habitat

MSOs are described as nocturnal "perch and pounce predators" that locate prey from an elevated perch by sight or sound and then pounce on the prey, capturing it with their talons (USDI 1995). They commonly eat small- and medium-sized rodents such as woodrats, peromyscid mice, and microtine voles, but also consume bats, birds, reptiles, and arthropods. Their diet varies by geographic location. The vegetation within the UGM RU has been described as a zonal pattern of grasslands within woodland and forest cover types (USDI 1995). Combined with the diverse topography, this historically created abundant and widespread forest-meadow interfaces. Because of this interspersion of meadows and grasslands, MSOs in the UGM RU have a higher reliance on voles compared to other prey species and compared to MSOs in other RUs (USDI 1995).

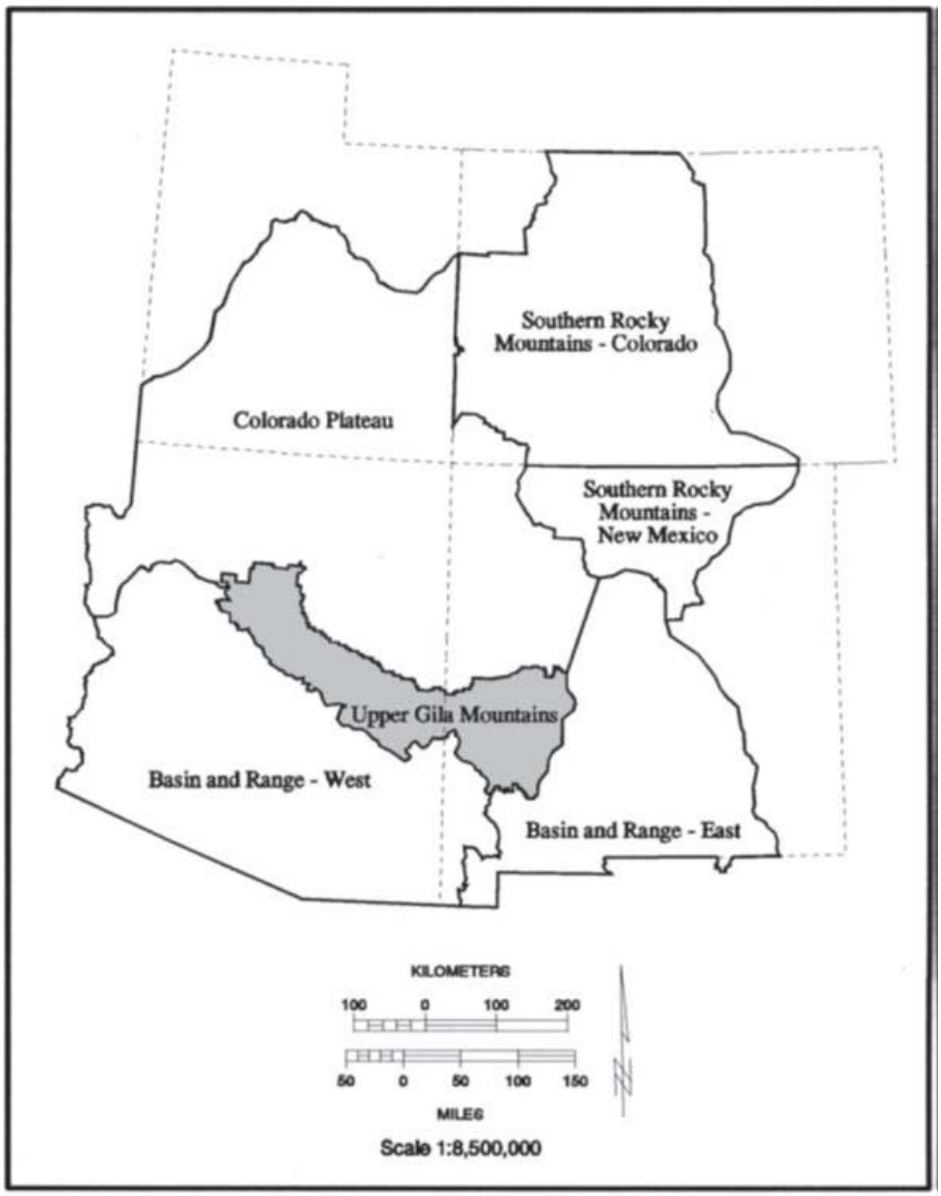


Figure 1. Recovery Units within the United States recognized in the Mexican spotted owl Recovery Plan (USDI 1995).

MSOs most commonly occur in mixed-conifer forests and canyons within the UGM RU. They also occur in ponderosa pine forests with developed Gambel oak understories. Gambel oak is considered a long-lived seral species in these forests (USDI 1995). A study on the Coconino NF found the presence of mature and old-growth oak an important factor in distinguishing MSO nest sites from all other sample points (May et al. 2004). They found MSO primarily nested in Gambel oak greater than 18 inches dbh (May et al. 2004). Alligator, Rocky Mountain, one-seed, and Utah juniper species, pinyon pine, and aspen also commonly occur in pine-oak forests.

Abella (2008) reported numbers of small Gambel oak have escalated since settlement in the late 1800s, with densities increasing from 4- to more than 63-fold. There are three basic growth forms in Gambel oak: shrubby thickets of small stems, pole-sized clumps, and large trees. Top-killed oak resprout prolifically, maintaining the shrub form (Abella and Fulé 2008). Historical fire return intervals in

southwestern pine-oak often averaged 2 to 22 years (Weaver 1951, Cooper 1960, Swetnam and Baison 1996, Covington et al. 1997, Fulé et al. 2003, Abella and Fulé 2008). Local research documented oak can be maintained during low-intensity burning with more than 66 percent of oak less than six inches dbh alive at least five years after two prescribed burns (Abella and Fulé 2008). Oak less than two inches dbh had survival rates less than 20 percent (Abella and Fulé 2008) but resprouted vigorously (Fulé et al. 2002).

Soil properties, species richness, plant cover, and the distribution of cool- and warm-season grasses are tied to the presence and status of the forest canopy (Abella 2009). Research on the Coconino NF found three to eight times greater plant cover in openings than under any tree canopy type, supporting species that were infrequent below trees (Abella 2009). Similarly, some understory species occurred more frequently beneath Gambel oak canopies. There were no species that were most frequent below ponderosa pine (Abella 2009). Thinning pine can recreate canopy openings and maintain productive and diverse understories (Abella 2009). Thinning competing pine also consistently increases oak diameter growth for promoting the large size-classes used by owls (Abella 2008).

The following section was summarized from Ganey et al. (2011): Although FS managers do not manipulate populations of native wildlife directly, understanding life history and habitat use is fundamental for informed conservation planning. Conservation of wildlife populations requires information about the factors that influence vital rates and ultimately population growth. Similar to other spotted owl subspecies, average reproductive rates are generally low in MSO populations. MSOs breed sporadically and do not nest every year (Gutiérrez and others 1995, White and others 1995, Stacey 2010). Reasons for this pattern of sporadic breeding are unknown, but temporal variation in food resources and weather are suspected to influence both the proportion of pairs nesting and the proportion of pairs fledging young. Survival estimates for MSOs within the UGM RU generally indicate relatively high survival rates for adult owls, intermediate survival rates for subadult owls, and relatively low survival of juvenile owls. While this pattern has been observed in the better-studied northern (Burnham and others 1996, Anthony and others 2006) and California subspecies of spotted owls (Franklin and others 2004, LaHaye and others 2004), temporal variation in survival rates appears to be greater in MSOs (Seamans and others 2002) than in the other subspecies. In a study of 2 MSO populations, Seamans et al. (2002) found precipitation from the previous year explained 73% of temporal variation in reproductive output on the Coconino NF and precipitation from the previous monsoon season explained 53% of the temporal variation in survival. In New Mexico, precipitation from the previous monsoon explained 42% of temporal variation in reproductive output and precipitation from the previous winter explained 56% of temporal variation in owl survival. For both study areas, reproductive output varied more than survival across years. This life history strategy allows owls to reproduce when conditions are favorable and to survive unfavorable periods with little or no reproduction.

The amount and arrangement of suitable habitat likely drives patterns of owl distribution (USDI 1995: 83). In most spotted owl populations studied, however, differences in habitat composition and configuration among owl territories explained less of the variation in owl vital rates among these territories than did weather (Franklin and others 2000, Olson and others 2004, Blakesley and others 2005, Dugger and others 2005). These studies suggest that temporal variation in climate is more variable than spatial variation in habitat among occupied owl territories, and that climate therefore is an important driver of vital rates within occupied owl habitat. The studies focused on areas that owls had already selected as home ranges and presumably represent high-quality spotted owl habitat. There is far less variability in habitat among these territories than between these territories and randomly available areas on the landscape. In at least some cases, aspects of within-territory habitat configuration that were optimal for survival were suboptimal for reproduction (Franklin and others 2000 as cited in Ganey et al. 2011).

Mexican Spotted Owl Prey Species

The inherent interspersion of forest and meadow as well as historical patterns of open pine-oak forest may have influenced available prey and the diet of the MSO. MSOs in the UGM RU take more microtine voles and fewer woodrats than owls in other RUs (USDI 1995). Peromycid mice are another key prey species, perhaps because they are ubiquitous in distribution and occupy variable habitats (USDI 1995).

Graminoid species function as both food and cover for Mogollon voles. They select areas with high grass cover and selectively feed on grasses with C_3 photosynthetic pathways ("cool season" grasses that flower in late spring or early summer; Chambers and Doucett 2008). Conversely, microhabitat characteristics do not appear to explain deer mouse distribution as well as simpler macrohabitat features (Coppeto et al. 2006). When small mammal populations were measured against forest basal area (BA), both Mogollon voles and deer mice responded negatively to increasing BA (Bagne and Finch 2009, Kalies et al. 2012). Two studies conducted within the 4FRI area concluded Mogollon voles and deer mice responded positively to reductions in overstory BA, noting strong associations with understory vegetation (Converse et al. 2006, Kalies et al. 2012). Overall, small mammal communities can benefit from thinning treatments in western fire-prone ecosystems, particularly when a variety of forest structural types are retained for dense forest obligates (Converse et al. 2006, Noss et al. 2006, Kalies et al. 2012). Interestingly, Bagne and Finch (2009) found winter precipitation could have a negative effect on deer mouse populations, but thinning treatments focused on restoring forest structure reversed this trend. The Recovery Plan notes total prey biomass may be more influential on the owl's fitness than abundance of any particular prey species (USDI 1995).

The following section was summarized from Ganey et al. (2011): The strong link between raptors and their food is well documented (Newton 1979). Understanding a predator's food choices along with the natural and life history of its common prey species can provide practical information for conserving and enhancing the predator's habitat. Several studies provided information on diets of MSOs within the UGM RU based on examination of prey remains from regurgitated owl pellets. However, soft-bodied prey (for example, insects such as butterflies and moths; Lepidoptera) may be under represented in pellets.

Several studies have estimated prey abundance within ponderosa pine or ponderosa pine-Gambel oak forests within the UGM RU (Table 1). Estimates varied among studies, but abundance typically was both greater and more variable for deer mice than for most other species. Density of deer mice was the most variable, ranging from a high of 4.9 mice per ac^{-1} (12.2 ha^{-1}) during summer 1991 to a low of 1.3 mice per ac^{-1} (3.3 ha^{-1}) during winter. Relative abundance of brush mice and woodrats generally was low in all seasons and years.

Table 1. Density (range in number per acre) of selected small mammals in ponderosa pine and ponderosa pine–Gambel oak forest, Arizona.

Source	Deer mouse	Brush mouse	Mexican woodrat	Pocket gopher
Goodwin and Hungerford (1979)	2–19	6–20	2–10	<0.2
Block and others (2005)	1–5	0–2	0–0.4	
Kyle and Block (2000)	0.4–4.7			
Converse and others (2006)[1]	2.2–12.6[1]	2.2–12.6[1]	0–2.5	

[1] Estimate provided in Converse and others (2006) was for deer and brush mice combined.

Ward (2001) estimated biomass of prey species during summer within cover types (mid- and late-seral stage mixed-conifer forest, grassland, and ponderosa pine forest and pinyon-juniper-oak woodland) and

evaluated variability in summer biomass among years. Biomass of all species except the Mexican woodrat differed significantly ($P < 0.05$) across years, and the year effect was nearly significant for woodrats ($P = 0.059$). Cover type by year interactions were observed for brush mice and both vole species, indicating that population trends were not always synchronous in different cover types. Similar interactions were not observed for deer mice and woodrats.

A study in the Sacramento Mountains, New Mexico (Basin and Range-East RU, Ward 2001) found that reproductive output of spotted owls was influenced by abundance of smaller rodents such as mice and voles in mixed-conifer forests. Abundance of these same prey species in two other cover types (montane meadow and xeric forest) had little influence. Temporal variability in abundance of these rodents was greater than spatial variability among cover types. That is, rodent abundance varied more among years than among cover types within years.

Available data on spotted owl diet composition suggest that owls are opportunistic predators that eat a wide variety of prey but typically prey primarily on relatively few groups of small mammals that are active at night. Significant relationships between consumption of large prey and successful breeding have not been observed in Mexican spotted owls, and efforts to link owl reproduction to consumption of particular prey species have been mostly unsuccessful. In fact, owl reproduction appears most linked to combined biomass of multiple prey species (for example, Ward 2001), as might be expected in an opportunistic predator. Given the variation in habitat relationships across the small mammal community, a diversity of various habitat features across the landscape likely will best maintain high diversity, ensure maintenance of important ecological functions in that community (Kalies and Chambers 2010), and buffer against population fluctuations of individual prey species to provide a more constant food supply for the owl (Ward 2001, Block et al. 2005). An important consideration here is that many small mammals may respond to variation in habitat features at relatively fine scales and different species may respond to habitat features at different scales.

Because total prey biomass may be more influential on MSO fitness than the abundance of any individual prey species, the Recovery Plan (USDI 1995) recommends managers provide diverse habitats to support a diverse prey base. For example, Mexican voles are found in areas with high herbaceous cover, especially dense grass cover, while Mexican woodrats are typically found in areas with high shrub or understory tree cover, high down log volumes, and little herbaceous cover. Deer mice are ubiquitous, occupying areas with variable conditions, whereas brush mice are restricted to areas with a strong oak component and dry, rocky substrates with sparse tree cover (USDI 1995).

Starvation, particularly for juveniles, was identified as a potentially important mortality factor in the Recovery Plan (USDI 1995). The Recovery Team identifies this as of particular concern where prey resources and availability are reduced in abundance.

Upper Gila Mountain Recovery Unit

Status of the Upper Gila Mountain Recovery Unit

The Apache-Sitgreaves, Coconino, Kaibab, and Tonto NFs that make up the 4FRI Project are within the Upper Gila Mountain Recovery Unit (UGM RU). These forests, along with 2 more in New Mexico encompass 42% of the RU (USDI 1995); the proposed 4FRI project occupies the western portion of the UGM RU. The UGM RU supports over half the known population of MSOs (Ganey et al. 2011) and is at significant risk of high-severity wildfire (USDI 1995). The Recovery Plan recommends recovery actions concentrate on: RUs with the highest owl populations and where significant threats exist; management within these RUs should emphasize alleviating the greatest threats; and that management actions should be tailored to the needs of the area under analysis (USDI 1995).

The following was extracted from Ganey et al. (2011): "Historical information on Mexican spotted owls throughout their range is sparse and anecdotal but clearly documents that these owls were present in the UGM RU. Referring to what is presumably the Blue Range Primitive Area and White Mountains of eastern Arizona, Ligon (1926:422) stated that MSOs were '…by no means as scarce in favored sections of their range as one unfamiliar with their habits might believe.' Bailey (1928; see also Steele 1927) also lists several locations where spotted owls were observed in this general region. Historical data for the western portion of the RU, where the 4FRI is proposing to begin forest treatments, are sparse. Huey (1930) collected an adult female spotted owl at the base of the San Francisco Peaks in June 1929. Beyond this, little is known about the historical distribution of MSOs within the UGM RU.

Today MSOs are known to be widely distributed within the UGM RU, with most locations occurring on National Forest System lands (see also USDI 1995, Ward and others 1995). They are located on all six NFs within this RU and have a relatively continuous distribution in the UGM RU in contrast to a patchy distribution throughout much of the rest of their range.

An estimated 2,941 territorial adult or subadult owls occupied the UGM RU (excluding tribal lands, which were not included in the sampling frame). This estimate was rigorous but imprecise, with a 95% confidence interval ranging from 833-5,049 owls. Since 1989, when the FS began using standardized procedures to identify and record occupied MSO "sites", a cumulative total of 424 such sites have been documented in the UGM RU (USDI 1995). This constitutes 55.9% of the known spotted owl sites documented range-wide (USDI 1995). It is not possible to estimate abundance directly from these data, however, for the following reasons: these sites may indicate occupancy by either a single owl or a pair of owls; it is not known how many of these sites are occupied during any given year, and these surveys may not be effective at locating non-territorial individuals. These known owl sites are well distributed among the NFs comprising this RU, with the exception of the Kaibab NF. The Kaibab NF has few known owl sites, which contrasts sharply with the neighboring Coconino NF. The UGM RU contains the two national forests with the greatest number of known sites (Gila and Coconino NFs) and three of the four top national forests in terms of known sites (including the Apache-Sitgreaves NF).

Metapopulation Dynamics in UGM RU

The distributional pattern of MSOs is disjunct relative to other subspecies of spotted owl, making MSO dispersal an important consideration (USDI 1995). Providing for connectivity could buffer MSO populations "from stochastic variability through time by providing the opportunity for local population failures to be 'rescued' by immigration from other populations" (USDI 1995).

The following was summarized from Ganey et al. (2011): The structure and spatial distribution of spotted owls at a range-wide scale suggests that groupings of individuals may occur as subpopulations, and that these subdivided populations may function as a metapopulation. Of the three spotted owl subspecies, the distribution of MSOs appears to most naturally resemble the metapopulation construct, with perceived subpopulations existing in useable habitat created by elevation gradients and disconnected mountain or canyon systems separated by a matrix of low-quality to non-useable habitat.

Keitt and others (1995, 1997) examined the spatial pattern of forest habitat patches across the range of the Mexican spotted owl. Patches of forest habitat in the range of the Mexican spotted owl showed a connectivity threshold of approximately 28 miles and the authors concluded that an organism capable of dispersing at least 28 miles (45 km) through inhospitable terrain, and with an average exponential dispersal distance of at least 9 mi (15 km), would perceive the landscape as a series of connected patches. They further concluded that Mexican spotted owls likely met these criteria, and that the Mexican spotted owl probably behaves as a classical metapopulation over much of its range. At this scale, the landscape consists of a set of large, more-or-less discrete habitat clusters. This suggests that owls could successfully

disperse within habitat clusters with very high probability and disperse between clusters with much lower probability.

Keitt and others (1995, 1997) also attempted to identify habitat clusters most important to overall landscape connectivity, using maps based on forest and woodland cover to define clusters. The UGM RU emerged as the most important RU in this analysis because of its large area and relatively continuous forest habitat. They next conducted a second analysis aimed at emphasizing positional effects on landscape connectivity. The UGM RU again emerged as important in this analysis, due to both its large size and central location. Some small habitat clusters also emerged as important. Because of their locations, these clusters may serve as stepping stones between other, larger clusters and thus may be important to landscape connectivity despite supporting relatively few resident owls.

Barrowclough and others (2006) investigated genetic structuring in Mexican spotted owl populations. Their data suggested substantial gene flow among populations sampled in the Mogollon Rim-Upper Gila Mountains region of central Arizona and New Mexico, with more restricted gene flow among other populations (Barrowclough and others 2006). They recognized three major haplotypes[1] within the range of the Mexican spotted owl. One haplotype was common in populations in the northwestern portion of the range and not found in the southeastern portion. A second haplotype was most common in the southeastern portion of the range, and not found in the northwestern portion. A third haplotype was found in all populations studied, but was most common in the UGM RU and in southern Arizona. All three haplotypes occurred in populations within the UGM RU, suggesting that this area is important in facilitating gene flow across the range of the Mexican spotted owl.

These findings highlight the importance of both large patches of habitat and of some small patches based on their location and consequent influence on landscape connectivity. The UGM RU is important in both contexts. This RU includes the largest contiguous area of habitat for Mexican spotted owls, and that is reflected in the large number of documented owls in that RU (Ganey and others 2004). This RU also is centrally located relative to other areas inhabited by Mexican spotted owls. The larger subpopulation in this RU likely serves as a core source population for supplying new recruits to proximal outlying locations and for facilitating gene flow throughout the range of the Mexican spotted owl.

Mexican Spotted Owl Habitat

Protected and Restricted Habitat

The authors of the MSO Recovery Plan ("Recovery Plan", USDI 1995) agreed that forests in the Southwest were outside the historical range of variation and are at high risk from uncharacteristic fire, insect, and disease events. They propose recovering MSO populations by sustaining adequate habitat quality and quantity through time and within the historical range of variation. They recommend managers emulate natural ecosystem processes to create landscape mosaics that balance natural variability and secure the landscape against uncharacteristic habitat loss. This coarse filter approach is expected to sustain biotic diversity, including most of the habitat conditions required by the owl and its prey, across the landscape (USDI 1995).

The Recovery Plan provides 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 protected activity centers (PACs); mixed conifer and pine-oak forests with slopes greater than 40 percent where timber harvest has not occurred in the last 20 years; and reserved lands which include wilderness, research natural areas, wild and scenic rivers, and congressionally recognized wilderness

[1] A haplotype is a set of DNA variations, or polymorphisms, that tend to be inherited together.

study areas. Restricted areas include all mixed-conifer, pine-oak, and riparian forests outside of protected areas. Other forest and woodland types include all ponderosa pine, spruce-fir, woodland, and aspen forests outside protected and restricted areas.

Protected areas receive the highest level of protection. PACs are at least 600 acres in size and based on known locations of owls. Within PACs are core areas of at least 100 acres intended to protect nesting and roosting habitat. Restricted habitat is less specific and intended to operate in conjunction with ecosystem management and existing management guidelines to provide for nest and roost habitat through time. A minimum of 10 percent of restricted habitat is designated Target and Threshold and intended to identify those acres closest to currently meeting nesting and roosting habitat for the MSO. Key nesting and roosting habitat values are defined in the Recovery Plan (Table 2). It is assumed in the Recovery Plan that by meeting recommended levels for tree density and BA, adequate amounts of snags and logs (12 inches at mid-line and 8 feet long) should be present. These desired conditions must be met simultaneously for a stand to qualify as existing threshold habitat. They also represent minimum values that must be maintained where conditions meet or exceed these values. In project design, no stands simultaneously meeting or exceeding these minimum threshold values should be reduced below those values unless a larger landscape analysis of restricted areas shows a surplus of acres simultaneously meeting threshold values. Treatments that reduce fire risk, lessen threats from uncharacteristic levels of insects and forest disease, or meet other ecosystem objectives are allowed as long as overall values remain at or above nesting and roosting conditions. The scale at which the evaluation occurs can add subjectivity to the decision. The Recovery Plan estimated most FS project planning occurred at about the 10,000-acre level, which they describe as a "limited spatial scale" that precluded a review of MSO habitat at more meaningful ecological scales (USDI 1995).

Table 2. Minimum values for achieving Target/Threshold stand conditions

Upper Gila Mountain Recovery Unit	Percent of Restricted Habitat	Percent of Total SDI by trees 12-18" dbh	Percent of Total SDI by trees 18-24" dbh	Percent of Total SDI by trees >24" dbh	Stand basal area	Trees per acre ≥ 18" dbh	Basal area of oak ≥ 5" dcr
Pine-oak forest	10	15	15	15	150	20	20

SDI = stand density index; dbh = diameter at breast height; drc = diameter at crown root

Overall, MSO habitat elements are not on a sustainable trajectory within the UGM RU. Recent wildland fire history indicates wildfires are larger and are burning at higher severity; for example, in 1910, only two crown fires were big enough to map in the ponderosa pine forests of the Kaibab Plateau. The larger of the two fires burned about 80 acres (Paxon 2011). In 1995, habitat loss from high severity wildland fire was identified as a primary risk in the Recovery Plan (USDI 1995), yet the three most active fire seasons in Arizona history have occurred since 2001, with nearly a million acres burned in 2011 alone (Paxon 2011).

Large snags cannot be created without large trees and both large trees and large snags are important to the MSO (USDI 1995). The Coconino and Kaibab forest plans call for an average of two snags per acre in ponderosa pine forests. However, these specifications may be unrealistic. Ganey (1999) found only 30% of ponderosa pine plots in un-logged sites met or exceeded FS snag guidelines and Waskiewicz et al. (2007) found pine snag densities well below FS guidelines in relatively undisturbed forests in northern Arizona. Fire promotes recruitment of large snags, but in one study conducted locally, 40% of fire-killed snags fell within seven years (Chambers and Mast 2005). Over 80% of ponderosa pine snags created by high severity fire fell within 10 years post-fire (Chambers personal communication 2008, Mast personal communication 2008). Similar fall rates appear to occur for beetle-killed ponderosa pine trees (Chambers

personal communication 2011, Mast personal communication 2011). Chambers and Mast (2005) found greater densities of large diameter snags in unburned plots vs. burned plots on the Coconino and Kaibab NFs. Holden et al. (2006) found significantly lower snag densities in the Gila NF (New Mexico) where fire had occurred 2 to 3 times since 1946 compared to areas that had only burned once. Bagne et al. (2008) found that in forests experiencing fire suppression for long periods of time, the greatest loss of snags occurred during first-entry burns, but in the long-term, the rate of loss decreased and eventually leveled off during subsequent burns.

Ganey and Vojta (2005) documented an increase in snag recruitment, but the greatest increase was among smaller-sized trees. This pattern is reflected in Forest Inventory Analysis (FIA) data collected between 1995 and 2007 showing an overall increase in ponderosa pine snag density on the Kaibab NF, similar to results reported by Ganey and Vojta (2005; Table 3). In 2011, Ganey and Vojta reported a 74 percent increase in ponderosa pine mortality from 2002 to 2007 compared to mortality between 1997 and 2002. While more trees were dying in the smaller size-classes, proportions of dying trees were greatest in the largest size classes. Mortality of aspen and Gambel oak in pine-oak forests were also proportionally greater than expected, relative to species composition of live tree forests (Ganey and Vojta 2011).

Table 3. Number of dead Ponderosa pine trees per acre on the Kaibab National Forest portion of the 4FRI (FIA unpublished data).

Ranger District	Diameter class		
	5"-10.9"	11"-14.9"	>=15"
1995			
Tusayan	0.39	0.00	0.11
Williams	0.99	0.00	0.24
Totals	2.49	0.00	0.49
2007			
Tusayan	0.33	0.16	0.33
Williams	2.18	0.60	0.79
Totals	5.00	1.50	1.20

The proximate cause for the observed mortality observed by Ganey and Vojta (2011) was a complex of bark beetles likely mediated by long-term drought conditions. Insects and disease outbreaks are also a function of stand density. Increased stand densities create prime conditions for insect epidemics and disease outbreaks, particularly among older trees. Fungi and parasitic plants weaken structural integrity of stressed trees, making them more susceptible to bark beetle attacks (Filip 2007). Historically, the western pine beetle (*Dendroctonus sp*.) was the most aggressive and damaging insect in ponderosa pine forests on the Kaibab NF (Lynch et al. 2008). On the Kaibab NF, mountain pine beetle outbreaks occurred in the 1910s and 1970s, but mortality was reported at less than 3% (Lang and Stewart 1910, Lynch et al. 2008). Since 2003, damage by *Dendroctonus* has been surpassed by the *Ips* genus, an aggressive beetle that favors denser forests. An unprecedented *Ips* outbreak damaged 60,000 acres on the Kaibab NF from 2002 to 2004 with 100% mortality occurring in some stands. In general, ponderosa pine mortality in the southwest has increased as a result of drought and more frequent bark beetle attacks (Kolb et al. 2007, Ganey and Vojta 2011).

Most beetle activity in Arizona decreased substantially since 2002, although the western pine beetle has remained active on the Coconino NF with over 5,000 acres of mortality reported in 2007 (USDA 2008). Large mortality events in northern Arizona forests are typically infrequent, followed by relatively low

mortality rates (Joel McMillin, personal communication 2012). However, future drought cycles would be expected to again accelerate tree mortality from bark beetles. Ponderosa pine mortality associated with *Ips* and other bark beetles is expected to continue to occur throughout the region as a result of high populations and dispersal distances of beetles (Allender et al. 2008). While losses of big trees will assist in meeting snag guidelines in the short-term, it will extend the time required to meet the large tree (i.e., trees greater than 18 inches dbh) guidance in the Recovery Plan over the long term.

Another result of current forest health issues in southwest ponderosa pine forests is an increase in large down logs. Ganey and Vojta (2012) documented increased fall rates of trees in plots across the Coconino and Kaibab NFs since 2004. Plots with logs present increased by over eight percent between 2004 and 2009 and log length, density, volume, and area covered all increased significantly ($p < 0.001$) during that same period. However, the changes documented here represent initial results from a drought-mediated pulse in tree mortality (Ganey and Vojta 2011).

The following section was summarized from Ganey et al. (2011): "Available information suggests that Mexican spotted owls use relatively large home ranges, with smaller areas of concentrated use embedded within those home ranges. There are 4 spatial scales relevant to understanding space use by resident MSOs: territory, home range, activity center, and core area. Spotted owls are described as territorial in the sense that mated pairs defend a breeding territory, at least during the nesting season. Seasonal and longer-term fidelity to territories is often strong, with many owls remaining on the same territory year after year (Gutiérrez and others 1995). No direct estimates of territory size are available for MSOs within the UGM RU, but estimates of nearest-neighbor distances between adjacent pairs indicate mean distances of 1.5 miles in Arizona (n = 42 pairs; May and Gutiérrez 2002; Coconino NF) and 1.3. miles in New Mexico (n = 31 pairs; Peery and others 1999; Gila NF). This suggests that exclusive use areas average approximately 1,115 and 855 acres, respectively.

Home ranges are usually assumed to be larger than territories, although few studies have formally evaluated differences between territories and home ranges. Home-range size varied considerably among study areas, but the factors underlying that variation are unclear. Home ranges of adjacent pairs may overlap spatially, and the entire home range typically is not defended. Research sampling regimes and sample sizes have varied and studies were conducted in different years, making direct comparisons among studies difficult (Kernohan and others 2001 as cited in Ganey et al. 2011). Consequently, observed differences among studies could be due to differences in methodology. We assume that some of the observed variation in home-range size is real rather than an artifact of methodology. Differences could be a result of local habitat quality including abundance of prey, biogeographic effects (for example, differences in climate pattern or biogeographic region), temporal variation (studies conducted in different years), or all of the above. There is evidence from outside the UGM RU that local habitat composition and/or prey abundance can influence home-range size of spotted owls (Carey and others 1992, Zabel and others 1995, Ganey and others 2005).

Only one study within the UGM RU estimated size of seasonal home ranges (Ganey and others 1999). Home range size more than doubled from the breeding to the non-breeding season in this study (Table 4). Annual activity centers for owl pairs generally were less than half the size of home ranges, suggesting considerable concentration of activity in particular areas. This pattern also held in a comparison of seasonal activity centers of individual owls within a single study area (Table 4).

Table 4. Area of home ranges or activity centers of radio-marked Mexican spotted owl pairs and individuals in ponderosa pine–Gambel oak forest during the breeding and non-breeding seasons (from Ganey et al. 2013).

Parameter	Breeding season[1] (acres)			Non-breeding season[1]		
	N	Mean	*SE*	*N*	Mean	*SE*
Owl pairs						
Home-range area	4	1303	214	7	2772	420
Activity-center area	4	319	40	7	981	200
% of home range[2]	4	24.5		7	35.4	
Individual owls						
Home-range area	8	971	173	14[4]	2345	363
Activity-center area	8	302	54	14[4]	808	133
% of home range[2]	8	31.1		14[4]	34.5	

Data from Ganey and others 1999: N = number of owl pairs or individual owls included in estimates. Home range estimates based on the 95% adaptive kernel estimator; activity centers based on the 75% adaptive kernel estimator.

[1] Seasons: Breeding = 1 Mar–30 Aug, Non-breeding = 1 Sep–28 Feb.

[2] Percent of seasonal home range contained within the activity center, calculated from table values as: (Activity-center area/Home-range area) * 100.

Resident owls concentrate activity around the nesting area during the breeding season, but they expand their range during the non-breeding season. Activity typically centers on the nest stand during the breeding season, even in years when resident pairs do not nest. Resident owls typically roost in or near the nest stand throughout the breeding season. Size of activity centers more than doubled during the non-breeding season, but overlap between seasonal activity centers was 83.3 percent of maximum potential overlap. This indicates that protection of breeding areas provides protection to areas and habitat used throughout the year.

Critical Habitat

Critical habitat is defined in section 3(5)(A) of the Endangered Species Act as—(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) that may require special management considerations or protection and; (ii) specific areas outside the geographical area occupied by the species at the time it is listed, upon a determination that such areas are essential for the conservation of the species. The term ‘‘conservation,’’ as defined in section 3(3) of the Act, means ‘‘the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary.’’

The U.S. Fish and Wildlife Service (FWS) has found that designation of statutory critical habitat provides little additional protection to most listed species, while consuming significant amounts of available conservation resources (USDI 2004). They concluded that comparable conservation can be achieved by implementation of laws and regulations obviating the need for critical habitat and that the “present system has evolved into a process that provides little real conservation benefit, is driven by litigation and the courts rather than biology, limits our ability to fully evaluate the science involved, consumes enormous agency resources, and imposes huge social and economic costs” (USDI 2004).

Critical habitat must be ‘‘essential to the conservation of the species.’’ Critical habitat designations identify, to the extent known using the best scientific and commercial data available, habitat areas that

provide essential life cycle needs of the species. Critical habitat designations include, but are not limited to: space for individual and population growth and normal behavior; food, water, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, or rearing of offspring; and habitats that are protected from disturbance or are representative of the historic geographical and ecological distribution of a species. Primary constituent elements identify physical and biological features that support nesting, roosting, and foraging. The primary constituent elements designated by the FWS (2004) can be used to identify the presence or absence of key MSO habitat elements and can be broken down into two main categories:

1) Forest Structure:

- A range of tree species of different sizes and ages;
- Thirty to 45% of the trees with a dbh of 12 inches or greater;
- Shade canopy of 40% or more;
- Snags of 12 inch or greater dbh; and

2) MSO Prey Habitat:

- High volume of fallen trees and other woody debris;
- A wide range of tree and plant species, including hardwoods;
- Adequate levels of residual plant cover to maintain fruits, seeds, and plant regeneration.

Therefore, conservation of MSOs should include consideration of both the habitat needs of the owl and its prey species. Designated critical habitat includes protected and restricted habitat that currently possess the habitat requirements for nesting, roosting, foraging, and dispersal.

Vegetation Management within Mexican Spotted Owl Habitat

In the revised MSO Recovery Plan (USDI 2012), the recovery team stated that ponderosa pine and xeric-mixed conifer forests in the west:

> are now very prone to stand-replacement, high-intensity and high-severity fires that are now very difficult to control. As a result, we have seen an increasing trend in the size and severity of wildland fires in the western U.S., including the Southwest.

Recognizing these changing aspects of southwestern forest ecology and the potential for more and larger high-severity fires to occur in the near future, the recovery team recognized stand-replacing wildland fire as one of the primary threats to the MSO and its habitat. The recovery team quantified trends in burn severity from 1995 to 2008 and determined the UGM RU was one of the Units with over 40 percent of the PAC area at risk of habitat alteration by high-severity fire. Additionally, the rate of habitat changes resulting from high-severity fire is likely to increase. They concluded that there is a need to significantly reduce habitat loss from high-severity fire within the next 30 to 40 years.

Effects of Forest Management on Mexican Spotted Owls

There has been limited work to date addressing the effects of vegetation manipulation within MSO home ranges. No empirical data exists on the effects of thinning or other mechanical forest treatments on MSOs. The absence of information complicates planning for restoration of ponderosa pine forests while simultaneously conserving MSOs and their habitats. The following summarizes published research on habitat treatments within the range of spotted owls, including the northern and California subspecies.

Irwin et al. (2004) found northern spotted owls on the eastside of the Cascade Mountains abandoned 45 territories that had abundant pole-sized trees and limited seedling and sapling-aged trees. In addition, northern spotted owl reproductive rates were lower in territories with more pole-sized trees. Blakesley et al. (2005) also found site occupancy negatively associated with medium-sized trees with high canopy cover for California spotted owls. The most productive owl pairs occurred in forests most at risk to uncharacteristic wildfire. They recommended managers prioritize treatments in dry forests most at risk of uncharacteristically intense wildfire.

Meiman et al. (2003) used radiotelemetry to follow a single male northern spotted owl before, during, and after a 237-acre commercial thinning. Thinning intensities varied from about 90 to 170 ft^2 BA. Tree harvest significantly reduced use of the thinned stand. The owl shifted its breeding-season home range to exclude part of the thinned area and used additional unthinned areas instead. However, results are difficult to interpret, in part because they are based on habitat use of a single owl. Also, information about temporal variation in space and stand use is lacking (USDI 2012). As the authors noted, "Because this was a case study involving one owl, we are unable to apply our findings to spotted owls in general; however, we believe that our results highlight important issues that need to be addressed…"

Seamans and Gutiérrez (2007) modeled the probability of territory colonization, territory extinction, and breeding dispersal in relation to the amount of mature forest within and among territories. They included a covariate to evaluate the effects of altering mature conifer forest habitat after timber harvest. The amount of untreated mature conifer forest habitat was positively related to the top models for colonization and the probability of occupancy. Conversely, territory extinction was inversely related to the amount of mature forest within a territory. However, Seamans and Gutiérrez (2007) did not provide details on what types of treatments were involved in habitat alteration in this study nor the spatial extent of those treatments, making it difficult to relate the results to any specific management proposals.

In another modeling effort, Lee and Irwin (2005) looked at effects to California spotted owl (CSO) habitat from reducing fire risk while maintaining forest canopy conditions. Their 60-year simulations found that mechanical thinning with or without fuel breaks did not degrade canopy conditions in productive owl territories and did not impede attainment of improved forest structure in non-productive territories. They concluded that forest treatments could reduce the risk of high-severity wildfire and maintain owl habitat.

Prather et al. (2008) looked at fuels reduction treatments in fire-excluded forest in MSO habitat. They used spatially-explicit modeling at a landscape scale to evaluate impacts of restoration-based treatments. They concluded that forest restoration was compatible with MSO conservation in at least two-thirds of the 2 million-plus acres analyzed across northern Arizona.

The Pacific Southwest Research Station of the FS conducted a large scale monitoring effort on the Plumas and Lassen NFs (USDA 2010). They monitored movements and habitat use of radio-marked CSOs in a portion of the northern Sierra Nevada Mountain Range modified by fuels treatments. Treatments included a defensible fuel profile zones, understory thin, understory thin followed by underburn, and group selection. Treatment objectives were to reduce fuel continuity across the landscape. Treatments were typically located along roads and ridgetops to provide a defensible zone for fire suppression activities. Understory thinning treatments allowed removal of trees less than 10 inches dbh. Radio-marked owls avoided the defensible fuel profile zones, but did not avoid other fuels treatment types. Owl home ranges contained fuels treatments in proportion to their availability on the landscape. One owl strongly selected underburn treatments over untreated forest for foraging; limited availability of this treatment type within the study area prevented further analysis of this relationship. In three-years post-treatment CSOs were distributed similarly to the pre-treatment landscape. The authors concluded that the results provide empirical support that CSOs persist in landscapes treated for fuels or restoration treatments.

The literature supports the concept of reducing the risk of future high-severity fire in occupied spotted owl habitat. However, no clear guidance emerges from the sum of these studies relative to types, extents, or spatial arrangement of treatments that might minimize impacts to owls. Lacking such information, the MSO recovery team recommended that managers proceed cautiously in terms of treatment intensity and extent and summarized the research by saying it suggests some mechanical forest treatments may negatively impact spotted owls. Given the uncertainty, they concluded treatments in MSO habitat should include rigorous monitoring (USDI 2012).

The 4FRI is proposing treatments in over 73,000 acres of MSO restricted habitat and over 35,000 acres of protected habitat. These treatments are fundamentally different from the research described above. The objective of the 4FRI treatments is to improve MSO habitat. This is very different from the emphasis on fuels reduction described in the literature above. Targeting mid-aged trees would improve health and growth rates of large trees. Canopy gaps would increase understory production and benefit prey species. No large trees would be cut. Treatment objectives include retaining Gambel oak and other non-ponderosa pine species to maintain overstory diversity. Improving meadows, riparian habitat, and aspen stands would improve foraging habitat. These actions would reduce fire risk, but the intent of the treatment design is to improve MSO habitat by using the recovery plan as a guide. The landscape approach of 4FRI allows emphasizing fuels reduction treatments outside of MSO habitat, particularly in stands southwest of PACs. Monitoring would be a component of this work and success would be determined by conserving MSOs and their habitat.

Summary

The status of MSO habitat within the 4FRI is, in part, a result of past timber management and over 100 years of fire suppression and exclusion. The large-scale, contiguous areas of dense forest are increasingly vulnerable to high-severity fire. Mechanical tree harvest and prescribed fire can potentially move these forests toward more sustainable and more resilient conditions. However, it is important to understand the ecological relationships between MSOs, their prey, and habitat structure in order to assess the effects of proposed forest management. This document presents an overview that is intended to be part of the project record in support of the 4FRI effects analysis.

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Protected Habitat Outside of Protected Activity Centers (PACs)

Forest Attributes by Subunit

Table 1. Changes in MSO Habitat Components by Alternative and Year (Note that all action alternatives propose prescribed-fire only in protected habitat outside of PACs)

Restoration Unit-Subunit and Forest Attributes	Existing Conditions Yr 2010	Alternative A Yr 2020	Alternative A Yr 2050	Alternatives B-E Yr 2020	Alternatives B-E Yr 2050
Subunit 1-3					
Acres	40				
% of SDI 12-18" DBH	23	25	27	25	27
% of SDI 18-24" DBH	10	12	16	12	16
% of SDI >24" DBH	7	7	9	8	9
% of Max SDI	86	88	88	85	87
TPA >18"	12	15	21	15	22
Ponderosa Pine BA	118	122	123	115	119
Gambel Oak BA	33	35	40	35	42
All BA	161	171	187	165	186
% Oak BA	20	20	21	21	22
Subunit 1-5					
Acres	555				
% of SDI 12-18" DBH	29	29	26	29	26
% of SDI 18-24" DBH	12	14	20	15	21
% of SDI >24" DBH	8	8	11	8	11
% of Max SDI	81	83	84	80	83
TPA >18"	14	17	26	17	26
Ponderosa Pine BA	115	119	120	113	117
Gambel Oak BA	26	27	32	28	33
All BA	157	167	184	161	182
% Oak BA	16	16	17	17	18
Subunit 3-3					

Restoration Unit-Subunit and Forest Attributes	Existing Conditions Yr 2010	Alternative A Yr 2020	Alternative A Yr 2050	Alternatives B-E Yr 2020	Alternatives B-E Yr 2050
Acres	45				
% of SDI 12-18" DBH	21	21	21	21	21
% of SDI 18-24" DBH	9	12	16	13	16
% of SDI >24" DBH	27	26	26	26	27
% of Max SDI	51	54	59	51	58
TPA >18"	13	15	21	15	21
Ponderosa Pine BA	90	96	109	91	106
Gambel Oak BA	9	8	9	9	9
All BA	112	121	145	116	142
% Oak BA	5	5	5	5	5
Subunit 3-4					
Acres	146				
% of SDI 12-18" DBH	32	33	29	33	28
% of SDI 18-24" DBH	12	15	22	16	23
% of SDI >24" DBH	7	7	10	7	10
% of Max SDI	89	90	90	87	89
TPA >18"	16	19	30	19	30
Ponderosa Pine BA	135	139	140	132	137
Gambel Oak BA	26	27	29	27	30
All BA	177	185	200	179	198
% Oak BA	15	15	15	15	15
Subunit 3-5					
Acres	47				
% of SDI 12-18" DBH	35	33	27	33	26
% of SDI 18-24" DBH	14	17	25	18	25
% of SDI >24" DBH	8	8	11	9	12
% of Max SDI	89	91	90	88	89
TPA >18"	18	22	34	23	34
Ponderosa Pine BA	138	142	142	136	138

Restoration Unit-Subunit and Forest Attributes	Existing Conditions Yr 2010	Alternative A Yr 2020	Alternative A Yr 2050	Alternatives B-E Yr 2020	Alternatives B-E Yr 2050
Gambel Oak BA	23	24	26	24	26
All BA	179	187	201	182	199
% Oak BA	13	13	13	13	13
Subunit 4-4					
Acres	3				
% of SDI 12-18" DBH	33	36	57	37	55
% of SDI 18-24" DBH	0	9	24	9	25
% of SDI >24" DBH	0	0	2	0	2
% of Max SDI	6	9	17	9	15
TPA >18"	0	1	6	1	5
Ponderosa Pine BA	13	20	44	19	40
Gambel Oak BA	0	0	0	0	0
All BA	13	20	44	19	40
% Oak BA	0	0	0	0	0

Prey Habitat Metrics by Subunit

Table 2. Changes in MSO Prey Habitat Components by Alternative and Year

Restoration Unit-Subunit and Forest Attributes	Existing Conditions Yr 2010	Alternative A Yr 2020	Alternative A Yr 2050	Alternatives B-E Yr 2020	Alternatives B-E Yr 2050
Subunit 1-3					
Acres	40				
Snags >12"	2.70	3.44	4.65	6.75	7.08
Snags >12" and <18"	2.05	2.80	4.03	5.41	5.76
Snags >18"	0.65	0.64	0.62	1.33	1.32
CWD >3"	5.35	7.14	2.94	7.77	11.78
Logs	1.34	2.20	1.43	4.76	5.30
Understory Index	28	24	27	18	18
Subunit 1-5					

Restoration Unit-Subunit and Forest Attributes	Existing Conditions Yr 2010	Alternative A Yr 2020	Alternative A Yr 2050	Alternatives B-E Yr 2020	Alternatives B-E Yr 2050
Acres	555				
Snags >12"	3.33	4.17	5.48	7.45	7.83
Snags >12" and <18"	2.66	3.46	4.78	5.74	6.12
Snags >18"	0.67	0.71	0.70	1.71	1.71
CWD >3"	5.78	7.56	3.09	8.29	12.38
Logs	2.40	3.42	2.15	6.44	7.37
Understory Index	31	26	29	20	19
Subunit 3-3					
Acres	45				
Snags >12"	2.35	2.56	3.60	3.56	3.30
Snags >12" and <18"	1.37	1.67	2.68	2.67	2.37
Snags >18"	0.99	0.89	0.93	0.89	0.92
CWD >3"	5.88	6.84	9.14	2.42	5.50
Logs	0.88	1.56	3.81	1.01	3.51
Understory Index	71	60	39	65	41
Subunit 3-4					
Acres	146				
Snags >12"	4.29	5.29	8.91	6.94	8.39
Snags >12" and <18"	3.59	4.52	6.99	6.18	6.48
Snags >18"	0.69	0.78	1.92	0.77	1.91
CWD >3"	6.30	8.37	13.77	3.42	9.21
Logs	2.18	3.39	7.97	2.18	7.09
Understory Index	51	46	38	50	39
Subunit 3-5					
Acres	47				
Snags >12"	5.11	6.15	9.56	7.80	9.01
Snags >12" and <18"	4.33	5.24	7.28	6.90	6.74
Snags >18"	0.78	0.91	2.28	0.90	2.27
CWD >3"	6.49	8.70	14.43	3.53	9.73

Restoration Unit-Subunit and Forest Attributes	Existing Conditions Yr 2010	Alternative A Yr 2020	Alternative A Yr 2050	Alternatives B-E Yr 2020	Alternatives B-E Yr 2050
Logs	2.44	3.89	9.26	2.50	8.21
Understory Index	21	18	14	20	14
Subunit 4-4					
Acres	3				
Snags >12"	0.62	0.90	2.23	1.08	2.16
Snags >12" and <18"	0.50	0.78	1.38	0.96	1.32
Snags >18"	0.12	0.12	0.85	0.12	0.84
CWD >3"	6.59	6.29	6.02	2.24	2.75
Logs	0.00	0.09	0.87	0.09	0.90
Understory Index	437	382	248	394	268

Protected Activity Centers

Forest Attributes

Table 3. Changes in MSO PAC Habitat Components by Alternative and Year by Individual PAC; Mechanical Treatment Group (n=18)

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Archies											
Acres	599	599	599	599	599	599	599	599	599	599	599
% of SDI 12-18” DBH	33	34	36	34	33	36	34	35	34	35	34
% of SDI 18-24” DBH	10	14	16	28	25	16	29	15	27	14	26
% of SDI >24” DBH	4	5	5	9	8	5	9	5	9	5	8
% of Max SDI	54%	57%	47%	54%	63%	46%	53%	49%	56%	51%	58%
TPA >18"	8	11	11	24	24	11	24	11	24	11	24
Ponderosa Pine BA	90	99	91	110	118	89	108	95	115	98	119
Gambel Oak BA	19	20	20	25	27	20	25	20	26	20	25
All BA	115	126	118	146	155	117	144	122	151	126	154

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% Oak BA	14	14	15	16	17	15	16	14	16	14	15
Bar M											
Acres	645	645	645	645	645	645	645	645	645	645	645
% of SDI 12-18” DBH	21	23	26	21	23	26	20	26	21	26	26
% of SDI 18-24” DBH	17	18	24	26	20	25	28	23	26	20	22
% of SDI >24” DBH	9	10	13	18	14	13	20	12	18	11	16
% of Max SDI	94%	93%	63%	66%	92%	59%	64%	65%	68%	74%	77%
TPA >18"	19	21	22	29	27	22	30	22	29	21	28
Ponderosa Pine BA	141	143	115	123	143	109	118	119	127	137	145
Gambel Oak BA	21	22	22	31	32	22	32	22	30	22	29
All BA	164	168	140	158	178	133	153	143	161	161	177
% Oak BA	13	14	16	20	19	17	21	15	19	14	18
Bear Seep											
Acres	703	703	703	703	703	703	703	703	703	703	703
% of SDI 12-18” DBH	24	23	25	23	21	25	23	25	24	25	23
% of SDI 18-24” DBH	18	19	23	27	23	24	27	23	26	20	24
% of SDI >24” DBH	19	19	23	28	22	23	29	23	27	20	23
% of Max SDI	65%	68%	54%	56%	71%	53%	56%	55%	57%	59%	62%
TPA >18"	20	23	23	29	29	23	29	23	29	23	29
Ponderosa Pine BA	118	124	115	119	130	112	117	117	121	122	128
Gambel Oak BA	14	16	15	18	22	15	18	15	18	15	18
All BA	138	147	137	153	165	135	151	140	154	145	162
% Oak BA	11	11	11	12	14	11	12	11	12	11	12
Bonita Tank											
Acres	896	896	896	896	896	896	896	896	896	896	896
% of SDI 12-18” DBH	35	35	38	23	28	38	19	39	23	41	31
% of SDI 18-24” DBH	16	19	24	38	30	26	40	23	37	21	33
% of SDI >24” DBH	5	6	7	11	9	8	13	7	11	7	10
% of Max SDI	84%	84%	67%	74%	84%	63%	70%	69%	75%	72%	76%

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
TPA >18"	19	22	23	40	36	24	41	23	40	23	38
Ponderosa Pine BA	139	144	117	131	149	107	122	122	135	133	144
Gambel Oak BA	28	29	29	32	31	30	33	29	32	29	31
All BA	173	181	155	183	196	145	175	159	187	171	193
% Oak BA	16	15	17	17	16	19	18	17	17	16	16
Crawdad											
Acres	703	703	703	703	703	703	703	703	703	703	703
% of SDI 12-18” DBH	40	41	41	36	37	41	32	41	36	43	40
% of SDI 18-24” DBH	11	14	16	29	24	18	32	16	27	15	27
% of SDI >24” DBH	6	7	8	10	8	9	12	7	10	7	9
% of Max SDI	70%	72%	61%	66%	76%	56%	62%	63%	67%	64%	68%
TPA >18"	13	16	16	30	28	17	31	16	29	16	29
Ponderosa Pine BA	128	135	121	137	149	110	128	125	141	130	144
Gambel Oak BA	22	24	24	30	30	25	31	24	30	24	29
All BA	151	161	146	170	180	136	162	151	173	155	177
% Oak BA	15	15	17	18	17	18	19	16	17	16	17
Foxhole											
Acres	555	555	555	555	555	555	555	555	555	555	555
% of SDI 12-18” DBH	23	25	27	27	28	27	24	27	27	29	33
% of SDI 18-24” DBH	10	12	17	20	15	19	23	16	19	13	16
% of SDI >24” DBH	8	9	11	13	10	11	14	10	13	9	10
% of Max SDI	95%	94%	65%	71%	93%	60%	66%	68%	74%	78%	82%
TPA >18"	13	15	16	22	20	16	23	16	22	16	21
Ponderosa Pine BA	142	144	113	128	148	102	117	118	134	138	153
Gambel Oak BA	18	19	19	23	24	19	24	19	22	18	21
All BA	167	171	140	164	184	129	155	145	170	165	187
% Oak BA	11	11	13	13	14	14	15	12	13	11	11
Frank											
Acres	701	701	701	701	701	701	701	701	701	701	701

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% of SDI 12-18” DBH	32	32	38	28	25	38	27	37	29	35	29
% of SDI 18-24” DBH	14	17	20	35	26	21	36	20	33	18	28
% of SDI >24” DBH	13	14	16	19	16	16	20	15	19	14	17
% of Max SDI	73%	73%	54%	52%	73%	50%	50%	55%	53%	64%	61%
TPA >18"	16	19	20	30	29	20	31	20	30	20	29
Ponderosa Pine BA	131	134	121	122	135	115	118	123	124	132	134
Gambel Oak BA	14	16	15	18	22	15	19	15	18	15	17
All BA	145	150	136	141	158	131	137	139	143	148	152
% Oak BA	10	11	12	15	16	13	15	12	14	11	13
Holdup											
Acres	638	638	638	638	638	638	638	638	638	638	638
% of SDI 12-18” DBH	28	28	30	23	27	31	22	30	23	29	28
% of SDI 18-24” DBH	14	14	17	27	21	19	28	17	26	15	22
% of SDI >24” DBH	15	16	20	25	19	21	27	19	24	16	19
% of Max SDI	62%	64%	49%	51%	65%	45%	48%	51%	52%	61%	61%
TPA >18"	15	17	17	25	25	17	25	17	25	17	24
Ponderosa Pine BA	127	136	113	122	143	106	115	117	125	135	142
Gambel Oak BA	6	7	7	9	9	7	9	7	9	6	8
All BA	134	144	121	135	156	115	129	125	138	143	154
% Oak BA	4	4	5	6	5	6	7	5	6	4	5
Iris Tank											
Acres	690	690	690	690	690	690	690	690	690	690	690
% of SDI 12-18” DBH	32	31	32	24	25	32	22	32	24	35	29
% of SDI 18-24” DBH	18	21	26	34	28	28	36	26	34	23	31
% of SDI >24” DBH	8	9	11	15	12	11	16	10	15	10	13
% of Max SDI	83%	83%	62%	63%	82%	59%	61%	64%	64%	69%	67%
TPA >18"	21	24	25	34	33	25	34	25	34	24	33
Ponderosa Pine BA	142	144	125	124	139	118	119	128	127	141	137
Gambel Oak BA	22	24	23	28	31	23	29	23	28	23	28

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
All BA	166	169	151	160	176	143	156	153	163	166	172
% Oak BA	14	15	16	19	20	17	20	15	18	15	18
Knob											
Acres	766	766	766	766	766	766	766	766	766	766	766
% of SDI 12-18” DBH	28	31	33	34	33	33	32	33	34	34	36
% of SDI 18-24” DBH	15	16	18	23	20	20	25	18	23	17	22
% of SDI >24” DBH	7	8	9	14	13	9	15	9	14	8	13
% of Max SDI	63%	66%	53%	60%	72%	50%	58%	55%	62%	57%	63%
TPA >18"	11	13	13	22	21	13	22	13	22	13	22
Ponderosa Pine BA	109	117	105	125	135	97	119	109	130	114	134
Gambel Oak BA	11	12	12	15	17	12	16	12	15	12	15
All BA	129	139	126	152	163	119	146	131	157	135	160
% Oak BA	8	8	8	9	10	9	9	8	9	8	8
Lake #1/Seruchos											
Acres	262	262	262	262	262	262	262	262	262	262	262
% of SDI 12-18” DBH	29	29	32	29	30	34	29	31	29	33	33
% of SDI 18-24” DBH	13	13	16	24	20	17	26	15	23	15	22
% of SDI >24” DBH	6	7	8	10	7	8	10	7	9	7	8
% of Max SDI	69%	73%	59%	68%	79%	54%	65%	62%	71%	62%	70%
TPA >18"	13	15	15	26	23	15	27	15	25	15	25
Ponderosa Pine BA	128	138	113	139	159	104	130	119	146	125	150
Gambel Oak BA	19	21	20	23	23	21	24	20	22	20	22
All BA	148	161	136	170	190	127	164	142	178	147	180
% Oak BA	13	13	15	14	12	16	15	14	12	14	12
Lee Butte											
Acres	867	867	867	867	867	867	867	867	867	867	867
% of SDI 12-18” DBH	34	35	37	37	35	37	36	35	35	37	38
% of SDI 18-24” DBH	10	13	14	27	25	14	27	13	26	13	26
% of SDI >24” DBH	3	4	4	5	4	4	5	4	4	4	4

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% of Max SDI	74%	76%	67%	70%	78%	66%	69%	73%	76%	69%	72%
TPA >18"	10	14	14	27	27	14	27	14	27	14	27
Ponderosa Pine BA	138	145	140	153	157	136	150	141	154	145	158
Gambel Oak BA	15	16	16	19	20	16	19	16	19	15	18
All BA	155	164	159	178	183	155	176	160	179	164	183
% Oak BA	10	10	10	11	11	11	12	10	11	10	10
Mayflower Tank											
Acres	660	660	660	660	660	660	660	660	660	660	660
% of SDI 12-18” DBH	30	29	29	24	24	28	22	29	24	30	26
% of SDI 18-24” DBH	14	17	18	22	21	20	22	18	21	17	21
% of SDI >24” DBH	5	6	6	8	8	6	9	6	8	6	8
% of Max SDI	85%	87%	72%	81%	89%	69%	79%	74%	82%	76%	82%
TPA >18"	13	17	17	24	24	17	24	17	24	17	24
Ponderosa Pine BA	98	101	91	95	98	84	88	95	97	100	100
Gambel Oak BA	43	46	46	57	54	47	58	46	56	46	56
All BA	147	156	148	179	175	140	174	151	181	156	183
% Oak BA	28	28	29	31	31	30	32	29	30	29	30
Red Hill											
Acres	863	863	863	863	863	863	863	863	863	863	863
% of SDI 12-18” DBH	31	33	34	25	31	34	23	34	26	36	33
% of SDI 18-24” DBH	18	20	24	30	26	25	32	24	30	21	27
% of SDI >24” DBH	5	6	7	12	10	7	13	7	12	6	11
% of Max SDI	80%	81%	69%	76%	79%	64%	72%	70%	77%	75%	77%
TPA >18"	22	23	24	36	32	24	37	24	36	24	34
Ponderosa Pine BA	155	157	130	142	158	119	132	134	145	147	153
Gambel Oak BA	11	12	12	13	12	12	14	12	13	12	12
All BA	178	186	159	190	198	149	182	163	192	176	196
% Oak BA	7	7	8	7	7	9	8	8	7	7	7
Red Raspberry											

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Acres	753	753	753	753	753	753	753	753	753	753	753
% of SDI 12-18” DBH	29	28	30	22	24	30	22	29	22	29	25
% of SDI 18-24” DBH	15	19	21	26	24	21	27	20	26	19	25
% of SDI >24” DBH	9	10	11	16	13	12	16	11	15	10	13
% of Max SDI	82%	83%	73%	78%	87%	72%	78%	75%	80%	78%	84%
TPA >18"	16	19	19	29	28	19	29	19	29	20	28
Ponderosa Pine BA	94	99	90	99	108	88	97	93	102	99	109
Gambel Oak BA	29	29	29	32	32	29	32	29	31	29	31
All BA	144	153	146	172	178	144	171	149	174	155	182
% Oak BA	19	18	18	18	19	18	18	18	18	18	18
Rock Top											
Acres	875	875	875	875	875	875	875	875	875	875	875
% of SDI 12-18” DBH	33	34	35	27	28	35	25	35	27	37	30
% of SDI 18-24” DBH	14	16	18	27	24	19	28	18	27	17	26
% of SDI >24” DBH	5	6	7	10	8	7	10	6	9	6	8
% of Max SDI	72%	74%	62%	67%	78%	58%	66%	64%	69%	65%	71%
TPA >18"	14	16	16	27	26	16	28	16	28	16	27
Ponderosa Pine BA	111	117	104	115	124	96	108	109	118	113	123
Gambel Oak BA	18	20	20	26	26	20	27	20	25	20	25
All BA	139	148	136	160	168	128	157	141	163	145	169
% Oak BA	12	13	14	16	15	15	17	13	15	13	14
Sawmill Springs											
Acres	629	629	629	629	629	629	629	629	629	629	629
% of SDI 12-18” DBH	35	36	39	35	32	39	34	39	35	39	37
% of SDI 18-24” DBH	15	16	19	26	22	19	26	18	25	17	24
% of SDI >24” DBH	5	6	7	12	10	7	13	7	12	6	11
% of Max SDI	73%	77%	57%	62%	81%	55%	61%	59%	64%	61%	67%
TPA >18"	14	16	16	26	25	16	27	16	26	16	26
Ponderosa Pine BA	117	125	115	132	137	111	129	119	136	124	141

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Gambel Oak BA	18	21	19	24	29	19	25	19	24	19	24
All BA	136	147	135	158	169	131	155	139	161	144	166
% Oak BA	14	15	14	15	18	15	16	14	15	13	15
T6 Tank											
Acres	784	784	784	784	784	784	784	784	784	784	784
% of SDI 12-18” DBH	26	26	29	24	24	29	23	29	24	29	28
% of SDI 18-24” DBH	12	14	17	26	20	18	27	16	25	15	22
% of SDI >24” DBH	16	16	19	22	17	20	23	18	21	17	19
% of Max SDI	65%	68%	49%	54%	72%	46%	52%	52%	56%	57%	59%
TPA >18"	13	16	16	24	23	16	24	16	24	16	24
Ponderosa Pine BA	112	121	102	118	133	96	112	107	123	117	130
Gambel Oak BA	14	15	15	18	20	15	19	15	18	15	18
All BA	127	138	119	137	155	112	133	123	142	133	149
% Oak BA	10	10	10	11	12	11	12	10	10	10	10

Table 4. Changes in MSO PAC Habitat Components by Alternative and Year by Individual PAC; Prescribed Fire Only Treatment Group (n=52)

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Blade Tank											
Acres	498	498	498	498	498	498	498	498	498	498	498
% of SDI 12-18” DBH	33	33	33	28	28	33	28	33	28	33	28
% of SDI 18-24” DBH	13	15	16	24	23	16	24	15	23	16	24
% of SDI >24” DBH	7	7	8	11	11	8	11	7	11	8	11
% of Max SDI	83%	85%	82%	84%	85%	82%	84%	85%	85%	82%	84%
TPA >18"	15	19	19	30	29	19	30	19	29	19	30
Ponderosa Pine BA	125	129	124	128	130	123	127	129	130	124	128
Gambel Oak BA	23	24	25	29	28	25	29	24	28	25	29

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
All BA	165	174	169	188	190	168	188	174	190	169	188
% Oak BA	14	14	14	15	15	15	15	14	15	14	15
Boondock											
Acres	310	310	310	310	310	310	310	310	310	310	310
% of SDI 12-18” DBH	29	28	28	25	26	28	25	28	26	28	25
% of SDI 18-24” DBH	13	15	16	21	21	16	21	15	21	16	21
% of SDI >24” DBH	8	9	9	11	11	9	11	9	11	9	11
% of Max SDI	88%	90%	87%	89%	90%	87%	89%	90%	90%	87%	89%
TPA >18"	17	20	20	29	29	20	29	20	29	20	29
Ponderosa Pine BA	129	133	127	129	132	126	129	133	132	127	129
Gambel Oak BA	27	29	29	33	32	29	33	29	32	29	33
All BA	173	182	176	195	196	176	195	182	196	176	195
% Oak BA	16	16	17	17	16	17	17	16	16	17	17
Bridge											
Acres	286	286	286	286	286	286	286	286	286	286	286
% of SDI 12-18” DBH	30	29	29	25	25	29	25	29	25	29	25
% of SDI 18-24” DBH	21	23	24	27	26	24	27	23	26	24	27
% of SDI >24” DBH	10	11	12	17	17	12	17	11	17	12	17
% of Max SDI	88%	88%	86%	87%	88%	85%	86%	88%	88%	86%	87%
TPA >18"	27	30	30	38	37	30	38	30	37	30	38
Ponderosa Pine BA	151	153	148	152	154	148	152	153	154	148	152
Gambel Oak BA	20	21	21	22	21	21	22	21	21	21	22
All BA	185	191	186	201	203	186	201	191	203	186	201
% Oak BA	11	11	11	11	11	11	11	11	11	11	11
Bristow Tank/Limpios											
Acres	591	591	591	591	591	591	591	591	591	591	591
% of SDI 12-18” DBH	26	26	26	24	25	26	24	26	25	26	24
% of SDI 18-24” DBH	13	14	14	18	18	14	18	14	18	14	18
% of SDI >24” DBH	9	9	10	12	12	10	12	9	12	10	12

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% of Max SDI	72%	75%	73%	78%	79%	73%	78%	75%	79%	73%	78%
TPA >18"	13	15	15	23	23	15	23	15	23	15	23
Ponderosa Pine BA	101	106	102	108	111	101	107	106	111	102	108
Gambel Oak BA	23	25	25	31	30	25	31	25	30	25	31
All BA	139	150	146	171	172	145	170	150	172	146	171
% Oak BA	16	16	17	18	17	17	18	16	17	17	18
Casner											
Acres	622	622	622	622	622	622	622	622	622	622	622
% of SDI 12-18” DBH	30	31	31	28	28	31	28	31	28	31	28
% of SDI 18-24” DBH	13	15	15	22	21	16	22	15	21	15	22
% of SDI >24” DBH	6	7	7	10	10	7	10	7	10	7	10
% of Max SDI	82%	85%	82%	85%	86%	81%	85%	85%	86%	82%	85%
TPA >18"	15	18	18	28	27	18	28	18	27	18	28
Ponderosa Pine BA	124	129	124	129	131	123	128	129	131	124	129
Gambel Oak BA	25	26	26	30	30	26	30	26	30	26	30
All BA	164	173	168	188	190	167	188	173	190	168	188
% Oak BA	15	15	16	16	16	16	16	15	16	16	16
Casner Cabin											
Acres	172	172	172	172	172	172	172	172	172	172	172
% of SDI 12-18” DBH	26	25	25	20	20	25	20	25	20	25	20
% of SDI 18-24” DBH	15	17	17	21	20	17	21	17	20	17	21
% of SDI >24” DBH	17	17	18	20	19	18	20	17	19	18	20
% of Max SDI	74%	77%	75%	79%	80%	75%	79%	77%	80%	75%	79%
TPA >18"	18	21	21	29	28	21	29	21	28	21	29
Ponderosa Pine BA	109	112	108	110	112	108	110	112	112	108	110
Gambel Oak BA	18	19	19	21	21	19	21	19	21	19	21
All BA	149	158	154	177	178	154	177	158	178	154	177
% Oak BA	12	12	12	12	11	12	12	12	11	12	12
Cave Springs											

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Acres	204	204	204	204	204	204	204	204	204	204	204
% of SDI 12-18” DBH	38	38	38	28	29	38	28	38	29	38	28
% of SDI 18-24” DBH	15	18	18	28	27	18	28	18	27	18	28
% of SDI >24” DBH	6	7	7	13	12	7	13	7	12	7	13
% of Max SDI	71%	73%	71%	75%	76%	71%	75%	73%	76%	71%	75%
TPA >18"	15	18	18	32	32	18	32	18	32	18	32
Ponderosa Pine BA	111	116	111	117	120	111	117	116	120	111	117
Gambel Oak BA	15	16	16	21	20	16	21	16	20	16	21
All BA	147	157	152	174	176	152	174	157	176	152	174
% Oak BA	10	10	10	12	11	10	12	10	11	10	12
Coulter Ridge											
Acres	671	671	671	671	671	671	671	671	671	671	671
% of SDI 12-18” DBH	33	33	34	29	29	34	29	33	29	34	29
% of SDI 18-24” DBH	13	16	16	23	23	16	23	16	23	16	23
% of SDI >24” DBH	7	7	7	10	10	7	10	7	10	7	10
% of Max SDI	80%	82%	79%	83%	83%	79%	82%	82%	83%	79%	83%
TPA >18"	14	18	18	29	28	18	29	18	28	18	29
Ponderosa Pine BA	124	128	123	129	132	123	129	128	132	123	129
Gambel Oak BA	22	23	23	27	27	24	27	23	27	23	27
All BA	161	170	165	185	187	164	185	170	187	165	185
% Oak BA	14	14	14	15	14	14	15	14	14	14	15
Coyote Park											
Acres	643	643	643	643	643	643	643	643	643	643	643
% of SDI 12-18” DBH	28	28	28	26	26	28	26	28	26	28	26
% of SDI 18-24” DBH	12	15	15	20	20	15	20	15	20	15	20
% of SDI >24” DBH	8	8	8	11	10	8	11	8	10	8	11
% of Max SDI	88%	90%	87%	88%	89%	87%	88%	90%	89%	87%	88%
TPA >18"	15	19	19	27	27	19	27	19	27	19	27
Ponderosa Pine BA	127	130	125	127	130	124	127	130	130	125	127

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Gambel Oak BA	28	30	30	35	34	30	35	30	34	30	35
All BA	169	178	174	192	193	172	192	178	193	174	192
% Oak BA	17	17	18	18	18	18	18	17	18	18	18
Crater Spring Tank											
Acres	63	63	63	63	63	63	63	63	63	63	63
% of SDI 12-18” DBH	41	41	41	33	33	41	33	41	33	41	33
% of SDI 18-24” DBH	12	15	15	27	26	15	27	15	26	15	27
% of SDI >24” DBH	4	4	5	7	7	5	7	4	7	5	7
% of Max SDI	88%	89%	86%	88%	89%	86%	88%	89%	89%	86%	88%
TPA >18"	14	18	18	33	33	18	33	18	33	18	33
Ponderosa Pine BA	144	148	142	148	151	142	148	148	151	142	148
Gambel Oak BA	22	23	23	26	26	23	26	23	26	23	26
All BA	177	185	179	198	199	179	198	185	199	179	198
% Oak BA	13	13	13	13	13	13	13	13	13	13	13
Dairy Spring											
Acres	204	204	204	204	204	204	204	204	204	204	204
% of SDI 12-18” DBH	34	33	33	25	25	33	25	33	25	33	25
% of SDI 18-24” DBH	15	18	18	25	25	18	25	18	25	18	25
% of SDI >24” DBH	9	9	10	14	14	10	14	9	14	10	14
% of Max SDI	75%	77%	75%	78%	79%	75%	78%	77%	79%	75%	78%
TPA >18"	16	20	20	31	31	20	31	20	31	20	31
Ponderosa Pine BA	111	115	110	113	116	110	113	115	116	110	113
Gambel Oak BA	18	19	19	24	23	19	24	19	23	19	24
All BA	152	162	157	178	180	157	178	162	180	157	178
% Oak BA	11	11	12	13	13	12	13	11	13	12	13
Fain Mountain											
Acres	382	382	382	382	382	382	382	382	382	382	382
% of SDI 12-18” DBH	36	35	35	27	27	35	27	35	27	35	27
% of SDI 18-24” DBH	14	17	18	25	25	18	26	17	25	18	25

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% of SDI >24" DBH	8	8	8	12	12	8	12	8	12	8	12
% of Max SDI	81%	83%	81%	83%	84%	81%	83%	83%	84%	81%	83%
TPA >18"	16	20	20	32	32	20	32	20	32	20	32
Ponderosa Pine BA	125	129	125	128	131	124	128	129	131	125	128
Gambel Oak BA	20	21	21	24	24	21	24	21	24	21	24
All BA	165	173	170	188	190	168	188	173	190	170	188
% Oak BA	12	12	12	13	12	12	13	12	12	12	13
Fisher Point											
Acres	24	24	24	24	24	24	24	24	24	24	24
% of SDI 12-18" DBH	15	14	14	11	11	14	11	14	11	14	11
% of SDI 18-24" DBH	14	12	12	12	12	12	12	12	12	12	12
% of SDI >24" DBH	30	31	32	30	30	32	30	31	30	32	30
% of Max SDI	58%	62%	61%	69%	70%	61%	69%	62%	70%	61%	69%
TPA >18"	17	18	18	21	21	18	21	18	21	18	21
Ponderosa Pine BA	69	72	69	69	70	69	69	72	70	69	69
Gambel Oak BA	11	12	12	14	14	12	14	12	14	12	14
All BA	112	124	122	153	154	122	153	124	154	122	153
% Oak BA	10	10	10	9	9	10	9	10	9	10	9
Frog Tank											
Acres	626	626	626	626	626	626	626	626	626	626	626
% of SDI 12-18" DBH	30	30	30	27	27	30	27	30	27	30	27
% of SDI 18-24" DBH	16	18	18	23	23	18	23	18	23	18	23
% of SDI >24" DBH	8	8	8	12	12	8	12	8	12	8	12
% of Max SDI	80%	82%	80%	82%	83%	79%	82%	82%	83%	80%	82%
TPA >18"	16	19	20	28	28	20	28	19	28	20	28
Ponderosa Pine BA	124	128	123	129	132	123	129	128	132	123	129
Gambel Oak BA	24	26	26	29	29	26	29	26	29	26	29
All BA	161	170	165	185	186	165	185	170	186	165	185
% Oak BA	15	15	16	16	15	16	16	15	15	16	16

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Fry											
Acres	132	132	132	132	132	132	132	132	132	132	132
% of SDI 12-18” DBH	31	31	31	28	28	31	28	31	28	31	28
% of SDI 18-24” DBH	12	14	15	21	21	15	21	14	21	15	21
% of SDI >24” DBH	7	7	7	10	9	7	10	7	9	7	10
% of Max SDI	84%	86%	83%	86%	87%	83%	86%	86%	87%	83%	86%
TPA >18"	14	17	17	27	27	17	27	17	27	17	27
Ponderosa Pine BA	125	130	124	128	132	124	128	130	132	124	128
Gambel Oak BA	26	27	28	32	31	28	32	27	31	28	32
All BA	163	173	167	187	189	167	187	173	189	167	187
% Oak BA	16	16	17	17	17	17	17	16	17	17	17
Gash Mountain											
Acres	627	627	627	627	627	627	627	627	627	627	627
% of SDI 12-18” DBH	33	34	34	30	30	34	30	34	30	34	30
% of SDI 18-24” DBH	14	17	17	24	24	17	24	17	24	17	24
% of SDI >24” DBH	6	6	6	10	10	6	10	6	10	6	10
% of Max SDI	83%	84%	81%	84%	85%	81%	84%	84%	85%	81%	84%
TPA >18"	15	18	18	30	29	18	30	18	29	18	30
Ponderosa Pine BA	131	136	131	138	140	130	137	136	140	131	138
Gambel Oak BA	24	25	25	29	28	25	29	25	28	25	29
All BA	167	175	170	189	190	169	189	175	190	170	189
% Oak BA	14	14	15	15	15	15	15	14	15	15	15
Girdner											
Acres	727	727	727	727	727	727	727	727	727	727	727
% of SDI 12-18” DBH	32	33	33	28	29	33	28	33	29	33	28
% of SDI 18-24” DBH	12	14	15	22	21	15	22	14	21	15	22
% of SDI >24” DBH	9	9	9	13	13	9	13	9	13	9	13
% of Max SDI	74%	76%	73%	77%	78%	73%	77%	76%	78%	73%	77%
TPA >18"	14	16	16	27	27	16	27	16	27	16	27

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Ponderosa Pine BA	114	118	113	119	122	113	119	118	122	113	119
Gambel Oak BA	20	21	21	26	25	21	26	21	25	21	26
All BA	152	161	157	178	180	156	178	161	180	157	178
% Oak BA	12	13	13	14	14	13	14	13	14	13	14
Harding Point											
Acres	134	134	134	134	134	134	134	134	134	134	134
% of SDI 12-18” DBH	26	24	25	22	22	25	22	24	22	25	22
% of SDI 18-24” DBH	27	29	30	29	29	30	29	29	29	30	29
% of SDI >24” DBH	7	9	10	16	16	10	16	9	16	10	16
% of Max SDI	89%	90%	87%	88%	89%	87%	88%	90%	89%	87%	88%
TPA >18"	31	35	35	40	40	35	40	35	40	35	40
Ponderosa Pine BA	149	151	146	150	152	146	150	151	152	146	150
Gambel Oak BA	22	22	22	23	23	22	23	22	23	22	23
All BA	184	189	185	201	202	185	201	189	202	185	201
% Oak BA	12	12	12	12	11	12	12	12	11	12	12
Howard Mountain											
Acres	648	648	648	648	648	648	648	648	648	648	648
% of SDI 12-18” DBH	34	33	33	27	27	33	27	33	27	33	27
% of SDI 18-24” DBH	14	17	17	24	24	17	24	17	24	17	24
% of SDI >24” DBH	8	8	8	12	12	8	12	8	12	8	12
% of Max SDI	82%	84%	81%	84%	84%	81%	83%	84%	84%	81%	84%
TPA >18"	16	20	20	31	31	20	31	20	31	20	31
Ponderosa Pine BA	124	127	123	126	129	122	126	127	129	123	126
Gambel Oak BA	21	22	22	26	25	22	26	22	25	22	26
All BA	165	174	170	189	190	169	188	174	190	170	189
% Oak BA	13	13	13	14	13	13	14	13	13	13	14
Iowa Camp											
Acres	672	672	672	672	672	672	672	672	672	672	672
% of SDI 12-18” DBH	27	29	29	28	28	29	28	29	28	29	28

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% of SDI 18-24” DBH	11	13	13	19	19	13	19	13	19	13	19
% of SDI >24” DBH	7	7	7	9	9	7	9	7	9	7	9
% of Max SDI	84%	86%	84%	86%	87%	83%	86%	86%	87%	84%	86%
TPA >18"	13	16	16	24	24	16	24	16	24	16	24
Ponderosa Pine BA	120	124	119	123	126	118	122	124	126	119	123
Gambel Oak BA	29	31	31	36	35	31	37	31	35	31	36
All BA	163	172	167	187	188	166	187	172	188	167	187
% Oak BA	18	18	19	19	19	19	20	18	19	19	19
James Canyon											
Acres	544	544	544	544	544	544	544	544	544	544	544
% of SDI 12-18” DBH	32	32	32	28	28	32	28	32	28	32	28
% of SDI 18-24” DBH	13	15	16	22	22	16	22	15	22	16	22
% of SDI >24” DBH	7	7	8	11	10	8	11	7	10	8	11
% of Max SDI	85%	87%	84%	86%	87%	84%	86%	87%	87%	84%	86%
TPA >18"	15	19	19	29	29	19	29	19	29	19	29
Ponderosa Pine BA	127	131	126	129	132	125	129	131	132	126	129
Gambel Oak BA	25	26	27	30	29	27	30	26	29	27	30
All BA	169	178	173	192	193	172	192	178	193	173	192
% Oak BA	15	15	15	16	15	15	16	15	15	15	16
Jeep											
Acres	214	214	214	214	214	214	214	214	214	214	214
% of SDI 12-18” DBH	35	36	36	30	31	36	30	36	31	36	30
% of SDI 18-24” DBH	12	14	15	23	23	15	24	14	23	15	23
% of SDI >24” DBH	6	6	6	10	10	6	10	6	10	6	10
% of Max SDI	72%	74%	73%	77%	77%	71%	76%	74%	77%	73%	77%
TPA >18"	12	15	15	27	27	15	27	15	27	15	27
Ponderosa Pine BA	110	115	112	118	120	110	117	115	120	112	118
Gambel Oak BA	19	20	20	25	25	20	25	20	25	20	25
All BA	146	156	154	175	176	151	174	156	176	154	175

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% Oak BA	12	12	13	14	14	13	14	12	14	13	14
Kelly											
Acres	666	666	666	666	666	666	666	666	666	666	666
% of SDI 12-18” DBH	29	29	29	27	27	29	27	29	27	29	27
% of SDI 18-24” DBH	13	15	15	21	20	15	21	15	20	15	21
% of SDI >24” DBH	9	9	9	12	12	9	12	9	12	9	12
% of Max SDI	83%	85%	82%	85%	86%	82%	85%	85%	86%	82%	85%
TPA >18"	15	18	18	27	26	18	27	18	26	18	27
Ponderosa Pine BA	123	128	123	127	130	122	127	128	130	123	127
Gambel Oak BA	26	27	27	31	30	27	31	27	30	27	31
All BA	164	173	169	188	190	168	188	173	190	169	188
% Oak BA	15	15	16	16	15	16	16	15	15	16	16
Kendrick											
Acres	171	171	171	171	171	171	171	171	171	171	171
% of SDI 12-18” DBH	32	35	36	53	54	36	53	35	54	36	53
% of SDI 18-24” DBH	1	9	10	25	24	10	25	9	24	10	25
% of SDI >24” DBH	1	1	1	3	3	1	3	1	3	1	3
% of Max SDI	10%	13%	13%	19%	21%	13%	19%	13%	21%	13%	19%
TPA >18"	1	2	2	7	7	2	7	2	7	2	7
Ponderosa Pine BA	20	27	25	45	50	25	45	27	50	25	45
Gambel Oak BA	1	1	1	1	1	1	1	1	1	1	1
All BA	22	29	28	49	53	28	49	29	53	28	49
% Oak BA	1	1	1	1	1	1	1	1	1	1	1
Lockwood											
Acres	271	271	271	271	271	271	271	271	271	271	271
% of SDI 12-18” DBH	29	29	29	25	26	29	25	29	26	29	25
% of SDI 18-24” DBH	13	16	16	22	21	16	22	16	21	16	22
% of SDI >24” DBH	8	9	9	12	11	9	12	9	11	9	12
% of Max SDI	89%	91%	88%	89%	90%	88%	89%	91%	90%	88%	89%

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
TPA >18"	17	21	21	30	29	21	30	21	29	21	30
Ponderosa Pine BA	130	134	128	130	133	128	130	134	133	128	130
Gambel Oak BA	27	28	28	32	31	28	32	28	31	28	32
All BA	174	183	177	196	197	177	196	183	197	177	196
% Oak BA	16	15	16	16	16	16	16	15	16	16	16
MB Smith											
Acres	571	571	571	571	571	571	571	571	571	571	571
% of SDI 12-18” DBH	30	31	31	29	29	31	29	31	29	31	29
% of SDI 18-24” DBH	12	14	14	21	20	14	21	14	20	14	21
% of SDI >24” DBH	7	8	8	10	10	8	10	8	10	8	10
% of Max SDI	78%	81%	78%	82%	83%	78%	82%	81%	83%	78%	82%
TPA >18"	13	16	16	26	26	16	26	16	26	16	26
Ponderosa Pine BA	118	123	117	123	126	117	123	123	126	117	123
Gambel Oak BA	23	25	25	29	28	25	29	25	28	25	29
All BA	155	165	160	182	184	159	182	165	184	160	182
% Oak BA	15	15	15	16	15	15	16	15	15	15	16
Meadow Tank											
Acres	105	105	105	105	105	105	105	105	105	105	105
% of SDI 12-18” DBH	25	22	22	18	18	22	18	22	18	22	18
% of SDI 18-24” DBH	36	38	38	34	33	38	34	38	33	38	34
% of SDI >24” DBH	13	15	16	24	23	16	24	15	23	16	24
% of Max SDI	61%	63%	62%	64%	66%	61%	64%	63%	66%	62%	64%
TPA >18"	31	34	34	36	36	34	37	34	36	34	36
Ponderosa Pine BA	120	124	123	132	133	122	131	124	133	123	132
Gambel Oak BA	12	13	13	15	15	13	15	13	15	13	15
All BA	138	145	144	160	161	142	160	145	161	144	160
% Oak BA	9	9	9	9	9	9	9	9	9	9	9
Milos Butte											
Acres	658	658	658	658	658	658	658	658	658	658	658

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% of SDI 12-18” DBH	33	32	32	27	27	32	27	32	27	32	27
% of SDI 18-24” DBH	13	16	16	23	23	16	23	16	23	16	23
% of SDI >24” DBH	7	8	8	11	11	8	11	8	11	8	11
% of Max SDI	89%	91%	88%	89%	90%	87%	89%	91%	90%	88%	89%
TPA >18"	17	20	21	31	31	21	31	20	31	21	31
Ponderosa Pine BA	135	138	133	136	139	132	136	138	139	133	136
Gambel Oak BA	25	26	26	29	29	26	30	26	29	26	29
All BA	176	185	180	197	199	179	197	185	199	180	197
% Oak BA	14	14	15	15	14	15	15	14	14	15	15
Mint Spring											
Acres	585	585	585	585	585	585	585	585	585	585	585
% of SDI 12-18” DBH	34	34	34	29	29	34	29	34	29	34	29
% of SDI 18-24” DBH	13	16	17	24	24	17	24	16	24	17	24
% of SDI >24” DBH	6	7	7	10	10	7	10	7	10	7	10
% of Max SDI	84%	86%	83%	86%	86%	83%	85%	86%	86%	83%	86%
TPA >18"	16	19	19	31	31	19	31	19	31	19	31
Ponderosa Pine BA	131	135	131	135	138	129	134	135	138	131	135
Gambel Oak BA	23	24	24	27	26	24	27	24	26	24	27
All BA	169	177	173	192	193	171	191	177	193	173	192
% Oak BA	13	13	14	14	14	14	14	13	14	14	14
Moore Well/Rock Dike											
Acres	567	567	567	567	567	567	567	567	567	567	567
% of SDI 12-18” DBH	31	31	31	26	27	31	26	31	27	31	26
% of SDI 18-24” DBH	13	15	16	22	22	16	22	15	22	16	22
% of SDI >24” DBH	10	11	11	15	14	11	15	11	14	11	15
% of Max SDI	81%	83%	80%	82%	83%	80%	82%	83%	83%	80%	82%
TPA >18"	17	20	20	30	29	20	30	20	29	20	30
Ponderosa Pine BA	125	129	124	127	130	123	126	129	130	124	127
Gambel Oak BA	21	22	22	26	25	22	26	22	25	22	26

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
All BA	167	175	170	189	190	169	188	175	190	170	189
% Oak BA	12	12	13	13	13	13	14	12	13	13	13
Mustang											
Acres	659	659	659	659	659	659	659	659	659	659	659
% of SDI 12-18” DBH	34	35	35	27	27	35	27	35	27	35	27
% of SDI 18-24” DBH	13	16	16	24	24	16	24	16	24	16	24
% of SDI >24” DBH	7	8	8	13	13	8	13	8	13	8	13
% of Max SDI	66%	69%	67%	71%	72%	66%	71%	69%	72%	67%	71%
TPA >18"	12	15	15	27	27	15	27	15	27	15	27
Ponderosa Pine BA	96	101	97	102	105	96	102	101	105	97	102
Gambel Oak BA	17	18	18	24	23	18	24	18	23	18	24
All BA	136	146	143	165	167	142	165	146	167	143	165
% Oak BA	12	12	12	14	14	12	14	12	14	12	14
Nestor											
Acres	436	436	436	436	436	436	436	436	436	436	436
% of SDI 12-18” DBH	34	33	33	27	27	33	27	33	27	33	27
% of SDI 18-24” DBH	13	16	17	24	24	17	24	16	24	17	24
% of SDI >24” DBH	7	8	8	11	11	8	11	8	11	8	11
% of Max SDI	86%	87%	85%	87%	88%	84%	87%	87%	88%	85%	87%
TPA >18"	16	20	20	31	31	20	31	20	31	20	31
Ponderosa Pine BA	131	135	130	133	136	129	133	135	136	130	133
Gambel Oak BA	23	24	25	28	27	25	28	24	27	25	28
All BA	170	179	174	193	194	173	192	179	194	174	193
% Oak BA	14	14	14	15	14	14	15	14	14	14	15
O'Leary Peak											
Acres	461	461	461	461	461	461	461	461	461	461	461
% of SDI 12-18” DBH	36	36	36	27	27	36	27	36	27	36	27
% of SDI 18-24” DBH	15	17	18	26	26	18	26	17	26	18	26
% of SDI >24” DBH	8	9	9	15	15	9	15	9	15	9	15

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% of Max SDI	55%	58%	56%	63%	64%	56%	63%	58%	64%	56%	63%
TPA >18"	12	15	15	27	27	15	27	15	27	15	27
Ponderosa Pine BA	80	86	82	89	92	82	89	86	92	82	89
Gambel Oak BA	9	11	11	17	17	11	17	11	17	11	17
All BA	117	129	125	151	153	125	151	129	153	125	151
% Oak BA	8	9	9	12	11	9	12	9	11	9	12
Orion Spring											
Acres	250	250	250	250	250	250	250	250	250	250	250
% of SDI 12-18” DBH	30	31	31	29	30	31	29	31	30	31	29
% of SDI 18-24” DBH	13	15	15	21	21	15	21	15	21	15	21
% of SDI >24” DBH	6	6	7	10	10	7	10	6	10	7	10
% of Max SDI	68%	72%	69%	76%	77%	69%	76%	72%	77%	69%	76%
TPA >18"	12	15	15	25	25	15	25	15	25	15	25
Ponderosa Pine BA	108	114	108	117	121	108	117	114	121	108	117
Gambel Oak BA	17	19	19	25	24	19	25	19	24	19	25
All BA	138	149	144	170	172	144	170	149	172	144	170
% Oak BA	13	13	13	15	14	13	15	13	14	13	15
Pierce Tank											
Acres	374	374	374	374	374	374	374	374	374	374	374
% of SDI 12-18” DBH	36	36	36	30	31	36	30	36	31	36	30
% of SDI 18-24” DBH	13	16	16	25	24	16	25	16	24	16	25
% of SDI >24” DBH	5	5	5	9	9	6	9	5	9	5	9
% of Max SDI	85%	86%	83%	86%	87%	83%	86%	86%	87%	83%	86%
TPA >18"	15	18	18	31	30	18	31	18	30	18	31
Ponderosa Pine BA	134	139	133	140	143	133	140	139	143	133	140
Gambel Oak BA	24	25	25	28	27	25	28	25	27	25	28
All BA	170	178	173	193	195	173	193	178	195	173	193
% Oak BA	14	14	15	15	14	15	15	14	14	15	15
Powerline Tank											

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Acres	351	351	351	351	351	351	351	351	351	351	351
% of SDI 12-18” DBH	25	28	28	31	31	28	31	28	31	28	31
% of SDI 18-24” DBH	11	12	12	17	16	12	17	12	16	12	17
% of SDI >24” DBH	6	6	6	8	8	6	8	6	8	6	8
% of Max SDI	70%	74%	71%	77%	78%	70%	77%	74%	78%	71%	77%
TPA >18"	10	12	12	20	20	12	20	12	20	12	20
Ponderosa Pine BA	104	110	105	114	117	104	113	110	117	105	114
Gambel Oak BA	23	25	25	31	31	26	32	25	31	25	31
All BA	139	150	145	171	173	144	171	150	173	145	171
% Oak BA	16	16	17	18	17	17	18	16	17	17	18
Pumphouse Wash											
Acres	588	588	588	588	588	588	588	588	588	588	588
% of SDI 12-18” DBH	33	33	33	29	29	33	29	33	29	33	29
% of SDI 18-24” DBH	14	16	16	23	23	17	23	16	23	16	23
% of SDI >24” DBH	8	8	8	12	11	8	12	8	11	8	12
% of Max SDI	86%	87%	84%	86%	87%	84%	86%	87%	87%	84%	86%
TPA >18"	17	20	20	31	31	20	31	20	31	20	31
Ponderosa Pine BA	136	140	135	139	142	134	139	140	142	135	139
Gambel Oak BA	23	25	25	28	27	25	28	25	27	25	28
All BA	174	181	177	195	196	176	194	181	196	177	195
% Oak BA	14	14	14	14	14	14	14	14	14	14	14
Racetrack Tank											
Acres	659	659	659	659	659	659	659	659	659	659	659
% of SDI 12-18” DBH	27	28	28	28	28	28	28	28	28	28	28
% of SDI 18-24” DBH	11	13	13	18	18	13	19	13	18	13	18
% of SDI >24” DBH	7	7	7	10	9	7	10	7	9	7	10
% of Max SDI	83%	86%	83%	86%	86%	82%	85%	86%	86%	83%	86%
TPA >18"	13	16	16	24	24	16	24	16	24	16	24
Ponderosa Pine BA	119	123	118	122	125	117	122	123	125	118	122

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Gambel Oak BA	29	31	31	36	35	31	36	31	35	31	36
All BA	162	171	167	187	188	165	186	171	188	167	187
% Oak BA	18	18	19	19	19	19	19	18	19	19	19
Rattlesnake											
Acres	592	592	592	592	592	592	592	592	592	592	592
% of SDI 12-18” DBH	36	35	35	26	26	35	26	35	26	35	26
% of SDI 18-24” DBH	15	18	18	26	26	18	26	18	26	18	26
% of SDI >24” DBH	8	9	9	14	14	9	15	9	14	9	14
% of Max SDI	71%	73%	71%	75%	76%	71%	75%	73%	76%	71%	75%
TPA >18"	15	19	19	31	31	19	31	19	31	19	31
Ponderosa Pine BA	106	110	106	110	112	105	109	110	112	106	110
Gambel Oak BA	15	16	17	21	20	17	21	16	20	17	21
All BA	146	156	152	173	175	152	173	156	175	152	173
% Oak BA	10	10	10	12	12	10	12	10	12	10	12
Roundup											
Acres	554	554	554	554	554	554	554	554	554	554	554
% of SDI 12-18” DBH	36	36	36	28	29	36	28	36	29	36	28
% of SDI 18-24” DBH	14	17	17	26	25	18	26	17	25	17	26
% of SDI >24” DBH	7	8	8	12	12	8	12	8	12	8	12
% of Max SDI	74%	76%	74%	77%	78%	73%	77%	76%	78%	74%	77%
TPA >18"	14	18	18	30	30	18	30	18	30	18	30
Ponderosa Pine BA	115	120	116	121	124	115	121	120	124	116	121
Gambel Oak BA	18	19	19	23	23	19	23	19	23	19	23
All BA	152	161	158	178	179	157	177	161	179	158	178
% Oak BA	11	11	12	13	13	12	13	11	13	12	13
Spruce Tank											
Acres	459	459	459	459	459	459	459	459	459	459	459
% of SDI 12-18” DBH	34	35	35	30	30	35	30	35	30	35	30
% of SDI 18-24” DBH	12	15	15	23	23	15	23	15	23	15	23

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% of SDI >24" DBH	6	6	6	10	10	6	10	6	10	6	10
% of Max SDI	74%	76%	74%	78%	79%	74%	78%	76%	79%	74%	78%
TPA >18"	13	16	16	28	27	16	28	16	27	16	28
Ponderosa Pine BA	115	120	115	123	125	115	122	120	125	115	123
Gambel Oak BA	19	21	21	25	25	21	26	21	25	21	25
All BA	150	160	155	178	180	154	178	160	180	155	178
% Oak BA	13	13	13	14	14	13	14	13	14	13	14
Sterling											
Acres	262	262	262	262	262	262	262	262	262	262	262
% of SDI 12-18" DBH	21	22	22	22	22	22	22	22	22	22	22
% of SDI 18-24" DBH	10	11	11	13	13	11	13	11	13	11	13
% of SDI >24" DBH	23	24	24	25	24	24	25	24	24	24	25
% of Max SDI	77%	78%	75%	78%	80%	75%	78%	78%	80%	75%	78%
TPA >18"	19	20	20	25	25	20	25	20	25	20	25
Ponderosa Pine BA	129	130	125	126	130	125	126	130	130	125	126
Gambel Oak BA	19	20	20	23	23	20	23	20	23	20	23
All BA	165	171	165	185	187	165	185	171	187	165	185
% Oak BA	12	12	13	13	12	13	13	12	12	13	13
Stock Tank											
Acres	108	108	108	108	108	108	108	108	108	108	108
% of SDI 12-18" DBH	26	27	28	31	31	28	31	27	31	28	31
% of SDI 18-24" DBH	17	19	19	23	23	20	23	19	23	19	23
% of SDI >24" DBH	8	9	9	13	13	9	13	9	13	9	13
% of Max SDI	41%	45%	44%	52%	53%	44%	52%	45%	53%	44%	52%
TPA >18"	12	13	13	19	19	13	19	13	19	13	19
Ponderosa Pine BA	73	81	78	92	95	77	91	81	95	78	92
Gambel Oak BA	9	11	11	16	15	11	16	11	15	11	16
All BA	89	100	97	124	127	96	124	100	127	97	124
% Oak BA	9	9	9	11	11	9	11	9	11	9	11

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
T Bird											
Acres	603	603	603	603	603	603	603	603	603	603	603
% of SDI 12-18” DBH	32	34	34	32	32	34	32	34	32	34	32
% of SDI 18-24” DBH	10	12	13	21	20	13	21	12	20	13	21
% of SDI >24” DBH	5	5	5	7	7	5	7	5	7	5	7
% of Max SDI	87%	89%	86%	88%	89%	85%	88%	89%	89%	86%	88%
TPA >18"	12	15	15	26	26	15	26	15	26	15	26
Ponderosa Pine BA	132	136	131	137	140	130	136	136	140	131	137
Gambel Oak BA	28	30	30	34	33	30	34	30	33	30	34
All BA	172	181	176	195	196	175	195	181	196	176	195
% Oak BA	17	17	17	17	17	17	18	17	17	17	17
Two Holes											
Acres	607	607	607	607	607	607	607	607	607	607	607
% of SDI 12-18” DBH	33	32	32	27	27	32	27	32	27	32	27
% of SDI 18-24” DBH	13	16	16	23	23	16	23	16	23	16	23
% of SDI >24” DBH	7	8	8	11	11	8	11	8	11	8	11
% of Max SDI	84%	86%	84%	86%	87%	83%	86%	86%	87%	84%	86%
TPA >18"	16	19	20	30	30	20	30	19	30	20	30
Ponderosa Pine BA	127	131	127	130	133	126	130	131	133	127	130
Gambel Oak BA	24	25	25	29	28	25	29	25	28	25	29
All BA	166	175	171	190	192	170	190	175	192	171	190
% Oak BA	14	14	15	15	15	15	15	14	15	15	15
Upper West Fork											
Acres	276	276	276	276	276	276	276	276	276	276	276
% of SDI 12-18” DBH	35	34	34	27	28	34	27	34	28	34	27
% of SDI 18-24” DBH	13	16	17	25	24	17	25	16	24	17	25
% of SDI >24” DBH	9	9	9	12	12	9	12	9	12	9	12
% of Max SDI	88%	89%	86%	88%	89%	86%	88%	89%	89%	86%	88%
TPA >18"	17	22	22	33	33	22	33	22	33	22	33

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Ponderosa Pine BA	139	142	137	140	143	137	140	142	143	137	140
Gambel Oak BA	22	23	23	25	25	23	25	23	25	23	25
All BA	177	185	180	198	199	180	198	185	199	180	198
% Oak BA	13	12	13	13	12	13	13	12	12	13	13
Volunteer											
Acres	430	430	430	430	430	430	430	430	430	430	430
% of SDI 12-18” DBH	32	31	31	26	26	31	26	31	26	31	26
% of SDI 18-24” DBH	17	20	20	25	25	20	25	20	25	20	25
% of SDI >24” DBH	9	9	10	14	13	10	14	9	13	10	14
% of Max SDI	81%	83%	80%	83%	84%	80%	83%	83%	84%	80%	83%
TPA >18"	19	23	23	32	32	23	32	23	32	23	32
Ponderosa Pine BA	129	132	128	133	135	127	132	132	135	128	133
Gambel Oak BA	21	22	22	24	24	22	25	22	24	22	24
All BA	165	173	169	188	189	169	188	173	189	169	188
% Oak BA	12	12	13	13	12	13	13	12	12	13	13
Walnut 33											
Acres	113	113	113	113	113	113	113	113	113	113	113
% of SDI 12-18” DBH	23	23	24	25	25	24	25	23	25	24	25
% of SDI 18-24” DBH	11	12	13	17	16	13	17	12	16	13	17
% of SDI >24” DBH	8	8	8	10	10	9	10	8	10	8	10
% of Max SDI	86%	88%	86%	87%	88%	85%	87%	88%	88%	86%	87%
TPA >18"	13	16	16	22	22	16	22	16	22	16	22
Ponderosa Pine BA	116	120	115	117	120	113	116	120	120	115	117
Gambel Oak BA	32	35	35	42	41	35	42	35	41	35	42
All BA	159	169	165	184	185	163	184	169	185	165	184
% Oak BA	20	21	21	23	22	22	23	21	22	21	23
Weatherford2											
Acres	147	147	147	147	147	147	147	147	147	147	147
% of SDI 12-18” DBH	32	31	31	25	25	31	25	31	25	31	25

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% of SDI 18-24” DBH	15	18	18	24	23	18	24	18	23	18	24
% of SDI >24” DBH	9	9	10	13	13	10	13	9	13	10	13
% of Max SDI	83%	85%	82%	85%	86%	82%	85%	85%	86%	82%	85%
TPA >18"	18	22	22	32	32	22	32	22	32	22	32
Ponderosa Pine BA	126	130	124	127	130	124	127	130	130	124	127
Gambel Oak BA	21	22	22	25	25	22	25	22	25	22	25
All BA	167	176	171	190	192	171	190	176	192	171	190
% Oak BA	13	12	13	13	13	13	13	12	13	13	13
Weimer Springs											
Acres	91	91	91	91	91	91	91	91	91	91	91
% of SDI 12-18” DBH	40	40	41	32	33	41	32	40	33	41	32
% of SDI 18-24” DBH	12	15	15	27	26	15	27	15	26	15	27
% of SDI >24” DBH	4	5	5	7	7	5	7	5	7	5	7
% of Max SDI	88%	89%	86%	88%	89%	86%	88%	89%	89%	86%	88%
TPA >18"	14	18	18	33	33	18	33	18	33	18	33
Ponderosa Pine BA	143	148	141	148	151	141	148	148	151	141	148
Gambel Oak BA	23	24	24	27	26	24	27	24	26	24	27
All BA	176	184	178	197	199	178	197	184	199	178	197
% Oak BA	13	13	13	13	13	13	13	13	13	13	13
Weir											
Acres	377	377	377	377	377	377	377	377	377	377	377
% of SDI 12-18” DBH	32	34	34	29	29	34	29	34	29	34	29
% of SDI 18-24” DBH	12	14	15	22	22	15	22	14	22	15	22
% of SDI >24” DBH	6	7	7	11	11	7	11	7	11	7	11
% of Max SDI	69%	72%	69%	74%	75%	69%	74%	72%	75%	69%	74%
TPA >18"	11	14	14	25	25	14	25	14	25	14	25
Ponderosa Pine BA	101	106	101	108	111	101	107	106	111	101	108
Gambel Oak BA	20	21	22	27	26	22	27	21	26	22	27
All BA	141	152	147	170	172	147	170	152	172	147	170

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% Oak BA	13	13	14	15	15	14	15	13	15	14	15
Woods											
Acres	853	853	853	853	853	853	853	853	853	853	853
% of SDI 12-18” DBH	29	30	30	27	27	30	27	30	27	30	27
% of SDI 18-24” DBH	12	14	14	21	20	15	21	14	20	14	21
% of SDI >24” DBH	9	10	10	12	12	10	12	10	12	10	12
% of Max SDI	80%	82%	80%	83%	84%	79%	83%	82%	84%	80%	83%
TPA >18"	14	17	17	26	26	17	26	17	26	17	26
Ponderosa Pine BA	120	124	119	124	127	118	124	124	127	119	124
Gambel Oak BA	24	25	26	29	29	26	30	25	29	26	29
All BA	159	168	163	184	186	162	184	168	186	163	184
% Oak BA	15	15	15	16	15	16	16	15	15	15	16

Prey Habitat

Table 5. Changes in MSO Prey Habitat Components by Alternative and Year by Individual PAC; Mechanical Treatment Group (n=18)

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Archies											
Acres	599	599	599	599	599	599	599	599	599	599	599
Snags >12"	1.22	1.59	3.38	2.42	3.18	2.70	3.27	1.53	2.84	2.95	3.38
Snags >12" & <18"	1.11	1.46	2.93	2.29	2.72	2.57	2.79	1.40	2.39	2.50	2.93
Snags >18"	0.11	0.13	0.44	0.13	0.46	0.13	0.48	0.13	0.45	0.45	0.44
CWD >3"	3.38	3.96	6.04	1.84	3.91	1.54	3.71	4.00	5.61	5.74	6.04
Logs	0.27	0.54	1.79	0.40	1.72	0.40	1.79	0.54	1.61	2.20	1.79
CWD >12"	0.09	0.18	0.60	0.13	0.57	0.13	0.60	0.18	0.54	0.73	0.60
Understory Index	67	54	32	63	38	65	39	58	35	32	32
Bar M											

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Acres	645	645	645	645	645	645	645	645	645	645	645
Snags >12"	5.02	5.04	6.73	5.04	4.89	5.08	4.56	4.30	4.95	5.90	6.73
Snags >12" & <18"	3.80	3.82	4.92	3.93	3.19	3.97	2.81	3.18	3.24	4.20	4.92
Snags >18"	1.22	1.22	1.82	1.12	1.71	1.10	1.75	1.11	1.71	1.69	1.82
CWD >3"	5.98	8.25	12.87	4.36	8.09	3.43	6.96	8.65	11.66	12.03	12.87
Logs	2.29	4.01	8.44	2.93	7.07	2.63	6.72	4.05	7.72	9.32	8.44
CWD >12"	0.76	1.34	2.81	0.98	2.36	0.88	2.24	1.35	2.57	3.11	2.81
Understory Index	27	25	21	42	31	48	33	40	29	21	21
Bear Seep											
Acres	703	703	703	703	703	703	703	703	703	703	703
Snags >12"	2.95	3.28	5.96	3.70	5.98	3.55	5.79	3.09	6.11	5.96	5.96
Snags >12" & <18"	1.96	2.35	4.15	2.85	3.97	2.70	3.74	2.25	4.09	4.05	4.15
Snags >18"	1.00	0.94	1.81	0.85	2.01	0.85	2.05	0.85	2.02	1.90	1.81
CWD >3"	4.87	6.20	9.86	2.97	6.67	2.96	6.51	6.18	9.30	9.66	9.86
Logs	2.01	3.08	6.38	2.08	5.53	2.10	5.48	3.04	6.18	7.18	6.38
CWD >12"	0.67	1.03	2.13	0.69	1.84	0.70	1.83	1.01	2.06	2.39	2.13
Understory Index	44	37	27	44	33	46	34	43	33	28	27
Bonita Tank											
Acres	896	896	896	896	896	896	896	896	896	896	896
Snags >12"	3.96	5.98	9.94	6.23	7.22	5.55	6.52	4.37	7.56	9.77	9.94
Snags >12" & <18"	3.42	5.33	8.21	5.61	5.41	4.96	4.51	3.78	5.64	7.99	8.21
Snags >18"	0.54	0.65	1.73	0.62	1.81	0.59	2.01	0.60	1.92	1.78	1.73
CWD >3"	5.33	7.38	13.24	3.73	8.38	2.89	7.06	7.70	11.37	11.94	13.24
Logs	1.30	2.57	7.60	2.09	6.50	1.74	5.91	2.59	6.31	8.62	7.60
CWD >12"	0.43	0.86	2.53	0.70	2.17	0.58	1.97	0.86	2.10	2.87	2.53
Understory Index	23	20	15	32	19	38	22	30	18	16	15
Crawdad											
Acres	703	703	703	703	703	703	703	703	703	703	703
% of SDI 12-18” DBH	2.69	3.14	5.51	4.39	4.79	4.22	3.83	2.69	5.01	6.00	5.51

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
% of SDI 18-24” DBH	2.36	2.73	4.53	3.99	3.66	3.82	2.64	2.29	3.88	4.90	4.53
% of SDI >24” DBH	0.33	0.41	0.97	0.40	1.13	0.40	1.19	0.40	1.13	1.11	0.97
% of Max SDI	4.32	5.48	8.59	2.76	5.76	2.17	4.86	5.64	8.05	8.22	8.59
TPA >18"	0.60	1.38	4.01	1.08	3.73	1.06	3.58	1.42	3.75	4.82	4.01
Ponderosa Pine BA	0.20	0.46	1.34	0.36	1.24	0.35	1.19	0.47	1.25	1.61	1.34
Gambel Oak BA	35	29	20	38	24	46	28	35	23	22	20
Foxhole											
Acres	555	555	555	555	555	555	555	555	555	555	555
Snags >12"	2.93	3.65	6.02	3.74	3.75	3.87	3.61	2.64	3.71	4.29	6.02
Snags >12" & <18"	2.36	3.09	5.10	3.25	2.93	3.38	2.77	2.16	2.91	3.53	5.10
Snags >18"	0.56	0.56	0.93	0.48	0.82	0.49	0.84	0.48	0.80	0.76	0.93
CWD >3"	5.65	7.54	11.39	3.90	6.60	3.12	5.75	7.92	9.81	10.08	11.39
Logs	1.74	2.58	5.05	1.97	4.14	1.76	4.03	2.67	4.42	5.15	5.05
CWD >12"	0.58	0.86	1.68	0.66	1.38	0.59	1.34	0.89	1.47	1.72	1.68
Understory Index	26	24	19	42	27	51	32	39	25	18	19
Frank											
Acres	701	701	701	701	701	701	701	701	701	701	701
Snags >12"	4.86	5.91	8.42	6.38	7.89	6.42	7.56	5.42	8.09	8.70	8.42
Snags >12" & <18"	4.18	5.09	6.60	5.58	5.81	5.63	5.39	4.62	6.06	6.77	6.60
Snags >18"	0.69	0.82	1.82	0.80	2.08	0.79	2.17	0.80	2.03	1.93	1.82
CWD >3"	4.71	6.45	11.05	3.44	7.84	2.64	6.91	6.60	10.47	11.07	11.05
Logs	1.20	2.51	7.20	1.99	6.80	1.75	6.51	2.55	7.01	8.98	7.20
CWD >12"	0.40	0.84	2.40	0.66	2.27	0.58	2.17	0.85	2.34	2.99	2.40
Understory Index	38	35	31	45	41	50	44	43	40	34	31
Holdup											
Acres	638	638	638	638	638	638	638	638	638	638	638
Snags >12"	1.81	2.46	7.33	3.21	6.57	3.37	6.32	2.30	6.79	7.57	7.33
Snags >12" & <18"	1.17	1.73	5.40	2.46	4.44	2.60	4.08	1.55	4.70	5.71	5.40
Snags >18"	0.64	0.73	1.93	0.75	2.13	0.77	2.24	0.75	2.08	1.86	1.93

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
CWD >3"	3.81	4.55	7.74	2.23	5.54	1.81	5.06	4.94	7.68	7.78	7.74
Logs	0.98	1.71	5.14	1.27	5.06	1.25	5.14	1.84	5.29	6.30	5.14
CWD >12"	0.33	0.57	1.71	0.42	1.69	0.42	1.71	0.61	1.76	2.10	1.71
Understory Index	49	41	33	62	49	70	54	58	46	34	33
Iris Tank											
Acres	690	690	690	690	690	690	690	690	690	690	690
Snags >12"	6.09	7.18	10.77	7.17	9.13	7.28	8.38	6.31	9.13	10.76	10.77
Snags >12" & <18"	5.07	5.93	8.05	5.96	6.16	6.07	5.38	5.10	6.22	7.92	8.05
Snags >18"	1.02	1.25	2.72	1.21	2.97	1.22	3.01	1.21	2.91	2.83	2.72
CWD >3"	5.80	8.10	14.01	4.33	9.61	3.47	8.49	8.51	13.15	13.59	14.01
Logs	1.98	3.71	10.02	2.82	8.85	2.64	8.64	3.93	9.52	12.10	10.02
CWD >12"	0.66	1.24	3.34	0.94	2.95	0.88	2.88	1.31	3.17	4.03	3.34
Understory Index	26	25	22	35	29	40	31	33	28	24	22
Knob											
Acres	766	766	766	766	766	766	766	766	766	766	766
Snags >12"	0.95	1.49	4.02	2.43	3.39	2.46	2.90	1.23	3.47	4.07	4.02
Snags >12" & <18"	0.65	1.26	3.54	2.21	2.89	2.23	2.39	1.01	2.98	3.58	3.54
Snags >18"	0.29	0.23	0.48	0.22	0.50	0.22	0.51	0.22	0.49	0.49	0.48
CWD >3"	3.41	4.15	6.57	2.05	4.43	1.70	3.75	4.29	6.03	6.27	6.57
Logs	0.52	0.82	2.04	0.63	2.02	0.63	1.97	0.87	1.93	2.47	2.04
CWD >12"	0.17	0.27	0.68	0.21	0.67	0.21	0.66	0.29	0.64	0.82	0.68
Understory Index	52	43	28	54	34	62	38	50	31	29	28
Lake #1/Seruchos											
Acres	262	262	262	262	262	262	262	262	262	262	262
Snags >12"	1.41	2.17	4.59	2.96	3.81	2.77	3.33	1.71	3.58	4.64	4.59
Snags >12" & <18"	1.17	1.91	4.12	2.74	3.27	2.57	2.76	1.47	3.06	4.10	4.12
Snags >18"	0.25	0.25	0.47	0.23	0.54	0.20	0.57	0.24	0.52	0.53	0.47
CWD >3"	4.25	5.13	8.60	2.40	5.35	2.07	4.52	5.48	7.73	7.90	8.60
Logs	0.29	0.75	2.62	0.57	2.56	0.57	2.33	0.77	2.41	3.17	2.62

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
CWD >12"	0.10	0.25	0.87	0.19	0.85	0.19	0.78	0.26	0.80	1.06	0.87
Understory Index	36	29	17	46	24	54	27	41	21	20	17
Lee Butte											
Acres	867	867	867	867	867	867	867	867	867	867	867
Snags >12"	3.24	4.19	7.85	4.01	8.12	4.12	7.77	4.02	7.59	8.41	7.85
Snags >12" & <18"	2.96	3.76	6.49	3.62	6.79	3.73	6.44	3.61	6.23	7.06	6.49
Snags >18"	0.28	0.43	1.36	0.39	1.33	0.39	1.33	0.41	1.37	1.35	1.36
CWD >3"	4.63	6.23	10.55	5.25	9.09	4.88	8.67	6.31	10.34	10.14	10.55
Logs	0.48	1.33	4.85	1.46	5.00	1.41	4.90	1.34	4.75	5.69	4.85
CWD >12"	0.16	0.44	1.62	0.49	1.67	0.47	1.63	0.45	1.58	1.90	1.62
Understory Index	32	27	19	30	21	32	22	29	20	19	19
Mayflower Tank											
Acres	660	660	660	660	660	660	660	660	660	660	660
Snags >12"	3.99	5.18	8.78	5.66	6.71	5.15	6.19	4.32	7.17	7.97	8.78
Snags >12" & <18"	3.54	4.67	7.13	5.19	5.11	4.69	4.55	3.86	5.60	6.37	7.13
Snags >18"	0.45	0.51	1.65	0.47	1.61	0.46	1.63	0.46	1.57	1.60	1.65
CWD >3"	4.33	6.30	11.51	2.71	6.99	2.71	6.64	6.22	10.03	10.50	11.51
Logs	0.92	2.04	6.36	1.41	5.15	1.47	5.01	2.00	5.46	7.36	6.36
CWD >12"	0.31	0.68	2.12	0.47	1.72	0.49	1.67	0.67	1.82	2.45	2.12
Understory Index	37	32	22	37	21	42	23	34	20	19	22
Red Hill											
Acres	863	863	863	863	863	863	863	863	863	863	863
Snags >12"	2.14	4.78	9.63	4.80	6.13	4.74	5.64	3.55	6.40	10.17	9.63
Snags >12" & <18"	1.91	4.00	7.79	4.21	4.69	4.15	4.15	2.95	4.96	8.26	7.79
Snags >18"	0.23	0.78	1.84	0.60	1.43	0.59	1.49	0.60	1.44	1.90	1.84
CWD >3"	5.27	6.84	12.92	3.62	8.01	2.93	6.96	7.36	11.06	11.89	12.92
Logs	1.51	2.27	6.71	1.60	5.15	1.59	5.03	2.37	5.48	7.37	6.71
CWD >12"	0.50	0.76	2.24	0.53	1.72	0.53	1.68	0.79	1.83	2.46	2.24
Understory Index	23	20	16	32	18	39	21	30	18	16	16

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Red Raspberry											
Acres	753	753	753	753	753	753	753	753	753	753	753
Snags >12"	3.66	4.52	6.22	4.97	5.70	4.96	5.54	4.03	5.86	5.85	6.22
Snags >12" & <18"	2.90	3.72	4.64	4.22	4.24	4.20	4.09	3.27	4.40	4.40	4.64
Snags >18"	0.76	0.80	1.58	0.75	1.47	0.75	1.46	0.75	1.46	1.45	1.58
CWD >3"	5.57	7.69	11.73	3.72	7.88	3.72	7.80	7.44	10.98	11.35	11.73
Logs	3.10	4.43	8.09	3.05	6.70	3.06	6.68	4.28	7.53	9.22	8.09
CWD >12"	1.03	1.48	2.70	1.02	2.23	1.02	2.23	1.43	2.51	3.07	2.70
Understory Index	39	33	21	38	23	39	24	36	23	19	21
Rock Top											
Acres	875	875	875	875	875	875	875	875	875	875	875
Snags >12"	3.57	4.22	6.74	4.91	5.89	4.64	5.23	3.48	6.11	6.81	6.74
Snags >12" & <18"	3.11	3.70	5.28	4.44	4.44	4.18	3.70	3.01	4.64	5.39	5.28
Snags >18"	0.46	0.53	1.46	0.47	1.45	0.46	1.53	0.47	1.47	1.42	1.46
CWD >3"	4.97	6.47	10.26	3.18	6.81	2.63	5.86	6.59	9.59	9.55	10.26
Logs	1.64	2.59	5.91	1.80	5.09	1.76	4.86	2.63	5.48	6.61	5.91
CWD >12"	0.55	0.86	1.97	0.60	1.70	0.59	1.62	0.88	1.83	2.20	1.97
Understory Index	43	36	25	45	29	52	31	42	27	25	25
Sawmill Springs											
Acres	629	629	629	629	629	629	629	629	629	629	629
Snags >12"	2.97	3.38	6.97	4.17	5.04	4.34	4.70	2.82	5.24	5.43	6.97
Snags >12" & <18"	2.19	2.64	5.64	3.50	3.86	3.69	3.51	2.15	4.03	4.27	5.64
Snags >18"	0.78	0.75	1.34	0.67	1.18	0.66	1.20	0.67	1.22	1.16	1.34
CWD >3"	4.44	5.57	8.95	3.04	6.04	2.16	5.06	5.61	8.01	8.10	8.95
Logs	1.16	2.05	5.14	1.59	4.38	1.36	4.07	2.01	4.48	5.38	5.14
CWD >12"	0.39	0.68	1.71	0.53	1.46	0.45	1.36	0.67	1.49	1.79	1.71
Understory Index	45	37	25	47	30	50	32	43	29	26	25
T6 Tank											
Acres	784	784	784	784	784	784	784	784	784	784	784

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Snags >12"	2.17	2.63	6.30	3.24	5.52	3.27	4.96	2.37	5.55	6.56	6.30
Snags >12" & <18"	1.67	2.10	4.73	2.69	3.84	2.72	3.25	1.82	3.89	4.94	4.73
Snags >18"	0.50	0.53	1.56	0.55	1.68	0.55	1.70	0.55	1.66	1.62	1.56
CWD >3"	3.67	4.62	7.70	2.25	5.19	1.86	4.69	4.89	7.26	7.62	7.70
Logs	0.90	1.60	4.44	1.15	4.14	1.15	4.12	1.69	4.39	5.52	4.44
CWD >12"	0.30	0.53	1.48	0.38	1.38	0.38	1.37	0.56	1.46	1.84	1.48
Understory Index	53	44	32	63	44	70	48	58	40	36	32

Table 6. Changes in MSO Prey Habitat Components by Alternative and Year by Individual PAC; Prescribed Fire Only Treatment Group (n=52)

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Blade Tank											
Acres	498	498	498	498	498	498	498	498	498	498	498
Snags >12"	4.09	5.06	8.72	6.44	8.28	6.64	8.22	5.06	8.72	8.28	8.72
Snags >12" & <18"	3.43	4.34	6.85	5.72	6.41	5.92	6.35	4.34	6.85	6.41	6.85
Snags >18"	0.66	0.73	1.87	0.72	1.86	0.72	1.86	0.73	1.87	1.86	1.87
CWD >3"	6.12	8.05	13.23	3.92	9.50	3.29	8.91	8.05	13.23	9.50	13.23
Logs	2.45	3.64	8.18	2.45	7.32	2.31	7.22	3.64	8.18	7.32	8.18
CWD >12"	0.82	1.21	2.73	0.82	2.44	0.77	2.41	1.21	2.73	2.44	2.73
Understory Index	27	23	17	25	17	25	18	23	17	17	17
Boondock											
Acres	310	310	310	310	310	310	310	310	310	310	310
Snags >12"	4.12	5.00	8.44	6.31	8.05	6.37	8.03	5.00	8.44	8.05	8.44
Snags >12" & <18"	3.34	4.13	6.44	5.45	6.04	5.51	6.03	4.13	6.44	6.04	6.44
Snags >18"	0.78	0.87	2.01	0.86	2.01	0.86	2.01	0.87	2.01	2.01	2.01
CWD >3"	6.07	8.11	13.42	3.47	9.13	3.30	8.96	8.11	13.42	9.13	13.42
Logs	2.17	3.39	7.90	2.20	6.99	2.18	6.98	3.39	7.90	6.99	7.90

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
CWD >12"	0.72	1.13	2.63	0.73	2.33	0.73	2.33	1.13	2.63	2.33	2.63
Understory Index	23	20	15	22	15	22	15	20	15	15	15
Bridge											
Acres	286	286	286	286	286	286	286	286	286	286	286
Snags >12"	3.98	6.25	9.30	7.66	8.73	7.70	8.72	6.25	9.30	8.73	9.30
Snags >12" & <18"	3.24	5.08	6.63	6.52	6.09	6.56	6.08	5.08	6.63	6.09	6.63
Snags >18"	0.74	1.16	2.67	1.14	2.64	1.14	2.64	1.16	2.67	2.64	2.67
CWD >3"	7.08	8.96	14.39	3.99	9.92	3.89	9.82	8.96	14.39	9.92	14.39
Logs	5.84	7.03	12.23	4.31	9.99	4.29	9.98	7.03	12.23	9.99	12.23
CWD >12"	1.95	2.34	4.08	1.44	3.33	1.43	3.33	2.34	4.08	3.33	4.08
Understory Index	95	91	82	94	83	94	83	91	82	83	82
Bristow Tank/Limpios											
Acres	591	591	591	591	591	591	591	591	591	591	591
Snags >12"	2.95	3.49	6.46	4.33	6.22	4.60	6.14	3.49	6.46	6.22	6.46
Snags >12" & <18"	2.26	2.78	4.93	3.62	4.70	3.89	4.61	2.78	4.93	4.70	4.93
Snags >18"	0.69	0.71	1.53	0.71	1.53	0.71	1.53	0.71	1.53	1.53	1.53
CWD >3"	5.35	6.79	10.79	3.63	8.01	2.80	7.23	6.79	10.79	8.01	10.79
Logs	2.86	3.72	6.94	2.48	6.01	2.30	5.88	3.72	6.94	6.01	6.94
CWD >12"	0.95	1.24	2.31	0.83	2.00	0.77	1.96	1.24	2.31	2.00	2.31
Understory Index	43	35	23	38	24	38	24	35	23	24	23
Casner											
Acres	622	622	622	622	622	622	622	622	622	622	622
Snags >12"	3.62	4.56	8.09	5.74	7.73	6.04	7.63	4.56	8.09	7.73	8.09
Snags >12" & <18"	3.00	3.86	6.37	5.05	6.01	5.35	5.92	3.86	6.37	6.01	6.37
Snags >18"	0.62	0.70	1.72	0.69	1.72	0.69	1.71	0.70	1.72	1.72	1.72
CWD >3"	5.88	7.69	12.57	4.22	9.38	3.15	8.40	7.69	12.57	9.38	12.57
Logs	2.22	3.26	7.28	2.38	6.65	2.07	6.41	3.26	7.28	6.65	7.28
CWD >12"	0.74	1.09	2.43	0.79	2.22	0.69	2.14	1.09	2.43	2.22	2.43
Understory Index	27	23	17	25	17	26	17	23	17	17	17

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Casner Cabin											
Acres	172	172	172	172	172	172	172	172	172	172	172
Snags >12"	4.17	4.72	7.26	5.80	6.89	5.80	6.89	4.72	7.26	6.89	7.26
Snags >12" & <18"	2.82	3.25	4.76	4.33	4.43	4.33	4.43	3.25	4.76	4.43	4.76
Snags >18"	1.34	1.47	2.50	1.46	2.46	1.46	2.46	1.47	2.50	2.46	2.50
CWD >3"	7.79	9.31	13.56	4.01	8.93	4.01	8.93	9.31	13.56	8.93	13.56
Logs	8.01	8.98	12.94	5.37	10.07	5.37	10.07	8.98	12.94	10.07	12.94
CWD >12"	2.67	2.99	4.31	1.79	3.36	1.79	3.36	2.99	4.31	3.36	4.31
Understory Index	139	125	101	129	102	129	102	125	101	102	101
Cave Springs											
Acres	204	204	204	204	204	204	204	204	204	204	204
Snags >12"	3.72	4.90	8.81	6.52	8.28	6.52	8.28	4.90	8.81	8.28	8.81
Snags >12" & <18"	3.19	4.26	6.87	5.88	6.35	5.88	6.35	4.26	6.87	6.35	6.87
Snags >18"	0.53	0.65	1.94	0.64	1.93	0.64	1.93	0.65	1.94	1.93	1.94
CWD >3"	6.32	7.95	12.78	3.26	8.70	3.26	8.70	7.95	12.78	8.70	12.78
Logs	3.90	4.98	9.68	3.06	8.26	3.06	8.26	4.98	9.68	8.26	9.68
CWD >12"	1.30	1.66	3.23	1.02	2.75	1.02	2.75	1.66	3.23	2.75	3.23
Understory Index	85	75	59	80	60	80	60	75	59	60	59
Coulter Ridge											
Acres	671	671	671	671	671	671	671	671	671	671	671
Snags >12"	3.88	4.77	8.25	6.12	7.83	6.37	7.76	4.77	8.25	7.83	8.25
Snags >12" & <18"	3.29	4.11	6.54	5.47	6.12	5.72	6.05	4.11	6.54	6.12	6.54
Snags >18"	0.60	0.66	1.72	0.65	1.71	0.65	1.71	0.66	1.72	1.71	1.72
CWD >3"	5.80	7.61	12.46	3.80	9.01	3.09	8.38	7.61	12.46	9.01	12.46
Logs	2.02	3.12	7.31	2.17	6.64	2.00	6.53	3.12	7.31	6.64	7.31
CWD >12"	0.67	1.04	2.44	0.72	2.21	0.67	2.18	1.04	2.44	2.21	2.44
Understory Index	29	25	18	27	18	27	18	25	18	18	18
Coyote Park											
Acres	643	643	643	643	643	643	643	643	643	643	643

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Snags >12"	3.84	4.70	8.19	5.84	7.84	6.06	7.77	4.70	8.19	7.84	8.19
Snags >12" & <18"	3.11	3.90	6.37	5.05	6.02	5.28	5.96	3.90	6.37	6.02	6.37
Snags >18"	0.73	0.80	1.82	0.78	1.82	0.78	1.82	0.80	1.82	1.82	1.82
CWD >3"	5.86	7.84	13.00	4.03	9.45	3.20	8.68	7.84	13.00	9.45	13.00
Logs	1.88	3.03	7.23	2.14	6.57	1.96	6.43	3.03	7.23	6.57	7.23
CWD >12"	0.63	1.01	2.41	0.71	2.19	0.65	2.14	1.01	2.41	2.19	2.41
Understory Index	25	21	16	23	16	23	16	21	16	16	16
Crater Spring Tank											
Acres	63	63	63	63	63	63	63	63	63	63	63
Snags >12"	4.99	6.21	10.00	8.39	9.22	8.39	9.22	6.21	10.00	9.22	10.00
Snags >12" & <18"	4.47	5.64	8.33	7.84	7.56	7.84	7.56	5.64	8.33	7.56	8.33
Snags >18"	0.52	0.57	1.67	0.55	1.66	0.55	1.66	0.57	1.67	1.66	1.67
CWD >3"	6.38	8.55	14.14	3.51	9.57	3.51	9.57	8.55	14.14	9.57	14.14
Logs	1.65	2.97	7.92	1.98	7.26	1.98	7.26	2.97	7.92	7.26	7.92
CWD >12"	0.55	0.99	2.64	0.66	2.42	0.66	2.42	0.99	2.64	2.42	2.64
Understory Index	22	19	14	21	15	21	15	19	14	15	14
Dairy Spring											
Acres	204	204	204	204	204	204	204	204	204	204	204
Snags >12"	3.94	4.87	8.51	6.21	8.13	6.21	8.13	4.87	8.51	8.13	8.51
Snags >12" & <18"	3.23	4.05	6.33	5.39	5.95	5.39	5.95	4.05	6.33	5.95	6.33
Snags >18"	0.71	0.82	2.18	0.82	2.18	0.82	2.18	0.82	2.18	2.18	2.18
CWD >3"	6.26	8.01	13.01	3.25	8.82	3.25	8.82	8.01	13.01	8.82	13.01
Logs	3.67	4.86	9.72	3.00	8.31	3.00	8.31	4.86	9.72	8.31	9.72
CWD >12"	1.22	1.62	3.24	1.00	2.77	1.00	2.77	1.62	3.24	2.77	3.24
Understory Index	34	28	20	31	21	31	21	28	20	21	20
Fain Mountain											
Acres	382	382	382	382	382	382	382	382	382	382	382
Snags >12"	4.55	5.55	9.09	6.70	8.74	7.14	8.59	5.55	9.09	8.74	9.09
Snags >12" & <18"	3.85	4.74	6.96	5.90	6.61	6.34	6.46	4.74	6.96	6.61	6.96

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Snags >18"	0.70	0.81	2.13	0.80	2.13	0.80	2.12	0.81	2.13	2.13	2.13
CWD >3"	6.34	8.30	13.61	4.45	10.18	3.37	9.21	8.30	13.61	10.18	13.61
Logs	2.91	4.21	9.26	2.94	8.30	2.65	8.10	4.21	9.26	8.30	9.26
CWD >12"	0.97	1.40	3.09	0.98	2.77	0.88	2.70	1.40	3.09	2.77	3.09
Understory Index	27	23	17	25	17	25	17	23	17	17	17
Fisher Point											
Acres	24	24	24	24	24	24	24	24	24	24	24
Snags >12"	3.60	3.44	4.74	3.75	4.51	3.75	4.51	3.44	4.74	4.51	4.74
Snags >12" & <18"	1.25	0.99	1.78	1.30	1.66	1.30	1.66	0.99	1.78	1.66	1.78
Snags >18"	2.35	2.45	2.96	2.45	2.85	2.45	2.85	2.45	2.96	2.85	2.96
CWD >3"	10.94	11.66	14.14	5.40	8.94	5.40	8.94	11.66	14.14	8.94	14.14
Logs	18.09	18.45	20.64	10.77	14.40	10.77	14.40	18.45	20.64	14.40	20.64
CWD >12"	6.03	6.15	6.88	3.59	4.80	3.59	4.80	6.15	6.88	4.80	6.88
Understory Index	211	180	127	185	128	185	128	180	127	128	127
Frog Tank											
Acres	626	626	626	626	626	626	626	626	626	626	626
Snags >12"	3.28	4.29	7.64	5.50	7.27	5.72	7.21	4.29	7.64	7.27	7.64
Snags >12" & <18"	2.66	3.55	5.85	4.77	5.48	4.99	5.42	3.55	5.85	5.48	5.85
Snags >18"	0.62	0.74	1.79	0.73	1.79	0.73	1.79	0.74	1.79	1.79	1.79
CWD >3"	5.50	7.21	11.85	3.61	8.54	2.94	7.95	7.21	11.85	8.54	11.85
Logs	2.00	2.99	6.92	2.09	6.27	1.91	6.15	2.99	6.92	6.27	6.92
CWD >12"	0.67	1.00	2.31	0.70	2.09	0.64	2.05	1.00	2.31	2.09	2.31
Understory Index	29	24	18	27	19	27	19	24	18	19	18
Fry											
Acres	132	132	132	132	132	132	132	132	132	132	132
Snags >12"	3.88	4.72	8.18	6.24	7.70	6.24	7.70	4.72	8.18	7.70	8.18
Snags >12" & <18"	3.25	4.06	6.56	5.59	6.08	5.59	6.08	4.06	6.56	6.08	6.56
Snags >18"	0.63	0.67	1.62	0.65	1.61	0.65	1.61	0.67	1.62	1.61	1.62
CWD >3"	5.68	7.58	12.53	3.09	8.40	3.09	8.40	7.58	12.53	8.40	12.53

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Logs	1.57	2.69	6.75	1.76	6.09	1.76	6.09	2.69	6.75	6.09	6.75
CWD >12"	0.52	0.90	2.25	0.59	2.03	0.59	2.03	0.90	2.25	2.03	2.25
Understory Index	78	70	58	75	59	75	59	70	58	59	58
Gash Mountain											
Acres	627	627	627	627	627	627	627	627	627	627	627
Snags >12"	3.59	4.78	8.44	6.17	8.00	6.52	7.87	4.78	8.44	8.00	8.44
Snags >12" & <18"	3.05	4.14	6.79	5.55	6.35	5.89	6.23	4.14	6.79	6.35	6.79
Snags >18"	0.53	0.64	1.65	0.63	1.64	0.62	1.64	0.64	1.65	1.64	1.65
CWD >3"	5.87	7.68	12.57	3.99	9.18	3.17	8.44	7.68	12.57	9.18	12.57
Logs	2.04	3.06	7.13	2.15	6.50	1.97	6.36	3.06	7.13	6.50	7.13
CWD >12"	0.68	1.02	2.38	0.72	2.17	0.66	2.12	1.02	2.38	2.17	2.38
Understory Index	26	22	17	24	17	25	17	22	17	17	17
Girdner											
Acres	727	727	727	727	727	727	727	727	727	727	727
Snags >12"	3.13	4.19	7.78	5.42	7.42	5.68	7.35	4.19	7.78	7.42	7.78
Snags >12" & <18"	2.52	3.53	6.07	4.76	5.71	5.02	5.64	3.53	6.07	5.71	6.07
Snags >18"	0.60	0.66	1.71	0.66	1.71	0.66	1.71	0.66	1.71	1.71	1.71
CWD >3"	6.06	7.67	12.25	4.02	9.02	3.21	8.31	7.67	12.25	9.02	12.25
Logs	3.81	4.72	8.59	3.21	7.53	2.89	7.30	4.72	8.59	7.53	8.59
CWD >12"	1.27	1.57	2.86	1.07	2.51	0.96	2.43	1.57	2.86	2.51	2.86
Understory Index	34	29	20	31	21	31	21	29	20	21	20
Harding Point											
Acres	134	134	134	134	134	134	134	134	134	134	134
Snags >12"	3.72	6.11	9.13	7.16	8.62	7.16	8.62	6.11	9.13	8.62	9.13
Snags >12" & <18"	2.97	4.75	6.16	5.86	5.71	5.86	5.71	4.75	6.16	5.71	6.16
Snags >18"	0.75	1.36	2.97	1.30	2.91	1.30	2.91	1.36	2.97	2.91	2.97
CWD >3"	7.13	8.83	14.09	3.80	9.43	3.80	9.43	8.83	14.09	9.43	14.09
Logs	5.96	7.10	12.37	4.33	9.85	4.33	9.85	7.10	12.37	9.85	12.37
CWD >12"	1.99	2.37	4.12	1.44	3.28	1.44	3.28	2.37	4.12	3.28	4.12

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Understory Index	97	92	83	95	84	95	84	92	83	84	83
Howard Mountain											
Acres	648	648	648	648	648	648	648	648	648	648	648
Snags >12"	4.25	5.24	8.86	6.51	8.47	6.76	8.39	5.24	8.86	8.47	8.86
Snags >12" & <18"	3.54	4.43	6.76	5.70	6.37	5.95	6.30	4.43	6.76	6.37	6.76
Snags >18"	0.71	0.81	2.10	0.81	2.09	0.81	2.09	0.81	2.10	2.09	2.10
CWD >3"	6.34	8.27	13.53	4.19	9.88	3.37	9.12	8.27	13.53	9.88	13.53
Logs	3.01	4.24	9.09	2.88	8.08	2.66	7.91	4.24	9.09	8.08	9.09
CWD >12"	1.00	1.41	3.03	0.96	2.69	0.89	2.64	1.41	3.03	2.69	3.03
Understory Index	27	23	17	24	17	25	17	23	17	17	17
Iowa Camp											
Acres	672	672	672	672	672	672	672	672	672	672	672
Snags >12"	3.11	3.95	7.66	5.04	7.34	5.33	7.25	3.95	7.66	7.34	7.66
Snags >12" & <18"	2.48	3.30	6.17	4.40	5.85	4.69	5.77	3.30	6.17	5.85	6.17
Snags >18"	0.63	0.65	1.48	0.64	1.49	0.64	1.49	0.65	1.48	1.49	1.48
CWD >3"	5.66	7.48	12.28	4.11	9.11	3.08	8.16	7.48	12.28	9.11	12.28
Logs	1.81	2.75	6.30	2.05	5.83	1.76	5.61	2.75	6.30	5.83	6.30
CWD >12"	0.60	0.92	2.10	0.68	1.94	0.59	1.87	0.92	2.10	1.94	2.10
Understory Index	28	23	17	26	18	26	18	23	17	18	17
James Canyon											
Acres	544	544	544	544	544	544	544	544	544	544	544
Snags >12"	4.01	4.97	8.60	6.34	8.18	6.51	8.12	4.97	8.60	8.18	8.60
Snags >12" & <18"	3.33	4.21	6.73	5.59	6.31	5.76	6.26	4.21	6.73	6.31	6.73
Snags >18"	0.68	0.75	1.87	0.75	1.87	0.75	1.87	0.75	1.87	1.87	1.87
CWD >3"	6.14	8.10	13.31	3.83	9.38	3.31	8.92	8.10	13.31	9.38	13.31
Logs	2.34	3.50	7.93	2.40	7.13	2.23	7.01	3.50	7.93	7.13	7.93
CWD >12"	0.78	1.17	2.64	0.80	2.38	0.74	2.34	1.17	2.64	2.38	2.64
Understory Index	91	83	71	87	72	88	72	83	71	72	71

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Jeep											
Acres	214	214	214	214	214	214	214	214	214	214	214
Snags >12"	3.27	4.16	7.96	4.90	7.78	5.76	7.48	4.16	7.96	7.78	7.96
Snags >12" & <18"	2.78	3.64	6.44	4.39	6.26	5.25	5.97	3.64	6.44	6.26	6.44
Snags >18"	0.49	0.51	1.52	0.52	1.52	0.51	1.51	0.51	1.52	1.52	1.52
CWD >3"	5.83	7.40	11.89	5.12	9.90	3.02	8.02	7.40	11.89	9.90	11.89
Logs	2.75	3.67	7.53	2.82	6.94	2.28	6.57	3.67	7.53	6.94	7.53
CWD >12"	0.92	1.22	2.51	0.94	2.31	0.76	2.19	1.22	2.51	2.31	2.51
Understory Index	38	32	22	33	22	35	23	32	22	22	22
Kelly											
Acres	666	666	666	666	666	666	666	666	666	666	666
Snags >12"	3.47	4.31	7.73	5.52	7.36	5.76	7.29	4.31	7.73	7.36	7.73
Snags >12" & <18"	2.70	3.47	5.95	4.68	5.59	4.92	5.52	3.47	5.95	5.59	5.95
Snags >18"	0.78	0.84	1.78	0.84	1.77	0.84	1.77	0.84	1.78	1.77	1.78
CWD >3"	6.19	7.96	12.68	4.11	9.15	3.31	8.41	7.96	12.68	9.15	12.68
Logs	3.09	4.04	7.79	2.72	6.82	2.52	6.67	4.04	7.79	6.82	7.79
CWD >12"	1.03	1.35	2.60	0.91	2.27	0.84	2.22	1.35	2.60	2.27	2.60
Understory Index	93	84	71	89	72	89	72	84	71	72	71
Kendrick											
Acres	171	171	171	171	171	171	171	171	171	171	171
Snags >12"	0.80	1.09	2.48	1.36	2.38	1.36	2.38	1.09	2.48	2.38	2.48
Snags >12" & <18"	0.62	0.92	1.59	1.19	1.51	1.19	1.51	0.92	1.59	1.51	1.59
Snags >18"	0.18	0.18	0.88	0.18	0.87	0.18	0.87	0.18	0.88	0.87	0.88
CWD >3"	6.54	6.38	6.39	2.29	3.07	2.29	3.07	6.38	6.39	3.07	6.39
Logs	0.09	0.24	1.18	0.18	1.18	0.18	1.18	0.24	1.18	1.18	1.18
CWD >12"	0.03	0.08	0.39	0.06	0.39	0.06	0.39	0.08	0.39	0.39	0.39
Understory Index	369	323	211	335	227	335	227	323	211	227	211

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Lockwood											
Acres	271	271	271	271	271	271	271	271	271	271	271
Snags >12"	4.26	5.16	8.59	6.56	8.17	6.56	8.17	5.16	8.59	8.17	8.59
Snags >12" & <18"	3.47	4.28	6.52	5.68	6.10	5.68	6.10	4.28	6.52	6.10	6.52
Snags >18"	0.79	0.89	2.07	0.88	2.07	0.88	2.07	0.89	2.07	2.07	2.07
CWD >3"	6.15	8.22	13.60	3.34	9.09	3.34	9.09	8.22	13.60	9.09	13.60
Logs	2.26	3.52	8.17	2.25	7.20	2.25	7.20	3.52	8.17	7.20	8.17
CWD >12"	0.75	1.17	2.72	0.75	2.40	0.75	2.40	1.17	2.72	2.40	2.72
Understory Index	22	19	15	21	15	21	15	19	15	15	15
MB Smith											
Acres	571	571	571	571	571	571	571	571	571	571	571
Snags >12"	3.45	4.23	7.58	5.55	7.18	5.67	7.14	4.23	7.58	7.18	7.58
Snags >12" & <18"	2.79	3.52	5.99	4.85	5.59	4.98	5.55	3.52	5.99	5.59	5.99
Snags >18"	0.66	0.71	1.60	0.70	1.59	0.70	1.58	0.71	1.60	1.59	1.60
CWD >3"	5.93	7.59	12.09	3.60	8.46	3.14	8.05	7.59	12.09	8.46	12.09
Logs	2.80	3.73	7.34	2.51	6.45	2.33	6.31	3.73	7.34	6.45	7.34
CWD >12"	0.93	1.24	2.45	0.84	2.15	0.78	2.10	1.24	2.45	2.15	2.45
Understory Index	32	27	19	29	19	30	19	27	19	19	19
Meadow Tank											
Acres	105	105	105	105	105	105	105	105	105	105	105
Snags >12"	2.09	3.72	5.88	4.24	5.83	4.53	5.64	3.72	5.88	5.83	5.88
Snags >12" & <18"	1.42	2.51	3.14	3.03	3.09	3.36	2.93	2.51	3.14	3.09	3.14
Snags >18"	0.67	1.21	2.74	1.21	2.74	1.18	2.71	1.21	2.74	2.74	2.74
CWD >3"	4.19	5.13	8.46	3.81	7.49	2.07	5.85	5.13	8.46	7.49	8.46
Logs	2.92	3.78	7.90	3.54	7.86	2.33	6.69	3.78	7.90	7.86	7.90
CWD >12"	0.97	1.26	2.63	1.18	2.62	0.78	2.23	1.26	2.63	2.62	2.63
Understory Index	44	39	29	39	29	40	29	39	29	29	29

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Milos Butte											
Acres	658	658	658	658	658	658	658	658	658	658	658
Snags >12"	4.56	5.55	9.06	6.86	8.64	7.15	8.54	5.55	9.06	8.64	9.06
Snags >12" & <18"	3.82	4.72	7.02	6.04	6.60	6.33	6.51	4.72	7.02	6.60	7.02
Snags >18"	0.73	0.83	2.04	0.82	2.03	0.82	2.03	0.83	2.04	2.03	2.04
CWD >3"	6.29	8.40	13.89	4.23	10.06	3.42	9.32	8.40	13.89	10.06	13.89
Logs	2.21	3.51	8.35	2.44	7.54	2.26	7.42	3.51	8.35	7.54	8.35
CWD >12"	0.74	1.17	2.78	0.81	2.51	0.75	2.47	1.17	2.78	2.51	2.78
Understory Index	22	19	14	20	15	21	15	19	14	15	14
Mint Spring											
Acres	585	585	585	585	585	585	585	585	585	585	585
Snags >12"	4.27	5.33	8.87	6.65	8.43	7.00	8.32	5.33	8.87	8.43	8.87
Snags >12" & <18"	3.64	4.61	6.99	5.94	6.56	6.29	6.45	4.61	6.99	6.56	6.99
Snags >18"	0.63	0.73	1.88	0.71	1.87	0.71	1.87	0.73	1.88	1.87	1.88
CWD >3"	6.16	8.11	13.30	4.39	9.93	3.32	8.95	8.11	13.30	9.93	13.30
Logs	2.35	3.54	8.15	2.53	7.39	2.27	7.20	3.54	8.15	7.39	8.15
CWD >12"	0.78	1.18	2.72	0.84	2.46	0.76	2.40	1.18	2.72	2.46	2.72
Understory Index	25	21	16	23	16	24	16	21	16	16	16
Moore Well/Rock Dike											
Acres	567	567	567	567	567	567	567	567	567	567	567
Snags >12"	3.77	4.97	8.44	6.24	8.06	6.47	7.99	4.97	8.44	8.06	8.44
Snags >12" & <18"	3.02	4.11	6.34	5.37	5.97	5.60	5.90	4.11	6.34	5.97	6.34
Snags >18"	0.75	0.86	2.09	0.87	2.10	0.87	2.10	0.86	2.09	2.10	2.09
CWD >3"	6.49	8.36	13.47	4.30	9.87	3.50	9.15	8.36	13.47	9.87	13.47
Logs	4.22	5.33	9.85	3.54	8.56	3.27	8.35	5.33	9.85	8.56	9.85
CWD >12"	1.41	1.78	3.28	1.18	2.85	1.09	2.78	1.78	3.28	2.85	3.28
Understory Index	26	22	17	24	17	25	17	22	17	17	17

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Mustang											
Acres	659	659	659	659	659	659	659	659	659	659	659
Snags >12"	2.84	3.74	7.68	4.81	7.39	5.09	7.30	3.74	7.68	7.39	7.68
Snags >12" & <18"	2.31	3.16	5.96	4.22	5.68	4.50	5.59	3.16	5.96	5.68	5.96
Snags >18"	0.53	0.58	1.72	0.59	1.72	0.59	1.72	0.58	1.72	1.72	1.72
CWD >3"	5.89	7.32	11.68	3.73	8.57	2.99	7.92	7.32	11.68	8.57	11.68
Logs	3.80	4.68	8.66	3.07	7.50	2.84	7.34	4.68	8.66	7.50	8.66
CWD >12"	1.27	1.56	2.89	1.02	2.50	0.95	2.45	1.56	2.89	2.50	2.89
Understory Index	46	38	26	40	27	41	27	38	26	27	26
Nestor											
Acres	436	436	436	436	436	436	436	436	436	436	436
Snags >12"	4.53	5.50	8.99	6.84	8.55	7.11	8.47	5.50	8.99	8.55	8.99
Snags >12" & <18"	3.83	4.72	7.00	6.06	6.57	6.34	6.48	4.72	7.00	6.57	7.00
Snags >18"	0.70	0.79	1.99	0.78	1.98	0.77	1.98	0.79	1.99	1.98	1.99
CWD >3"	6.17	8.21	13.57	4.20	9.94	3.34	9.15	8.21	13.57	9.94	13.57
Logs	2.24	3.53	8.35	2.45	7.56	2.27	7.42	3.53	8.35	7.56	8.35
CWD >12"	0.75	1.18	2.78	0.82	2.52	0.76	2.47	1.18	2.78	2.52	2.78
Understory Index	24	21	16	22	16	23	16	21	16	16	16
O'Leary Peak											
Acres	461	461	461	461	461	461	461	461	461	461	461
Snags >12"	2.70	3.47	7.33	4.68	7.02	4.68	7.02	3.47	7.33	7.02	7.33
Snags >12" & <18"	2.20	2.91	5.51	4.11	5.21	4.11	5.21	2.91	5.51	5.21	5.51
Snags >18"	0.50	0.56	1.82	0.57	1.82	0.57	1.82	0.56	1.82	1.82	1.82
CWD >3"	5.80	6.96	10.90	2.81	7.48	2.81	7.48	6.96	10.90	7.48	10.90
Logs	4.62	5.47	9.52	3.27	7.92	3.27	7.92	5.47	9.52	7.92	9.52
CWD >12"	1.54	1.82	3.17	1.09	2.64	1.09	2.64	1.82	3.17	2.64	3.17
Understory Index	78	62	37	67	39	67	39	62	37	39	37

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Orion Spring											
Acres	250	250	250	250	250	250	250	250	250	250	250
Snags >12"	3.52	3.94	6.76	5.26	6.39	5.26	6.39	3.94	6.76	6.39	6.76
Snags >12" & <18"	3.00	3.40	5.33	4.74	4.98	4.74	4.98	3.40	5.33	4.98	5.33
Snags >18"	0.52	0.54	1.43	0.53	1.42	0.53	1.42	0.54	1.43	1.42	1.43
CWD >3"	4.89	6.32	10.25	2.51	6.91	2.51	6.91	6.32	10.25	6.91	10.25
Logs	1.35	2.30	5.71	1.50	5.16	1.50	5.16	2.30	5.71	5.16	5.71
CWD >12"	0.45	0.77	1.90	0.50	1.72	0.50	1.72	0.77	1.90	1.72	1.90
Understory Index	44	36	23	40	24	40	24	36	23	24	23
Pierce Tank											
Acres	374	374	374	374	374	374	374	374	374	374	374
Snags >12"	4.09	5.34	8.97	7.06	8.36	7.19	8.31	5.34	8.97	8.36	8.97
Snags >12" & <18"	3.58	4.73	7.29	6.46	6.69	6.59	6.65	4.73	7.29	6.69	7.29
Snags >18"	0.51	0.61	1.68	0.60	1.67	0.60	1.67	0.61	1.68	1.67	1.68
CWD >3"	6.09	8.02	13.17	3.60	9.15	3.31	8.89	8.02	13.17	9.15	13.17
Logs	2.13	3.26	7.68	2.16	6.89	2.11	6.85	3.26	7.68	6.89	7.68
CWD >12"	0.71	1.09	2.56	0.72	2.30	0.70	2.28	1.09	2.56	2.30	2.56
Understory Index	24	21	15	23	16	23	16	21	15	16	15
Powerline Tank											
Acres	351	351	351	351	351	351	351	351	351	351	351
Snags >12"	2.37	2.76	5.90	3.74	5.68	3.98	5.61	2.76	5.90	5.68	5.90
Snags >12" & <18"	1.89	2.31	4.84	3.31	4.62	3.54	4.55	2.31	4.84	4.62	4.84
Snags >18"	0.47	0.44	1.06	0.44	1.05	0.44	1.06	0.44	1.06	1.05	1.06
CWD >3"	4.74	6.04	9.69	3.12	7.04	2.44	6.40	6.04	9.69	7.04	9.69
Logs	1.17	1.83	4.24	1.32	3.94	1.18	3.85	1.83	4.24	3.94	4.24
CWD >12"	0.39	0.61	1.41	0.44	1.31	0.39	1.28	0.61	1.41	1.31	1.41
Understory Index	43	35	23	38	24	39	24	35	23	24	23

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Pumphouse Wash											
Acres	588	588	588	588	588	588	588	588	588	588	588
Snags >12"	3.95	5.35	8.88	6.75	8.40	7.04	8.31	5.35	8.88	8.40	8.88
Snags >12" & <18"	3.31	4.57	6.96	5.98	6.50	6.27	6.40	4.57	6.96	6.50	6.96
Snags >18"	0.64	0.78	1.91	0.77	1.91	0.77	1.91	0.78	1.91	1.91	1.91
CWD >3"	6.41	8.36	13.59	4.33	9.92	3.51	9.19	8.36	13.59	9.92	13.59
Logs	3.30	4.43	8.92	3.15	7.97	2.78	7.69	4.43	8.92	7.97	8.92
CWD >12"	1.10	1.48	2.97	1.05	2.66	0.93	2.56	1.48	2.97	2.66	2.97
Understory Index	62	56	47	59	48	60	48	56	47	48	47
Racetrack Tank											
Acres	659	659	659	659	659	659	659	659	659	659	659
Snags >12"	3.01	3.82	7.44	4.91	7.14	5.16	7.06	3.82	7.44	7.14	7.44
Snags >12" & <18"	2.38	3.16	5.94	4.26	5.64	4.51	5.56	3.16	5.94	5.64	5.94
Snags >18"	0.63	0.65	1.50	0.65	1.50	0.64	1.50	0.65	1.50	1.50	1.50
CWD >3"	5.61	7.38	12.09	3.72	8.67	3.03	8.02	7.38	12.09	8.67	12.09
Logs	1.87	2.77	6.24	1.90	5.61	1.77	5.53	2.77	6.24	5.61	6.24
CWD >12"	0.62	0.92	2.08	0.63	1.87	0.59	1.84	0.92	2.08	1.87	2.08
Understory Index	28	24	17	26	18	26	18	24	17	18	17
Rattlesnake											
Acres	592	592	592	592	592	592	592	592	592	592	592
Snags >12"	3.84	4.79	8.55	6.08	8.17	6.17	8.15	4.79	8.55	8.17	8.55
Snags >12" & <18"	3.17	4.02	6.38	5.30	6.01	5.40	5.98	4.02	6.38	6.01	6.38
Snags >18"	0.67	0.77	2.17	0.78	2.16	0.78	2.16	0.77	2.17	2.16	2.17
CWD >3"	6.31	7.98	12.87	3.57	9.03	3.23	8.75	7.98	12.87	9.03	12.87
Logs	4.06	5.22	10.10	3.38	8.72	3.19	8.59	5.22	10.10	8.72	10.10
CWD >12"	1.35	1.74	3.37	1.13	2.91	1.06	2.86	1.74	3.37	2.91	3.37
Understory Index	38	31	22	34	23	34	23	31	22	23	22

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Roundup											
Acres	554	554	554	554	554	554	554	554	554	554	554
Snags >12"	3.72	4.73	8.49	5.93	8.13	6.35	7.99	4.73	8.49	8.13	8.49
Snags >12" & <18"	3.15	4.08	6.65	5.28	6.29	5.70	6.15	4.08	6.65	6.29	6.65
Snags >18"	0.57	0.65	1.84	0.65	1.84	0.65	1.84	0.65	1.84	1.84	1.84
CWD >3"	6.03	7.73	12.54	4.18	9.44	3.15	8.50	7.73	12.54	9.44	12.54
Logs	2.99	4.07	8.54	2.79	7.62	2.54	7.45	4.07	8.54	7.62	8.54
CWD >12"	1.00	1.36	2.85	0.93	2.54	0.85	2.48	1.36	2.85	2.54	2.85
Understory Index	34	29	21	30	21	31	21	29	21	21	21
Spruce Tank											
Acres	459	459	459	459	459	459	459	459	459	459	459
Snags >12"	3.61	4.42	7.93	5.84	7.49	6.01	7.45	4.42	7.93	7.49	7.93
Snags >12" & <18"	3.10	3.87	6.38	5.30	5.95	5.46	5.91	3.87	6.38	5.95	6.38
Snags >18"	0.52	0.55	1.55	0.54	1.54	0.54	1.54	0.55	1.55	1.54	1.55
CWD >3"	5.68	7.32	11.85	3.40	8.40	2.97	7.99	7.32	11.85	8.40	11.85
Logs	2.22	3.22	7.14	2.10	6.36	2.04	6.33	3.22	7.14	6.36	7.14
CWD >12"	0.74	1.07	2.38	0.70	2.12	0.68	2.11	1.07	2.38	2.12	2.38
Understory Index	35	29	20	32	21	32	21	29	20	21	20
Sterling											
Acres	262	262	262	262	262	262	262	262	262	262	262
Snags >12"	2.82	4.57	6.89	5.91	6.46	5.91	6.46	4.57	6.89	6.46	6.89
Snags >12" & <18"	1.61	3.25	4.70	4.56	4.26	4.56	4.26	3.25	4.70	4.26	4.70
Snags >18"	1.21	1.32	2.19	1.35	2.20	1.35	2.20	1.32	2.19	2.20	2.19
CWD >3"	7.83	9.41	13.78	4.39	9.52	4.39	9.52	9.41	13.78	9.52	13.78
Logs	10.40	11.12	14.41	6.60	11.08	6.60	11.08	11.12	14.41	11.08	14.41
CWD >12"	3.47	3.71	4.80	2.20	3.69	2.20	3.69	3.71	4.80	3.69	4.80
Understory Index	37	34	26	37	27	37	27	34	26	27	26

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Stock Tank											
Acres	108	108	108	108	108	108	108	108	108	108	108
Snags >12"	1.67	1.80	3.72	2.36	3.65	2.57	3.60	1.80	3.72	3.65	3.72
Snags >12" & <18"	1.24	1.31	2.47	1.88	2.41	2.09	2.35	1.31	2.47	2.41	2.47
Snags >18"	0.44	0.49	1.25	0.48	1.25	0.48	1.24	0.49	1.25	1.25	1.25
CWD >3"	3.75	4.31	6.22	2.28	4.63	1.58	4.04	4.31	6.22	4.63	6.22
Logs	0.41	0.93	2.93	0.71	2.87	0.62	2.82	0.93	2.93	2.87	2.93
CWD >12"	0.14	0.31	0.98	0.24	0.96	0.21	0.94	0.31	0.98	0.96	0.98
Understory Index	107	88	54	92	56	94	57	88	54	56	54
T Bird											
Acres	603	603	603	603	603	603	603	603	603	603	603
Snags >12"	3.50	4.51	8.40	5.94	7.94	6.29	7.83	4.51	8.40	7.94	8.40
Snags >12" & <18"	2.96	3.96	7.01	5.40	6.56	5.75	6.45	3.96	7.01	6.56	7.01
Snags >18"	0.54	0.55	1.38	0.54	1.38	0.54	1.38	0.55	1.38	1.38	1.38
CWD >3"	5.99	7.92	12.96	4.14	9.42	3.28	8.61	7.92	12.96	9.42	12.96
Logs	1.61	2.57	6.29	1.83	5.80	1.68	5.71	2.57	6.29	5.80	6.29
CWD >12"	0.54	0.86	2.10	0.61	1.93	0.56	1.90	0.86	2.10	1.93	2.10
Understory Index	23	20	15	22	15	22	15	20	15	15	15
Two Holes											
Acres	607	607	607	607	607	607	607	607	607	607	607
Snags >12"	4.33	5.25	8.60	6.47	8.21	6.78	8.11	5.25	8.60	8.21	8.60
Snags >12" & <18"	3.65	4.48	6.68	5.71	6.29	6.03	6.19	4.48	6.68	6.29	6.68
Snags >18"	0.68	0.77	1.92	0.76	1.92	0.75	1.92	0.77	1.92	1.92	1.92
CWD >3"	5.95	7.91	13.10	4.14	9.68	3.21	8.83	7.91	13.10	9.68	13.10
Logs	2.08	3.33	7.95	2.35	7.23	2.15	7.08	3.33	7.95	7.23	7.95
CWD >12"	0.69	1.11	2.65	0.78	2.41	0.72	2.36	1.11	2.65	2.41	2.65
Understory Index	26	22	16	24	17	24	17	22	16	17	16

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Upper West Fork											
Acres	276	276	276	276	276	276	276	276	276	276	276
Snags >12"	4.95	6.11	9.47	7.85	8.87	7.85	8.87	6.11	9.47	8.87	9.47
Snags >12" & <18"	4.17	5.21	7.29	6.97	6.71	6.97	6.71	5.21	7.29	6.71	7.29
Snags >18"	0.78	0.90	2.18	0.89	2.17	0.89	2.17	0.90	2.18	2.17	2.18
CWD >3"	6.68	8.82	14.41	3.65	9.75	3.65	9.75	8.82	14.41	9.75	14.41
Logs	3.18	4.55	9.70	2.88	8.46	2.88	8.46	4.55	9.70	8.46	9.70
CWD >12"	1.06	1.52	3.23	0.96	2.82	0.96	2.82	1.52	3.23	2.82	3.23
Understory Index	79	73	64	77	65	77	65	73	64	65	64
Volunteer											
Acres	430	430	430	430	430	430	430	430	430	430	430
Snags >12"	3.96	5.19	8.49	6.41	8.07	6.65	7.99	5.19	8.49	8.07	8.49
Snags >12" & <18"	3.21	4.23	6.30	5.47	5.89	5.71	5.82	4.23	6.30	5.89	6.30
Snags >18"	0.75	0.95	2.19	0.94	2.17	0.94	2.17	0.95	2.19	2.17	2.19
CWD >3"	6.43	8.21	13.14	4.38	9.67	3.41	8.82	8.21	13.14	9.67	13.14
Logs	3.81	4.93	9.51	3.60	8.45	3.06	8.03	4.93	9.51	8.45	9.51
CWD >12"	1.27	1.64	3.17	1.20	2.82	1.02	2.68	1.64	3.17	2.82	3.17
Understory Index	86	78	66	82	67	83	67	78	66	67	66
Walnut 33											
Acres	113	113	113	113	113	113	113	113	113	113	113
Snags >12"	2.85	3.54	7.05	4.39	6.82	4.64	6.75	3.54	7.05	6.82	7.05
Snags >12" & <18"	2.15	2.84	5.62	3.71	5.38	3.96	5.31	2.84	5.62	5.38	5.62
Snags >18"	0.70	0.70	1.43	0.68	1.44	0.68	1.44	0.70	1.43	1.44	1.43
CWD >3"	5.25	7.06	11.74	3.83	8.66	2.90	7.77	7.06	11.74	8.66	11.74
Logs	1.32	2.25	5.52	1.64	5.08	1.47	4.95	2.25	5.52	5.08	5.52
CWD >12"	0.44	0.75	1.84	0.55	1.69	0.49	1.65	0.75	1.84	1.69	1.84
Understory Index	120	109	94	114	95	115	96	109	94	95	94

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Weatherford2											
Acres	147	147	147	147	147	147	147	147	147	147	147
Snags >12"	4.65	5.49	8.69	6.86	8.28	6.86	8.28	5.49	8.69	8.28	8.69
Snags >12" & <18"	3.85	4.56	6.41	5.94	6.00	5.94	6.00	4.56	6.41	6.00	6.41
Snags >18"	0.80	0.92	2.28	0.92	2.27	0.92	2.27	0.92	2.28	2.27	2.28
CWD >3"	6.16	8.14	13.42	3.28	9.05	3.28	9.05	8.14	13.42	9.05	13.42
Logs	2.68	4.02	9.06	2.55	7.92	2.55	7.92	4.02	9.06	7.92	9.06
CWD >12"	0.89	1.34	3.02	0.85	2.64	0.85	2.64	1.34	3.02	2.64	3.02
Understory Index	26	22	16	24	17	24	17	22	16	17	16
Weimer Springs											
Acres	91	91	91	91	91	91	91	91	91	91	91
Snags >12"	4.95	6.16	9.94	8.32	9.17	8.32	9.17	6.16	9.94	9.17	9.94
Snags >12" & <18"	4.42	5.58	8.28	7.76	7.52	7.76	7.52	5.58	8.28	7.52	8.28
Snags >18"	0.52	0.57	1.67	0.55	1.66	0.55	1.66	0.57	1.67	1.66	1.67
CWD >3"	6.36	8.52	14.09	3.50	9.53	3.50	9.53	8.52	14.09	9.53	14.09
Logs	1.64	2.96	7.87	1.97	7.21	1.97	7.21	2.96	7.87	7.21	7.87
CWD >12"	0.55	0.99	2.62	0.66	2.40	0.66	2.40	0.99	2.62	2.40	2.62
Understory Index	22	19	14	21	15	21	15	19	14	15	14
Weir											
Acres	377	377	377	377	377	377	377	377	377	377	377
Snags >12"	2.62	3.47	7.45	4.80	7.10	4.88	7.07	3.47	7.45	7.10	7.45
Snags >12" & <18"	2.11	2.94	5.94	4.26	5.58	4.34	5.56	2.94	5.94	5.58	5.94
Snags >18"	0.51	0.53	1.51	0.54	1.51	0.54	1.51	0.53	1.51	1.51	1.51
CWD >3"	5.83	7.28	11.58	3.30	8.07	2.99	7.78	7.28	11.58	8.07	11.58
Logs	3.29	4.08	7.63	2.56	6.57	2.48	6.51	4.08	7.63	6.57	7.63
CWD >12"	1.10	1.36	2.54	0.85	2.19	0.83	2.17	1.36	2.54	2.19	2.54
Understory Index	41	34	23	37	24	37	24	34	23	24	23

PAC Name and Forest Attributes	Existing Conditions 2010	Alt A 2020	Alt A 2050	Alt B 2020	Alt B 2050	Alt C 2020	Alt C 2050	Alt D 2020	Alt D 2050	Alt E 2020	Alt E 2050
Woods											
Acres	853	853	853	853	853	853	853	853	853	853	853
Snags >12"	3.56	4.36	7.71	5.65	7.29	5.84	7.23	4.36	7.71	7.29	7.71
Snags >12" & <18"	2.75	3.51	5.99	4.81	5.59	5.00	5.53	3.51	5.99	5.59	5.99
Snags >18"	0.81	0.85	1.71	0.84	1.70	0.84	1.70	0.85	1.71	1.70	1.71
CWD >3"	6.42	8.12	12.69	4.01	8.96	3.41	8.41	8.12	12.69	8.96	12.69
Logs	3.77	4.70	8.33	3.06	7.11	2.90	6.99	4.70	8.33	7.11	8.33
CWD >12"	1.26	1.57	2.78	1.02	2.37	0.97	2.33	1.57	2.78	2.37	2.78
Understory Index	30	25	18	28	19	28	19	25	18	19	18

Appendix 13. Summary of Habitat Changes by Alternative in Mexican Spotted Owl Restricted Habitat

Threshold Habitat 2
Forest Attributes by Subunit 2
Prey Habitat Metrics by Subunit 4
Target Habitat 6
Forest Attributes by Subunit 6
Prey Habitat Metrics by Subunit 10
Restricted "Other" Habitat 13
Forest Attributes by Subunit 13
Prey Habitat Metrics by Subunit 19

Table 1. Changes in Forest Structure Attributes in MSO Threshold Habitat Components by Alternative and Year 2
Table 2. Prey Habitat Changes in MSO Threshold Habitat by Alternative and Year 4
Table 3. Changes in Forest Structure Attributes in MSO Target Habitat Components by Alternative and Year 6
Table 4. Prey Habitat Changes in MSO Target Habitat by Alternative and Year 10
Table 5. Changes in Forest Structure Attributes in MSO Restricted "Other" Habitat Components by Alternative and Year 13
Table 6. Prey Habitat Changes in MSO Restricted "Other" Habitat by Alternative and Year 19

Threshold Habitat

Forest Attributes by Subunit

Table 1. Changes in Forest Structure Attributes in MSO Threshold Habitat Components by Alternative and Year

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
		Yr 2020	Yr 2050	Yr 2020	Yr 2050	Yr 2020	Yr 2050	Yr 2020	Yr 2050	Yr 2020	Yr 2050
Subunit 1-3											
Acres	414										
% of SDI 12-18" DBH	24	23	27	25	25	22	24	25	25	25	25
% of SDI 18-24" DBH	32	34	33	38	35	38	33	37	34	38	35
% of SDI >24" DBH	2	3	7	3	8	3	9	3	8	3	8
% of Max SDI	96	97	100	89	96	85	95	89	97	89	96
TPA >18"	35	38	40	38	41	37	38	38	40	38	41
Ponderosa Pine BA	111	114	123	95	107	87	100	98	109	95	107
Gambel Oak BA	54	54	54	56	56	56	58	56	56	56	56
All BA	186	193	215	175	205	167	200	178	207	175	205
% Oak BA	29	28	25	32	28	33	29	31	27	32	28
Subunit 1-5											
Acres	459										
% of SDI 12-18" DBH	25	25	26	28	21	19	19	28	21	28	21
% of SDI 18-24" DBH	17	19	23	27	32	27	26	26	32	27	32
% of SDI >24" DBH	3	3	5	4	8	5	9	4	8	4	8
% of Max SDI	106	105	104	80	89	77	86	81	90	80	89
TPA >18"	21	25	31	26	37	24	30	26	38	26	37
Ponderosa Pine BA	153	155	161	97	114	85	105	99	116	97	114
Gambel Oak BA	63	62	62	64	68	64	69	63	68	64	68
All BA	220	224	235	167	198	156	190	169	199	167	198
% Oak BA	28	28	26	38	34	41	36	37	34	38	34

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
		Yr 2020	Yr 2050	Yr 2020	Yr 2050	Yr 2020	Yr 2050	Yr 2020	Yr 2050	Yr 2020	Yr 2050
Subunit 3-1											
Acres	311										
% of SDI 12-18" DBH	25	23	17	20	15	18	15	20	15	20	15
% of SDI 18-24" DBH	19	21	25	23	25	23	22	23	25	23	25
% of SDI >24" DBH	9	9	12	10	14	11	15	10	13	10	14
% of Max SDI	100	101	102	93	99	91	99	94	99	93	99
TPA >18"	23	26	35	26	34	25	31	26	34	26	34
Ponderosa Pine BA	98	100	103	81	87	74	81	83	88	81	87
Gambel Oak BA	67	68	75	70	79	70	80	69	77	70	79
All BA	182	189	208	173	201	166	197	175	201	173	201
% Oak BA	37	36	36	40	39	42	41	39	38	40	39
Subunit 3-2											
Acres	244										
% of SDI 12-18" DBH	29	26	17	22	13	19	13	22	12	22	13
% of SDI 18-24" DBH	19	22	29	25	29	25	25	25	29	25	29
% of SDI >24" DBH	10	11	14	12	16	13	17	12	16	12	16
% of Max SDI	95	95	95	85	92	83	91	86	92	85	92
TPA >18"	24	28	40	28	39	27	35	28	39	28	39
Ponderosa Pine BA	116	119	120	95	101	87	94	96	102	95	101
Gambel Oak BA	50	51	54	52	58	53	60	52	57	52	58
All BA	179	186	203	166	196	159	191	167	195	166	196
% Oak BA	28	27	26	31	30	33	31	31	29	31	30
Subunit 3-3											
Acres	410										
% of SDI 12-18" DBH	24	23	20	21	18	19	18	21	18	21	18
% of SDI 18-24" DBH	19	21	24	23	24	23	23	23	24	23	24
% of SDI >24" DBH	8	8	11	9	12	9	12	9	12	9	12
% of Max SDI	100	101	102	93	99	91	98	94	99	93	99
TPA >18"	23	25	33	25	33	25	31	25	33	25	33

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
		Yr 2020	Yr 2050	Yr 2020	Yr 2050	Yr 2020	Yr 2050	Yr 2020	Yr 2050	Yr 2020	Yr 2050
Ponderosa Pine BA	103	105	108	85	91	79	86	87	92	85	91
Gambel Oak BA	67	68	74	69	77	70	79	69	76	69	77
All BA	187	193	212	175	203	170	200	177	203	175	203
% Oak BA	36	35	35	39	38	41	39	39	37	39	38
Subunit 3-5											
Acres	139										
% of SDI 12-18" DBH	29	28	26	30	22	23	21	31	22	30	22
% of SDI 18-24" DBH	22	25	30	31	35	31	30	30	35	31	35
% of SDI >24" DBH	4	4	8	6	10	6	12	6	11	6	10
% of Max SDI	97	97	96	80	88	76	85	81	89	80	88
TPA >18"	26	29	38	31	41	28	35	30	42	31	41
Ponderosa Pine BA	136	139	146	100	116	88	106	102	118	100	116
Gambel Oak BA	54	54	55	55	60	56	61	55	59	55	60
All BA	198	203	217	166	195	154	187	168	196	166	195
% Oak BA	27	26	25	33	31	36	33	33	30	33	31

Prey Habitat Metrics by Subunit

Table 2. Prey Habitat Changes in MSO Threshold Habitat by Alternative and Year

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 1-3											
Acres	414										
Snags >12"	1.82	3.17	5.92	2.92	4.84	2.47	4.09	2.23	4.84	2.92	4.84
Snags >12" and <18"	1.59	2.62	4.45	2.45	3.50	1.96	2.94	1.78	3.51	2.45	3.50
Snags >18"	0.23	0.56	1.47	0.48	1.33	0.51	1.15	0.45	1.32	0.48	1.33
CWD >3"	8.38	9.27	12.70	4.07	7.08	4.29	6.78	9.49	11.64	4.09	7.10
Logs	10.66	10.85	12.76	6.47	8.36	6.81	8.13	10.82	12.02	6.49	8.37

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Understory Index	18	16	11	22	13	26	14	21	12	22	13
Subunit 1-5											
Acres	459										
Snags >12"	2.97	3.68	5.21	4.13	3.15	3.10	2.55	2.76	3.49	4.13	3.15
Snags >12" and <18"	2.32	3.22	4.17	3.73	2.21	2.70	1.73	2.34	2.52	3.73	2.21
Snags >18"	0.65	0.47	1.04	0.40	0.94	0.41	0.82	0.42	0.97	0.40	0.94
CWD >3"	5.92	8.39	13.10	3.58	6.82	3.97	6.90	9.63	12.04	3.58	6.82
Logs	2.07	2.95	5.53	1.98	4.16	2.65	4.19	3.08	4.94	1.98	4.16
Understory Index	10	9	7	26	14	32	17	25	14	26	14
Subunit 3-1											
Acres	311										
Snags >12"	3.59	4.90	6.44	4.14	4.72	3.95	4.26	3.66	4.96	4.14	4.72
Snags >12" and <18"	2.89	3.80	4.20	3.13	2.44	2.96	2.33	2.64	2.61	3.13	2.44
Snags >18"	0.70	1.10	2.24	1.01	2.28	0.99	1.93	1.02	2.35	1.01	2.28
CWD >3"	3.74	5.96	11.10	2.45	6.76	2.55	6.55	6.31	10.25	2.45	6.76
Logs	0.93	2.37	7.50	1.77	6.00	2.05	5.86	2.74	6.89	1.77	6.00
Understory Index	20	17	12	24	14	27	15	23	14	24	14
Subunit 3-2											
Acres	244										
Snags >12"	4.01	5.59	7.28	4.44	4.96	4.37	4.42	4.10	5.23	244	244
Snags >12" and <18"	3.33	4.46	4.59	3.44	2.27	3.37	2.14	3.09	2.41	4.44	4.96
Snags >18"	0.68	1.13	2.69	1.01	2.69	1.00	2.28	1.01	2.81	3.44	2.27
CWD >3"	4.31	6.54	11.97	2.69	7.04	2.84	6.92	6.44	10.34	1.01	2.69
Logs	1.26	2.87	8.69	2.16	6.70	2.51	6.63	3.26	7.71	2.69	7.04
Understory Index	21	18	13	26	15	30	17	26	15	0.72	2.23
Subunit 3-3											
Acres	410										
Snags >12"	3.39	4.43	6.08	4.33	4.81	4.04	4.41	3.77	4.98	4.33	4.81
Snags >12" and <18"	2.61	3.40	4.11	3.33	2.79	3.06	2.61	2.77	2.94	3.33	2.79

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Snags >18"	0.78	1.03	1.97	0.99	2.02	0.98	1.80	1.00	2.04	0.99	2.02
CWD >3"	4.37	6.53	11.37	2.72	7.06	2.82	6.87	6.39	10.35	2.72	7.06
Logs	1.88	3.15	7.55	2.18	6.18	2.40	6.02	3.26	7.12	2.18	6.18
Understory Index	18	16	11	22	13	24	14	21	13	22	13
Subunit 3-5											
Acres	139										
Snags >12"	4.02	5.22	6.76	4.71	4.02	3.91	3.41	3.59	4.31	4.71	4.02
Snags >12" and <18"	3.57	4.63	5.32	4.27	2.73	3.46	2.41	3.14	2.98	4.27	2.73
Snags >18"	0.45	0.59	1.44	0.45	1.29	0.45	1.00	0.45	1.33	0.45	1.29
CWD >3"	6.51	8.54	13.46	3.59	6.95	3.93	6.79	9.24	11.82	3.59	6.95
Logs	4.12	5.07	8.79	3.19	5.93	3.81	5.78	5.13	7.51	3.19	5.93
Understory Index	18	17	13	33	20	40	23	32	20	33	20

Target Habitat

Forest Attributes by Subunit

Table 3. Changes in Forest Structure Attributes in MSO Target Habitat Components by Alternative and Year

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 1-1											
Acres	105										
% of SDI 12-18" DBH	36	35	30	35	24	27	22	35	25	35	24
% of SDI 18-24" DBH	12	15	23	19	27	20	21	19	26	19	27
% of SDI >24" DBH	7	7	9	9	11	10	13	8	11	9	11
% of Max SDI	85	86	86	71	78	63	75	72	79	71	78
TPA >18"	14	18	29	19	31	17	24	19	30	19	31
Ponderosa Pine BA	135	140	144	106	116	85	98	110	119	106	116

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Gambel Oak BA	27	28	33	29	36	29	41	29	36	29	36
All BA	167	175	192	144	173	124	161	147	175	144	173
% Oak BA	16	16	17	20	21	24	25	20	20	20	21
Subunit 1-3											
Acres	1,967										
% of SDI 12-18" DBH	31	30	31	31	25	26	23	32	26	31	25
% of SDI 18-24" DBH	11	13	11	16	23	17	19	16	23	16	23
% of SDI >24" DBH	7	7	7	9	11	10	12	9	11	9	11
% of Max SDI	78	80	78	67	75	63	74	69	77	67	75
TPA >18"	12	15	12	16	25	15	21	16	25	16	25
Ponderosa Pine BA	116	121	116	93	105	81	94	97	108	93	105
Gambel Oak BA	30	32	30	33	42	33	45	33	42	33	42
All BA	151	160	151	134	165	122	157	137	167	134	165
% Oak BA	19	19	19	24	25	26	28	23	25	24	25
Subunit 1-4											
Acres	118										
% of SDI 12-18" DBH	19	19	18	14	11	11	10	14	12	14	11
% of SDI 18-24" DBH	28	28	24	33	26	34	24	33	26	33	26
% of SDI >24" DBH	18	19	24	22	28	24	30	22	28	22	28
% of Max SDI	70	72	78	62	72	59	70	63	73	62	72
TPA >18"	32	34	35	34	36	32	33	34	36	34	36
Ponderosa Pine BA	119	122	127	98	109	90	101	100	110	98	109
Gambel Oak BA	21	23	31	24	34	24	35	24	34	24	34
All BA	154	162	185	139	171	131	165	140	172	139	171
% Oak BA	14	14	17	17	20	18	22	17	20	17	20
Subunit 1-5											
Acres	1,729										
% of SDI 12-18" DBH	29	29	28	29	24	23	21	30	24	29	24
% of SDI 18-24" DBH	12	14	19	17	22	17	18	16	22	17	22

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
% of SDI >24" DBH	7	7	9	9	11	10	12	9	11	9	11
% of Max SDI	85	87	87	73	81	68	80	74	82	73	81
TPA >18"	14	16	24	17	26	16	22	17	26	17	26
Ponderosa Pine BA	120	124	128	95	105	81	93	98	108	95	105
Gambel Oak BA	35	37	43	38	48	38	51	38	47	38	48
All BA	161	170	188	142	174	129	166	146	175	142	174
% Oak BA	22	22	23	27	28	29	31	26	27	27	28
Subunit 3-1											
Acres	0.10									130	
% of SDI 12-18" DBH	37	35	23	35	22	33	21	35	22	18	12
% of SDI 18-24" DBH	12	15	21	16	21	16	20	16	21	29	19
% of SDI >24" DBH	2	2	5	2	6	2	7	2	6	17	23
% of Max SDI	86	89	92	86	92	84	92	87	92	58	71
TPA >18"	10	14	24	14	24	14	24	14	24	23	25
Ponderosa Pine BA	82	87	91	77	84	73	80	79	86	72	78
Gambel Oak BA	50	49	51	50	54	51	56	50	53	29	44
All BA	144	157	186	149	184	145	182	151	183	108	145
% Oak BA	35	31	27	34	30	35	31	33	29	27	31
Subunit 3-2											
Acres	676										
% of SDI 12-18" DBH	26	25	21	25	21	23	19	25	21	25	21
% of SDI 18-24" DBH	16	17	17	18	17	18	16	18	17	18	17
% of SDI >24" DBH	7	8	12	9	13	9	13	9	13	9	13
% of Max SDI	73	77	82	73	82	71	81	74	82	73	82
TPA >18"	13	15	21	15	21	15	20	15	21	15	21
Ponderosa Pine BA	84	89	95	79	88	74	84	81	90	79	88
Gambel Oak BA	37	38	45	39	48	39	49	39	47	39	48
All BA	132	144	172	135	170	131	168	137	170	135	170
% Oak BA	28	27	27	29	28	30	29	28	28	29	28

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 3-3											
Acres	1,240									1,674	
% of SDI 12-18" DBH	26	27	26	27	25	24	23	28	25	27	25
% of SDI 18-24" DBH	11	12	16	14	18	14	16	14	17	14	17
% of SDI >24" DBH	6	6	8	7	9	8	10	7	9	7	9
% of Max SDI	82	84	87	77	84	74	83	78	84	77	85
TPA >18"	11	14	20	14	21	13	19	14	21	13	20
Ponderosa Pine BA	102	107	113	88	100	81	93	91	102	85	97
Gambel Oak BA	38	39	44	40	48	40	50	40	47	42	49
All BA	152	163	185	146	178	139	174	149	179	146	179
% Oak BA	25	24	24	28	27	29	29	27	26	29	28
Subunit 3-4											
Acres	318										
% of SDI 12-18" DBH	25	25	26	27	23	21	21	27	24	27	23
% of SDI 18-24" DBH	12	13	17	16	20	17	17	16	20	16	20
% of SDI >24" DBH	8	8	10	10	12	11	12	10	11	10	12
% of Max SDI	85	87	88	74	83	71	82	75	84	74	83
TPA >18"	14	16	22	17	24	16	21	17	24	17	24
Ponderosa Pine BA	114	118	121	90	100	79	90	93	103	90	100
Gambel Oak BA	38	41	48	42	53	42	56	42	52	42	53
All BA	159	168	186	142	174	132	168	146	176	142	174
% Oak BA	24	24	26	30	30	32	33	29	30	30	30
Subunit 3-5											
Acres	561										
% of SDI 12-18" DBH	28	28	26	27	21	22	19	27	22	27	21
% of SDI 18-24" DBH	16	18	22	22	25	22	21	22	24	22	25
% of SDI >24" DBH	11	11	14	13	16	14	18	13	16	13	16
% of Max SDI	75	77	80	65	74	61	72	66	75	65	74
TPA >18"	19	21	28	21	29	20	25	21	29	21	29

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Ponderosa Pine BA	119	123	130	97	108	84	97	99	110	97	108
Gambel Oak BA	26	28	34	28	38	29	40	28	37	28	38
All BA	152	161	181	135	166	123	158	138	168	135	166
% Oak BA	17	17	19	21	23	23	25	20	22	21	23

Prey Habitat Metrics by Subunit

Table 4. Prey Habitat Changes in MSO Target Habitat by Alternative and Year

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 1-1											
Acres	105										
Snags >12"	3.77	4.85	8.19	5.23	6.31	4.29	4.75	3.82	6.56	5.23	6.31
Snags >12" and <18"	3.27	4.27	6.47	4.69	4.44	3.76	3.31	3.28	4.65	4.69	4.44
Snags >18"	0.50	0.58	1.72	0.54	1.87	0.53	1.44	0.54	1.91	0.54	1.87
CWD >3"	6.38	7.88	13.14	3.54	7.93	3.89	7.29	8.58	12.09	3.54	7.93
Logs	5.28	6.00	9.75	3.87	7.53	4.59	7.08	6.27	9.24	3.87	7.53
CWD >12"	1.76	2.00	3.25	1.29	2.51	1.53	2.36	2.09	3.08	1.29	2.51
Understory Index	112	103	89	142	105	180	118	137	103	142	105
Subunit 1-3											
Acres	1,967										
Snags >12"	2.92	3.74	6.77	4.27	5.37	3.64	4.38	3.01	5.67	4.27	5.37
Snags >12" and <18"	2.47	3.25	5.43	3.81	3.95	3.18	3.20	2.54	4.22	3.81	3.95
Snags >18"	0.45	0.49	1.34	0.46	1.42	0.46	1.19	0.47	1.44	0.46	1.42
CWD >3"	6.07	7.43	11.59	3.28	6.79	3.51	6.49	7.93	10.65	3.28	6.79
Logs	5.23	5.76	8.43	3.63	6.36	4.07	6.15	5.93	8.02	3.63	6.36
CWD >12"	1.74	1.92	2.81	1.21	2.12	1.36	2.05	1.98	2.67	1.21	2.12
Understory Index	35	29	20	47	27	59	31	44	26	47	27

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 1-4											
Acres	118										
Snags >12"	4.21	4.40	5.68	4.14	3.13	3.66	2.71	3.71	3.32	4.14	3.13
Snags >12" and <18"	2.80	2.81	3.19	2.64	1.03	2.18	0.80	2.21	1.14	2.64	1.03
Snags >18"	1.41	1.59	2.49	1.50	2.10	1.48	1.91	1.50	2.18	1.50	2.10
CWD >3"	5.69	7.02	10.89	2.92	5.95	3.05	5.74	7.58	9.82	2.92	5.95
Logs	3.30	4.44	9.06	3.00	6.84	3.33	6.63	4.83	8.25	3.00	6.84
CWD >12"	1.10	1.48	3.02	1.00	2.28	1.11	2.21	1.61	2.75	1.00	2.28
Understory Index	33	28	19	43	24	50	27	42	23	43	24
Subunit 1-5											
Acres	1,729										
Snags >12"	2.99	3.79	6.75	4.28	5.17	3.52	4.12	3.04	5.51	4.28	5.17
Snags >12" and <18"	2.46	3.23	5.41	3.75	3.78	3.00	2.96	2.51	4.09	3.75	3.78
Snags >18"	0.52	0.56	1.34	0.53	1.39	0.52	1.15	0.53	1.42	0.53	1.39
CWD >3"	5.96	7.56	12.11	3.25	6.90	3.50	6.56	8.09	10.99	3.25	6.90
Logs	4.02	4.68	7.63	3.00	5.86	3.48	5.62	4.84	7.17	3.00	5.86
CWD >12"	1.34	1.56	2.54	1.00	1.95	1.16	1.87	1.61	2.39	1.00	1.95
Understory Index	29	24	18	41	23	52	26	38	22	41	23
Subunit 3-1											
Acres	0.10									130	
Snags >12"	3.31	4.63	8.20	5.40	6.66	4.84	6.06	4.21	7.18	2.28	3.71
Snags >12" and <18"	2.86	4.14	6.46	4.92	4.96	4.37	4.52	3.73	5.48	1.40	1.41
Snags >18"	0.45	0.49	1.74	0.48	1.70	0.47	1.54	0.48	1.70	0.88	2.30
CWD >3"	3.90	5.76	11.89	2.26	8.30	2.34	8.14	5.86	11.43	1.17	3.91
Logs	0.87	1.95	6.90	1.35	6.24	1.53	5.97	2.01	6.69	0.69	3.75
CWD >12"	0.29	0.65	2.30	0.45	2.08	0.51	1.99	0.67	2.23	0.23	1.25
Understory Index	NA – Not basalt or limestone parent material									76	39

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 3-2											
Acres	676										
Snags >12"	2.35	2.89	5.27	3.67	4.42	3.32	3.92	2.84	4.75	3.67	4.43
Snags >12" and <18"	1.91	2.33	3.80	3.11	2.94	2.77	2.59	2.27	3.27	3.11	2.94
Snags >18"	0.45	0.56	1.47	0.56	1.48	0.55	1.33	0.56	1.48	0.56	1.48
CWD >3"	3.55	4.97	8.94	1.91	5.89	1.99	5.83	4.80	8.28	1.92	5.89
Logs	0.83	1.57	4.54	1.06	4.12	1.18	3.98	1.54	4.41	1.06	4.12
CWD >12"	0.28	0.52	1.51	0.35	1.37	0.39	1.33	0.51	1.47	0.35	1.37
Understory Index	54	44	27	52	28	55	29	50	28	52	28
Subunit 3-3											
Acres	1,240									1,674	
Snags >12"	2.62	3.16	5.83	4.05	4.70	3.55	4.05	3.02	5.03	4.03	4.61
Snags >12" and <18"	2.16	2.69	4.68	3.60	3.57	3.10	3.05	2.57	3.87	3.61	3.52
Snags >18"	0.46	0.47	1.15	0.45	1.13	0.44	1.00	0.45	1.15	0.42	1.09
CWD >3"	4.65	6.28	10.62	2.60	6.59	2.72	6.44	6.00	9.42	2.49	6.56
Logs	2.06	2.75	5.43	1.79	4.52	2.02	4.36	2.73	5.16	1.63	4.36
CWD >12"	0.69	0.92	1.81	0.60	1.51	0.67	1.45	0.91	1.72	0.54	1.45
Understory Index	37	31	21	41	23	46	25	39	23	41	23
Subunit 3-4											
Acres	318										
Snags >12"	2.69	3.35	6.09	3.86	4.59	3.18	3.77	2.72	4.97	4.59	6.09
Snags >12" and <18"	2.12	2.76	4.87	3.30	3.39	2.62	2.72	2.16	3.74	3.39	4.87
Snags >18"	0.57	0.59	1.21	0.56	1.19	0.55	1.05	0.56	1.23	1.19	1.21
CWD >3"	5.76	7.42	11.66	3.11	6.43	3.31	6.21	7.87	10.50	6.43	11.66
Logs	3.33	3.99	6.67	2.56	5.10	2.93	4.95	4.12	6.22	5.10	6.67
CWD >12"	1.11	1.33	2.22	0.85	1.70	0.98	1.65	1.37	2.07	1.70	2.22
Understory Index	30	25	18	41	22	49	25	38	22	22	18

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 3-5											
Acres	561										
Snags >12"	3.42	4.09	6.64	4.36	4.85	3.76	3.97	3.33	5.10	4.85	6.64
Snags >12" and <18"	2.68	3.26	4.89	3.58	3.15	2.99	2.52	2.55	3.36	3.15	4.89
Snags >18"	0.74	0.83	1.75	0.78	1.70	0.77	1.45	0.78	1.74	1.70	1.75
CWD >3"	6.02	7.34	11.49	3.21	6.67	3.42	6.36	7.88	10.53	6.67	11.49
Logs	4.89	5.60	8.97	3.60	6.77	4.03	6.53	5.86	8.43	6.77	8.97
CWD >12"	1.63	1.87	2.99	1.20	2.26	1.34	2.18	1.95	2.81	2.26	2.99
Understory Index	65	56	42	82	52	99	58	79	51	52	42

Restricted “Other” Habitat

Forest Attributes by Subunit

Table 5. Changes in Forest Structure Attributes in MSO Restricted “Other” Habitat Components by Alternative and Year

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 1-1											
Acres	1,193										
% of SDI 12-18" DBH	24	25	24	20	18	20	18	18	17	20	18
% of SDI 18-24" DBH	14	14	17	20	17	20	17	18	15	20	17
% of SDI >24" DBH	12	12	15	20	23	20	23	18	20	20	23
% of Max SDI	57	61	67	31	42	31	42	40	52	31	42
TPA >18"	11	13	19	11	15	11	15	11	15	11	15
Ponderosa Pine BA	93	100	113	50	67	50	67	56	74	50	67
Gambel Oak BA	17	20	27	13	22	13	22	18	29	13	22
All BA	116	127	152	69	99	69	99	80	115	69	99
% Oak BA	14	15	18	19	22	19	22	22	24	19	22

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 1-2											
Acres	588										
% of SDI 12-18" DBH	25	27	29	23	23	23	23	21	22	23	23
% of SDI 18-24" DBH	11	12	16	18	17	18	17	15	14	18	17
% of SDI >24" DBH	7	7	9	13	17	13	17	11	14	13	17
% of Max SDI	71	74	79	37	49	37	49	47	60	37	49
TPA >18"	10	13	19	10	15	10	15	11	15	10	15
Ponderosa Pine BA	104	111	121	49	67	49	67	56	74	49	67
Gambel Oak BA	27	29	38	21	32	21	32	27	40	21	32
All BA	138	148	171	76	109	76	109	90	127	76	109
% Oak BA	18	19	22	26	28	26	28	28	31	26	28
Subunit 1-3											
Acres	7,088										
% of SDI 12-18" DBH	31	32	31	26	22	26	22	24	21	26	22
% of SDI 18-24" DBH	13	14	21	22	21	22	21	20	18	22	21
% of SDI >24" DBH	8	8	11	15	20	15	20	13	17	15	20
% of Max SDI	66	69	73	33	44	33	44	41	54	33	44
TPA >18"	12	14	24	11	17	12	17	12	17	12	17
Ponderosa Pine BA	113	121	133	54	74	54	75	60	81	54	75
Gambel Oak BA	18	19	24	14	21	14	21	18	27	14	21
All BA	136	147	169	72	105	73	105	84	121	73	105
% Oak BA	12	13	14	19	20	19	20	20	22	19	20
Subunit 1-4											
Acres	883										
% of SDI 12-18" DBH	28	30	33	26	26	26	26	24	25	26	26
% of SDI 18-24" DBH	9	11	17	18	18	18	18	15	15	18	18
% of SDI >24" DBH	5	5	7	11	15	11	15	10	12	11	15
% of Max SDI	70	73	77	34	47	34	47	44	57	34	47
TPA >18"	9	12	19	9	15	9	15	10	15	9	15

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Ponderosa Pine BA	111	118	130	50	70	50	70	57	78	50	70
Gambel Oak BA	21	23	29	16	25	16	25	21	32	16	25
All BA	139	150	173	72	107	72	107	86	125	72	107
% Oak BA	15	15	17	22	23	22	23	24	25	22	23
Subunit 1-5											
Acres	15,958										
% of SDI 12-18" DBH	30	31	30	25	21	25	21	23	20	25	21
% of SDI 18-24" DBH	12	14	12	22	21	22	21	19	18	22	21
% of SDI >24" DBH	6	7	6	13	18	13	18	11	15	13	18
% of Max SDI	70	72	70	35	47	35	47	44	57	35	47
TPA >18"	12	14	12	11	17	11	17	12	17	11	17
Ponderosa Pine BA	112	118	112	52	71	52	71	58	77	52	71
Gambel Oak BA	22	25	22	18	27	18	27	22	34	18	27
All BA	140	150	140	75	108	75	108	87	124	75	108
% Oak BA	15	16	15	23	24	23	24	25	27	23	24
Subunit 3-1											
Acres	7,289									7,159	
% of SDI 12-18" DBH	29	29	24	25	19	25	19	23	19	25	20
% of SDI 18-24" DBH	12	14	20	19	20	19	20	16	17	18	20
% of SDI >24" DBH	7	7	9	11	15	11	15	10	13	11	15
% of Max SDI	66	69	75	39	52	39	52	51	62	39	52
TPA >18"	10	12	21	10	16	10	16	10	16	10	16
Ponderosa Pine BA	80	86	97	45	62	45	62	51	66	45	61
Gambel Oak BA	35	38	47	26	39	26	39	34	46	26	39
All BA	126	137	163	80	115	80	115	96	131	80	115
% Oak BA	26	26	28	31	32	31	32	33	34	31	32

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 3-2											
Acres	4,825										
% of SDI 12-18" DBH	29	29	23	25	18	25	19	23	18	25	19
% of SDI 18-24" DBH	13	15	21	20	21	20	21	18	18	20	21
% of SDI >24" DBH	8	8	11	13	17	12	16	11	15	12	16
% of Max SDI	63	66	72	38	50	42	53	49	60	42	53
TPA >18"	11	13	22	11	17	11	18	11	17	11	18
Ponderosa Pine BA	78	85	94	47	63	53	67	52	67	53	67
Gambel Oak BA	33	35	45	24	36	25	37	30	43	25	37
All BA	121	132	158	79	112	87	119	94	128	87	119
% Oak BA	25	25	27	29	30	28	30	30	32	28	30
Subunit 3-3											
Acres	12,663										
% of SDI 12-18" DBH	28	28	24	24	19	24	20	23	19	24	20
% of SDI 18-24" DBH	14	16	21	22	20	21	20	20	19	21	20
% of SDI >24" DBH	7	7	11	12	17	12	17	11	15	12	17
% of Max SDI	70	73	77	40	52	42	53	50	61	42	53
TPA >18"	12	15	23	12	18	12	18	12	18	12	18
Ponderosa Pine BA	88	93	102	51	66	53	68	55	70	53	68
Gambel Oak BA	35	37	45	25	36	25	37	31	43	25	36
All BA	134	144	167	85	118	87	120	98	132	87	120
% Oak BA	24	25	26	24	19	28	29	30	31	28	29
Subunit 3-4											
Acres	2,447										
% of SDI 12-18" DBH	30	32	32	25	23	25	23	23	22	25	23
% of SDI 18-24" DBH	12	14	20	22	20	22	20	19	18	22	20
% of SDI >24" DBH	6	6	9	13	18	13	18	11	15	13	18
% of Max SDI	70	73	77	34	46	34	46	43	56	34	46
TPA >18"	12	14	23	11	17	11	17	12	17	11	17

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Ponderosa Pine BA	117	124	135	53	73	53	73	59	79	53	73
Gambel Oak BA	20	22	27	16	24	16	24	20	31	16	24
All BA	143	154	175	74	107	74	107	86	124	74	107
% Oak BA	14	14	15	21	22	21	22	23	24	21	22
Subunit 3-5											
Acres	11,304										
% of SDI 12-18" DBH	31	32	31	25	21	25	21	23	20	25	21
% of SDI 18-24" DBH	12	14	21	23	21	23	21	21	19	23	21
% of SDI >24" DBH	6	7	9	13	19	13	19	12	16	13	19
% of Max SDI	75	77	80	36	48	36	48	45	58	36	48
TPA >18"	13	16	25	12	18	12	18	13	18	12	18
Ponderosa Pine BA	125	131	140	55	75	55	75	61	81	55	75
Gambel Oak BA	22	24	28	17	25	17	25	22	32	17	25
All BA	154	163	182	78	112	78	112	90	128	78	112
% Oak BA	14	14	15	22	22	22	22	24	24	22	22
Subunit 4-3											
Acres	116										
% of SDI 12-18" DBH	26	23	15	20	13	20	13	20	13	20	13
% of SDI 18-24" DBH	32	33	26	38	25	38	25	36	24	38	25
% of SDI >24" DBH	12	14	25	19	36	19	36	18	32	19	36
% of Max SDI	36	40	48	27	34	27	34	30	38	27	34
TPA >18"	16	19	24	16	20	16	20	16	21	16	20
Ponderosa Pine BA	70	78	94	58	74	58	74	61	77	58	74
Gambel Oak BA	8	10	18	6	12	6	12	8	15	6	12
All BA	81	92	119	67	90	67	90	71	97	67	90
% Oak BA	9	10	15	9	13	9	13	11	16	9	13

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 4-4											
Acres	1,271										
% of SDI 12-18" DBH	26	26	23	22	18	22	18	20	18	22	18
% of SDI 18-24" DBH	12	14	18	19	17	19	17	17	15	19	17
% of SDI >24" DBH	9	9	11	14	17	14	17	12	14	14	17
% of Max SDI	70	74	78	41	54	41	54	53	65	41	54
TPA >18"	11	14	21	11	16	11	16	12	16	11	16
Ponderosa Pine BA	82	88	96	45	60	45	60	50	64	45	60
Gambel Oak BA	37	40	51	28	42	28	42	36	49	28	42
All BA	131	143	167	83	118	83	118	100	135	83	118
% Oak BA	28	27	29	33	34	33	34	34	36	33	34
Subunit 4-5											
Acres	188										
% of SDI 12-18" DBH	39	40	33	32	21	32	21	30	21	32	21
% of SDI 18-24" DBH	11	15	27	24	27	24	27	22	23	24	27
% of SDI >24" DBH	4	4	7	10	17	10	17	9	13	10	17
% of Max SDI	68	71	74	32	44	32	44	40	54	32	44
TPA >18"	11	15	28	11	19	11	19	12	19	11	19
Ponderosa Pine BA	123	131	144	54	77	54	77	60	84	54	77
Gambel Oak BA	16	17	20	13	19	13	19	16	24	13	19
All BA	144	155	176	71	106	71	106	82	123	71	106
% Oak BA	11	11	11	17	17	17	17	19	19	17	17
Subunit 5-1											
Acres	207										
% of SDI 12-18" DBH	21	24	28	19	21	19	21	17	20	19	21
% of SDI 18-24" DBH	12	12	16	18	16	18	16	16	14	18	16
% of SDI >24" DBH	14	15	15	23	25	23	25	21	21	23	25
% of Max SDI	61	64	69	33	44	33	44	40	53	33	44
TPA >18"	13	15	20	12	16	12	16	13	16	12	16

Restoration Unit-Subunit and Forest Attributes	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Ponderosa Pine BA	102	110	123	54	71	54	71	59	78	54	71
Gambel Oak BA	14	15	19	11	17	11	17	14	22	11	17
All BA	126	137	162	73	106	73	106	84	123	73	106
% Oak BA	10	10	12	15	15	15	15	16	17	15	15
Subunit 5-2											
Acres	399										
% of SDI 12-18" DBH	26	28	28	27	26	27	26	24	24	27	26
% of SDI 18-24" DBH	9	9	14	14	17	14	17	11	14	14	17
% of SDI >24" DBH	6	6	7	9	11	9	11	8	9	9	11
% of Max SDI	47	52	63	29	41	29	41	37	51	29	41
TPA >18"	5	7	13	6	11	6	11	6	11	6	11
Ponderosa Pine BA	68	76	94	41	59	41	59	47	67	41	59
Gambel Oak BA	15	20	33	12	24	12	24	18	31	12	24
All BA	90	104	139	59	94	59	94	72	110	59	94
% Oak BA	18	21	25	21	26	21	26	24	28	21	26

Prey Habitat Metrics by Subunit

Table 6. Prey Habitat Changes in MSO Restricted "Other" Habitat by Alternative and Year

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 1-1											
Acres	1,193										
Snags >12"	1.44	1.80	3.96	3.08	1.71	3.08	1.71	1.28	1.90	3.08	1.71
Snags >12" and <18"	1.01	1.39	3.10	2.28	0.97	2.28	0.97	0.86	1.19	2.28	0.97
Snags >18"	0.43	0.41	0.86	0.80	0.74	0.80	0.74	0.41	0.71	0.80	0.74
CWD >3"	3.53	4.35	6.85	2.58	4.61	2.58	4.61	5.53	6.40	2.58	4.61
Logs	0.79	1.25	2.96	1.58	3.51	1.58	3.51	2.32	3.29	1.58	3.51

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
CWD >12"	0.26	0.42	0.99	0.53	1.17	0.53	1.17	0.77	1.10	0.53	1.17
Understory Index	208	180	132	399	250	399	250	332	202	399	250
Subunit 1-2											
Acres	588										
Snags >12"	1.86	2.34	5.01	3.81	1.94	3.81	1.94	1.52	2.28	588	588
Snags >12" and <18"	1.43	1.95	4.16	3.00	1.23	3.00	1.23	1.14	1.59	3.81	1.94
Snags >18"	0.43	0.39	0.86	0.81	0.70	0.81	0.70	0.38	0.69	3.00	1.23
CWD >3"	4.21	5.37	8.34	3.27	5.49	3.27	5.49	6.83	7.66	0.81	0.70
Logs	0.90	1.48	3.47	1.89	3.93	1.89	3.93	2.76	3.72	3.27	5.49
CWD >12"	0.30	0.49	1.16	0.63	1.31	0.63	1.31	0.92	1.24	1.89	3.93
Understory Index	44	36	24	138	74	138	74	105	53	0.63	1.31
Subunit 1-3											
Acres	7,088										
Snags >12"	2.05	2.83	5.91	4.00	2.02	3.97	2.04	1.75	2.33	3.97	2.04
Snags >12" and <18"	1.66	2.42	4.86	3.18	1.22	3.16	1.24	1.37	1.54	3.16	1.24
Snags >18"	0.38	0.41	1.05	0.82	0.81	0.81	0.81	0.39	0.79	0.81	0.81
CWD >3"	4.22	5.37	8.77	3.35	5.58	3.38	5.60	7.12	7.95	3.38	5.60
Logs	1.04	1.63	4.10	2.24	4.44	2.23	4.43	3.32	4.33	2.23	4.43
CWD >12"	0.35	0.54	1.37	0.75	1.48	0.74	1.48	1.11	1.44	0.74	1.48
Understory Index	45	37	25	147	81	145	80	119	60	145	80
Subunit 1-4											
Acres	883										
Snags >12"	1.83	2.41	5.45	3.77	1.91	3.77	1.91	1.50	2.23	3.77	1.91
Snags >12" and <18"	1.44	2.05	4.64	3.07	1.29	3.07	1.29	1.17	1.62	3.07	1.29
Snags >18"	0.39	0.35	0.81	0.70	0.62	0.70	0.62	0.34	0.61	0.70	0.62
CWD >3"	4.27	5.41	8.71	3.36	5.52	3.36	5.52	7.08	7.83	3.36	5.52
Logs	0.91	1.45	3.50	1.94	3.85	1.94	3.85	2.85	3.70	1.94	3.85
CWD >12"	0.30	0.48	1.17	0.65	1.28	0.65	1.28	0.95	1.23	0.65	1.28
Understory Index	43	35	23	147	77	147	77	114	55	147	77

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 1-5											
Acres	15,958										
Snags >12"	2.19	2.95	6.03	4.14	2.10	4.14	2.10	1.85	2.45	4.14	2.10
Snags >12" and <18"	1.78	2.51	4.93	3.28	1.26	3.28	1.26	1.44	1.62	3.28	1.26
Snags >18"	0.41	0.44	1.10	0.86	0.84	0.86	0.84	0.42	0.84	0.86	0.84
CWD >3"	4.34	5.58	9.09	3.46	5.79	3.46	5.79	7.30	8.23	3.46	5.79
Logs	1.08	1.73	4.31	2.29	4.59	2.29	4.59	3.38	4.50	2.29	4.59
CWD >12"	0.36	0.58	1.44	0.76	1.53	0.76	1.53	1.13	1.50	0.76	1.53
Understory Index	42	35	24	141	77	141	77	111	57	141	77
Subunit 3-1											
Acres	7,289									7,159	
Snags >12"	2.03	2.43	4.50	4.43	1.96	4.43	1.96	1.76	2.46	4.44	1.96
Snags >12" and <18"	1.58	1.97	3.43	3.52	1.11	3.52	1.11	1.31	1.60	3.55	1.12
Snags >18"	0.45	0.46	1.06	0.91	0.86	0.91	0.86	0.44	0.85	0.89	0.84
CWD >3"	3.15	4.21	7.28	2.70	5.61	2.70	5.61	5.23	6.71	2.70	5.61
Logs	1.25	1.78	3.90	1.98	4.34	1.98	4.34	2.88	4.06	1.97	4.30
CWD >12"	0.42	0.59	1.30	0.66	1.45	0.66	1.45	0.96	1.35	0.66	1.43
Understory Index	56	45	28	128	68	128	68	95	50	127	67
Subunit 3-2											
Acres	4,825										
Snags >12"	2.05	2.46	4.54	4.55	2.06	4.32	2.45	1.99	2.52	4.32	2.45
Snags >12" and <18"	1.60	1.97	3.39	3.57	1.11	3.40	1.47	1.49	1.58	3.40	1.47
Snags >18"	0.45	0.49	1.15	0.98	0.94	0.92	0.98	0.50	0.94	0.92	0.98
CWD >3"	3.10	4.11	7.09	2.60	5.49	2.83	5.77	5.02	6.58	2.83	5.77
Logs	1.44	1.97	4.14	2.05	4.56	2.00	4.50	2.96	4.30	2.00	4.50
CWD >12"	0.48	0.66	1.38	0.68	1.52	0.67	1.50	0.99	1.43	0.67	1.50
Understory Index	62	51	32	134	73	116	65	102	55	116	65

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 3-3											
Acres	12,663										
Snags >12"	2.25	2.88	5.25	5.46	2.33	5.38	2.49	3.17	2.80	5.41	2.51
Snags >12" and <18"	1.79	2.35	3.98	4.33	1.30	4.28	1.44	2.50	1.75	4.30	1.45
Snags >18"	0.46	0.53	1.27	1.13	1.04	1.11	1.05	0.66	1.04	1.11	1.06
CWD >3"	3.57	4.79	8.28	3.20	6.44	3.28	6.55	5.75	7.73	3.28	6.56
Logs	1.51	2.12	4.71	2.33	5.31	2.31	5.29	3.21	5.09	2.32	5.31
CWD >12"	0.50	0.71	1.57	0.78	1.77	0.77	1.76	1.07	1.70	0.77	1.77
Understory Index	48	40	27	119	65	113	63	93	50	114	63
Subunit 3-4											
Acres	2,447										
Snags >12"	2.22	3.07	6.36	4.15	2.10	4.15	2.10	1.87	2.44	4.15	2.10
Snags >12" and <18"	1.84	2.65	5.27	3.32	1.29	3.32	1.29	1.48	1.64	3.32	1.29
Snags >18"	0.38	0.42	1.09	0.83	0.81	0.83	0.81	0.39	0.80	0.83	0.81
CWD >3"	4.46	5.72	9.43	3.60	5.91	3.60	5.91	7.60	8.46	3.60	5.91
Logs	1.11	1.75	4.40	2.37	4.61	2.37	4.61	3.51	4.56	2.37	4.61
CWD >12"	0.37	0.58	1.47	0.79	1.54	0.79	1.54	1.17	1.52	0.79	1.54
Understory Index	51	43	30	170	94	170	94	136	70	170	94
Subunit 3-5											
Acres	11,304										
Snags >12"	2.46	3.54	7.08	4.69	2.22	4.69	2.22	2.43	2.60	4.69	2.22
Snags >12" and <18"	2.06	3.05	5.83	3.74	1.30	3.74	1.30	1.93	1.68	3.74	1.30
Snags >18"	0.40	0.49	1.25	0.95	0.92	0.95	0.92	0.50	0.92	0.95	0.92
CWD >3"	4.90	6.39	10.61	4.07	6.61	4.07	6.61	8.36	9.43	4.07	6.61
Logs	1.58	2.28	5.32	2.87	5.42	2.87	5.42	4.14	5.44	2.87	5.42
CWD >12"	0.53	0.76	1.77	0.96	1.81	0.96	1.81	1.38	1.81	0.96	1.81
Understory Index	42	35	26	155	84	155	84	125	64	155	84

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 4-3											
Acres	116										
Snags >12"	1.25	1.46	2.79	3.92	2.13	3.92	2.13	2.87	2.17	3.92	2.13
Snags >12" and <18"	0.86	0.91	1.31	2.73	0.78	2.73	0.78	2.11	0.86	2.73	0.78
Snags >18"	0.39	0.55	1.48	1.19	1.35	1.19	1.35	0.76	1.31	1.19	1.35
CWD >3"	2.81	3.16	4.69	1.75	4.05	1.75	4.05	3.27	4.88	1.75	4.05
Logs	2.04	2.28	3.83	2.05	4.75	2.05	4.75	2.96	4.78	2.05	4.75
CWD >12"	0.68	0.76	1.28	0.68	1.58	0.68	1.58	0.99	1.59	0.68	1.58
Understory Index	125	103	63	162	106	162	106	150	93	162	106
Subunit 4-4											
Acres	1,271										
Snags >12"	2.23	2.77	5.07	4.62	2.06	4.62	2.06	1.93	2.58	4.62	2.06
Snags >12" and <18"	1.70	2.17	3.80	3.54	1.06	3.54	1.06	1.38	1.58	3.54	1.06
Snags >18"	0.53	0.59	1.26	1.08	0.99	1.08	0.99	0.55	1.01	1.08	0.99
CWD >3"	2.99	4.16	7.80	2.69	5.83	2.69	5.83	5.24	7.08	2.69	5.83
Logs	0.94	1.60	4.29	1.93	4.63	1.93	4.63	2.79	4.31	1.93	4.63
CWD >12"	0.31	0.53	1.43	0.64	1.54	0.64	1.54	0.93	1.44	0.64	1.54
Understory Index	50	40	26	121	63	121	63	88	47	121	63
Subunit 4-5											
Acres	188										
Snags >12"	2.56	3.70	7.44	4.58	2.12	4.58	2.12	2.13	2.52	4.58	2.12
Snags >12" and <18"	2.25	3.34	6.27	3.85	1.32	3.85	1.32	1.81	1.72	3.85	1.32
Snags >18"	0.32	0.35	1.17	0.73	0.80	0.73	0.80	0.32	0.80	0.73	0.80
CWD >3"	4.60	5.97	10.12	3.81	6.06	3.81	6.06	8.11	8.91	3.81	6.06
Logs	1.21	1.89	4.96	2.72	4.99	2.72	4.99	4.08	5.04	2.72	4.99
CWD >12"	0.40	0.63	1.65	0.91	1.66	0.91	1.66	1.36	1.68	0.91	1.66
Understory Index	39	32	22	150	78	150	78	122	58	150	78

Restoration Unit-Subunit and Prey Habitat Metrics	Existing Yr 2010	Alt A Yr 2020	Alt A Yr 2050	Alt B Yr 2020	Alt B Yr 2050	Alt C Yr 2020	Alt C Yr 2050	Alt D Yr 2020	Alt D Yr 2050	Alt E Yr 2020	Alt E Yr 2050
Subunit 5-1											
Acres	207										
Snags >12"	207	207	207	3.26	1.90	3.26	1.90	1.54	2.10	3.26	1.90
Snags >12" and <18"	1.93	2.22	4.87	2.29	1.01	2.29	1.01	0.97	1.22	2.29	1.01
Snags >18"	1.33	1.64	3.75	0.98	0.88	0.98	0.88	0.57	0.87	0.98	0.88
CWD >3"	0.60	0.58	1.12	2.94	5.26	2.94	5.26	6.28	7.34	2.94	5.26
Logs	3.91	4.91	8.24	1.91	4.17	1.91	4.17	2.78	4.07	1.91	4.17
CWD >12"	0.94	1.58	3.89	0.64	1.39	0.64	1.39	0.93	1.36	0.64	1.39
Understory Index	0.31	0.53	1.30	144	79	144	79	117	58	144	79
Subunit 5-2											
Acres	399										
Snags >12"	1.17	1.39	2.89	2.88	1.46	2.88	1.46	1.08	1.71	2.88	1.46
Snags >12" and <18"	0.93	1.17	2.43	2.44	1.09	2.44	1.09	0.86	1.32	2.44	1.09
Snags >18"	0.24	0.23	0.46	0.44	0.37	0.44	0.37	0.22	0.39	0.44	0.37
CWD >3"	2.76	3.21	4.87	1.88	3.56	1.88	3.56	3.95	4.72	1.88	3.56
Logs	0.38	0.69	1.81	0.92	2.24	0.92	2.24	1.31	1.99	0.92	2.24
CWD >12"	0.13	0.23	0.60	0.31	0.75	0.31	0.75	0.44	0.66	0.31	0.75
Understory Index	106	82	43	188	99	188	99	147	73	188	99

Appendix 14. Summary of Habitat Changes by Alternative in Mexican Spotted Owl Critical Habitat

Forest Attributes by Subunit 1
Prey Habitat Metrics by Subunit 7

Table 1. Changes in Upper Gila Mountain (UGM) MSO Critical Habitat Components by Alternative and Year 1
Table 2. Prey Habitat Changes in Upper Gila Mountain (UGM) MSO Critical Habitat Components by Alternative and Year 7

Forest Attributes by Subunit

Table 1. Changes in Upper Gila Mountain (UGM) MSO Critical Habitat Components by Alternative and Year

Critical Habitat Subunits & Forest Attributes	Existing Condition	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
UGM-11											
Restoration Unit 1											
Subunit 1-2											
Acres	532	532	532	532	532	532	532	532	532	532	532
% of SDI 12-18" DBH	25	27	30	23	24	23	24	21	22	23	24
% of SDI 18-24" DBH	10	11	15	17	16	17	16	15	14	17	16
% of SDI >24" DBH	6	6	8	12	16	12	16	11	13	12	16
% of Max SDI	74	77	81	38	50	38	50	49	62	38	50
TPA >18"	10	12	19	10	14	10	14	10	14	10	14
Ponderosa Pine BA	106	112	121	49	67	49	67	55	73	49	67
Gambel Oak BA	28	31	40	22	33	22	33	28	42	22	33
All BA	142	152	174	77	111	77	111	92	130	77	111
% Oak BA	19	20	22	28	29	28	29	30	32	28	29

Critical Habitat Subunits & Forest Attributes	Existing Condition	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
Subunit 1-3											
Acres	9,431	9,431	9,431	9,431	9,431	9,431	9,431	9,431	9,431	9,431	9,431
% of SDI 12-18" DBH	32	32	30	30	25	29	24	29	25	30	25
% of SDI 18-24" DBH	12	15	22	19	24	19	23	18	22	19	23
% of SDI >24" DBH	7	7	10	11	15	11	15	10	13	11	14
% of Max SDI	73	75	78	54	63	53	62	59	68	55	63
TPA >18"	13	16	26	15	24	15	23	15	23	15	23
Ponderosa Pine BA	113	119	129	81	95	77	92	85	100	83	97
Gambel Oak BA	23	25	29	22	28	23	29	24	31	22	28
All BA	146	156	177	115	145	111	143	122	153	117	146
% Oak BA	15	15	16	19	19	19	20	19	20	19	19
Subunit 1-4											
Acres	3,591	3,591	3,591	3,591	3,591	3,591	3,591	3,591	3,591	3,591	3,591
% of SDI 12-18" DBH	31	32	30	31	29	31	29	31	29	31	29
% of SDI 18-24" DBH	12	14	20	17	22	17	22	16	21	17	21
% of SDI >24" DBH	6	7	9	8	12	8	12	8	11	8	12
% of Max SDI	76	79	81	64	70	63	70	68	74	65	71
TPA >18"	13	16	25	15	24	15	24	15	24	15	24
Ponderosa Pine BA	118	124	131	101	113	100	112	107	117	103	115
Gambel Oak BA	22	24	29	22	27	22	28	23	29	22	27
All BA	150	160	180	135	161	134	160	142	167	137	162
% Oak BA	14	15	16	17	18	17	18	17	18	17	18
Subunit 1-5											
Acres	35,123	35,123	35,123	35,123	35,123	35,123	35,123	35,123	35,123	35,123	35,123
% of SDI 12-18" DBH	30	31	28	29	25	29	24	29	25	30	26
% of SDI 18-24" DBH	13	15	22	19	23	19	23	18	22	18	22
% of SDI >24" DBH	7	8	10	11	14	11	15	10	13	10	14
% of Max SDI	76	78	80	60	66	59	65	64	70	61	67

Critical Habitat Subunits & Forest Attributes	Existing Condition	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
TPA >18"	14	17	26	16	24	16	24	16	24	16	24
Ponderosa Pine BA	119	124	130	94	105	92	103	99	109	97	108
Gambel Oak BA	23	24	29	22	28	22	28	24	30	22	28
All BA	151	160	178	127	152	125	150	134	159	130	154
% Oak BA	15	15	16	18	19	18	19	18	19	18	19
UGM-12											
Restoration Unit 1											
Subunit 1											
Acres	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
% of SDI 12-18” DBH	24	25	25	21	20	21	20	20	19	21	20
% of SDI 18-24” DBH	13	14	17	18	18	19	17	17	16	18	18
% of SDI >24” DBH	12	13	15	19	22	19	22	17	19	19	22
% of Max SDI	63	66	70	41	50	40	50	47	58	41	50
TPA >18"	12	14	20	12	17	12	17	13	17	12	17
Ponderosa Pine BA	101	107	118	63	79	61	77	69	84	63	79
Gambel Oak BA	19	21	28	17	24	17	25	20	29	17	24
All BA	126	136	159	87	115	85	114	96	128	87	115
% Oak BA	14	15	17	19	21	19	21	20	22	19	21
UGM-13											
Restoration Unit 3											
Subunit 3-1											
Acres	7,321	7,321	7,321	7,321	7,321	7,321	7,321	7,321	7,321	7,321	7,321
% of SDI 12-18” DBH	29	28	23	25	19	25	19	23	19	25	19
% of SDI 18-24” DBH	12	14	20	19	20	19	20	17	18	19	20
% of SDI >24” DBH	7	7	9	11	15	11	15	10	13	11	15
% of Max SDI	68	71	77	41	54	41	54	52	64	42	54
TPA >18"	10	13	22	11	17	10	17	11	17	11	17
Ponderosa Pine BA	81	87	97	47	62	46	62	52	67	47	63

Critical Habitat Subunits & Forest Attributes	Existing Condition	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
Gambel Oak BA	36	39	48	28	40	28	40	35	48	28	41
All BA	128	139	165	84	118	83	118	99	134	84	119
% Oak BA	27	27	29	31	33	32	33	33	34	32	33
Subunit 3-2											
Acres	3,508	3,508	3,508	3,508	3,508	3,508	3,508	3,508	3,508	3,508	3,508
% of SDI 12-18” DBH	30	29	24	25	19	26	20	24	18	26	20
% of SDI 18-24” DBH	14	16	21	21	21	20	21	19	19	20	21
% of SDI >24” DBH	7	8	11	12	17	12	16	11	15	12	16
% of Max SDI	66	69	74	43	54	48	58	52	62	49	58
TPA >18"	11	14	23	12	18	12	19	12	18	13	19
Ponderosa Pine BA	82	88	97	52	67	60	73	57	71	60	74
Gambel Oak BA	33	36	45	26	37	28	38	31	43	28	38
All BA	126	137	161	87	120	98	128	100	133	98	129
% Oak BA	24	24	27	28	29	27	29	30	31	27	29
Subunit 3-3											
Acres	15,296	15,296	15,296	15,296	15,296	15,296	15,296	15,296	15,296	15,296	15,296
% of SDI 12-18” DBH	28	28	25	25	20	25	20	24	20	26	21
% of SDI 18-24” DBH	14	16	21	21	21	21	21	19	19	20	21
% of SDI >24” DBH	7	7	10	11	16	11	16	10	14	11	16
% of Max SDI	72	75	78	48	58	48	59	56	65	50	60
TPA >18"	13	15	23	13	20	13	20	14	20	13	20
Ponderosa Pine BA	93	98	106	61	75	61	76	65	79	65	78
Gambel Oak BA	34	37	44	27	37	27	37	32	42	27	37
All BA	139	150	171	98	131	99	132	110	142	103	134
% Oak BA	24	24	25	27	28	27	28	28	29	27	28
Subunit 3-4											
Acres	4,051	4,051	4,051	4,051	4,051	4,051	4,051	4,051	4,051	4,051	4,051
% of SDI 12-18” DBH	30	31	29	28	25	28	24	27	24	28	25

Critical Habitat Subunits & Forest Attributes	Existing Condition	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
% of SDI 18-24” DBH	13	15	21	19	21	19	21	18	20	19	21
% of SDI >24” DBH	7	8	10	11	15	11	15	10	14	11	15
% of Max SDI	77	79	81	58	65	58	65	64	71	58	65
TPA >18"	14	17	26	15	23	15	23	16	23	15	23
Ponderosa Pine BA	122	127	134	89	101	88	100	94	105	89	101
Gambel Oak BA	23	24	28	21	27	21	27	23	30	21	27
All BA	155	164	183	121	148	121	148	130	157	121	148
% Oak BA	14	14	15	18	19	19	19	19	20	18	19
Subunit 3-5											
Acres	7,433	7,433	7,433	7,433	7,433	7,433	7,433	7,433	7,433	7,433	7,433
% of SDI 12-18” DBH	33	33	29	26	20	26	20	25	20	26	20
% of SDI 18-24” DBH	15	17	24	25	24	25	24	23	22	25	24
% of SDI >24” DBH	7	8	11	13	19	13	19	12	17	13	19
% of Max SDI	76	78	79	47	56	46	56	53	63	47	56
TPA >18"	16	19	29	17	23	16	23	17	23	17	23
Ponderosa Pine BA	130	136	144	75	92	74	91	80	97	75	92
Gambel Oak BA	20	21	24	18	24	18	24	20	28	18	24
All BA	158	167	185	101	132	100	131	110	143	101	132
% Oak BA	12	13	13	18	18	18	19	19	20	18	18
UGM-14											
Restoration Unit 5											
Subunit 5-1											
Acres	250	250	250	250	250	250	250	250	250	250	250
% of SDI 12-18” DBH	30	31	30	31	29	31	29	31	30	31	29
% of SDI 18-24” DBH	13	15	21	15	21	15	21	15	21	15	21
% of SDI >24” DBH	6	6	10	7	10	7	10	6	10	7	10
% of Max SDI	68	72	77	69	76	69	76	72	77	69	76
TPA >18"	12	15	25	15	25	15	25	15	25	15	25

Critical Habitat Subunits & Forest Attributes	Existing Condition	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
Ponderosa Pine BA	108	114	121	108	117	108	117	114	121	108	117
Gambel Oak BA	17	19	24	19	25	19	25	19	24	19	25
All BA	138	149	172	144	170	144	170	149	172	144	170
% Oak BA	13	13	14	13	15	13	15	13	14	13	15
Subunit 5-2											
Acres	658	658	658	658	658	658	658	658	658	658	658
% of SDI 12-18” DBH	35	35	27	35	26	35	26	34	26	35	26
% of SDI 18-24” DBH	14	17	24	18	25	18	25	17	24	18	25
% of SDI >24” DBH	8	8	14	9	14	9	14	9	14	9	14
% of Max SDI	62	65	70	60	66	60	66	63	68	60	66
TPA >18"	13	16	27	16	27	16	27	16	27	16	27
Ponderosa Pine BA	93	98	103	88	95	88	95	93	99	88	95
Gambel Oak BA	13	14	20	14	20	14	20	14	20	14	20
All BA	130	141	163	130	155	130	155	135	159	130	155
% Oak BA	10	10	12	11	13	11	13	11	13	11	13
UGM-15											
Restoration Unit 4											
Subunit 4-3											
Acres	289	289	289	289	289	289	289	289	289	289	289
% of SDI 12-18” DBH	37	37	31	38	31	38	31	38	31	38	31
% of SDI 18-24” DBH	12	15	25	16	26	16	26	16	25	16	26
% of SDI >24” DBH	5	6	9	6	10	6	10	6	10	6	10
% of Max SDI	72	74	77	71	75	70	75	73	76	71	75
TPA >18"	12	15	28	15	28	15	28	15	28	15	28
Ponderosa Pine BA	114	119	125	114	122	113	121	118	123	114	122
Gambel Oak BA	18	20	24	19	24	19	24	19	23	19	24
All BA	147	157	176	152	172	150	172	155	173	152	172
% Oak BA	12	12	13	12	13	13	14	12	13	12	13

Critical Habitat Subunits & Forest Attributes	Existing Condition	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
Subunit 4-4											
Acres	289	289	289	281	281	281	281	281	281	281	281
% of SDI 12-18” DBH	37	37	31	33	45	33	45	32	46	33	45
% of SDI 18-24” DBH	12	15	25	13	24	13	24	13	23	13	24
% of SDI >24” DBH	5	6	9	4	7	4	7	4	7	4	7
% of Max SDI	72	74	77	25	31	25	31	26	33	25	31
TPA >18"	12	15	28	6	11	6	11	6	12	6	11
Ponderosa Pine BA	114	119	125	45	63	45	63	48	67	45	63
Gambel Oak BA	18	20	24	5	7	5	7	5	7	5	7
All BA	147	157	176	54	78	54	77	56	81	54	78
% Oak BA	12	12	13	4	5	4	5	4	4	4	5

Prey Habitat Metrics by Subunit

Table 2. Prey Habitat Changes in Upper Gila Mountain (UGM) MSO Critical Habitat Components by Alternative and Year

Restoration Unit-Subunit and Prey Habitat Metrics	Existing	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
UGM-11											
Restoration Unit 1											
Subunit 1-2											
Acres	532	532	532	532	532	532	532	532	532	532	532
Snags >12"	1.93	2.45	5.19	3.90	1.95	3.90	1.95	1.58	2.32	3.90	1.95
Snags >12" & <18"	1.51	2	4	3.08	1.25	3.08	1.25	1.19	1.63	3.08	1.25
Snags >18"	0.42	0.40	0.87	0.81	0.70	0.81	0.70	0.38	0.69	0.81	0.70
CWD >3"	4.35	5.59	8.72	3.41	5.68	3.41	5.68	7.11	7.95	3.41	5.68
Logs	0.92	1.52	3.59	1.93	4.00	1.93	4.00	2.82	3.79	1.93	4.00
CWD >12"	0.31	0.51	1.20	0.64	1.33	0.64	1.33	0.94	1.26	0.64	1.33
Understory Index	41	34	22	135	72	135	72	102	51	135	72

Restoration Unit-Subunit and Prey Habitat Metrics	Existing	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
Subunit 1-3											
Acres	9,431	9,431	9,431	9,431	9,431	9,431	9,431	9,431	9,431	9,431	9,431
Snags >12"	2.72	3.59	6.69	4.46	4.34	4.36	4.09	2.79	4.61	4.25	4.52
Snags >12" & <18"	2.26	3	5	3.81	3.18	3.72	2.96	2.32	3.44	3.60	3.36
Snags >18"	0.46	0.49	1.26	0.64	1.16	0.64	1.13	0.47	1.17	0.64	1.17
CWD >3"	5.19	6.61	10.64	3.55	6.85	3.38	6.55	7.49	9.82	4.21	7.48
Logs	2.56	3.30	6.29	2.71	5.57	2.73	5.46	4.08	6.16	2.95	5.91
CWD >12"	0.85	1.10	2.10	0.90	1.86	0.91	1.82	1.36	2.05	0.98	1.97
Understory Index	38	31	21	67	39	72	40	59	33	65	38
Subunit 1-4											
Acres	3,591	3,591	3,591	3,591	3,591	3,591	3,591	3,591	3,591	3,591	3,591
Snags >12"	3.11	3.77	7.08	4.98	5.56	5.07	5.47	3.43	5.91	4.77	5.63
Snags >12" & <18"	2.50	3	6	4.30	4.25	4.39	4.16	2.83	4.59	4.09	4.33
Snags >18"	0.60	0.62	1.40	0.68	1.31	0.68	1.31	0.60	1.32	0.68	1.31
CWD >3"	5.14	6.62	10.74	3.34	7.29	2.97	6.90	7.06	10.33	3.78	7.66
Logs	1.60	2.49	5.83	1.94	5.33	1.87	5.23	2.84	5.74	2.08	5.50
CWD >12"	0.53	0.83	1.94	0.65	1.78	0.62	1.74	0.95	1.91	0.69	1.83
Understory Index	35	29	20	46	29	47	29	41	26	45	28
Subunit 1-5											
Acres	35,123	35,123	35,123	35,123	35,123	35,123	35,123	35,123	35,123	35,123	35,123
Snags >12"	3.06	3.90	7.10	4.89	5.29	4.92	5.11	3.37	5.58	4.70	5.48
Snags >12" & <18"	2.51	3	6	4.16	3.90	4.20	3.73	2.79	4.19	3.97	4.11
Snags >18"	0.55	0.60	1.46	0.73	1.38	0.73	1.39	0.58	1.38	0.73	1.37
CWD >3"	5.11	6.65	10.85	3.59	7.38	3.22	6.95	7.25	10.25	4.28	8.02
Logs	1.81	2.70	6.11	2.26	5.67	2.19	5.57	3.27	6.05	2.50	6.03
CWD >12"	0.60	0.90	2.04	0.75	1.89	0.73	1.86	1.09	2.02	0.83	2.01
Understory Index	35	29	21	54	34	56	35	47	30	51	32

Restoration Unit-Subunit and Prey Habitat Metrics	Existing	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
UGM-12											
Restoration Unit 1											
Subunit 1-1											
Acres	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150
Snags >12"	1.73	2.18	4.56	3.40	2.69	3.34	2.55	1.71	2.87	3.40	2.69
Snags >12" & <18"	1.23	2	4	2.60	1.74	2.54	1.63	1.22	1.95	2.60	1.74
Snags >18"	0.50	0.49	1.01	0.80	0.95	0.80	0.91	0.49	0.92	0.80	0.95
CWD >3"	4.15	5.11	7.98	2.86	5.40	2.80	5.25	6.11	7.58	2.86	5.40
Logs	1.58	2.07	4.04	1.93	4.19	1.98	4.13	2.92	4.29	1.93	4.19
CWD >12"	0.53	0.69	1.35	0.64	1.40	0.66	1.38	0.97	1.43	0.64	1.40
Understory Index	182	160	123	312	208	319	210	269	175	312	208
UGM-13											
Restoration Unit 3											
Subunit 3-1											
Acres	7,321	7,321	7,321	7,321	7,321	7,321	7,321	7,321	7,321	7,321	7,321
Snags >12"	2.11	2.55	4.60	4.45	2.07	4.44	2.06	1.84	2.56	4.41	2.10
Snags >12" & <18"	1.65	2	3	3.53	1.16	3.53	1.16	1.38	1.65	3.52	1.18
Snags >18"	0.46	0.49	1.11	0.91	0.91	0.91	0.90	0.46	0.91	0.90	0.92
CWD >3"	3.18	4.30	7.46	2.70	5.67	2.71	5.66	5.30	6.87	2.68	5.63
Logs	1.24	1.81	4.05	1.98	4.41	1.99	4.41	2.89	4.18	1.95	4.37
CWD >12"	0.41	0.60	1.35	0.66	1.47	0.66	1.47	0.96	1.39	0.65	1.46
Understory Index	54	44	27	120	64	121	64	90	48	119	63
Subunit 3-2											
Acres	3,508	3,508	3,508	3,508	3,508	3,508	3,508	3,508	3,508	3,508	3,508
Snags >12"	2.26	2.76	4.93	4.71	2.43	4.36	2.92	2.37	2.90	4.39	2.97
Snags >12" & <18"	1.80	2	4	3.73	1.36	3.48	1.83	1.82	1.82	3.51	1.85
Snags >18"	0.46	0.52	1.25	0.97	1.07	0.88	1.09	0.55	1.08	0.88	1.12
CWD >3"	3.24	4.35	7.58	2.60	5.68	2.92	6.05	5.09	6.95	2.91	6.05
Logs	1.42	2.02	4.50	2.02	4.74	1.98	4.66	2.89	4.57	1.96	4.66

Restoration Unit-Subunit and Prey Habitat Metrics	Existing	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
CWD >12"	0.47	0.67	1.50	0.67	1.58	0.66	1.55	0.96	1.52	0.65	1.55
Understory Index	54	45	29	111	61	92	52	88	48	91	52
Subunit 3-3											
Acres	15,296	15,296	15,296	15,296	15,296	15,296	15,296	15,296	15,296	15,296	15,296
Snags >12"	2.34	3.08	5.59	5.31	2.96	5.20	3.00	3.26	3.39	5.20	3.38
Snags >12" & <18"	1.88	3	4	4.28	1.85	4.20	1.89	2.60	2.27	4.20	2.23
Snags >18"	0.46	0.56	1.31	1.02	1.11	1.00	1.11	0.66	1.12	0.99	1.15
CWD >3"	3.84	5.14	8.89	3.18	6.64	3.19	6.63	5.88	8.23	3.40	6.94
Logs	1.62	2.27	5.03	2.25	5.30	2.25	5.25	3.13	5.25	2.26	5.39
CWD >12"	0.54	0.76	1.68	0.75	1.77	0.75	1.75	1.04	1.75	0.75	1.80
Understory Index	46	38	26	96	54	94	53	78	43	88	50
Subunit 3-4											
Acres	4,051	4,051	4,051	4,051	4,051	4,051	4,051	4,051	4,051	4,051	4,051
Snags >12"	2.99	3.92	7.23	5.08	4.87	5.17	4.81	3.34	5.24	5.08	4.87
Snags >12" & <18"	2.44	3	6	4.26	3.54	4.34	3.49	2.73	3.90	4.26	3.54
Snags >18"	0.55	0.62	1.48	0.83	1.33	0.82	1.33	0.61	1.34	0.83	1.33
CWD >3"	5.31	6.87	11.19	3.78	7.55	3.46	7.25	7.70	10.56	3.78	7.55
Logs	2.03	2.88	6.30	2.56	5.93	2.46	5.84	3.74	6.34	2.56	5.93
CWD >12"	0.68	0.96	2.10	0.85	1.98	0.82	1.95	1.25	2.11	0.85	1.98
Understory Index	65	57	43	116	77	117	77	101	66	116	77
Subunit 3-5											
Acres	7,433	7,433	7,433	7,433	7,433	7,433	7,433	7,433	7,433	7,433	7,433
Snags >12"	2.99	4.27	7.77	5.05	3.58	5.00	3.51	3.03	3.97	5.04	3.59
Snags >12" & <18"	2.48	4	6	4.06	2.26	4.01	2.21	2.40	2.64	4.05	2.27
Snags >18"	0.51	0.68	1.65	0.99	1.32	0.99	1.31	0.63	1.33	0.99	1.32
CWD >3"	5.37	6.95	11.56	3.94	7.13	3.95	7.10	8.58	10.49	3.96	7.15
Logs	2.57	3.41	7.13	3.29	6.49	3.32	6.47	5.06	7.10	3.29	6.49
CWD >12"	0.86	1.14	2.38	1.10	2.16	1.11	2.16	1.69	2.37	1.10	2.16
Understory Index	57	50	38	145	88	147	89	124	73	145	88

Restoration Unit-Subunit and Prey Habitat Metrics	Existing	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
UGM-14											
Restoration Unit 5											
Subunit 5-1											
Acres	250	250	250	250	250	250	250	250	250	250	250
Snags >12"	3.52	3.94	6.76	5.26	6.39	5.26	6.39	3.94	6.76	5.26	6.39
Snags >12" & <18"	3.00	3	5	4.74	4.98	4.74	4.98	3.40	5.33	4.74	4.98
Snags >18"	0.52	0.54	1.43	0.53	1.42	0.53	1.42	0.54	1.43	0.53	1.42
CWD >3"	4.89	6.32	10.25	2.51	6.91	2.51	6.91	6.32	10.25	2.51	6.91
Logs	1.35	2.30	5.71	1.50	5.16	1.50	5.16	2.30	5.71	1.50	5.16
CWD >12"	0.45	0.77	1.90	0.50	1.72	0.50	1.72	0.77	1.90	0.50	1.72
Understory Index	44	36	23	40	24	40	24	36	23	40	24
Subunit 5-2											
Acres	658	658	658	658	658	658	658	658	658	658	658
Snags >12"	3.01	3.78	7.44	5.07	6.88	5.07	6.88	3.72	7.20	5.07	6.88
Snags >12" & <18"	2.46	3	6	4.43	5.07	4.43	5.07	3.11	5.40	4.43	5.07
Snags >18"	0.55	0.61	1.81	0.64	1.81	0.64	1.81	0.61	1.81	0.64	1.81
CWD >3"	5.74	7.07	11.21	2.95	7.63	2.95	7.63	7.21	11.16	2.95	7.63
Logs	3.88	4.79	8.85	2.97	7.54	2.97	7.54	4.90	8.88	2.97	7.54
CWD >12"	1.29	1.60	2.95	0.99	2.51	0.99	2.51	1.63	2.96	0.99	2.51
Understory Index	41	34	23	48	30	48	30	43	27	48	30
UGM-15											
Restoration Unit 4											
Subunit 4-3											
Acres	289	289	289	289	289	289	289	289	289	289	289
Snags >12"	3.62	4.53	8.10	6.08	7.77	6.71	7.55	5.13	8.05	6.08	7.77
Snags >12" & <18"	3.11	4	6	5.42	6.17	6.06	5.95	4.48	6.45	5.42	6.17
Snags >18"	0.51	0.57	1.60	0.65	1.60	0.65	1.60	0.65	1.60	0.65	1.60
CWD >3"	5.63	7.23	11.73	4.57	9.53	3.02	8.14	7.11	11.78	4.57	9.53
Logs	2.28	3.26	7.28	2.51	6.99	2.11	6.72	3.28	7.51	2.51	6.99

Restoration Unit-Subunit and Prey Habitat Metrics	Existing	Alternative A		Alternative B		Alternative C		Alternative D		Alternative E	
	2010	2020	2050	2020	2050	2020	2050	2020	2050	2020	2050
CWD >12"	0.76	1.09	2.43	0.84	2.33	0.70	2.24	1.09	2.50	0.84	2.33
Understory Index	37	31	22	34	23	35	24	32	23	34	23
Subunit 4-4											
Acres	281	281	281	281	281	281	281	281	281	281	281
Snags >12"	1.13	1.36	2.95	1.74	2.87	1.82	2.85	1.36	2.95	1.74	2.87
Snags >12" & <18"	0.85	1	2	1.45	1.85	1.53	1.83	1.07	1.93	1.45	1.85
Snags >18"	0.28	0.29	1.02	0.29	1.02	0.29	1.02	0.29	1.02	0.29	1.02
CWD >3"	5.47	5.59	6.32	2.29	3.67	2.02	3.44	5.55	6.29	2.29	3.67
Logs	0.21	0.50	1.85	0.38	1.82	0.35	1.80	0.50	1.85	0.38	1.82
CWD >12"	0.07	0.17	0.62	0.13	0.61	0.12	0.60	0.17	0.62	0.13	0.61
Understory Index	231	197	125	205	133	206	134	197	125	205	133

Appendix 15. Miles of Road Maintenance, Construction, and Decommissioning by Individual Protected Activity Centers (PACs)

Table 1. Miles of Roads Proposed for Decommissioning Within PAC Habitat, Including Core Areas (about 29% of total roads in 52 PACs would be decommissioned)

Forest	PAC Name	Road Miles Decommissioned in PAC	Total Road Miles in PAC	% of Total Roads in PAC Decommissioned
COF	Bar M	0.29	4.77	6
	Bear Jaw	0.19	0.19	100
	Bear Seep	0.08	3.82	2
	Blade Tank	0.57	2.76	21
	Bonita Tank	0.04	4.34	1
	Bridge	0.63	1.63	39
	Bristow Tank/Limpios	0.78	4.26	18
	Casner	1.43	2.37	60
	Casner Cabin	0.23	0.55	42
	Clark	2.56	4.99	51
	Coyote Park	0.76	0.76	100
	Dry Lake	0.03	0.65	5
	Fain Mountain	0.68	3.98	17
	Frank	0.48	3.17	15
	Frog Tank	1.48	3.70	40
	Fry	0.58	0.97	60
	Gash Mountain	0.11	3.73	3
	Harding Point	0.81	1.09	74
	Hochderffer	0.98	2.45	40
	Holdup	0.96	2.35	41
	Howard Mountain	0.85	3.36	25
	Iowa Camp	3.77	6.96	54
	James Canyon	1.75	2.52	69
	Jeep	1.25	1.49	84
	Kelly	1.36	2.11	64
	Lake #1/Seruchos	0.96	3.83	25
	Little Spring	2.41	2.98	81
	Lockwood	0.00	3.20	0
	MB Smith	2.87	4.78	60
	Milos Butte	0.60	3.28	18
	Mint Spring	0.55	1.46	38
	Moore Well/Rock Dike	0.37	3.75	10
	Mormon Mountain	0.40	3.64	11

Forest	PAC Name	Road Miles Decommissioned in PAC	Total Road Miles in PAC	% of Total Roads in PAC Decommissioned
	Mustang	1.64	4.38	37
	O'Leary Peak	0.00	0.08	0
	Pierce Tank	1.41	2.22	64
	Pumphouse Wash	1.62	1.87	87
	Racetrack Tank	1.09	2.03	54
	Red Hill	0.68	2.55	27
	Red Raspberry	1.27	6.75	19
	Rock Top	1.03	5.26	20
	Roundup	0.46	2.72	17
	Sawmill Springs	0.19	3.47	5
	Snowbowl Road	0.77	4.14	19
	Sterling	0.11	1.13	10
	Stock Tank	0.22	0.22	100
	T Bird	0.38	1.89	20
	Two Holes	0.48	3.26	15
	Weimer Springs	0.04	5.32	<1
	Woods	0.77	6.45	12
	Woody Ridge	0.02	0.03	67
KNF	Sitgreaves	0.08	0.61	13
Total for 52 PACs		**43.1**	**150.3**	**29**

Table 2. Miles and Percent of Roads Decommissioned in Core Areas Only, Coconino NF (No Core Areas Will be Affected by Road Decommissioning on the Kaibab NF)

PAC Name	Road Miles Decommissioned	Total Road Miles	Percent of Total Miles Decommissioned
Casner	0.68	0.68	100
Clark	0.93	0.93	100
Frog Tank	0.07	0.67	11
Holdup	0.33	0.33	100
Howard Mountain	0.23	0.84	28
Iowa Camp	0.59	0.59	100
Jeep	0.69	0.69	100
Lake #1/Seruchos	0.02	0.94	2
Little Spring	0.25	0.54	47
MB Smith	0.37	0.37	100
Mint Spring	0.01	0.08	16
Mormon Mountain	0.32	0.32	100
Mustang	0.56	0.61	91
Grand Total for 13 Core Areas	**5.08**	**7.61**	**67**

Table 3. Road Maintenance for Hauling and Construction of Temporary Roads (Miles) in PACs (Including Core Areas)

PAC Name	Road Maintenance	Temporary Road Construction	Grand Total
Mechanical Treatment Group			
Archies	2.2		2.2
Bar M	3.6		3.6
Bear Seep	3.2	0.3	3.5
Bonita Tank	2.8	1.2	3.9
Crawdad	3.5		3.5
Foxhole	2.2		2.2
Frank	2.5		2.5
Holdup	1.9		1.9
Iris Tank	3.1		3.1
Knob	4.2		4.2
Lake #1/Seruchos	1.2	1.4	2.6
Lee Butte	5.8		5.8
Mayflower Tank	1.0		1.0
Red Hill	2.2		2.2
Red Raspberry	6.1	0.3	6.4
Rock Top	4.3		4.3
Sawmill Springs	2.0		2.0
T6 Tank	5.4		5.4
Mechanical Treatment Group Total	**57.1**	**3.1**	**60.2**
Prescribed Fire Only Treatment Group			
Blade Tank	1.2		1.2
Boondock	0.0		0.0
Bridge	0.0		0.0
Bristow Tank/Limpios	0.5		0.5
Casner	1.5		1.5
Coulter Ridge	3.0	1.8	4.7
Coyote Park	0.1	<0.1	0.2
Dairy Spring	0.0		0.0
Fain Mountain	0.1		0.1
Frog Tank	2.8		2.8
Fry	0.3		0.3
Gash Mountain	0.9		0.9
Girdner	1.7		1.7
Harding Point	0.8		0.8
Howard Mountain	2.5		2.5
Iowa Camp	2.3		2.3
James Canyon	0.0		0.0
Jeep	0.6	0.2	0.8

PAC Name	Road Maintenance	Temporary Road Construction	Grand Total
Kelly	0.6		0.6
Kendrick	0.2		0.2
Meadow Tank	0.2		0.2
Milos Butte	0.6		0.6
Mint Spring	0.6		0.6
Moore Well/Rock Dike	0.6	0.3	0.8
Mustang	0.6		0.6
Nestor	0.0		0.0
Orion Spring	0.3	0.5	0.8
Pierce Tank	1.5		1.5
Pumphouse Wash	0.3		0.3
Racetrack Tank	0.3	<0.1	0.3
Rattlesnake	0.0		0.0
Spruce Tank	0.2		0.2
Sterling	0.1		0.1
Stock Tank	0.2		0.2
T Bird	1.0		1.0
Two Holes	2.6		2.6
Upper West Fork	0.3	<0.1	0.3
Volunteer	0.2	0.1	0.3
Weimer Springs	2.0		2.0
Woods	1.2		1.2
Prescribed Fire Only Treatment Group Total	**32.1**	**2.9**	**35.0**
PACs With No Proposed Vegetation Treatments			
Aspen Spring	0.3	<0.1	0.3
Casner Cabin	0.2		0.2
De Toros	0.3		0.3
Lockwood	0.0		0.0
Mormon Mountain North	0.6		0.6
PACs with No Proposed Treatments Total	**1.4**	**<0.1**	**1.5**
Grand Total	**90.6**	**6.1**	**96.7**

Appendix 16. Northern Leopard Frog Designated Occupied and Critical Breeding Sites

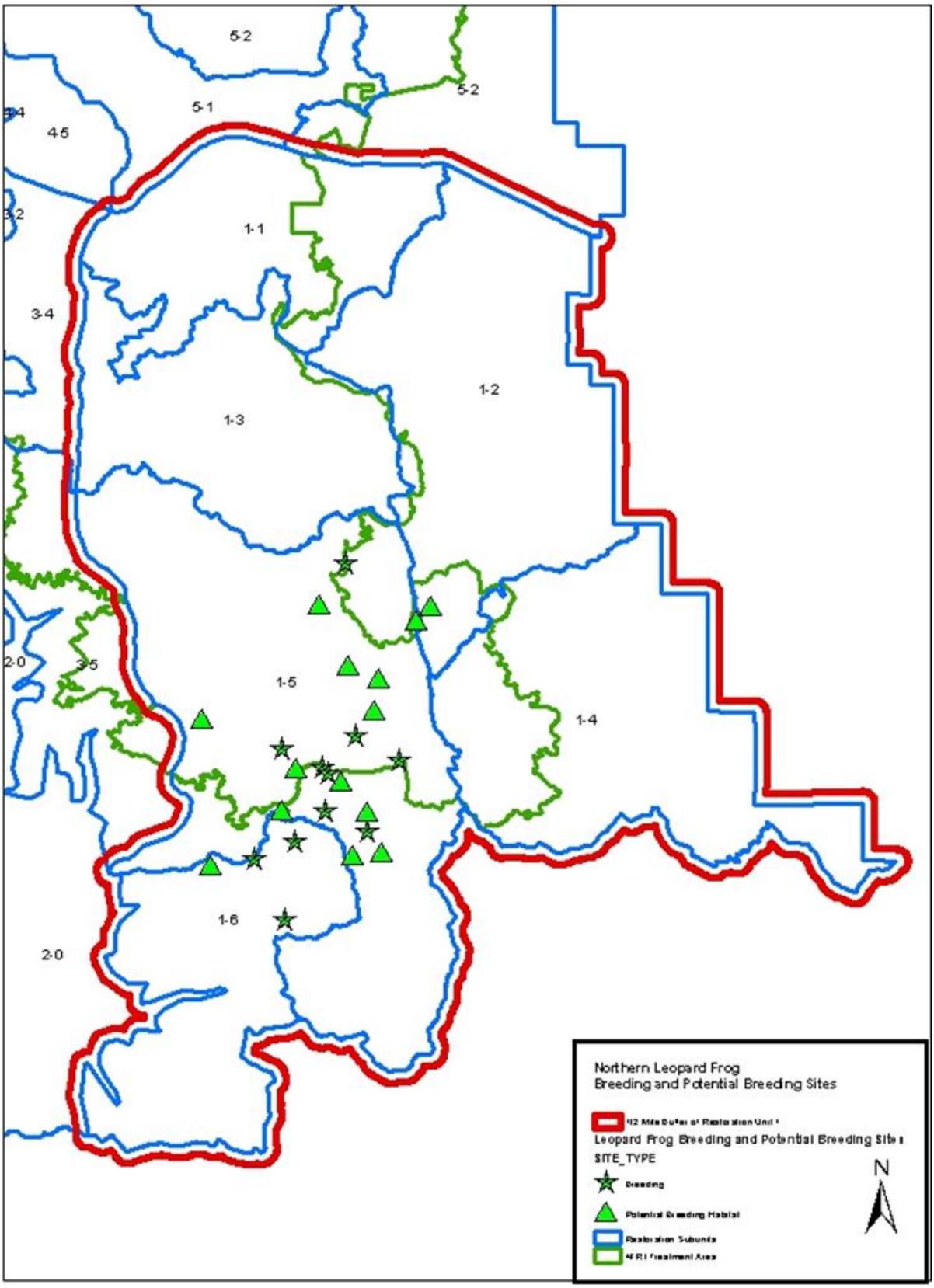


Figure 1. Breeding (Star) and Potential Breeding (Triangle) Sites in and Near the 4FRI Treatment Area (Green Lines) by Subunit (Blue Lines)

Table 1. Northern Leopard Frog Occupied/Critical Breeding Sites within ¼ mile of the Project Area

Site Name	Note	Subunit
Allan Lake	Breeding	1-5
Brolliar Park Tank	Breeding	1-5
Little Daisy Tank	Breeding	1-5
Round Up Park Tank	Breeding	1-5
Gash Mountain Tank	Breeding	1-5
Dairy Springs Tank	Breeding	1-5

Italic indicates breeding site is within the treatment area

Table 2. Northern Leopard Frog Potential Breeding Sites within ¼ mile of the Project Area

Site Name	Note	Subunit
Potato Tanks - Upper and Lower	Potential Breeding	1-5
Cow Tank	Potential Breeding	1-5
Mulholland Tank	Potential Breeding	1-5
Un-mapped Tank (west of Fulton Canyon)	Potential Breeding	1-5
Winsor Tank	Potential Breeding	1-5
Burn Tank	Potential Breeding	1-5
Hennesey Tank/Wallace Lake	Potential Breeding	1-5
Flying M Tank /Ashurst Run	Potential Breeding/also within the NLF Corridor	1-2
Elk Tank	Potential Breeding	1-5
Ohaca Tank	Potential Breeding	1-5

Italic indicates potential breeding site is within the treatment area

Table 3. NLF Potential Breeding Sites outside Treatment Area and ¼ mile buffer but inside Analysis Area

Site Name	Note	Subunit
Butch Tank	Breeding	1-5
Unnamed (Ollie)	Potential Breeding	1-5
Pratt Park	Breeding	1-5
Natural Tank	Potential Breeding	1-5
Steven's Tank (West of Jones Mountain)	Potential Breeding	1-5
Cinder Tank	Potential breeding	1-6
Rarick Tank	Breeding	1-6
Stoneman Lake	Breeding	1-6
Bar-T-Bar #2	Breeding	1-6

Table 4. Potential Habitat the Ashurst/Kinnikinick – Mormon Lake Northern Leopard Frog Corridor (AGFD 2011)

Site Name	Note	Sub Unit
Wallace Lake/Hennesey	Potential Breeding. Borders also within project area.	1-5
Flying M – Ashurst Run	Potential Breeding – In project. Occupied in 2008.	1-2
Mud Lake		1-4
Mud Lake Tank		1-4
Loading Chute Tank		1-2
Ashurst Lake		1-2
Ashurst Run (Flying M)		1-2
VJ Tank	Within ¼ mile of project. Occupied in 2008	1-2
Wallace Tank	In project	1-2
Tony's Tank	In project	1-2
Rogue Tank	In project	1-2
Kinnickinick Reservoir		1-4
Morton Lake	East of Kinnickinick	1-4

Italic indicates potential habitat is within the treatment area

Table 5. NLF Tanks within Potential Habitat within the Treatment Area

Subunit	Number of Tanks
1-1	1
1-2	7
1-3	3
1-4	8
1-5	55 (12 Breeding or Potential Breeding)
3-2	3
3-3	12
3-4	5
3-5	11
4-4	6
5-1	2
TOTAL	942 (12 Breeding or Potential Breeding)

Appendix 17. Cumulative Effects for Wildlife

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Table 1. Cumulative Effects: MSO and other Habitats

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Thin Mixed Con Protected MSO Hab	Burn Mixed Con Protected MSO Hab	MSO Pac Treat Thin	MSO PAC Burn	Thin Mc MSO Hab (Restricted)	Burn Mc MSO Hab (Restricted)	Thin Pipo MSO Hab (Restricted)	Burn Pipo MSO Hab (Restricted)	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Spring Restoration	Rock Pit Development	Channel Restoration
K-Williams	Frenchy	2003 decision	current	yes	yes	no	Total Mechanical: 9,319 -	Objective: Restore forest health, reduce fuel accumulations, improve wildlife habitat diversity, increase large, old trees							1,050	2,713					12.9						
K- Williams	Dogtown Fuels Reduction Project	2004 decision	current	yes	yes	no	Total Acres: 8,209, implementation began in 2004 – 6,509 acres implemented with 1,700 acres left to implement in 2013	Objective: reduce hazardous fuels and associated fire risk							2,321	2,321						18					
K-Williams	City Project	2005 decision	current	yes	yes	no	Total acres: 12,400, implemented 2006 to 2010 with 600 acres left to implement in 2014	Objective: Reduce tree densities and hazardous fuels to improve forest health and sustainability, reduce potential for high severity fire in the City of Williams and its watershed, provide for public & firefighter safety																			
K-Williams	Community Tank Grassland Restoration Project	2011 decision	current	yes	yes	no	Acres implemented: 185 thinning/burning	Part of shelf stock – 865 acres left to implement in 2013 – 185 acres categorized as past									1,050	1,400			2.2						
C-Flagstaff	Doney Park	2007 decision	current	yes	yes	no	1.75 miles of 69 kV line from US Highway 89 to existing 69 kV line - 8.48 acres	Categorized as both past and ongoing due to maintenance (8.48 acre) – part of forest-wide acre summary (ongoing)																			
C-Flagstaff	Woody Ridge Forest Restoration Project	2004	current	yes	yes	yes	Total acres of maintenance prescribed (broadcast) burning: 11,184 ac, thin 8,599 ac	Objective: reduce fire risk and improve forest health, restore travelways for antelope and bear			71	71			4,498	4,498											
C-Flagstaff	Mormon Lake Basin Fuels Reduction	2005	current	yes	yes	no	2,388 ac thinned and broadcast burned – confusing description of ac to be treated	Objective: fuels reduction			38	160	200	200													
C-Flagstaff	Skunk Canyon Prescribed Burn Fuel Reduction	2005 decision	current	yes	yes	no	831 ac of low intensity ground fire in 50 to 200 ac blocks – maintain with burning every 5 to 9 yrs in up to 400-ac blocks	Objective: Reduce fuel loading and fire hazard within WUI																			
Coconino/ Flagstaff	Eastside Fuels Reduction and Forest Health	2006	current	yes	yes	no	Total thin/burn acres: 7,819 acres thin and 20,197 acre burn:	Objective: fuels reduction (WUI) with some restoration							429	1,941											

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Thin Mixed Con Protected MSO Hab	Burn Mixed Con Protected MSO Hab	MSO Pac Treat Thin	MSO PAC Burn	Thin Mc MSO Hab (Resticted)	Burn Mc MSO Hab (Restricted)	Thin Pipo MSO Hab (Resticted)	Burn Pipo MSO Hab (Restricted)	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Spring Restoration	Rock Pit Development	Channel Restoration
C-Flagstaff	Munds Park Fuels Reduction	2009 decision	current	yes	yes	yes	Thin 990 acres of ponderosa pine - complete	Reduce fire risk							139	139											
C-Flagstaff	Hart Prairie Fuels Reduction and Forest Health Project	2010 decision	current	yes	yes	no	pipo restoration 3,790 ac, thin from below 30 ac pipo; mc restoration 250 ac, aspen restoration 3,215 ac, meadow restoration 1,515 ac, bebb's willow restoration 25 acres and burn 965 ac	Project objective: forest restoration and forest health	250	295	161	161					1,515	1,515					3,215				
K-Williams	McCracken Project	2012-NEPA in progress	current	yes	yes	no	Planned treatments: 3,597 acres – group selection, 2,049 acres – shelterwood, 17 acres – irregular thinning, 43 acres – sanitation, 87 acres – aspen release, 806 acres – meadow restoration, 3,551 acres – pine/woodland savanna, 1,053 acres – woodland thinning,4,049 acres – pre-commercial thinning	Project objective: move towards uneven-aged forest structure, reduce mistletoe, restore meadows, savanna, and woodlands							7,181	7,181			326	326							
C-MR	Upper Beaver Watershed Fuel Reduction	2010 (decision)	current	outside project area	yes	no	2,000 acres planned for 2013 vegetation treatments by a variety of prescriptions on about 15,807 acres (about 5,897 acres are in WUI), Prescribed burning on about 31,162 acres (about 10,870 acres are in WUI), Maintenance burning on about 43,906 acres (about 15, 024 acres are in WUI)	Reduce the areas at risk to stand-replacement wildfire that threatens people, private property and natural resource values within the WUI.	525	525	159	159			11,401	29,828											
C-Flagstaff	Wing Mountain Fuels Reduction and Forest Health	2012 (under analysis)	current	yes	yes	no	Total acres thinning: 10,190 acres	Restoration in ponderosa pine, mountain grassland, pine savanna, aspen and spring (Maxwell and Big Leroux), road decommission			392	524	302	316			629						1,422				
C-Flagstaff	Elk Park Fuels Reduction and Forest Health	2007	current	yes	yes	no	4,700 acres of UEA in ponderosa pine	No mention of maintenance burning in DN/FONSI			390	390			1,605	1,605					0.8						0.8
K- Williams	Aspen Restoration Project	2012 - NEPA in progress	future foreseeable	yes	yes	no	Treat 402 acres of aspen within 69 stands and prescribed fire	Objective: Thin conifers, fencing, jackstrawing, prescribed fire, and cutting diseased or dying aspen within stands to encourage regeneration															406				
K-Tusayan	Ten X-Fire Planting	2010 (scoping) – NEPA on hold	future foreseeable	yes	yes	no	Plant 12 acres of ponderosa pine seedlings in 15 plantations that range in from 0.3 to 2.5 ac.	Objective: restore vegetation in high severity burn area																12			

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Thin Mixed Con Protected MSO Hab	Burn Mixed Con Protected MSO Hab	MSO Pac Treat Thin	MSO PAC Burn	Thin Mc MSO Hab (Resticted)	Burn Mc MSO Hab (Restricted)	Thin Pipo MSO Hab (Resticted)	Burn Pipo MSO Hab (Restricted)	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Spring Restoration	Rock Pit Development	Channel Restoration
K-Williams	Bill Williams Mountain Restoration Project (EIS)	2012- In progress	future foreseeable	yes	yes	no	11,650 ac of veg treatment, 15,200 ac of RX Burn: (1) 11,100 ac – treat ≤ 40% slopes, (2) treat 200 ac with specialized equipment, (3) treat 350 ac > 40% slopes, (4) 2,500 ac non-commercial thinning, (5) 15,200 ac of Rx fire, (6) 23 miles of new road construction, (7) 16 miles of temporary road construction, (8) obliterate 28 miles of poorly located roads, (9) 1 mile of new trail and trailhead construction, (10) 3 plan amendments: remove 8,954 ac from timber suitability, treat slopes >40%, deviate in goshawk PFA nest areas	Categorized as reasonably foreseeable due to NEPA status (underway)	920	920	931	931	136	136	3,532	3,532					28						
KNF/CNF	Rock Pit Development: Coconino and Kaibab National Forests	2012 (forsee-able)	future foreseeable	yes	yes	partial	39 material pits to support road maintenance for all projects across the Coc & Kaibab NFs	Road maintenance – see GIS spatial data																		39	
Department of Defense	Camp Navajo Westside Buffer Thinning and Prescribed Fire Project	2013	future foreseeable	yes	yes	no	1,269 acres of mechanical thin																				
Department of Defense	AZARNG Thinning, Burning	2013	future foreseeable	yes	yes	no	17,049 acres – mechanical thin, hand thin, slash treatment and prescribed fire – reduce tree density in 5” dbh to 18” dbh	Ponderosa pine, pine-oak and grasslands to mitigate fire risk, provide diversity in forest conditions, ecosystem health																			
GFFP Projects	GFFP	2013-2014	future foreseeable	yes	yes	partial	535 acres of vegetation thinning and prescribed fire on private land parcels within 180,000-acre GFFP boundary	245 acres (5 private land parcels) in 2013, 190 acres (4 to 10 parcels) in 2014, and 100 acres of prescribed burning through 2014																			
C-Flagstaff	Marshall Fuels Reduction	2011 (decision)	future foreseeable	yes	yes	no	Total thinning acres: 10,800 ac.	Project objective: reduce the risk of wildfire, improve forest health and associated habitats, according to Coconino NF Plan guidance. There is a need to move vegetation toward conditions supporting natural and desirable fire behavior with healthy and sustainable forests, woodlands, meadows, & wetlands.							1,373	1,373	3,680	3,590	2,000	2,000							
C-Flagstaff	Turkey/Barney Pasture Forest Health Restoration	2012	future foreseeable	yes	yes	yes	Thin in dwarf mistletoe	Project objective: reduce the risk of wildfire, improve forest health and associated habitats			1,703				6,030	6,442											

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Thin Mixed Con Protected MSO Hab	Burn Mixed Con Protected MSO Hab	MSO Pac Treat Thin	MSO PAC Burn	Thin Mc MSO Hab (Resticted)	Burn Mc MSO Hab (Restricted)	Thin Pipo MSO Hab (Resticted)	Burn Pipo MSO Hab (Restricted)	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Spring Restoration	Rock Pit Development	Channel Restoration
CNF	Western Area Power Administration	2012-Foreseeable	future foreseeable	yes	yes	no	4,584 acres of vegetation thinning (equates to 9,572 total trees removed) to remove trees that impinging on power line: 1,770 ac are in ponderosa pine, 8 ac of aspen, 10 ac of cottonwood/ willow riparian, 25 ac of wetland cienega, 35 ac montane/sub-alpine grass, 175 ac semi-desert grass, 810 acres pinyon-juniper evergreen shrub, 1,280 ac p/j woodland - EA underway	Hazard tree removal											2,090								
AZ State Lands Dept, C-Flagstaff	Grapevine Canyon Wind Project	2012 analysis in progress	future foreseeable	yes	yes	no	22 miles SE of Flagstaff, AZ/ S of I-40 to Happy Jack – 200 ft ROW & 8.5 miles of NFSL and construction of 15-ac switchyard																					
C-Flagstaff	Flagstaff Watershed Protection/ Fuels Reduction	2013 analysis initiated	future foreseeable	yes	yes	no	PA	Fuels reduction and watershed protection in Dry Lake Hills and Mormon Mountain in Upper Lake Mary Watershed			3,723		1,736	1,736			59						22				
K-Williams	Williams High Risk Pre Commerical Thin	2001 (decision)	past	yes	yes	no	Activities database shows 756 ac thinned, machine piled and burned in 2002 to 2003	No project records could be located																			
K-Williams	Potato Hill Habitat Improvement	2003 (decision)	past	yes	yes	no	& total 1,275 ac	Objective: improve wildlife habitat											1,275								
K-Williams	Clover High Fuels Reduction	2004	past	yes	yes	no	385 ac by 2004 -thin, machine pile, burn	No project records could be located																			
K-Williams	Pineaire Fuels Reduction	2004 (decision)	past	yes	yes	no	Total acres: 650 acres of treatments, implemented 2004 to 2009	Objective: reduce fuel hazards around communities. No MSO habitat in project area (BAE)																			
K-Williams	Williams Follow-up Mistletoe Treatment Project	2004 (decision)	past	yes	yes	no	Total Acres: 368	Objective: forest health																			
K-Williams	Govt Mtn/ Coleman Aspen Restoration	2005 (decision)	past	yes	yes	no	Total acres: 75	Encourage and promote aspen and protect from heavy browse															11				
K - Williams	Garland Prairie Grassland Restoration	2005 (decision)	past	yes	yes	no	Total acres: 500	Objective: improve wildlife habitat including pronghorn fawning, movement, migration, and sighting distance and elk winter and summer range									500	47									
K-Williams	Kendrick Prescribed Burning	2005-2006 (implemented)	past	yes	yes	no	Total Acres: Unknown – need data from Kaibab																				

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Thin Mixed Con Protected MSO Hab	Burn Mixed Con Protected MSO Hab	MSO Pac Treat Thin	MSO PAC Burn	Thin Mc MSO Hab (Resticted)	Burn Mc MSO Hab (Restricted)	Thin Pipo MSO Hab (Resticted)	Burn Pipo MSO Hab (Restricted)	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Spring Restoration	Rock Pit Development	Channel Restoration
K – Williams	Flag Tank Aspen Restoration	2007 (decision)	past	yes	yes	no	Total acres: 36	Objective: prevent further loss of aspen. No MSO habitat as per wildlife specialist report															22				
K-Williams	Ida Grassland Maintenance Project	2008 (decision)	past	yes	yes	no	Total Acres: 1,800	Categorized as past – Kaibab web information states project was implemented in 2010									1,800										
K-Williams	Bill Williams Cap Fuels Reduction	2009 (decision)	past	yes	yes	no	Total acres: 10	Reduce hazardous fuels on 10 ac at the top of Bill Williams Mtn to protect electronic site																			
K-Tusayan	Ten X and Red Horse Mudersbach Timber Sale	1998 (decision)	past	yes	yes	no	Total Mechanical Treatment Acres: 324 acres	Objective: forest health (vigor, distribution, understory and forage), reduce hazardous fuels, improve water sources and watershed											85		10						
K-Tusayan	Tusayan South/Boggy Tank	2000-2002	past	outside project area	yes	no	Tusayan S. = 1,100 ac of fuel reduction; Boggy Tank – 1,848 ac of fuels reduction	No project record – found in airport fuels cum effects categorized as on-going in Airport Fuels cum effects																			
K-Tusayan	Ten X Pre-Commercial Thinning Project	2004 (decision)	past	yes	yes	no	Total Acres implemented 2,761 acres	Objective: improve forest health, stand and tree resilience and vigor, improve understory diversity 2,761 acres																			
K-Tusayan	Topeka Fuels Reduction Project	2004 (decision)	past	yes	yes	no	Total acres: 1,100	Objective: Reduce fuels within the urban interface areas around Tusayan and adjacent to the Grand Canyon NP											1,100	1,100							
K-Tusayan	Scott	2001-2007 (implementation)	past	yes	yes	no	From 2002 to 2004: 421 ac of pre-commercial thin and 300 ac machine piled and burned 2002 to 2007 – 9,434 ac broadcast burned	No project records could be found other than shape files																			
K- Tusayan	X-Fire Hazard Tree Removal	2009 (decision)	past	yes	yes	no	140 acres	Categorized as past due to scope and date of decision																			
K-Tusayan	Tusayan Wildlife Waters Project	2008 (decision)	past	yes	yes	no	24 water developments constructed	Digitized points																	24		
C-Flagstaff	Arboretum WUI	2000	past	yes	yes	no	602 acres total:	Reduce fuel loading, fuel ladders, & overall fire hazards within the WUI; reduce fire potential to The Arboretum and Dry Lake Caldera																			
C- Peaks RD	Fort Valley	2000	past	yes	yes	no	1,700 acres of thinning less than 16” dbh	Categorized as past due to volume and year'																			
C-Flagstaff	A-1 MultiProduct Timber Sale (in PALS) East M-P, A-1 West, A-1 East	2000-2002	past	yes	yes	no	3 projects = 14,155 ac; 8,274 ac = broadcast burn; 364 ac are pile burn; and 5,517 ac = thinning	13,463 acre-boundary found in GIS, acreage is from GFFP 2010 data summary																			
C-Flagstaff	Rocky Park Fuels Reduction	2001	past	yes	yes	yes	5,651 ac thinned	Reduce fire potential																			
C-Flagstaff	Lake Mary Fuels Reduction (PALS : Lake Mary Meadows Tow Fuel Reduction)	2005	past	yes	yes	no	2 projects: 3,245 ac of Rx burning & 1,845 ac thinned; 1,616 ac of Rx burning & 1,824 ac of thinned & 1,629 ac of Rx burning	Only shape files could be retrieved from corporate data, numbers are from GFFP data																			

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Thin Mixed Con Protected MSO Hab	Burn Mixed Con Protected MSO Hab	MSO Pac Treat Thin	MSO PAC Burn	Thin Mc MSO Hab (Resticted)	Burn Mc MSO Hab (Restricted)	Thin Pipo MSO Hab (Resticted)	Burn Pipo MSO Hab (Restricted)	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Spring Restoration	Rock Pit Development	Channel Restoration
C-Flagstaff	APS Hazard Tree Removal	2003	past	yes	yes	no	315 ac Rx fire	Data from GFFP data - past																			
C-Flagstaff	APS Powerline	2007 (decision)	past	yes	yes	no	Construction of 46 mile 12kV distribution powerline from Flagstaff to Happy Jack, with vegetation clearing on 167 ac (30 ft wide)	See project details - assume construction and vegetation clearing is complete due to date of decision and that maintenance on 167 acres is ongoing – part of forest-wide acre summary (ongoing)																	
C-Flagstaff	Kachina Village	2003	past	yes	yes	yes	Thin 4,800 acres (3,801 acres implemented) broadcast and maintenance burn on 6,229 ac (2,147 ac implemented)	Implementation acres data from GFFP report – project objective: improve declining forest health and reduce wildfire potential																	
Coconino/ GFFP	Elden	2006	past	yes	yes	no	193 ac of fuels reduction cooperatively thinned	No project record located – project referenced in Eastside Fuels DN																	
C-Flagstaff	Little Draw Aspen	2009	past	yes	yes	no	53 aspen exclosures on 107 ac w/fencing	Implemented 2010															107		
C-Flagstaff	Slate Mountain Pronghorn Habitat Restoration Phase III	2010	past	yes	yes	no	2,250 ac of grassland restoration – hand cut encroaching ponderosa pine and juniper	Categorized as past due to date of decision									2,250								
C-Flagstaff	Shultz Fire BAER	2010-2011	past	yes	yes	no	150 snags removed within 100 ft of road along 17.5 miles; Waterline Rd = 22 snags removed in Weatherford PAC; 29 snags removed in Pipeline PAC; 2 ac disturbance in MSO habitat; Reconstruction activities:– 0.5 ac lost in Pipeline PAC & 0.4 ac lost in Weatherford PAC, 0.8 acres restricted habitat lost	Categorized as past																	
Dept of Defense	Camp Navajo	2003-2010	past	yes	yes	no	1,636 acres of Rx fire	Camp Navajo Data, no data before 2003																	
Dept of Defense	Camp Navajo Westside Buffer	2006-2011	past	yes	yes	no	1,045 ac of thinning and broadcast burn	retain trees > 18"dbh, removed excess density of trees between 5" to 18"dbh to an avg BA of 50																	
Dept of Defense	Camp Navajo Tornado Fuels Reduction Project	2012	past	yes	yes	no	854 ac damaged tree removal	Data from Camp Navajo																	
GFFP/State Forestry	AZ State Forestry	2000 to 2010	past	yes	yes	no	1,310 ac private land thinning w/ State Forestry $	Data from AZ State Forestry																	
TOTALS											7,568				39,559	61,573	11,483	6,552	6,876	3,426	54	18	5,205	12	24	39	1
K-Tusayan – out of 4FRI area	Upper Basin Project	2000 (decision)	no	outside 4FRI	outside 4FRI	no	Total acres: 1,884	Objective: Improve and maintain grassland and winter range habitat										1,884									
K-Tusayan– out of 4FRI area	Tusayan West	1998-2001	no	outside 4FRI	outside 4FRI	no	850 ac total: 1) 549 ac thinned, (2) 850 ac Rx, (3) 75 miles rd oblit	No project record located – found in airport fuels cum effects											549	850	75						

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Thin Mixed Con Protected MSO Hab	Burn Mixed Con Protected MSO Hab	MSO Pac Treat Thin	MSO PAC Burn	Thin Mc MSO Hab (Resticted)	Burn Mc MSO Hab (Restricted)	Thin Pipo MSO Hab (Resticted)	Burn Pipo MSO Hab (Restricted)	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Spring Restoration	Rock Pit Development	Channel Restoration
K-Tusayan– out of 4FRI area	Anita project	2002	no	outside 4FRI area	outside 4FRI area	no	100 miles of rd obliteration	No project record located – found in airport fuels cum effects													100						
K-Tusayan– out of 4FRI area	Moqui Antelope Habitat Improvement Project	2006 (decision)	no	outside 4FRI area	outside 4FRI area	no	Total Acres: 1,300 Moqui, 1,690 Red Butte	Objective: antelope habitat and watershed improvement									2,990										
K-Tusayan– out of 4FRI area	O'Connell	Pre-2009	no	outside 4FRI area	outside 4FRI area	no	500 ac grassland improvement/ sagebrush mowing	No project record found in airport fuels cum effects									500										
C-Mogollon Rim– out of 4FRI area	Blue Ridge 69 KV Transmission Line	2005 (decision)	no	outside 4FRI area	outside 4FRI area	no	11 miles of powerline & 2-acre substation	See spatial data																			
C-Mogollon Rim– out of 4FRI area	Apache Maid Grass CE	2004	no	outside 4FRI area	outside 4FRI area	no	54,528 ac hand-cutting (lop & scatter) invasive pine and juniper trees in Apache Maid Allotment	Grassland maintenance											54,528								
C-Mogollon Rim– out of 4FRI area	East Clear Creek Watershed Heatlh Improvement	2006	no	outside 4FRI area	outside 4FRI area	no	Total project = 16,228 ac	Restore understory and overstory health & diversity; reduce high severity fire risk & rd impacts on watershed and riparian habitat																			
TOTAL											**0**				**0**	**0**	**3,490**	**1,884**	**55,077**	**850**	**175**	**0**	**0**	**0**	**0**	**0**	**0**

Table 2. Cumulative Effects: Northern Goshawks and Other Habitats

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Rx Burn Pipo LOPFA	Thin Pipo LOPFA	NOGO PFA/Nest Treats	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Water Development	Rock Pit Development	Channel Restoration
K-Williams	Frenchy	2003 (decision)	current	yes	yes	no	Total Mechanical: 9,319 -	Objective: Restore forest health, reduce fuel accumulations, improve wildlife habitat diversity, increase large, old trees	6,606	7,117						12.9						
K- Williams	Dogtown Fuels Reduction Project	2004 (decision)	current	yes	yes	no	8,209 Ac: implementation began in 2004 – 6,509 acres implemented; 1,700 ac left in 2013	Objective: reduce hazardous fuels and associated fire risk	5,888	5,888							18					
K-Williams	City Project	2005 (decision)	current	yes	yes	no	12,400 acres: implemented 2006 to 2010; 600 ac left in 2014	Reduce tree densities & hazardous fuels to improve forest health and sustainability; reduce potential for high severity fire in the City of Williams and its watershed; provide public & firefighter safety	12,400	8,667												

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Rx Burn Pipo LOPFA	Thin Pipo LOPFA	NOGO PFA/Nest Treats	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Water Development	Rock Pit Development	Channel Restoration
K-Williams	Community Tank Grassland Restoration Project	2011 (decision)	current	yes	yes	no	185 Ac implemented: thinning/burning	Part of shelf stock – 865 acres left to implement in 2013 – 185 acres categorized as past				1,050	1,400			2.2						
C-Flagstaff	Doney Park	2007 decision	current	yes	yes	no	1.75 miles of 69 kV line from US Highway 89 to existing 69 kV line - 8.48 acres	Categorized as both past and ongoing due to maintenance (8.48 acre) – part of forest-wide acre summary (ongoing)		9												
C-Flagstaff	Woody Ridge Forest Restoration Project	2004	current	yes	yes	yes	Total acres of maintenance prescribed (broadcast) burning: 11,184 ac, thin 8,599 ac	Objective: reduce fire risk and improve forest health, restore travelways for antelope and bear	6,747	3,802	228											
C-Flagstaff	Mormon Lake Basin Fuels Reduction	2005	current	yes	yes	no	2,388 ac thinned and broadcast burned – confusing description of ac to be treated	Objective: fuels reduction	2,028	2,150												
C-Flagstaff	Skunk Canyon Prescribed Burn Fuel Reduction	2005 decision	current	yes	yes	no	831 ac of low intensity ground fire in 50 to 200 ac blocks – maintain with burning every 5 to 9 yrs in up to 400-ac blocks	Objective: Reduce fuel loading and fire hazard within WUI	831													
Coconino/ Flagstaff	Eastside Fuels Reduction and Forest Health	2006	current	yes	yes	no	Total thin/burn acres: 7,819 acres thin and 20,197 acre burn:	Objective: fuels reduction (WUI) with some restoration	18,256	7,390												
C-Flagstaff	Munds Park Fuels Reduction	2009 (decision)	current	yes	yes	yes	Thin 990 acres of ponderosa pine - complete	Reduce fire risk	2,811	851												
C-Flagstaff	Hart Prairie Fuels Reduction and Forest Health Project	2010 decision	current	yes	yes	no	pipo restoration 3,790 ac, thin from below 30 ac pipo; mc restoration 250 ac, aspen restoration 3,215 ac, meadow restoration 1,515 ac, bebb's willow restoration 25 acres and burn 965 ac	Project objective, forest restoration and forest health	4,785	3,820		1,515	1,515					3,215				
K-Williams	McCracken Project	2012- NEPA in progress	current	yes	yes	no	Planned treatments: 3,597 ac group selection, 2,049 ac shelterwood, 17 ac irregular thinning, 43 ac sanitation, 87 ac aspen release, 806 ac meadow restoration, 3,551 ac pine/ woodland savanna, 1,053 ac woodland thinning,4,049 ac pre-commercial thinning	Project objective: move towards uneven-aged forest structure, reduce mistletoe, restore meadows, savanna, and woodlands	9,830	7,755				326	326							
C-MR	Upper Beaver Watershed Fuel Reduction	2010 (decision)	current	outside project area	yes	no	2,000 ac for 2013 vegetation treatments by a variety of prescriptions on about 15,807 ac (about 5,897 ac are in WUI), Prescribed burning on about 31,162 ac (about 10,870 ac are in WUI), Maintenance burning on about 43,906 ac (about 15, 024 ac are in WUI)	Reduce the areas at risk to stand-replacement wildfire that threatens people, private property and natural resource values within the WUI.	13,394	3,722												
C-Flagstaff	Wing Mountain Fuels Reduction and Forest Health	2012 (under analysis)	current	yes	yes	no	Total acres thinning: 10,190 acres	Restoration in ponderosa pine, mountain grassland, pine savanna, aspen and spring r(Maxwell and Big Leroux), road decommission	9,927	7,344		629						1,422				

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Rx Burn Pipo LOPFA	Thin Pipo LOPFA	NOGO PFA/Nest Treats	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Water Development	Rock Pit Development	Channel Restoration
C-Flagstaff	Elk Park Fuels Reduction and Forest Health	2007	current	yes	yes	no	4,700 acres of UEA in ponderosa pine	No mention of maintenance burning in DN/FONSI	4,405	2,715						0.8						0.8
K- Williams	Aspen Restoration Project	2012 - NEPA in progress	future foreseeable	yes	yes	no	Treat 402 acres of aspen in 69 stands & Rx fire	Objective: Thin conifers, fencing, jackstrawing, prescribed fire, and cutting diseased or dying aspen within stands to encourage regeneration										406				
K-Tusayan	Ten X-Fire Planting	2010 (scoping) – NEPA on hold	future foreseeable	yes	yes	no	Plant 12 acres of ponderosa pine seedlings in 15 plantations that range in from 0.3 to 2.5 ac.	Objective: restore vegetation in high severity burn area											12			
K-Williams	Bill Williams Mountain Restoration Project (EIS)	2012- In progress	future foreseeable	yes	yes	no	11,650 ac of veg treatment, 15,200 ac of RX Burn: (1) 11,100 ac – treat ≤ 40% slopes, (2) treat 200 ac with specialized equipment, (3) treat 350 ac > 40% slopes, (4) 2,500 ac non-commercial thinning, (5) 15,200 ac of Rx fire, (6) 23 miles of new road construction, (7) 16 miles of temporary road construction, (8) obliterate 28 miles of poorly located roads, (9) 1 mile of new trail and trailhead construction, (10) 3 plan amendments: remove 8,954 ac from timber suitability, treat slopes >40%, deviate in goshawk PFA nest areas	Categorized as reasonably foreseeable due to NEPA status (underway)	5,281	5,281	1,660					28						
KNF/CNF	Rock Pit Development: Coconino and Kaibab National Forests	2012 (foreseeable)	future foreseeable	yes	yes	partial	39 material pits to support road maintenance for all projects across the Coc & Kaibab NFs	Road maintenance – see GIS spatial data													39	
Department of Defense	Camp Navajo Westside Buffer Thinning & Rx Fire Project	2013	future foreseeable	yes	yes	no	1,269 acres of mechanical thin		1,629	1,629												
Department of Defense	AZARNG Thinning, Burning	2013	future foreseeable	yes	yes	no	17,049 acres – mechanical thin, hand thin, slash treatment and prescribed fire – reduce tree density in 5” dbh to 18” dbh	Ponderosa pine, pine-oak and grasslands to mitigate fire risk, provide diversity in forest conditions, ecosystem health	17,049	17,049												
GFFP Projects	GFFP	2013-2014	future foreseeable	yes	yes	partial	535 acres of vegetation thinning & Rx fire on private land within 180,000-acre GFFP boundary	245 acres (5 private land parcels) in 2013, 190 acres (4 to 10 parcels) in 2014, and 100 acres of prescribed burning through 2014	535	535												
C-Flagstaff	Marshall Fuels Reduction	2011 (decision)	future foreseeable	yes	yes	no	Total thinning acres: 10,800 ac.	Reduce the risk of wildfire, improve forest health & wildlife habitats, according to Coconino NF Plan guidance. There is a need to move vegetation toward conditions supporting natural and desirable fire behavior with healthy and sustainable forests, woodlands, meadows, & wetlands.	4,887	3,747		3,680	3,590	2,000	2,000							

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Rx Burn Pipo LOPFA	Thin Pipo LOPFA	NOGO PFA/Nest Treats	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Water Development	Rock Pit Development	Channel Restoration
C-Flagstaff	Turkey/Barney Pasture Forest Health Restoration	2012	future foreseeable	yes	yes	yes	Thin in dwarf mistletoe	Project objective: reduce the risk of wildfire, improve forest health and associated habitats	5,993	6,405												
CNF	Western Area Power Administration	2012-Foreseeable	future foreseeable	yes	yes	no	4,584 acres of vegetation thinning (equates to 9,572 total trees removed) to remove trees that impinging on power line: 1,770 ac are in ponderosa pine, 8 ac of aspen, 10 ac of cottonwood/ willow riparian, 25 ac of wetland cienega, 35 ac montane/sub-alpine grass, 175 ac semi-desert grass, 810 acres pinyon-juniper evergreen shrub, 1,280 ac p/j woodland - EA underway	Hazard tree removal		1,770				2,090								
AZ State Lands Dept, C-Flagstaff	Grapevine Canyon Wind Project	2012 analysis in progress	future foreseeable	yes	yes	no	22 miles SE of Flagstaff, AZ/ S of I-40 to Happy Jack – 200 ft ROW & 8.5 miles of NFSL and construction of 15-ac switchyard															
C-Flagstaff	Flagstaff Watershed Protection/ Fuels Reduction	2013 analysis initiated	future foreseeable	yes	yes	no	PA	Fuels reduction and watershed protection in Dry Lake Hills and Mormon Mountain in Upper Lake Mary Watershed	2,881	2,743	387	59						22				
K-Williams	Williams High Risk Pre Commerical Thin	2001 (decision)	past	yes	yes	no	Activities database shows 756 ac thinned, machine piled and burned in 2002 to 2003	No project records could be located	756	756												
K-Williams	Potato Hill Habitat Improvement	2003 (decision)	past	yes	yes	no	1,275 acres	Objective: improve wildlife habitat						1,275								
K-Williams	Clover High Fuels Reduction	2004	past	yes	yes	no	385 ac by 2004 -thin, machine pile, burn	No project records could be located	385	385												
K-Williams	Pineaire Fuels Reduction	2004 (decision)	past	yes	yes	no	650 ac of treatments, implemented 2004 to 2009	Objective: reduce fuel hazards around communities. No MSO habitat in project area (BAE)	645	650												
K-Williams	Williams Follow-up Mistletoe Treatment Project	2004 (decision)	past	yes	yes	no	368 Acres	Objective: forest health	368	368												
K-Williams	Government Mountain/Coleman Aspen Restoration	2005 (decision)	past	yes	yes	no	75 acres	Encourage & promote aspen/ protect from heavy browse		75								11				
K - Williams	Garland Prairie Grassland Restoration	2005 (decision)	past	yes	yes	no	Total acres: 500	Improve wildlife habitat including pronghorn fawning, movement, migration, and sighting distance and elk winter and summer range				500	47									

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Rx Burn Pipo LOPFA	Thin Pipo LOPFA	NOGO PFA/Nest Treats	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Water Development	Rock Pit Development	Channel Restoration
K-Williams	Kendrick Prescribed Burning	2005-2006 (implemented)	past	yes	yes	no	Total Acres: Unknown – need data from Kaibab															
K – Williams	Flag Tank Aspen Restoration	2007 (decision)	past	yes	yes	no	Total acres: 36	Prevent further loss of aspen. No MSO habitat as per wildlife specialist report	36									22				
K-Williams	Ida Grassland Maintenance Project	2008 (decision)	past	yes	yes	no	Total Acres: 1,800	Categorized as past – Kaibab web information states project was implemented in 2010				1,800										
K-Williams	Bill Williams Cap Fuels Reduction	2009 (decision)	past	yes	yes	no	Total acres: 10	Objective: Reduce hazardous fuels on 10 acres at the top of Bill Williams Mountain to protect electronic site	8	10												
K-Tusayan	Ten X and Red Horse Mudersbach Timber Sale	1998 (decision)	past	yes	yes	no	Total Mechanical Treatment Acres: 324 acres	Objective: forest health (vigor, distribution, understory and forage), reduce hazardous fuels, improve water sources and watershed	3,500	198				85		10						
K-Tusayan	Tusayan South/Boggy Tank	2000-2002	past	Out of 4FRI area	yes	no	Tusayan S.= 1,100 ac fuel reduction, Boggy Tank – 1,848 ac of fuels reduction	No project record – found in airport fuels cum effects categorized as on-going in Airport Fuels cum effects	2,948	2,948												
K-Tusayan	Ten X Pre-Commercial Thinning Project	2004 (decision)	past	yes	yes	no	Total Acres implemented 2,761 acres	Objective: improve forest health, stand and tree resilience and vigor, improve understory diversity 2,761 acres	2,761	1,780												
K-Tusayan	Topeka Fuels Reduction Project	2004 (decision)	past	yes	yes	no	Total acres: 1,100	Objective: Reduce fuels within the WUI areas around Tusayan and adjacent to the Grand Canyon NP						1,100	1,100							
K-Tusayan	Scott	2001-2007 (implementation)	past	yes	yes	no	2002 to 2004: 421 ac of pre-commercial thin & 300 ac machine piled & burned; 2002 to 2007: 9,434 ac Rx fire	No project records could be found other than shape files	9,434	421												
K- Tusayan	X-Fire Hazard Tree Removal	2009 (decision)	past	yes	yes	no	Total acres: 140:	Categorized as past due to scope and date of decision		140												
K-Tusayan	Tusayan Wildlife Waters Project	2008 (decision)	past	yes	yes	no	24 water developments constructed	Digitized points													24	
C-Flagstaff	Arboretum WUI	2000	past	yes	yes	no	602 acres total:	Objective: reduce fuel loading, fuel ladders, and overall fire hazards within the WUI and reduce fire potential to The Arboretum and Dry Lake Caldera	602	602												
C- Peaks RD	Fort Valley	2000	past	yes	yes	no	1,700 ac thinning < 16” dbh	Categorized as past due to volume and year'	786	786	914											
C-Flagstaff	A-1 MultiProduct Timber Sale (in PALS) East M-P, A-1 West, A-1 East	2000-2002	past	yes	yes	no	3 projects: 14,155 ac; 8,274 ac = broadcast burn; 364 ac = pile burn; and 5,517 ac = thinning	13,463 acre-boundary found in GIS, acreage is from GFFP 2010 data summary	8,274	5,517												
C-Flagstaff	Rocky Park Fuels Reduction	2001	past	yes	yes	yes	5,651 acres thinned	Objective: reduce fire potential	8,000	5,651												

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Rx Burn Pipo LOPFA	Thin Pipo LOPFA	NOGO PFA/Nest Treats	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Water Development	Rock Pit Development	Channel Restoration
C-Flagstaff	Lake Mary Fuels Reduction (PALS : Lake Mary Meadows Tow Fuel Reduction)	2005	past	yes	yes	no	2 projects: 3,245 ac of Rx burning & 1,845 ac thinned; 1,616 ac of Rx burning & 1,824 ac of thinned & 1,629 ac of Rx burning	Only shape files could be retrieved from corporate data, numbers are from GFFP data	3,245	1,845												
C-Flagstaff	APS Hazard Tree Removal	2003	past	yes	yes	no	315 acres broadcast burn	Data from GFFP data - past	315													
C-Flagstaff	APS Powerline	2007 (decision)	past	yes	yes	no	Construction of 46 mile 12kV distribution powerline from Flagstaff to Happy Jack, with vegetation clearing on 167 ac (30 ft wide)	See project details - assume construction and vegetation clearing is complete due to date of decision and that maintenance on 167 acres is ongoing – part of forest-wide acre summary (ongoing)		167												
C-Flagstaff	Kachina Village	2003	past	yes	yes	yes	Thin 4,800 ac: (3,801 ac done); broadcast and maintenance burn on 6,229 ac (2,147 ac done)	Implementation acres data from GFFP report – project objective: improve declining forest health and reduce wildfire potential	5,925	4,496	304											
Coconino/ GFFP	Elden	2006	past	yes	yes	no	193 acres of fuels reduction – cooperatively thinned	No project record located – project referenced in Eastside Fuels DN	193	193												
C-Flagstaff	Little Draw Aspen	2009	past	yes	yes	no	53 aspen exclosures/107 ac w/fencing	Implemented 2010										107				
C-Flagstaff	Slate Mountain Pronghorn Habitat Restoration Phase III	2010	past	yes	yes	no	2,250 ac of grassland restoration – hand cut encroaching ponderosa pine and juniper	Categorized as past due to date of decision				2,250										
C-Flagstaff	Shultz Fire BAER	2010-2011	past	yes	yes	no	150 snags removed within 100 ft of road along 17.5 miles; Waterline Rd = 22 snags removed in Weatherford PAC; 29 snags removed in Pipeline PAC; 2 ac disturbance in MSO habitat; Reconstruction activities:– 0.5 ac lost in Pipeline PAC & 0.4 ac lost in Weatherford PAC, 0.8 ac lost restricted habitat	Categorized as past													
Department of Defense	Camp Navajo	2003-2010	past	yes	yes	no	1,636 acres of broadcast burning	Camp Navajo Data, no data available prior to 2003	1,636													
Department of Defense	Camp Navajo Westside Buffer	2006-2011	past	yes	yes	no	1,045 ac of thinning and broadcast burn	retain trees > 18"dbh, removed excess density of trees between 5” to 18"dbh to an average stand basal area of 50	1,045	1,045												
Department of Defense	Camp Navajo Tornado Fuels Reduction	2012	past	yes	yes	no	854 acres – removed storm damaged trees	Data from Camp Navajo		854												
GFFP/State Forestry	AZ State Forestry	2000 to 2010	past	yes	yes	no	1,310 ac private land thinning w/ State Forestry $	Data from AZ State Forestry		1,310												
TOTALS									**187,025**	**130,586**	**3,493**	**11,483**	**6,552**	**6,876**	**3,426**	**54**	**18**	**5,205**	**12**	**24**	**39**	**1**

Forest/ RD	Project	Year	Cum effects Project	in project area	in project area and 1/2 mile buffer	in restoration unit 3-5	Planned Treatments by Type and Size (acres)	Project Objective	Rx Burn Pipo LOPFA	Thin Pipo LOPFA	NOGO PFA/Nest Treats	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Obliteration	Closed Road	Aspen Regeneration	Reforestation	Water Development	Rock Pit Development	Channel Restoration
K-Tusayan	Upper Basin Project	2000 (decision)	no	outside 4FRI area	outside 4FRI area	no	Total acres: 1,884	Objective: Improve and maintain grassland and winter range habitat					1,884									
K-Tusayan	Tusayan West	1998-2001	no	outside 4FRI area	outside 4FRI area	no	850 ac total: 1) 549 ac thinned, (2) 850 ac Rx, (3) 75 miles rd oblit	No project record located – found in airport fuels cum effects						549	850	75						
K-Tusayan	Anita project	2002	no	outside 4FRI area	outside 4FRI area	no	100 miles of rd obliteration	No project record located – found in airport fuels cum effects								100						
K-Tusayan	Moqui Antelope Habitat Improvement Project	2006 (decision)	no	outside 4FRI area	outside 4FRI area	no	Total Acres: 1,300 Moqui, 1,690 Red Butte	Objective: antelope habitat and watershed improvement				2,990										
K-Tusayan	O'Connell	Pre-2009	no	outside 4FRI area	outside 4FRI area	no	500 ac grassland improvement/ sagebrush mowing	No project record found in airport fuels cum effects				500										
C-Mogollon Rim	Blue Ridge 69 KV Transmission Line	2005 (decision)	no	outside 4FRI area	outside 4FRI area	no	11 miles of powerline & 2-acre substation	See spatial data	1,300	50												
C-Mogollon Rim	Apache Maid Grass CE	2004	no	outside 4FRI area	outside 4FRI area	no	54,528 ac hand-cutting (lop & scatter) invasive pine and juniper trees in Apache Maid Allotment	Objective: grassland maintenance						54,528								
C-Mogollon Rim	East Clear Creek Watershed Heatlh Improvement	2006	no	outside 4FRI area	outside 4FRI area	no	Total project acres: 16,228:	Restore understory & overstory health and diversity, reduce potential for stand-replacing fire and road impacts on watershed and riparian habitat	14,500	4,700												
TOTAL									**15,800**	**4,750**	**0**	**3,490**	**1,884**	**55,077**	**850**	**175**	**0**	**0**	**0**	**0**	**0**	**0**

Table 3. Summary Totals for Cumulative Effects by Habitat Type in the Project Area

Cumulative Effects Project Type	Thin Pipo LOPFA	Rx Burn Pipo LOPFA	Thin Mixed Con Protected MSO Hab	Burn Mixed Con Protected MSO Hab	MSO PAC Treat Thin	MSO PAC Burn	NOGO PFA/Nest Treats	Thin Mc MSO Hab (Restricted)	Burn Mc MSO Hab (Restricted)	Thin Pipo MSO Hab (Restricted)	Burn Pipo MSO Hab (Restricted)
current	57,508	84,514	250	295	1,052	1,306	228	502	516	17,223	20,398
future foreseeable	39,159	38,255	920	920	6,357	931	2,047	1,872	1,872	10,935	11,347
past	27,249	47,914					1,218				
Grand Total	123,916	170,683	1,170	1,215	7,409	2,237	3,493	2,374	2,388	28,158	31,745
Cumulative Effects Project Type	thin grassland	rx burn grassland	thin p-j	rx burn p-j	rd oblit	closed road	aspen regen	reforestation	rock pit development	water development	channel restoration
current	3,194	2,915	326	326	16	18	4,637				1
future foreseeable	3,739	3,590	4,090	2,000	28		428	12	39		
past	4,550	47	2,460	1,100	10		140			24	
Grand Total	11,483	6,552	6,876	3,426	54	18	5,205	12	39	24	1
Cumulative Effects Project Type	Thin ponderosa pine habitat	Rx burn ponderosa pine habitat	Thin mixed con habitat	Rx burn mixed con habitat		4FRI Project Area		Mechanical Treatments (acres)	Prescribed Fire (acres)	cumulative + alternative: Mechanical	cumulative + alternative: Prescribed Fire

Cumulative Effects Project Type	Thin Pipo LOPFA	Rx Burn Pipo LOPFA	Thin Mixed Con Protected MSO Hab	Burn Mixed Con Protected MSO Hab	MSO PAC Treat Thin	MSO PAC Burn	NOGO PFA/Nest Treats	Thin Mc MSO Hab (Resticted)	Burn Mc MSO Hab (Restricted)	Thin Pipo MSO Hab (Resticted)	Burn Pipo MSO Hab (Restricted)
current	74,959	104,912	1,804	2,117		Cumulative Effects[1]		166,520	208,268	Treatment acres	acres
future foreseeable	52,141	49,602	9,149	3,723		Alternative B		384,966	583,330	551,486	791,598
past	28,467	47,914	0	0		Alternative C		431,049	586,110	597,569	794,378
Grand Total	155,567	202,428	10,953	5,840		Alternative D		384,966	178,441	551,486	386,709
						Alternative E		403,500	581,301	570,020	789,569

[1]Cumulative Effects = Total Past, Current and Future Foreseeable Projects

Table 4. Summary Totals for Cumulative Effects by Habitat Type in the Project and within a ½ Buffer Outside the Project Boundary

Cumulative Effects Project Type	Thin Pipo LOPFA (Ac)	Rx Burn Pipo LOPFA (Ac)	Thin Mixed Con Protected MSO Hab (Ac)	Burn Mixed Con Protected MSO Hab (Ac)	MSO PAC Treat Thin (Ac)	MSO PAC Burn (Ac)	NOGO PFA/Nest Treats (Ac)	Thin Mc MSO Hab (Resticted) (Ac)	Burn Mc MSO Hab (Restricted) (Ac)	Thin Pipo MSO Hab (Resticted) (Ac)	Burn Pipo MSO Hab (Restricted) (Ac)	Thin Grassland (Ac)	Rx Burn Grassland (Ac)	Thin P-J (Ac)	Rx Burn P-J (Ac)	Rd Oblit (Miles)	Closed Road (Miles)	Aspen Regen (Ac)	Reforestation (Ac)	Rock Pit Development (# Of Pits)	Water Development (#)	Channel Restoration (#	Thin Ponderosa Pine Habitat	Rx Burn Ponderosa Pine Habitat	
current	61,230	97,908	775	820	1,211	1,465	228	502	516	28,624	50,226	3,194	2,915	326	326	16	18	4,637				1	91,795	150,115	
future foreseeable	39,159	38,255	920	920	6,357	931	2,047	1,872	1,872	10,935	11,347	3,739	3,590	4,090	2,000	28		428	12	39			60,370	52,375	
past	30,197	50,862					1,218					4,550	47	2,460	1,100	10		140			24				
Grand Total	130,586	187,025	1,695	1,740	7,568	2,396	3,493	2,374	2,388	39,559	61,573	11,483	6,552	6,876	3,426	54	18	5,205	12	39	24	1	152,165	202,490	

4FRI Project Area	Mechanical Treatments (acres)	Prescribed Fire (acres)	cumulative + alternative: Mechanical Treatment acres	cumulative + alternative: Prescribed Fire acres
Cumulative Effects[1]	166,520	208,268		
Alternative B	384,966	583,330	551,486	791,598
Alternative C	431,049	586,110	597,569	794,378
Alternative D	384,966	178,441	551,486	386,709
Alternative E	403,500	581,301	570,020	789,569

Table 5. Summary of Cumulative Effects Projects in the Restoration Unit 3-5 (Narrow-headed Gartersnake Habitat)

Cumulative Effects Project Type	Thin Pipo LOPFA	Rx Burn Pipo LOPFA	Thin Mixed Con Protected MSO Hab	Burn Mixed Con Protected MSO Hab	MSO PAC Treat Thin	MSO PAC Burn	NOGO PFA/Nest Treats	Thin Mc MSO Hab (Resticted)	Burn Mc MSO Hab (Restricted)	Thin Pipo MSO Hab (Resticted)	Burn Pipo MSO Hab (Restricted)	Thin Grassland	Rx Burn Grassland	Thin P-J	Rx Burn P-J	Rd Oblit	Closed Road	Aspen Regen	Reforestation	Rock Pit Development	Water Development	Channel Restoration
current	4,653	9,558	0	0	71	71	228	0	0	4,637	4,637	0	0	0	0	0	0	0	0	0	0	0
future foreseeable	6,940	6,528	0	0	1,703	0	0	0	0	6,030	6,442	0	0	0	0	0	0	0	0	39	0	0
past	10,147	13,925	0	0	0	0	304	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	**21,740**	**30,011**	**0**	**0**	**1,774**	**71**	**532**	**0**	**0**	**10,667**	**11,079**	0	0	0	0	0	0	0	0	39	0	0

Appendix 18. Livestock Allotments in 4FRI

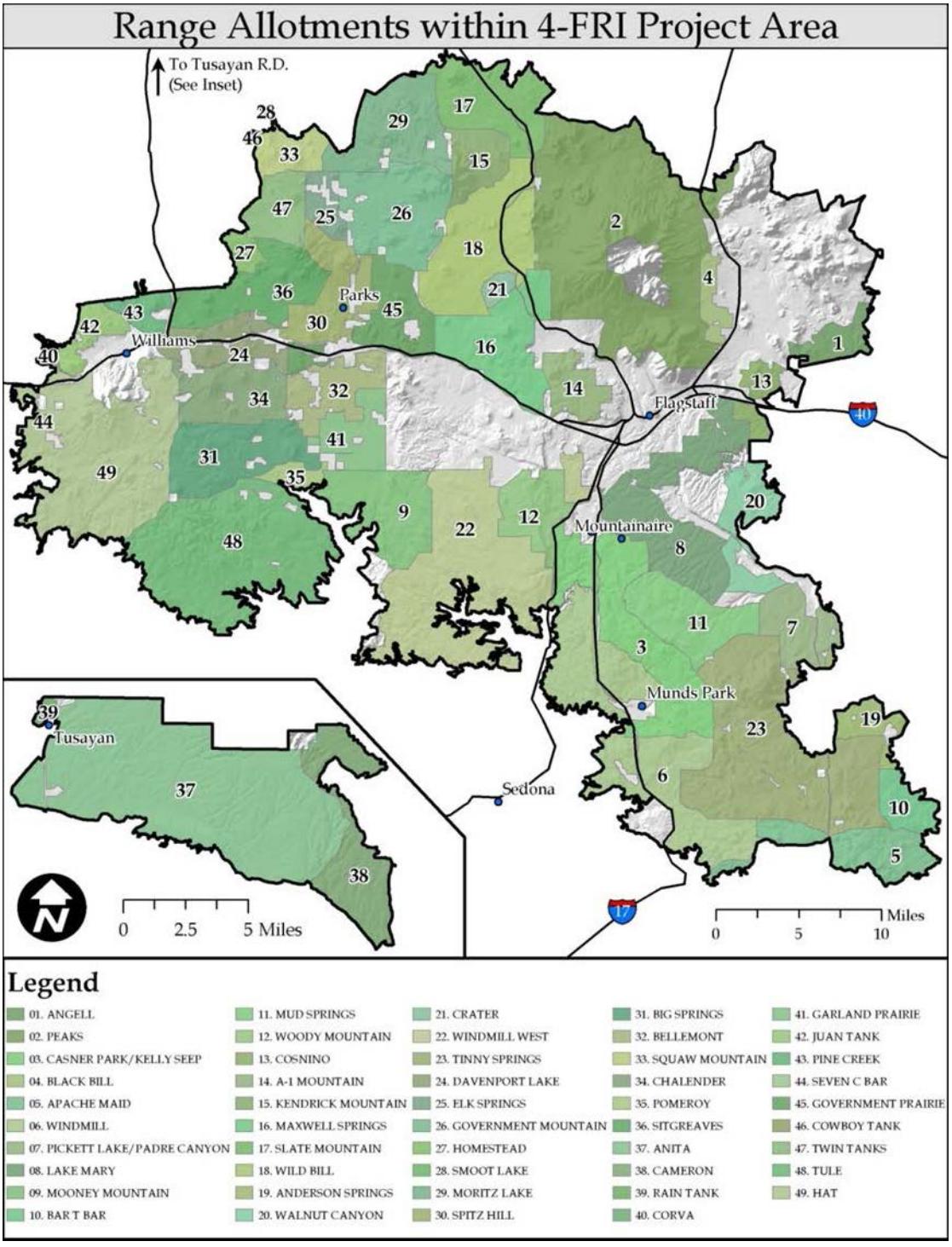


Figure 1. Map of Range Allotments in the 4FRI Project Area

Appendix 19. Surface Fuel Loading by Alternative

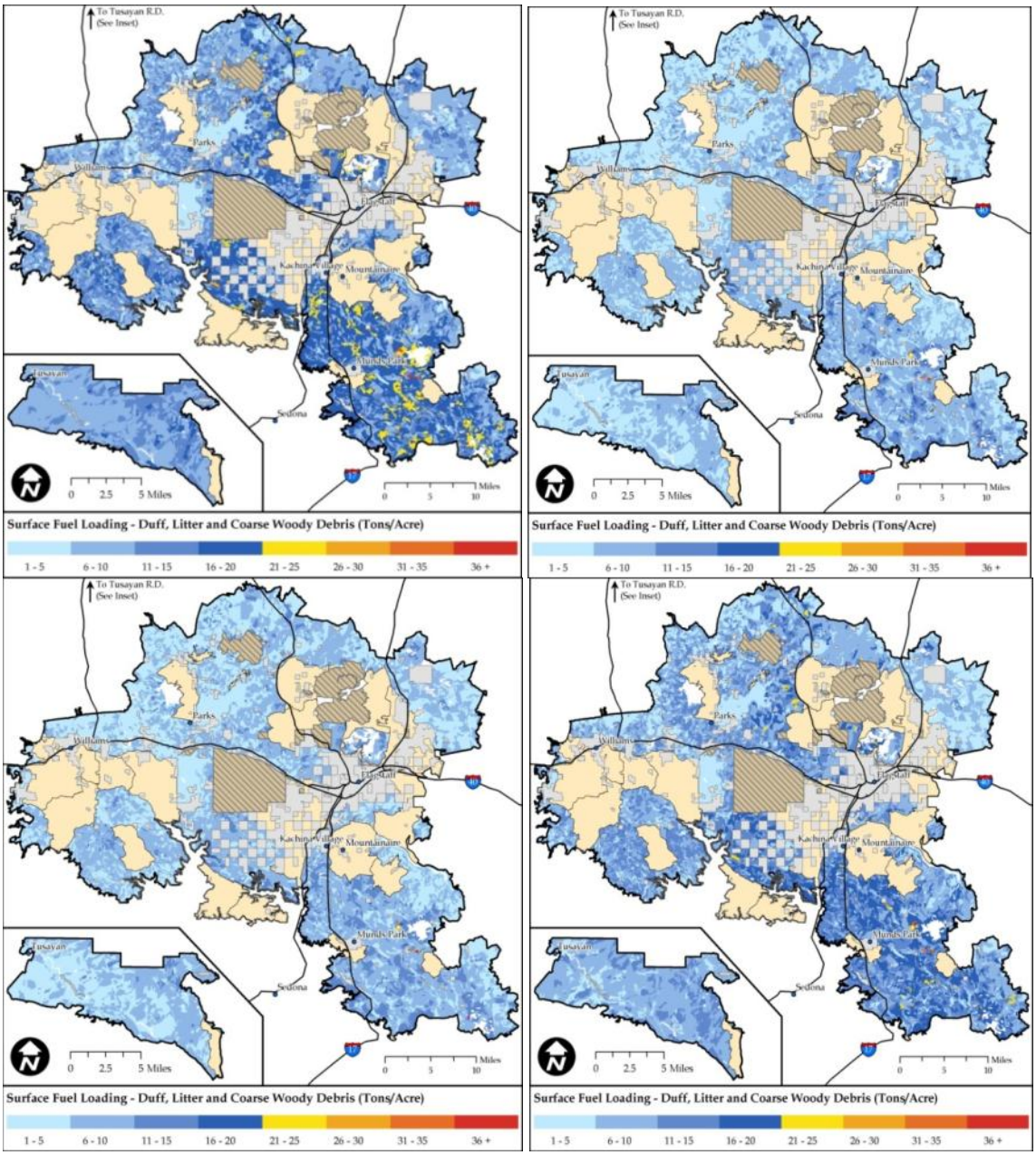


Figure 1. Surface fuel loading by alternatives (clockwise starting in the upper left) A, B, C, and D

Alternatives B and C would have the lowest percent of acres with fuel loads exceeding 20 tons/acre. Alternative D has the most acres of high fuel loading (exceeding 20 tone/acre) of the action alternatives and alternative A (no action) has the highest overall ratings of fuel loading.

Appendix 20. Treatment Acres and Forest Structure in Goshawk Habitat by Subunit, Restoration Unit, and Alternative

Table 1. Treatment Acres by PFA/dPFA by Alternative

PFA Name	PFA Number	Within MSO Habitat	Outside MSO Habitat	Total PFA Acres	Treated Acres Alt B	Percent Treated Alt B	Treated Acres Alt C	Percent Treated Alt C	Treated Acres Alt D	Percent Treated Alt D	Treated Acres Alt E	Percent Treated Alt E
Alto	030402009		494	588	494	84%	494	84%	494	84%	494	84%
Ashurst	030405018		682	682	682	100%	682	100%	682	100%	682	100%
Badger	030402016		630	630	630	100%	630	100%	630	100%	630	100%
Beale	030702009		635	635	635	100%	635	100%	635	100%	635	100%
Bear	030405012	311	331	642	642	100%	642	100%	551	86%	642	100%
Big Spring	030702022		603	604	603	100%	596	99%	603	100%	596	99%
Blackjack	030405004	526		617	526	85%	617	100%	336	55%	526	85%
Boulin Tank	030702014		596	596	596	100%	596	100%	596	100%	596	100%
Camp 36	030704001		649	649	649	100%	649	100%	649	100%	649	100%
Casner Cabin	030402003	260	74	652	335	51%	335	51%	238	36%	335	51%
Cherry Canyon	030405020	437	151	632	588	93%	588	93%	588	93%	588	93%
Corner	030402017	444	193	726	637	88%	726	100%	637	88%	637	88%
Cowhill	030407002		632	632	632	100%	632	100%	632	100%	632	100%
Coxcombs	030702028		624	624	624	100%	624	100%	624	100%	624	100%
Coyote Basin	030405014	146	370	612	516	84%	612	100%	370	61%	516	84%
Crater	030402014	214	351	691	566	82%	566	82%	351	51%	566	82%
Devil Dog	030701015		410	602	410	68%	410	68%	410	68%	410	68%
El Paso	030702002		596	596	596	100%	596	100%	596	100%	596	100%
Fort Valley	030402012		86	632	86	14%	86	14%	86	14%	86	14%
Grandview	030704007		157	157	157	100%	157	100%	157	100%	157	100%
Hammer	030704002		393	862	393	46%	393	46%	393	46%	393	46%
Horseshoe	030402023		744	745	744	100%	744	100%	744	100%	744	100%

PFA Name	PFA Number	Within MSO Habitat	Outside MSO Habitat	Total PFA Acres	Treated Acres Alt B	Percent Treated Alt B	Treated Acres Alt C	Percent Treated Alt C	Treated Acres Alt D	Percent Treated Alt D	Treated Acres Alt E	Percent Treated Alt E
Jackass North	030701009	88	57	652	145	22%	145	22%	145	22%	145	22%
Juniper Ridge	030702005		591	591	591	100%	591	100%	591	100%	591	100%
Kaibab Lake East	030702016		620	620	620	100%	620	100%	620	100%	620	100%
Kaibab Lake West	030701001		655	655	655	100%	655	100%	655	100%	655	100%
Kaufman	030702017		106	617	106	17%	106	17%	106	17%	106	17%
Kennedy Dam	030701008	178	464	649	642	99%	553	85%	642	99%	553	85%
Long Jim	030704010		753	753	753	100%	753	100%	753	100%	753	100%
Lost Spring Tank	030702007		648	648	648	100%	648	100%	648	100%	648	100%
Mars	030402022		227	558	227	41%	227	41%	227	41%	227	41%
Marteen	030702004		627	627	627	100%	627	100%	627	100%	627	100%
Mason	030405011	149	477	626	626	100%	626	100%	626	100%	626	100%
Mud	030405010	541	120	775	661	85%	775	100%	262	34%	661	85%
Newman	030405016		642	642	642	100%	642	100%	642	100%	642	100%
Orion	030402025	250	136	777	386	50%	386	50%	136	17%	386	50%
Path	030402026	164	446	610	610	100%	610	100%	487	80%	610	100%
Phillips	030701004		354	637	354	56%	354	56%	354	56%	354	56%
Porkchops	030402024		718	718	718	100%	718	100%	718	100%	718	100%
Pump-house	030405007		239	643	239	37%	239	37%	239	37%	239	37%
Pumpkin	030702030		227	671	227	34%	227	34%	227	34%	227	34%
Racetrack	030405013	436	57	679	493	73%	679	100%	130	19%	493	73%
Reese	030402008		437	573	437	76%	437	76%	437	76%	437	76%
Roadside	030405009	382	380	762	762	100%	762	100%	762	100%	762	100%
Rosilda Springs	030701233		130	604	130	22%	130	22%	130	22%	130	22%
Schultz Pass	030402006		189	611	189	31%	189	31%	189	31%	189	31%
Sheep Spring	030405024	423	47	604	470	78%	604	100%	250	41%	470	78%
Sitgreaves	030702006		667	667	667	100%	667	100%	667	100%	667	100%
Squaw	030702029		612	612	612	100%	612	100%	612	100%	612	100%

PFA Name	PFA Number	Within MSO Habitat	Outside MSO Habitat	Total PFA Acres	Treated Acres Alt B	Percent Treated Alt B	Treated Acres Alt C	Percent Treated Alt C	Treated Acres Alt D	Percent Treated Alt D	Treated Acres Alt E	Percent Treated Alt E
Stage Station	030701010	75	427	530	501	95%	501	95%	501	95%	501	95%
T Six	030405001	504	22	631	526	83%	631	100%	526	83%	526	83%
Thicket	030405006	239	36	650	275	42%	275	42%	275	42%	275	42%
Three Sisters	030701014		314	733	314	43%	314	43%	314	43%	314	43%
Trail	030704005		135	677	135	20%	135	20%	135	20%	135	20%
Tree Spring	030405019	303	262	642	565	88%	642	100%	565	88%	565	88%
Tule Tank Wash	030701012		635	635	635	100%	635	100%	635	100%	635	100%
Volunteer	030702025	104	256	360	360	100%	360	100%	360	100%	360	100%
Walker Hill (CNF & KNF)	030402002 030702005		612	612	612	100%	612	100%	612	100%	612	100%
White Horse	030402007		463	804	463	58%	463	58%	463	58%	463	58%
Wing West	# not yet assigned		201	623	201	32%	201	32%	201	32%	201	32%
Dispersal PFA 01	01		624	624	624	100%	624	100%	624	100%	624	100%
Dispersal PFA 03	03		608	608	608	100%	608	100%	608	100%	608	100%
Dispersal PFA 04	04	330	228	601	558	93%	558	93%	558	93%	558	93%
Dispersal PFA 06	06	381	148	630	529	84%	630	100%	529	84%	529	84%
Dispersal PFA 07	07	349	264	613	613	100%	613	100%	613	100%	613	100%
Dispersal PFA 08	08	131	496	627	627	100%	627	100%	627	100%	627	100%
Dispersal PFA 09	09		625	625	625	100%	625	100%	625	100%	625	100%
Dispersal PFA 10	10	207	399	612	606	99%	606	99%	606	99%	606	99%
Dispersal PFA 11	11	254	320	630	573	91%	573	91%	573	91%	573	91%
Dispersal PFA 13	13	296	330	629	626	100%	626	100%	626	100%	626	100%
Dispersal PFA 17	17		600	600	600	100%	600	100%	600	100%	600	100%
Dispersal PFA 18	18		631	631	631	100%	631	100%	631	100%	631	100%
Dispersal PFA 19	19		621	621	621	100%	621	100%	621	100%	621	100%
Dispersal PFA 20	20		180	627	180	29%	180	29%	180	29%	180	29%
Dispersal PFA 21	21		610	610	610	100%	610	100%	610	100%	610	100%
Dispersal PFA 23	23	616		616	616	100%	616	100%	616	100%	616	100%

PFA Name	PFA Number	Within MSO Habitat	Outside MSO Habitat	Total PFA Acres	Treated Acres Alt B	Percent Treated Alt B	Treated Acres Alt C	Percent Treated Alt C	Treated Acres Alt D	Percent Treated Alt D	Treated Acres Alt E	Percent Treated Alt E
Dispersal PFA 26	26	267		594	267	45%	319	54%		0%	267	45%
Dispersal PFA 27	27		602	602	602	100%	602	100%	602	100%	602	100%
Grand Total		9,002	30,680	49,385	39,683	80%	40,633	82%	37,323	76%	39,586	80%

Table 2. Percent Existing (Alternative A) Forest Structure – Uneven-Aged Goshawk PFA/dPFA

Restoration Unit and Subunit	VSS 1			VSS 2			VSS 3			VSS 4			VSS 5			VSS 6			Total Acres
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	
Uneven Age	0	0	0	< 1	< 1	< 1	35	33	6	45	47	47	14	14	29	5	6	17	20,707
1	0	0	0	< 1	1	1	34	33	3	54	53	53	5	5	33	6	8	10	6,781
1-1	0	0	0	0	0	0	84	84	0	16	16	84	0	0	16	0	0	0	265
1-2	0	0	0	0	0	0	38	38	0	6	6	38	27	27	32	29	29	29	338
1-3	0	0	0	0	0	0	19	19	0	74	74	65	6	6	29	1	1	7	1,661
1-4	0	0	0	0	0	0	46	46	0	50	50	46	0	0	50	3	3	3	465
1-5	0	0	0	1	2	1	35	33	5	53	51	48	4	4	34	7	10	12	4,053
3	0	0	0	0	0	0	24	23	3	47	48	40	24	24	36	5	5	21	4,212
3-1	0	0	0	0	0	0	37	19	4	45	63	33	18	18	63	0	0	0	310
3-2	0	0	0	0	0	0	9	9	1	70	70	28	8	8	53	13	13	18	1,237
3-3	0	0	0	0	0	0	27	27	4	33	33	44	39	39	22	1	1	29	2,111
3-5	0	0	0	0	0	0	40	40	0	49	49	56	9	9	33	2	2	11	554
4	0	0	0	0	0	0	28	28	5	47	48	41	24	23	35	1	1	1	5,360
4-2	0	0	0	0	0	0	40	40	11	25	25	29	35	35	39	0	0	21	701
4-3	0	0	0	0	0	0	33	33	4	50	52	50	15	13	31	2	2	15	2,663
4-4	0	0	0	0	0	0	18	18	5	51	51	33	31	31	40	0	0	22	1,936
4-5	0	0	0	0	0	0	0	0	0	34	34	34	66	66	0	0	0	66	60
5	0	0	0	0	0	0	15	15	0	61	61	44	23	23	32	1	1	24	1,140
5-1	0	0	0	0	0	0	18	18	0	74	74	30	7	7	63	0	0	7	546

Restoration Unit and Subunit	VSS 1			VSS 2			VSS 3			VSS 4			VSS 5			VSS 6			Total Acres
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	
5-2	0	0	0	0	0	0	11	11	0	48	48	57	38	38	3	2	2	40	594
6	0	0	0	1	1	0	71	61	18	17	28	58	0	0	2	11	11	22	3,214
6-2	0	0	0	1	1	0	6	6	1	82	82	69	0	0	20	11	11	11	238
6-3	0	0	0	1	1	0	76	65	19	12	23	57	0	0	10	11	11	23	2,977

Table 3 PFAs. Percent Existing (Alternative A) Forest Structure – Even Aged Goshawk PFA/dPFA

Restoration Unit and Subunit	VSS 1			VSS 2			VSS 3			VSS 4			VSS 5			VSS 6			Total Acres
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	
Even Age	0	0	0	1	1	0	37	37	6	53	54	65	7	6	23	1	1	5	19,876
1	0	0	0	0	0	0	53	51	3	44	46	82	0	0	12	2	2	2	3,794
1-1	0	0	0	0	0	0	100	100	0	0	0	100	0	0	0	0	0	0	324
1-2	0	0	0	0	0	0	71	71	0	29	29	71	0	0	29	0	0	0	345
1-3	0	0	0	0	0	0	39	39	8	59	59	79	0	0	12	0	0	0	736
1-4	0	0	0	0	0	0	83	83	0	17	17	93	0	0	7	0	0	0	573
1-5	0	0	0	0	0	0	37	33	4	57	61	78	0	0	12	4	4	4	1,818
3	0	0	0	0	0	0	30	30	5	61	62	71	8	8	23	0	0	1	4,760
3-1	0	0	0	0	0	0	44	39	17	47	52	61	10	8	22	0	0	0	655
3-2	0	0	0	0	0	0	16	16	3	65	65	41	15	15	53	0	0	0	759
3-3	0	0	0	0	0	0	40	40	4	51	51	71	9	9	22	0	0	3	2,232
3-5	0	0	0	0	0	0	0	0	0	100	100	100	0	0	0	0	0	0	1
4	0	0	0	0	0	0	11	11	0	87	87	95	0	0	3	0	0	0	1,114
4-2	0	0	0	0	0	0	33	34	6	57	57	59	9	8	29	1	1	6	9,014
4-3	0	0	0	0	0	0	29	33	12	36	36	50	34	3	11	0	0	27	721
4-4	0	0	0	0	0	0	28	29	5	66	67	59	5	4	31	< 1	< 1	4	4,506
4-5	0	0	0	0	0	0	42	42	5	47	47	66	9	9	23	1	1	5	3,121

Restoration Unit and Subunit	VSS 1			VSS 2			VSS 3			VSS 4			VSS 5			VSS 6			Total Acres
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	
5	0	0	0	0	0	0	34	34	10	61	61	29	5	5	62	0	0	0	665
5-1	0	0	0	0	0	0	34	34	4	55	55	50	11	11	34	1	1	11	1,414
5-2	0	0	0	0	0	0	47	47	7	49	49	69	3	3	20	0	0	3	827
6	0	0	0	0	0	0	15	15	0	62	62	24	22	22	53	1	1	23	588
6-2	0	0	0	18	18	0	55	55	38	11	11	44	0	0	0	15	15	18	893
6-3	0	0	0	3	3	0	58	58	54	0	0	7	0	0	0	40	40	40	76

Table 4. Percent Existing (Alternative A) Forest Structure – Even-Aged Goshawk LOPFA: Stands

Restoration Unit and Subunit	VSS 1			VSS 2			VSS 3			VSS 4			VSS 5			VSS 6			Total Acres
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	
Even Age	1	9	< 1	1	< 1	8	41	27	5	48	44	39	8	18	39	1	1	9	255,310
1	0	8	0	1	1	8	43	23	1	50	56	50	5	11	36	2	2	5	64,143
1-1	0	7	0	2	2	7	37	20	2	49	53	39	2	9	41	9	8	10	3,431
1-2	0	4	0	4	0	4	36	27	0	55	65	52	4	4	39	0	0	4	3,526
1-3	0	8	0	1	0	8	44	26	< 1	50	54	47	3	10	40	2	2	5	15,953
1-4	0	8	0	2	< 1	8	50	21	< 1	45	64	57	3	7	32	0	0	3	8,235
1-5	0	8	0	1	1	8	41	23	1	51	53	50	6	14	35	1	2	6	32,999
3	1	11	< 1	1	< 1	9	36	21	8	53	43	31	10	25	43	< 1	< 1	10	69,122
3-1	1	12	0	1	0	11	37	27	20	53	35	14	10	26	43	0	0	12	9,280
3-2	1	13	0	2	< 1	10	18	12	12	58	32	11	20	41	46	< 1	1	22	11,335
3-3	1	11	< 1	1	< 1	9	41	18	10	48	45	34	8	25	40	1	1	8	22,617
3-5	0	8	0	0	0	8	45	23	0	48	48	48	7	20	35	1	1	8	4,606
4	0	9	0	1	0	9	37	26	< 1	56	49	41	6	16	46	< 1	< 1	5	21,284
4-2	2	12	0	2	0	8	34	20	6	52	43	31	9	25	43	< 1	< 1	12	80,930
4-3	0	11	0	4	0	7	23	24	9	47	15	22	26	49	35	0	0	27	3,456

Restoration Unit and Subunit	VSS 1			VSS 2			VSS 3			VSS 4			VSS 5			VSS 6			Total Acres
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	
4-4	3	11	0	2	0	7	36	28	7	51	44	36	8	17	42	< 1	< 1	8	31,402
4-5	1	12	0	2	0	9	33	12	6	55	45	28	9	30	44	< 1	< 1	13	41,466
5	0	8	0	0	0	8	46	26	0	47	44	38	7	22	42	0	0	12	4,605
5-1	0	2	0	1	< 1	3	47	43	< 1	43	45	47	7	8	41	2	2	8	26,793
5-2	0	3	0	< 1	0	5	62	59	0	29	29	60	8	9	2	1	1	8	11,229
6	0	2	0	1	1	2	36	31	1	54	56	37	7	7	52	3	3	9	15,563
6-2	0	4	0	5	< 1	4	82	78	15	8	7	64	0	< 1	7	5	11	11	14,323
6-3	0	3	0	9	0	3	89	86	18	< 1	0	69	0	0	0	1	11	11	1,034
6-4	0	4	0	5	< 1	4	81	77	16	9	7	62	0	< 1	7	5	11	11	12,331

Table 5. Percent Existing (Alternative A) Forest Structure – Uneven-Aged Goshawk LOPFA Stands

Restoration Unit and Subunit	VSS 1			VSS 2			VSS 3			VSS 4			VSS 5			VSS 6			Total Acres
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	
Uneven Age	0	8	0	1	< 1	7	37	22	6	36	24	19	14	28	23	11	18	46	213,861
1	0	8	0	1	1	8	39	19	6	45	28	14	11	32	28	4	13	43	69,868
1-1	0	13	0	2	1	13	32	23	1	49	11	14	10	41	10	7	12	62	4,895
1-2	0	9	0	3	0	9	46	20	4	42	28	10	9	31	28	0	12	49	2,309
1-3	0	9	0	3	2	9	36	15	5	40	20	11	15	34	18	6	21	57	18,210
1-4	0	7	0	< 1	< 1	7	57	12	1	35	41	18	6	20	33	2	20	41	8,013
1-5	0	7	0	1	< 1	7	36	21	8	49	31	15	11	33	35	3	8	34	36,441
3	0	10	0	< 1	< 1	9	37	24	14	42	27	12	15	31	26	6	8	39	51,493
3-1	0	14	0	< 1	< 1	11	50	33	25	34	20	8	12	30	19	4	3	36	8,769
3-2	0	9	0	< 1	< 1	9	26	20	12	39	23	11	29	41	21	6	7	47	9,639
3-3	0	10	0	1	< 1	9	37	29	15	47	31	15	13	25	28	2	5	32	17,517
3-5	0	8	0	0	0	8	29	13	3	45	25	6	18	42	39	8	12	44	4,313

Restoration Unit and Subunit	VSS 1			VSS 2			VSS 3			VSS 4			VSS 5			VSS 6			Total Acres
	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	2010	2020	2050	
4	0	9	0	< 1	< 1	9	41	18	8	39	30	15	7	27	27	12	15	41	11,255
4-2	0	9	0	1	< 1	9	34	20	1	40	25	19	22	37	23	4	9	49	39,594
4-3	0	11	0	0	0	9	26	21	2	50	24	10	24	45	21	0	< 1	59	2,504
4-4	0	7	0	0	0	7	38	27	0	33	29	26	26	26	25	3	11	43	17,061
4-5	0	11	0	1	1	10	32	15	1	44	23	14	18	44	20	4	8	55	18,768
5	0	1	0	0	0	1	14	12	0	14	10	13	23	26	11	49	51	74	30,090
5-1	0	4	0	0	0	4	22	16	0	39	20	19	14	32	28	25	28	50	5,830
5-2	0	1	0	0	0	1	13	11	0	8	7	12	25	25	7	55	56	80	24,260
6	0	7	0	3	1	7	69	44	5	20	19	52	0	1	12	9	28	24	22,816
6-2	0	4	0	< 1	0	4	59	47	2	17	15	44	0	0	15	23	33	35	3,721
6-3	0	9	0	4	1	9	69	38	7	22	22	50	0	1	12	5	29	22	16,569
6-4	0	< 1	0	0	0	< 1	78	75	0	5	4	78	0	0	1	17	20	21	2,526