United States Department of Agriculture

Forest Service

Southwestern Region

Amended Final Range Specialist Report

Coconino and Kaibab Four Forest Restoration Initiative (4FRI) EIS

Submitted by: ____________________

Date 4/24/15

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Kaibab National Forest

In response to the objection resolution process, edits have been made in this final report (see attachment 1). Some items that are specific to the FEIS, ROD or other specialist reports have not been incorporated in this report.

Sierra Club Issue 6: Add the following references to peer-reviewed literature: Kerns et al. 201 1 (which describes USDA research: "understory release from a long history of cattle grazing caused a greater degree of change than the initial reintroduction of fire."), Belsky and Bl umenthal 1997, Cooper 1960, Madany and West 1983, Savage and Swetnam 1990, Arnold 1950.

Sierra Club Issue 7: Explain how future livestock management would differ from the past practices that helped lead to unhealthy forests in the first place.

- Clarify how range readiness is assessed in the Range Report and clearly link range readiness to the Implementation Plan (Appendix D) and the Monitoring Plan (Appendix E).
- Clarify in the range report that allotment management monitoring occurs in addition to 4FRI monitoring.

Sierra Club Issue 9: Acknowledge that removal of livestock after treatment (fire, cutting, or seeding/planting/mulching) may be necessary for a period of years. Only fire is mentioned as potentially impacting the availability of pastures to livestock, but if forests are returning to an unhealthy state (i.e., reduced understory, dense regeneration, altered fire regimes, noxious weeds) then livestock utilization may have to be altered.

- Clarify in Appendix C (Design Features, Best Management Practices, and Mitigation) and range report that restrictions in grazing of livestock will occur after significant bums in pastures, that livestock pasture rest after ground disturbing treatments (i.e., thinning, seeding, and aspen restoration) may occur, and that line officers will evaluate, at a minimum, annual monitoring of range readiness to determine when grazing may resume within a pasture.
- Clarify in Appendix C and range report that annual monitoring includes measures for forage production, precipitation, forage utilization, livestock numbers, and livestock season of use.
- Clarify in Appendix C and range report that condition and trend monitoring every five to 10 years measures plant canopy cover, plant frequency, and ground cover.
- Modify a design feature in Appendix C (Design Features, Best Management Practices, and Mitigation) to clarify the process of evaluating range readiness after ground-disturbing treatments.

Range Management Relevant Laws, Regulations and Policy

Congress

Congressional intent to allow grazing on National Forest System lands comes from the following acts: Multiple Use-Sustained Yield Act of 1960, Forest and Rangeland Renewable Resources Planning Act of 1974, Federal Land Policy and Management Act of 1976, National Forest Management Act of 1976.

Forest Service Manuals

The Forest Service Manual (FSM) contains legal authorities, objectives, policies, responsibilities, instructions, and guidance needed on a continuing basis by Forest Service line officers and primary staff in more than one unit to plan and execute assigned programs and activities.

Forest Service Manual 2200 – Range Management

Forest Service Handbooks

Forest Service Handbooks (FSH) are the principal source of specialized guidance and instruction for carrying out the direction issued in the FSM. Specialists and technicians are the primary audience of Handbook direction. Handbooks may also incorporate external directives with related USDA and Forest Service directive supplements.

Forest Service Handbook 2200 – Range Management
Service Wide Issuance
2209.13 - Grazing Permit Administration Handbook

Regulations for Range Management are found at 36 CFR Part 222, Subpart A - Grazing and Livestock Use on the National Forest System, Subpart B – Management of Wild Free-Roaming Horses and Burros, and Subpart C – Grazing Fees. Regulations at 36 CFR 222.2 (c) states that National Forest System lands would be allocated for cattle grazing and allotment management plans (AMP) would be prepared consistent with land management plans.

Forest Plans

The forest plans defines a set of goals, objectives, standards, and guidelines that provide direction for managing the forests and their resources (USDA FS 1987 and 1988). See Appendix C of the DEIS for forest plan direction that applies to this project.

Coconino National Forest Plan

Relevant direction from the 1988 Coconino National Forest Land Management Plan includes:

- Cooperate with private range owners and other agencies to develop coordinated range management systems of livestock grazing. (USDA Forest Service 1988: page 23)
- Permitted use and capacities are maintained in balance for the Allotment by increasing or decreasing numbers of livestock, by changing the management intensity levels, and by initiating changes in livestock class, season of use, and rotation patterns. (USDA Forest Service 1988: page 67)
- Manage grazing use to maintain or enhance condition classes of full capacity rangelands. (USDA Forest Service 1988: page 68)
- Control livestock grazing by management and/or fencing to allow adequate regeneration of grasses and forbs. (USDA Forest Service 1988: page 160)

- Control livestock grazing through management and/or fencing to allow for adequate establishment of vegetation and the elimination of overuse. (USDA Forest Service 1988: page 176)
- Increase and improve vegetative species composition and diversity in the surrounding landscapes to diffuse grazing pressure from elk and livestock. (USDA Forest Service 1988: page 206-78)

Kaibab National Forest Plan

Relevant direction from the 2014 Kaibab National Forest Land Management Plan includes (USDA Forest Service 2014: page 64):

- There are opportunities to engage in ranching activities and graze livestock on NFS lands. These activities contribute to the stability and social, economic, and cultural aspects of rural communities.
- Grasses and forbs provide adequate forage for permitted livestock.
- Livestock use is consistent with other desired conditions.
- Livestock management should favor the development of native cool season grasses and forbs.
- As grazing permits are waived back to the Forest, they should be evaluated for conversion to forage reserves to improve flexibility for restoring fire-adapted ecosystems and in response to other range management needs.
- New construction and reconstruction of fences should have a barbless bottom wire that is at least 18 inches high to facilitate pronghorn movement.
- Annual operating instructions for livestock grazing permittees should ensure livestock numbers are balanced with capacity and address any relevant resource concerns (e.g., forage production, weeds, fawning habitat, soils, etc.).
- Post-fire grazing should not be authorized until Forest Service range staff confirms range readiness.
- Livestock use in aspen areas should be authorized at levels that are consistent with the desired conditions for aspen regeneration and establishment.
- Livestock use in and around wetlands should be evaluated on an allotment specific basis. Mitigation measures such as deferment and fencing (full or partial) should be implemented as needed to minimize potential livestock effects.

Forest Plan direction for livestock grazing provides guidelines for how domestic livestock grazing is to be managed. Forage production and forage understory goals would be met within each grazing allotment, regardless of which alternative is selected for this project.

Summary of Issues, Alternatives and Mitigation Measures (Resource Protection Measures)

Issues

Key issues received from comments to the proposed action were related to smoke, large tree retention, and tree canopy cover retention are issues for this project and are not range management issues. Comments and concerns that were related to range management included livestock grazing effects to restoring fire regime and effects to understory response after proposed treatments. These items would be addressed as part of the range effects analysis.

Alternatives

The Forest Service developed five alternatives, including the no action (alternative A), the final proposed action (alternative B), and three additional alternatives (alternatives C -E). Alternatives C through D respond to recommendations and issues raised by the public during the extended scoping period. These issues were addressed in the DEIS. Alternative E was developed in response to comments on the DEIS.

- **Alternative A** is the no action alternative as required by 40 CFR 1502.14(c). There would be no changes in current management and the forest plans would continue to be implemented. Approximately 166,897 acres of current and ongoing vegetation treatments and 195,076 acres of prescribed fire projects would continue to be implemented adjacent to the treatment area. Approximately 43,041 acres of vegetation treatments and 58,714 acres of prescribed fire and maintenance burning would be implemented adjacent to the treatment area by the Forests in the foreseeable future (within 5 years). Alternative A is the point of reference for assessing action alternatives B-E.
- **Alternative B** is the proposed action. This alternative would mechanically treat 384,966 acres of vegetation and utilize prescribed fire on 583,330 acres. It incorporates comments and recommendations received during eight months of collaboration with individuals, agencies, and organizations. It proposes mechanically treating up to 16-inch d.b.h. in 18 Mexican spotted owl (MSO) Protected Activity Areas (PACs) and includes low-severity prescribed fire within 70 MSO PACs, excluding 54 core areas. Three non-significant forest plan amendments on the Coconino NF would be required to be in compliance with the plans (see table 2).
- **Alternative C** is the **preferred alternative.** This alternative would mechanically treat 431,049 acres of vegetation and utilize prescribed fire on 586,110 acres. It responds to **Issue 2** (conservation of large trees), and **Issue 4** (increased restoration and research). It adds acres of grassland treatments on the Kaibab NF, incorporates wildlife and watershed research on both forests, and mechanically treats and uses prescribed fire within the proposed Garland Prairie management area on the Kaibab NF. It proposes mechanically treating up to 17.9-inch d.b.h. in 18 MSO PACs and includes low-severity prescribed fire within 70 MSO PACs, including 54 core areas. Key components of the stakeholder-created Large Tree Retention Strategy are incorporated into the alternative's implementation plan. Three non-significant forest plan amendments on the Coconino NF would be required (see table 2).
- **Alternative D** would mechanically treat 384,966 acres of vegetation and utilize prescribed fire on 178,441 acres. This alternative was developed in response to **Issue 1**, Prescribed Fire Emissions. It decreases the acres that would receive prescribed fire by 69 percent (when compared to alternative B, proposed action). This equates to removing fire on about 404, 889 acres. It proposes mechanically treating up to 16-inch d.b.h. in 18 Mexican spotted owl (MSO) Protected Activity Areas (PACs) but

the PACs would not be treated with prescribed fire. Three non-significant forest plan amendments on the Coconino NF would be required (see table 2).

Alternative E: This alternative would mechanically treat 403,218 acres of vegetation and utilize prescribed fire on 581,119 acres. It responds to **Issue 3** (post-treatment landscape openness and canopy cover), and **Issue 5** (range of alternatives and comparison between alternatives). It is similar to alternative C in that it adds acres of grassland treatments on the Kaibab NF and incorporates wildlife and watershed research on both forests. It proposes mechanically treating up to 9-inch d.b.h. in 18 MSO PACs and includes low-severity prescribed fire within 70 MSO PACs, excluding 54 core areas. Key components of the stakeholder-created Large Tree Retention Strategy are incorporated into the alternative's implementation plan. No forest plan amendments are proposed.

Table 1. Summary of Alternatives Analyzed in Detail

Proposed Activity	Alt. A (No Action)	Alternative B (Proposed Action)	Alternative C	Alternative D	Alternative E
Vegetation Mechanical Treatment (acres)	0	384,966	431,049	384,966	403,218
Prescribed Fire (acres)*	0	583,330	586,110	178,441	581,020
MSO PAC Habitat Treatments	N/A	Mechanically treat up to 16-inch d.b.h. in 18 PACs (excluding core areas) Utilize prescribed fire in 70 MSO PACs (excluding core areas)	Mechanically treat up to 17.9-inch d.b.h. in 18 PACs Utilize prescribed fire in 54 MSO PACs (including core areas) Utilize prescribed fire in 16 MSO PACs (excluding core areas)	Mechanically treat up to 16-inch d.b.h. in 18 PACs (excluding core areas)	Mechanically treat up to 9-inch d.b.h. in 18 PACs (excluding core areas) Utilize prescribed fire in 70 MSO PACs (excluding core areas)
Springs Restored (number)	0	74	Same as alternative B		
Springs Protective Fence Construction (miles)	0	Up to 4	Same as alternative B		
Aspen Protective Fencing (miles)		Up to 82	Same as alternative B		
Ephemeral Stream Restoration (miles)	0	39	Same as alternative B		
Temporary Road Construction and Decommission (miles)	0	520	Same as alternative B		

Road Reconstruction/ Improvement (miles)	N/A	Up to 30	Same as alternative B
Road Relocation (miles)	N/A	Up to 10	Same as alternative B
Existing Road Decommission (miles)	N/A	726	Same as alternative B
Unauthorized Route Decommission (miles)	N/A	134	Same as alternative B

*In alternatives B–E, on those acres proposed for prescribed fire, two fires would be conducted over the 10-year period.

Mitigation and Design Features related to livestock grazing

The following mitigation and design features related to livestock grazing were built into the action alternatives to reduce impacts on rangeland resources, livestock management, and livestock permittees.

- Historic range monitoring sites including witness trees/posts, 1” angle iron stakes, and any other site location markers would be protected. These sites would not be excluded from treatment but care needs to be taken to avoid loss of these site markers. These sites would not be used as locations for temporary access roads, skid trails, landing areas, or large slash piles.
- The sale administrator would work closely with the district range staff to determine pasture use during harvest activities.
- All fences in the cutting area would be protected from harvest activities. Skid trail layout would keep equipment on one side of the fence to avoid having to cut fences. Temporary cattleguards would be installed on all haul roads where gates exist within active grazed pastures. All cattleguards on harvest haul roads would be maintained throughout hauling activities.
- Burning often damages/destroys wood stays and h-brace posts in existing pasture/allotment fencing. Protection of these fences is critical for implementation of planned grazing systems and is important to reduce the costs of replacing these items. Even with protection, wood stays and h-braces would be damaged by the fire. The cost of prescribed burning would include fence protection measures and replacement/reconstruction costs for burned wood stays and h-braces. Fire personnel will look at using the fence lines as burn area boundaries whenever possible to reduce these impacts
- Fire personnel would coordinate with district range staff to schedule main pasture burning to limit impacts to allotment grazing management. The general goal would be to limit burns to no more than one main grazing pasture/year/allotment in allotments with a less than, or equal to, six pasture grazing system. The general goal would be to limit burns to no more than two main grazing pastures/year/allotment in allotments with a greater than six pasture

grazing system. Main pastures are pastures that are large enough to hold the allotments livestock for more than an average of 20 days/year. This is a general rule of thumb; however, each allotment has specific situations that would need to be addressed.

- Restrictions in grazing of livestock will occur after significant burns in pastures. Livestock pasture rest after ground disturbing treatments (i.e. thinning, seeding, and aspen treatments) may occur. Line officers will evaluate annual range readiness monitoring (at a minimum) to determine when grazing may resume within a pasture. Grazing regimes may need to be altered based on ground conditions after treatments. Livestock use after treatments will be carefully and actively managed. The range management definition for range readiness is: Plants are ready for grazing when at least one of the following characteristics is present: 1) seed heads or flowers, 2) multiple leaves or branches, and/or 3) a root system that does not allow plants to be easily pulled from the ground. These characteristics provide evidence of plant recovery, high vigor and reproductive ability. Other factors evaluated may include forage production, precipitation and fuel loading. An estimate of this restriction is not available because of each pasture's response to ground disturbing treatments (including vegetation and prescribed fire) is unique. Climatic conditions, soils, vegetation, the severity of fire effects, burn amount, intensity of vegetation treatments and pasture management may vary greatly from year to year or from pasture to pasture.Range and fire managers will coordinate grazing schedules and prescribed fires on allotments within burn units to ensure there is sufficient surface fuel to allow burn objectives to be met. If grazing cannot cease long enough for sufficient fuel to build up to meet objectives, planned prescribed fires will be postponed until there can be sufficient fuel to meet objectives (see ROD, Appendix C, R7).
- Range, silviculture and fire managers will coordinate grazing schedules with vegetation and prescribed fire treatments that will occur on allotments (and within burn units) to ensure there is sufficient surface fuel to allow burn objectives to be met. Planned vegetation treatments and prescribed fires will be postponed until there can be sufficient fuel to meet objectives (see ROD, Appendix C, R8).
- Range readiness monitoring will be included in the appendix D implementation plan checklist. Annual monitoring typically includes measures for forage production, precipitation, forage utilization, livestock numbers, and livestock season of use. Condition and trend monitoring every 5 to 10 years measures plant canopy cover, plant frequency, and ground cover. By requiring inclusion of all design features and mitigation, appendix E, the biophysical and social monitoring and adaptive management plan, includes grazing-related monitoring (see ROD, Appendix C, R10).
- The removal or exclusion of livestock water would be mitigated with alternative water sources, providing lanes to the water, or piping water to a livestock drinker.

Analysis Questions to be answered.

The following is a list of questions to be answered for this project concerning livestock management. This list incorporates questions designed to evaluated management toward desired conditions (see Purpose and Need), issues and key concerns (see Issues).

  - *How would project activities affect livestock grazing management in the project area?*

- *How would project activities affect livestock forage in the project area?*
- *Would livestock grazing affect the restoration of understory species?*
- *How would livestock grazing affect the ability to return fire as a natural process to the project area?*
- *How would climate change affect the range resource, how would the project affect climate change (relative to range)?*

Methodology and Analysis Process

GIS was used for this analysis to determine number and acres of allotments and pastures in the planning and treatments by alternative. The scale of this analysis was primarily based on an individual range allotment. This scale was used because each allotment is unique in size, livestock type, season of use, ownership, number of pastures, vegetation, waters, utilization patterns, and grazing system. Data is typically reported to the nearest acre, mile, or percentage. Most values have been rounded from their actual decimal values. Totals were calculated before any values were rounded in order to give the most accurate sum. Any apparent inconsistency between the total values reported in a table and a sum resulting from adding up individual values in a table typically accounts for a discrepancy of about 1% in the case of rounding percentages or miles, and <2 acres in the case of acres.

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

Data from historic range clusters sites scattered throughout the project area were used to show understory trends from the 1950’s too current time (Brewer 2011). Rangeland analysis through history including allotment NEPA analysis for the majority of allotments within the analysis area was used in analysis (2200 Range Files: Coconino NF Flagstaff and Mogollon Rim Districts, and Kaibab NF Williams and Tusayan Ranger Districts).

The vegetation, fire, watershed and silviculture specialist reports were used in this report. Individual reports are located in the project record.

Many of studies referenced used in this analysis were conducted within or near the project boundary or within similar vegetation types and similar rangeland management systems.

Changes from DEIS to FEIS and the Objection Resolution Process

Acres and alternatives were corrected or updated as described in chapter 1 of the FEIS. In response to comments on the DEIS (Cara #181) that indicated there was inadequate mitigation related to post-fire grazing, a new design feature was added that clarifies that restrictions in grazing of livestock would primarily occur after significant burns in a pasture (see R7 (revised), R8 (revised) and R10 (new) in Appendix C of the ROD). As a result of the objection resolution process, additional literature references have been added to the reference list. A complete literature review has been added to this report as attachment 2. As a result of comments on the DEIS, the range analysis was updated to reflect managing canopy cover on approximately 39,000 acres in alternatives C and E at the stand level (see chapter 3 effects).

Description of Affected Environment's Existing Conditions

Pre-settlement Rangeland Conditions

More than a century ago, Lt. Edward Beale wrote of northern Arizona: "It is 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, was traversed by our party for many days." (quoted by Bell, 1870).

- 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).
- C. Hart Merriam (1890) based his life zone concept largely on a study of vertical z-nation of vegetation on the San Francisco Mountains. In describing his study 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."

Dutton's classic "Physical Geology of the Grand Canyon Region" (1887) says of the Kaibab Plateau: "The trees are large and noble in aspect and stand widely apart, except in the highest part of the plateau where spruces predominate. Instead of dense thickets where we are shut in by impenetrable foliage, we can look far beyond and see the tree trunks vanishing away like an infinite colonnade. The ground is unobstructed and inviting. There is a constant succession of parks and glades- dreamy avenues of grass and flowers winding between sylvan walls, or spreading out in broad open meadows. From June until September there is a display of wild flowers which is quite beyond description."

Existing Conditions

The affected environment for the range analysis is the project area. Only allotments within the project area have been considered.Of the 989,029 acres of this project area (specific to grazing), 791,250 are within grazing allotments and 197,779 acres that are not grazed by livestock. The majority of the understory vegetation within the grazing area is dominated by Arizona fescue, mountain muhly, blue grama and squirreltail.

Within the project area there are 49 livestock grazing allotments, 47 are active allotments and two are vacant (Figure 1). Of these 49 allotments, 40 permit cattle grazing and nine permit sheep grazing. The amount of each allotment lying within the project area averages 65%, and varies between 0.002 to 100%. There are 229 main pastures located within the project area. Main pastures are the large pastures that are used more than 20 days per year by livestock.

Within the 49 livestock grazing allotments within the project area there are 211 main summer use pastures. Main pastures are pastures that are large enough to hold the allotments livestock for more than an average of 20 days/year. There are 29 main summer use pastures within these allotments that are not within the planning area. In addition, these pasture totals do not include winter use pastures or private lands associated with these allotments.

All the acres of each of the 49 allotments in the project area by restoration unit and total allotment acres are displayed on Table 2. Restoration units are used for display purposes only are not used in the analysis for this report. Restoration units were used by the 4FRI team as a strategy developed by the 4FRI stakeholders to stratify the landscape into six restoration units. A restoration unit is a contiguous geographic area that ranges from about 46,000 acres to 333,000 acres in size. A need for change (vegetation structure, pattern, spatial arrangement, potential for destructive fire behavior and effects) was identified for each unit.

All current range allotments on the Kaibab National Forest have been through a rigorous evaluation and NEPA process since 1992 (FSM r3-2209.13-90). The majority of Coconino National Forest allotments have been through the same evaluation process and the ones that are not as recent have been monitored showing no preliminary management adjustment needs. Within the project area, forage production has been properly matched with permitted livestock numbers. Adaptive management is being used to maintain and improve the rangeland resources.

All the grazing management systems, current numbers of permitted livestock, and seasons of use within the project area are found in Table 3. The effects analysis in this report is geared toward the effects on the allotments within the project area.

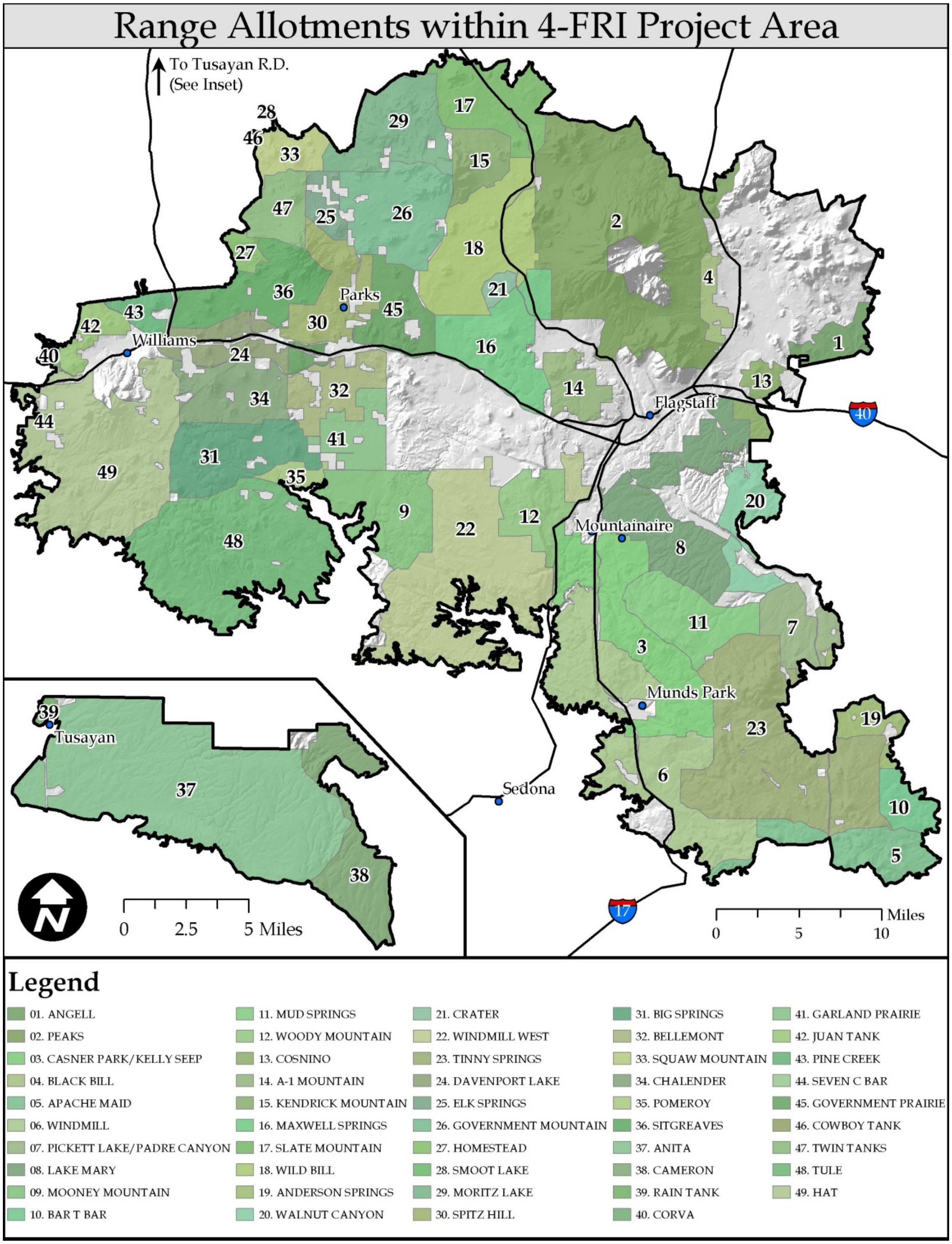

Figure 1. Range Allotments within the 4FRI Project Area

Table 2. Allotment acres by restoration unit (RU) and totals within project area

Allotment Acres by RU	1	2	3	4	5	6	Totals
A-1 Mountain				7,362			7,362
Anderson Springs	5,521						5,521
Angell					5,702		5,702
Anita						36,078	36,078
Apache Maid	14,452						14,452
Bar T Bar	6,119						6,119
Bellemont			10,433				10,433
Big Springs			18,581				18,581
Black Bill					3,937		3,937
Cameron						8,668	8,668
Casner/Kelly Seep	22,900		6,071				28,971
Chalender			13,915				13,915
Corva				887			887
Cosnino	2,036				2,764		4,800
Cowboy Tank				0.2			0.2
Crater				1,874			1,874
Davenport Lake			4,677	4,124			8,801
Elk Springs				3995			3,995
Garland Prairie			9,054				9,054
Government Mtn.				20,737			20,737
Government Prairie			1,273	12,092			13,365
Hat			48,235	685			48,919
Homestead				2,676			2,676
Juan Tank				5,446			5,446
Kendrick Mountain				8,136			8,136
Lake Mary	27,919						27,919
Maxwell Springs			0.4	17,652	3,056		20,709
Mooney Mountain			18,058				18,058
Moritz Lake				18,516			18,516
Mud Springs	15,802						15,802
Peaks				3,846	70,424		74,270
Pickett/Padre	10,747						10,747
Pine Creek			0.1	4,137			4,137
Pomeroy			2,792				2,792
Rain Tank						446	446
Seven C Bar			294				294
Sitgreaves				17,562			17,562
Slate Mountain				18,223			18,223
Smoot Lake				56			56
Spitz Hill				13,749			13,749
Squaw Mountain				6,945			6,945
Tinny Springs	53,017						53,017
Tule			48,681				48,681
Twin Tanks				8,521			8,521
Walnut Canyon	10,584						10,584
Wild Bill				20,858	5,449		26,307
Windmill	23,396		19,161				42,557
Windmill West			52,148				52,148
Woody Mountain			10,517				10,517

Table 3. Allotment information within project area related to grazing management

Allotment	Total Acres	Project Acres	Grazing System	On/off Dates	Livestock # and Kind
A-1 Mountain	7,361	7,362	Rest Rotation	6/1-10/31	99 cattle
Anderson Springs	47,061	5,521	Rest Rotation	3/1-10/31	587 cattle
Angell	51,699	5,702	Rest Rotation	5/15-10/31	425 cattle
Anita*	102,257	36,078	Rest Rotation	5/1-10/31	1310 cattle
Apache Maid	149,052	14,453	Rest Rotation	6/1-10/31	1445 cattle/yr
Bar T Bar	186,489	6,119	Rest Rotation	5/1-10/31	3470 cattle/yr
Bellemont*	10,451	10,433	Rest Rotation	6/15-11/15	285 cattle
Big Springs*	18,571	18,581	Deferred Rotation	5/1-5/31	2000 sheep
Black Bill	3,938	3,937	Rest Rotation	6/1-10/15	60 cattle
Cameron*	104,479	8,668	Rest Rotation	5/1-10/31	1310 cattle
Casner/Kelly Seep	28,940	28,971	Rest Rotation	6/1-10/31	395 cattle yr.
Chalender*	13,630	13,915	Rest Rotation	6/15-10/15	115 cattle
Corva*	13,415	887	Rest Rotation	3/1-8/31	250 cattle
Cosnino	10,501	4,800	Rest Rotation	6/1-10/31	160 cattle
Cowboy Tank*	8,516	0.2	Deferred Rotation	5/21-10/20	1016 sheep
Crater	1,875	1,874	Deferred Rotation	6/1-10/31	61 cattle
Davenport Lake*	8,864	8,801	Rest Rotation	5/16-10/31	145 cattle
Elk Springs*	3,933	3,995	Rest Rotation	7/1-1/31	46 cattle
Garland Prairie*	8,024	9,054	Deferred Rotation	6/1-7/15	1840 sheep
Government Mtn.*	18,129	20,737	Rest Rotation	5/15-9/30	420 cattle
Government Prairie*	11,134	13,365	Rest Rotation	6/15-10/31	265 cattle
Hat*	104,847	48,919	Rest Rotation	5/1-10/31	4160 sheep
Homestead*	6,894	2,676	Rest Rotation	5/1-10/31	125 cattle
Juan Tank*	19,356	5,446	Rest Rotation	3/1-2/28	190 cattle
Kendrick Mountain*	8,061	8,136	Deferred Rotation	6/1-10/31	75 cattle
Lake Mary	28,002	27,919	Rest Rotation	6/1-10/31	0 cattle
Maxwell Springs	20,704	20,709	Deferred Rotation	6/1-10/31	285 cattle
Mooney Mountain*	20,864	18,058	Deferred Rotation	6/1-8/31	1840 sheep
Moritz Lake*	25,573	18,516	Rest Rotation	3/1-8/31	270 cattle
Mud Springs	15,802	15,802	Deferred Rotation	6/1-10/31	200 cattle yr.
Peaks	157,306	74,270	Rest Rotation	5/15-10/15	375 cattle
Pickett/Padre	54,473	10,747	Rest Rotation	6/1-9/30	913 cattle
Pine Creek*	8,965	4,137	Deferred Rotation	6/1-10/31	133 cattle
Pomeroy*	3,106	2,792	Deferred Rotation	6/1-7/15	400 sheep
Rain Tank*	63,851	446	Rest Rotation	6/1-10/31	0 cattle
Seven C Bar*	294	294	Rest Rotation	7/1-10/31	20 cattle yr.
Sitgreaves*	20,427	17,562	Rest Rotation	6/1-10/15	486 cattle yr.
Slate Mountain	45,818	18,223	Rest Rotation	5/15-9/30	600 cattle
Smoot Lake*	40,584	56	Rest Rotation	9/1-2/28	270 cattle
Spitz Hill*	12,909	13,749	Rest Rotation	6/1-10/16	195 cattle
Squaw Mountain*	15,461	6,945	Deferred Rotation	5/21-10/20	2032 sheep
Tinny Springs	59,300	53,017	Rest Rotation	6/1-10/31	500 cattle
Tule*	60,258	48,682	Rest Rotation	5/15-12/15	300 cattle
Twin Tanks*	12,100	8,521	Deferred Rotation	5/21-10/20	1025 sheep
Walnut Canyon	24,863	10,584	Rest Rotation	6/1-10/31	350 cattle
Wild Bill	26,306	26,307	Rest Rotation	5/15-9/30	502 cattle
Windmill	90,343	42,557	Rest Rotation	3/1-2/28	500 cattle
Windmill West	121,388	52,148	Rest Rotation	3/1-2/28	500 cattle
Woody Mountain	10,516	10,517	Deferred Rotation	6/1-10/15	830 sheep

*Kaibab National Forest Allotments. yr. = yearling cattle permitted; cattle/yr. = both cattle and yearling cattle permitted

General Overview of Potential and Existing Livestock Grazing Effects to Fire, Understory Species, Riparian, Aspen, Soils, and Hydrologic Function

Livestock grazing can affect vegetation by reducing plant height, plant canopy cover, ground cover, and can have the effect of compacting soils. Current grazing management systems on allotments within the project area are designed to mitigate these effects by rotating grazing so individual forage plants are not grazed at the same time each year. They are also designed so forage species can reach maturity and seed most years. **Emphasis added:** Current allotment management plans have utilization guidelines of 30-40% by ungulates which leave 60-70% for ground cover, soils, fire spread, hiding cover, and forage for other animals and insects. Adaptive management for all allotment grazing management systems in the planning area is also mitigation to grazing. It is primarily used match livestock numbers with annual available forage. Restrictions in grazing of livestock after fires are also a mitigation to reduce impact to forage species. These mitigations have shown to maintain static understory conditions in grazed areas.

Annual stocking rates are based on a range readiness assessment. The range management definition for range readiness is: Plants are ready for grazing when at least one of the following characteristics is present: 1) seed heads or flowers, 2) multiple leaves or branches, and/or 3) a root system that does not allow plants to be easily pulled from the ground. These characteristics provide evidence of plant recovery, high vigor and reproductive ability. Other factors evaluated may include forage production, precipitation and fuel loading. An estimate of this restriction is not available because of each pasture's response to ground disturbing treatments (including vegetation and prescribed fire) is unique. Climatic conditions, soils, vegetation, the severity of fire effects, burn amount, intensity of vegetation treatments and pasture management may vary greatly from year to year or from pasture to pasture.

Range readiness monitoring is included in the Appendix D implementation plan checklist. Annual monitoring typically includes measures for forage production, precipitation, forage utilization, livestock numbers, and livestock season of use. Condition and trend monitoring every 5 to 10 years measures plant canopy cover, plant frequency, and ground cover. By requiring inclusion of all design features and mitigation, Appendix E, the biophysical and social monitoring and adaptive management plan, includes grazing-related monitoring.

Managed livestock grazing can affect the spread of natural fire by the removal of fine herbaceous fuel until the plants regrow. Historic unregulated livestock management from the 1860's to the 1920's removed a significant the amount of forage plants and did not allow for much regrowth. As range management practices were improved through the years more forage plants became available to carry a fire. A likely factor to the increase in the amount of forest acres burned in recent history is a result of this improvement in range management practices.

Emphasis Added: Current grazing management systems effects to fire within the project area is short lived and limited in size. The effect is normally limited to one pasture in an allotment, until that pasture can regrow, for typically between two to six weeks depending on climate conditions. The effect is short lived because this area is grazed from May through October which is the same time in which the forage is typically growing. It is also limited in scope because of conservative 30-40% utilization levels used in these grazing management systems in the project area, leaving 60-70% of the plants available for fire spread or mulch. These utilization guidelines have been followed for these allotments in the project area over the last

20 years with few exceptions (2200 Range Files Coconino and Kaibab Ranger District inspections and utilization data; Hannemann personnel observations). The exceptions were always corrected the following year by resting the pasture, deferring use, reducing grazed periods, and/or reducing livestock numbers. Many fuels reduction and restoration projects have occurred within the project area have been successful with livestock grazing. The A-1 project, Kachina, Lee, Government, Horse Pine, to name just a few, have been completed with current livestock grazing in place.

Grazing effects appeared less important than abiotic and biotic factors in explaining the observed spatial variation in vegetation (Laughlin and Abella 2007). The model results imply that ungulate (cattle, sheep, deer and elk) grazing might directly influence plant community composition. Heavy grazing can shift the community toward greater abundance of unpalatable species (Westoby et al., 1989; O'Connor, 1991). A few unpalatable species, including broom snakeweed (*Gutierrezia sarothrae* (Pursh, Britt. & Rusby) and spreading fleabane (*Erigeron divergens* Torr. & Gray), were most abundant in the heavily grazed plots (Abella and Covington, 2006). It is likely that the unregulated grazing in the 1860's to 1920's in the project area likely led to temporary changes in vegetation. As heavy grazing was eliminated through time the plant composition responded.

Livestock grazing can affect riparian and aspen areas similarly to upland areas. However, livestock can be more attracted to riparian and aspen areas because of the increased water and/or forage. Riparian plants and aspen can be reduced by grazing these species. Special livestock management techniques have been employed within the project area to reduce the impacts including livestock exclosures, deferred grazing, herding, and alternative water sources with adjustments in Allotment Management Plans over the years. These practices have limited the amount of livestock grazing on riparian vegetation and aspen. Additional adjustments in management may be necessary to reduce impacts to these areas, especially if riparian and aspen regeneration areas would be expanded with new management practices.

Domestic cattle grazing has the potential to affect soil and hydrologic functions that are important in the maintenance of long-term productivity and favorable conditions of water flow. Specifically, changes in the soil's surface structure and its ability to accept hold, and release water may be affected by compaction caused by trampling. The nutrient cycling function of the soil may be interrupted by removal of vegetation that impacts above ground nutrient inputs into the system. Finally, the soil's resistance to erosion is affected by changes in plant density, composition, and protective vegetative ground cover that are part of the organic components in the soil.

The effect of livestock grazing to soil and hydrologic function is limited within the project area because of the current management in place that limits utilization, maintains forage plants, and limits compaction with deferred and rest rotational grazing systems.

Historic and Past Factors Affecting Current Understory Vegetation

Since European settlement of the project area heavy tree harvest, fire exclusion, overgrazing, and climate change has altered the trajectory of stand development, ecosystem function, and spatial pattern of ponderosa pine stands in northern Arizona (Moore et al 2004). Many others have documented this as well (Pearson 1910, Arnold 1950, Cooper 1960, Stein 1988, Savage and Swetnam 1990, Savage 1991, Covington and Moore 1994, Swetnam and Baisan 1996, Heinlein 1996). Figures 2 and 3 shows an example of how the landscape has changed over the years.

Grazing Effects from the 1860's to Present

There has been a long livestock grazing history within the project area. The first pioneers settled in this area in the 1860's with their livestock. As more settlers moved in, they brought with them more and more livestock. Initially, livestock numbers started low but increased quickly throughout the entire project area. The major factor contributing to the increase in cattle occurred when the Atlantic and Pacific Railroad connected Flagstaff with Albuquerque and the eastern US markets in 1882.

The capacity of the land was quickly filled. In 1888 a quote from the Arizona Champion states: "many portions of the Territory are now overstocked to an alarming extent…all available ranges where a natural supply of water can be had are now located and settled upon and those seeking ranges are compelled to buy or intrude on other parties property."

Cattle production in the project area peaked in 1891. After a two-year drought from 1891 to July of 1893, the financial panic of 1893, and the winter of 1892-93 cattle numbers were greatly reduced. In 1893, the Grand Canyon Forest Reserve was established within the present day Tusayan Ranger District. In 1898, the Black Mesa and San Francisco Mountain Forest Reserves were established on the remainder of the project area. However, there were no livestock grazing limitations with these designations.

The project area was designated National Forest lands in 1908. There were no legal hindrances to grazing on the public domain, but permits were required. Grazing management was minimal, consisting of issuing permits and collecting fees. Uncontrolled public domain grazing inevitably produced conflict and exploitation in which the range deteriorated and most stockmen suffered. To help resolve some of these problems, the first fences were built in 1915.

In 1916, the Homestead Act allowed settlers to claim up to 640 acres and graze 50 head of cattle on these 640 acres. The act provided vast opportunities for settlement in the West and resulted in overgrazing of many areas including the project area.

Livestock numbers on the Coconino and Kaibab National Forest have generally declined over time since the 1890's. One exception to this general trend was during the WWII when numbers were temporary increased. Livestock reductions were generally made in the early years when allotments changed hands. Some of the reductions were made for range protection without a permit changing hands. A complete record of the early grazing history of individual allotments does not exist. However, an estimated summary of numbers from 1910 to 2010 for the Coconino National Forest is presented in Tables 4 and 5. Both tables display the permitted number and head months of livestock, and the actual numbers of livestock that grazed the Forest during these different time periods. As new data is found and compiled these numbers may change slightly.

In addition, to the numbers in Tables 1 and 2, a large number of feral and trespass horses and burros were running on the Forests. The majority of these animals were removed in the 1950's.

The Kaibab National Forest numbers show this same general pattern. The following numbers shows the decline in permitted livestock Animal Unit Months (AUMs) on the Kaibab National Forest in the last 40 years: 1971 - 108,545; 1986 - 86,375; 2002 - 73,541; 2009 -

64,351. Of the 64, 351 AUM’s in 2009, 51,416 AUM’s permitted in cattle, 12,683 in sheep, and 252 in horses. From 1971 to 2009 AUMs declined by over 57,000.

Until the 1920’s, most of the grazing permits within the project area were yearlong or for eight months from 4/1 or 4/15 to 11/20 or 11/30. After 1922, several permits changed to summer grazing use, and were typically for five months from 6/1-10/31. From 1927 until the early 1930’s individual allotments were fenced. By 1940, most dual use between cattle and sheep ended in this region as most of the permittees switched to cattle. All these changes improved grazing management and reduced the impacts of grazing to understory vegetation within the project area.

Overgrazing by livestock and the changes to understory vegetation in the late 1880’s and early 1890’s is well documented. In 1889, Farish wrote of the San Francisco Mountains: "In this mountain range are found fine valleys, formerly covered with a growth of wild rye and pea vine, which has been replaced by other grasses." Replacement of the better forage plants had taken no more than a dozen years after the introduction of livestock. In 1892 a severe drought combined with range depletion to cause heavy stock losses, which became even worse in 1893. The Governor of Arizona stated in his annual report (Hughs 1893): "In nearly all districts, owing to overstocking, many weeds have taken the place of the best grasses. In other places where ten years ago the end of the wet season would find a rich growth of grass, now it is of inferior quality, or less quantity, or does not exist at all."

Figure 2. Fern Mountain (Hart Prairie) grassland circa 1880

Figure 3. Fern Mountain (Hart Prairie) grassland encroachment circa 1980s

Table 4. Number of Cattle and Horses on the Coconino National Forest, 1910-2000

Year	Permitted Number	Permitted Head Months	Actual Head Months
1910	33,200	247,000	239,000
1920	49,106	427,000	400,000
1930	19,088	149,000	142,000
1940	19,500	144,992	139,835
Late 1940's-50	19,000	137,589	132,639
1960	18,000	138,906	131,018
1970	19,000	138,688	123,611
1980	17,350	134,589	112,713
1990	17,540	136,160	96,118
2000	16,271	126,684	88,801
2010	16,318	112,947	75,715

Table 5. Number of Sheep and Goats on the Coconino National Forest, 1910-2000

Year	Permitted Number	Permitted Head Months	Actual Head Months
1910	89,550	360,000	300,000
1920	95,090	420,000	350,000
1930	63,080	240,000	200,000
1940	50,000	188,237	153,966
Late 1940's-50	24,000	112,827	94,594
1960	17,000	73,554	66,512
1970	15,000	57,742	53,993
1980	10,000	41,565	13,666
1990	2,670	14,747	12,002
2000	2,670	14,747	10,227
2010	2,670	12,038	12,038

Arnold (1955) described the following grazing effect of early livestock grazing. "Under heavy grazing the original tall bunchgrasses have been largely replaced by plants more resistant to grazing, except where dense tree cover discourages livestock use. In addition, grass cover decreases as pine reproduction becomes established; the greater the density of pine saplings, the less the total herbaceous cover. Decline in total forage production as a result of competition from young pine stands is accompanied by no great botanical change in the herbaceous vegetation, but heavy grazing induces a major change in species composition. In openings within the forest, ranges in good to excellent condition near Flagstaff support a high proportion of midgrasses, dominated by Arizona fescue, mountain muhly, muttongrass, and June grass. Under heavy grazing pressure, the midgrasses are replaced by a shortgrass cover composed largely of blue grama and squirreltail. Under still more severe use, even these resistant grasses are largely replaced by less desirable perennial and annual forbs."

Cooper (1960) follows up a summary of the effects of livestock management through history. “The large reduction in numbers of livestock permitted on national forests, plus the extensive conversion of sheep operations to cattle, have greatly alleviated the browsing problem. Localized damage continues due to livestock concentration, but is relatively minor. The results of past browsing damage, however, are clearly apparent in large areas that lack reproduction due to past sheep use. Grazing has been important in reducing the spread of fire. Large amounts of inflammable grass, which used to remain on the ground, are now removed by grazing animals. Many of the early arguments against reduction of grazing on the national forests were based on the premise that heavy grazing made forest fires much less frequent. It has been widely held that removal of herbaceous cover and plant litter by grazing animals, and the exposure of mineral seedbeds by livestock trampling have been important factors in the establishment of dense pine stands. Pine seeds germinate well under proper weather conditions on almost any type of ground cover, but they soon die from desiccation unless they become rooted in mineral soil. In addition, direct root competition for soil water from the established grass cover is considered to inhibit seedling growth.”

“In a normal year, most if not all pine seedlings in a virgin forest would die regardless of competition. In the rare year in which a wave of seedlings establishes itself, there may be so much moisture that no degree of herbaceous competition is really inhibitory. Reduction of competition may be a means of encouraging better reproduction in managed stands, but under virgin conditions it appears that seedlings could have developed even in a heavy grass cover. The reduction of grass competition and the preparation of a mineral seedbed by grazing animals probably helped to bring about the dense thickets, but do not seem to have been the controlling factor. There are many severely grazed openings which remain nearly denuded of vegetation and in which pine seedlings have not become established (Cooper 1960).”

The Hill Plots livestock grazing exclosures were established in 1911 within the project area. The exclosures were reevaluated in 2004 (Baker and Moore 2007). In 1941, canopy cover of tree regeneration was significantly higher inside exclosures. In 2004, total tree canopy cover was twice as high, density was three times higher, trees were smaller, and total basal area was 40% higher inside exclosures. Understory species density, herbaceous plant density, and herbaceous cover were negatively correlated with overstory vegetation in both years. Most understory variables were lower inside exclosures in 2004. Differences between grazing treatments disappeared once overstory effects were accounted for, indicating that they were due to the differential overstory response to historical livestock grazing practices. These variables did not differ between grazing treatments or years once overstory effects were accounted for, indicating that the declines were driven by the increased dominance of the overstory during this period. In addition, the understory vegetation was more strongly controlled by the ponderosa pine overstory than by recent livestock grazing or by temporal dynamics, indicating that overstory effects must be accounted for when examining understory responses in this ecosystem.

In summary, historic livestock effects to understory vegetation follow the history of livestock management within the project area. Range trends within the project area follow this grazing history. Unregulated grazing from the 1860’s to the 1920’s led to declines in grass, forb, and shrubs and an increase in trees. Since then, grazing management practices have evolved through time to limit overgrazing by livestock and to match conservative livestock utilization with forage production. With the improvement in grazing management, trends in understory vegetation have generally improved in areas where tree density does not limit recovery. Tree density limits the amount of understory vegetation; as tree densities increase, the understory vegetation declines. The direct relationship between tree basal area and understory production has been widely studied (Moore et al 2004, Arnold 1950, Cooper 1960, Pearson and Jameson 1967). In these studies, the direct relationship between tree density and understory vegetation was observed regardless of whether the study area was grazed by livestock, or whether the study area was excluded from livestock grazing.

Dave Brewer of Ecological Restoration Institute of Northern Arizona University did a study in 2011 of the trends of understory vegetation within the study area (Brewer 2011). Example pictures from this project are shown on Figures 4 and 5. This study used information from 121 historic range Parker cluster monitoring sites. Most of these sites were first established in the late 1950 and 1960's. Range trend showed a static trend at 51 sites, a decline in trend at 34 sites, and an increase in trend at 36 sites comparing the last two readings of the cluster. Declines in range trend are primarily related to an increase in invader plants, while the increase is related to an increase in decreaser grass species. This study also shows that trees play a large role in trend in understory vegetation. As trees increase at the sites, trends decline. When tree cover is reduced, trends increase. In summary, the range trend for the project area is generally static from the late 1950 and 1960's. However, range trend must not be used as an ecological trend, as it shows the indication of trend for livestock. For instance an increase in forbs, half-shrubs, and blue grama may show a decline in trend for cattle grazing but maybe an improvement for certain wildlife species or ground cover. As an example, recent analysis on 7CBar, Pine Creek, Twin Tanks and Hat Allotments showed an increase in blue grama in recent years during years of poor winter moisture and better summer moisture. The historic cluster data method would show a decline in range trend because of increase in blue grama. However, an increase in blue grama is an improvement in ground cover because it is a bunch grass.

Tree Density Effects – Pre-settlement to the Present

Tree stand structure has changed dramatically from pre-settlement conditions to present day (silviculture, vegetation, and fire specialist reports). Trees are dominantly even-aged, where they used to be more uneven aged. Trees are primarily of mid-size with little large or small trees, where they used to be of various sizes. Trees are spaced throughout the forest, where they used to be more groupie and clumpy with more forest openings. An increase in tree density has increased the probability for increase in tree mortality from insects, disease, and fire. An increase in trees has reduced understory vegetation amount, species and composition.

A century ago the pine forests were dominated by widely-spaced large trees with a more open, herbaceous forest floor (Cooper 1960). Typical historic tree group/patch size ranged from 0.1 to 0.75 acres in size, (2 to >40 trees) (White 1985). This historic range of variability condition for trees per acre on the Fort Valley Experimental Forest, near Flagstaff, Arizona, is estimated to average 23 to 56 trees per acre (Covington 1993). This increase in trees primarily came from the 1919 pine seedlings established in this high moisture year. Because of this increase in trees, understory vegetation and forage has declined over time within the project area.

This relationship between trees and herbaceous understory has been well documented (Moore et al 2004, Arnold 1950, Cooper 1960). The 1960's Wild Bill Range study by Rocky Mountain Research Station (within the project area) showed a solid relationship between tree basal area (BA) and herbage production. As tree basal area increased from 0 to 50 BA sq ft/acre there was a sharp drop in forage from over 650 to 100 pounds per acre. Trees BA's above 50 had herbage production between 100 and 45 pounds per acre (Pearson and Jameson 1967). One aspect to the decrease in allowable livestock numbers through history within the project area has been this increase in trees and a decrease in forage. This is evident for all the allotments within the project area. Allotment analysis and trend monitoring has repeatedly shown this affect (2200 Range Files: Coconino NF Flagstaff and Mogollon Rim Districts, and Kaibab NF Williams District).

Arnold (1950) showed the relationship between canopy cover and herbaceous densities and grass yields was highly significant uniform linear regression. Grasses and forbs decreased at about the same rate as canopy cover increased. There was about a fivefold decrease in herbaceous cover from 10% canopy cover to 100% canopy cover. Under complete canopy cover yield trees make full use of the site regardless of site conditions. Under an even-aged forest, each 1% in density of ground cover was equal to an air-dry grass yield of 150 lbs. In uneven-aged forests, the relationship between canopy and herbaceous density was still linear, but with more variability. Perennial herbs made up a small but constant part of the understory. Annuals were rare except in years of abundant moisture.

Several studies that have shown high ponderosa pine abundance to depress understory plant production (Ffolliott 1983; Tapia et al. 1990; Moore & Deiter 1992, Laughlin et al 2011) since pine trees create deep shade, intercept precipitation and compete for soil resources (McLaughlin 1978; Riegel et al. 1995; Naumburg and DeWald 1999). Pine abundance was also related to variation in species composition, suggesting that differences in forest structure could cause changes in floristic assemblages. (Laughlin et al 2005).

Laughlin et al 2011 wrote "A century of increasing ponderosa pine density was associated with shifts in herbaceous plant strategies and reduced functional diversity. Shade- and stress-tolerant herbaceous plants that use a more conservative strategy for acquiring and maintaining resources have increased in relative abundance over time likely because light, water, and nutrients have become more limiting beneath the dense overstory."

Baker and Moore (2007) reexamined the Hill Plot livestock exclosures built in 1910's. The Hill Plots are located within the project area. They determined that in 1941, canopy cover of tree regeneration was significantly higher inside exclosures. In 2004, total tree canopy cover was twice as high, density was three times higher, trees were smaller, and total basal area was 40% higher inside exclosures. Understory species density, herbaceous plant density, and herbaceous cover were negatively correlated with overstory vegetation in both years. Most understory variables were lower inside exclosures in 2004. Differences between grazing treatments disappeared once overstory effects were accounted for, indicating that they were

Figure 4. Government Mountain monitoring transect circa 1953

Figure 5. Government Mountain monitoring transect in 2010

due to the differential overstory response to historical livestock grazing practices. Between 1941 and 2004, species density declined by 34%, herbaceous plant density by 37%, shrub cover by 69%, total herbaceous cover by 59%, graminoid cover by 39%, and forb cover by 82%. However, these variables did not differ between grazing treatments or years once overstory effects were accounted for, indicating that the declines were driven by the increased dominance of the overstory during this period. In addition, the understory vegetation was more strongly controlled by the ponderosa pine overstory than by recent livestock grazing or by temporal dynamics, indicating that overstory effects must be accounted for when examining understory responses in this ecosystem.

Several of these studies were conducted within the project area. Allotment analysis and trend monitoring has repeatedly shown this affects (2200 Range Files: Coconino NF Flagstaff and Mogollon Rim Districts, and Kaibab NF Williams District). As understory vegetation and forage has decreased over time, allotment numbers have also dropped, in part, to match this decline (Tables 4 and 5, above).

Fire Effects

Fire suppression has been the norm in the project area since European settlement, until recent years. Pre-settlement natural wildfires burned on an average of 3-7 years in the project areas ponderosa pine forest. These fires reduced the number of pine trees, provided abundant nutrient cycling, and reduced pine litter build-up on the forest floor. The reduction in fire frequency reduced these processes.

One study (Laughlin et al 2005) showed that length of time since a fire may also be important for preserving landscape-scale heterogeneity with respect to plant community structure. The variability in plant cover and annual forb richness is much greater on sites that have burned recently and frequently than on sites that have not burned for over 60 years. However, variability in total species richness and in perennial forb richness was not noticeably greater in recently burned forests than in fire-excluded forests. Apparently, plant cover and annual species are more sensitive than total species richness and perennial forb richness to variations in conditions created by fire.

Gundale (etal. 2005) wrote that native grass species that reportedly dominated the understory of historical ponderosa pine forests likely relied on rapid nitrogen cycling that was promoted by periodic fire. Differences in short-term N cycling rates among restoration treatments may lead to substantial differences in site productivity and plant community composition. In addition to differences among restoration treatments, N cycling appears to have a positive linear relationship with fire severity within the severity range experienced in this study.

With the reduction in fire, resulting in more trees and pine needle ground cover, less understory forage was available for livestock grazing over time in the planning area. This is another reason that livestock numbers have declined over time (Table 4 and 5). Where fires have occurred within the project area, forage production has increased. A small representative of fires within the project area that have shown this increase in production are Horseshoe (1996), Hockderffer (1996), Pumpkin (2000), Miller (2008), Marteen (2008), Whitehorse (2009). These fires affected the short term use of the fire area for livestock grazing, but within one year the areas had recovered and forage improved (Hannemann, personal observations). The timing of recovery was related to fire severity but it is primarily driven by moisture after a fire.

Climate Change Effects

Precipitation and temperature influence what plants can grow and where. Variations of climate through time have greatly influenced plant conditions in the project area. For example, a high moisture period along with a high pine seed crop and low understory competition from heavy livestock grazing produced the dense 1919 pine tree crop in much of the project area. Lesser tree seed crops were also established in 1910, 1914, and 1929.

In a review of the range data within the project area, changes in species composition have changed throughout this time period in a direct response to the amount and timing of moisture. From the 1950's to the early 1990's cool season grasses replaced warm season species with the increase in winter and spring moisture. Since the 1990's, warm season species have increased with a decrease in winter moisture and increase in summer moisture. Ground cover has increased with warm season species, primarily because blue grama is sod forming species (Coconino and Kaibab District 2200 Range Files).

An analysis of the Williams climate station median statistics (1897-2005) shows that 42% of the growing season precipitation arrives during the cool season, while 58% arrives during the warm season. An analysis of the Flagstaff (1950-2006) and Fort Valley (1910-2005) climate station median statistics shows that 47% of the growing season precipitation arrives during the cool season, while 53% arrives during the warm season. The climate in the Southwest United States is characterized by an erratic precipitation pattern. The amount, timing, and location of precipitation are extremely variable and difficult to predict. The most predictable months are March during the cool season and July, August, and September during the warm season. Since there are more months of dependable precipitation during the warm season, the long-term climate favors a plant community with a higher proportion of warm season species and a lower proportion of cool season species. The planning area has seen this shift in warm season species in the last 10 years.

The project area was generally wet from 1978 to 1999. From 1999 to 2011 in the project area, drought (less than 90% of average annual precipitation) has occurred during 4 calendar years, 2001, 2002, 2006, and 2011. Severe drought (less than 75% of average annual precipitation) occurred in 2001 and 2002. There have been 3 wet years (greater than 110% of average annual precipitation), 2004, 2005 and 2010. Winter/spring drought has been more common during the last 10 years, while summer precipitation has been generally dependable. Winter/spring drought (November through April) has occurred in 8 years, 1999-00, 2000-01, 2001-02, 2003-04, 2005-06, 2006-07, 2008-09, and 2010-11. Severe winter/spring drought has occurred in 3 years, 2001-02, 2005-06, and 2006-07. This new precipitation pattern has increased the advantage that warm season plants have over cool season plants. Again, the planning area has seen this shift in warm season species in the last 10 years. However, the amount of forage available to livestock has not significant changed.

Temperature records have been kept in Williams and Flagstaff for over 100 years. Average annual temperatures during the last 10 years have exceeded the 100-year average every year by 2 to 4 degrees F. The average temperature during the last 20 years is 3 degrees higher than the average temperature in Williams from 1912-1932 (the earliest records available). The average precipitation during the last 20 years is one inch lower than the average precipitation in Williams from 1912-1932. Again, this explains the shift to warm season species in this area.

Another example of climate influences on vegetation in the project area has been shown to be the dominate factor in several rangeland studies comparing grazing management and restoration practices (Loeser et al 2007, Abella 2004, Laughlin and Moore 2009, Laughlin et al 2006, Breshears et al. 2005, Moore et al 2006).

Climate change would likely continue into the future. Shifts in precipitation and temperature (up and down, plus intensity and duration) through time would continue. With these shifts forest plants would continue to shift with these longer duration trends. Livestock numbers and season of use within the project area over the last +/- 20 years (and likely longer) have gone up and down to match the changes in climate from season to season and year to year through adaptive management. The goal for livestock management in this area is match forage utilization with available forage production. The more or less forage produced in a given season or year, the more or less that is available for livestock to utilize. For example, during the drought of 2002 livestock numbers and season of use were significantly reduced throughout the project area. Some allotments were completed destocked while others reduced by as little as 20%.

Effects Analysis (Direct and Indirect)

Common to all Alternatives (A-E)

Livestock grazing and climate change

In all the alternatives, climate change may have an effect on livestock grazing management. Increased temperatures combined with decreased precipitation could lead to lower plant productivity and cover, which in turn could decrease litter cover. The reduction in plant and litter cover could make the soils more vulnerable to wind and water erosion. Timing of moisture could also lead to a shift from warm to cool plant species or vice-versa.

Currently the range has seen a shift to warm season species dominance in many areas of northern Arizona as a result of relative lower winter moisture and to higher summer moisture. The warm season plant that has benefited most from this shift is blue grama. Because blue grama is a dense mat forming species, many areas have seen an increase in perennial plant cover and ground cover. The trends of forage production during this time period have been static. Long term trends would likely stay the same except during severe long term drought and high temperature periods, when understory plants would decline.

To address climate change, all the allotments within the project area use adaptive management in response to seasonal and annual changes in forage production. The adaptive management used in allotment management planning allows for adjustments in the number of livestock and season of pasture use so that livestock use matches forage production for every grazing season regardless of weather conditions. Direction for the use of rangelands prior to and after drought to ensure continued health of the forage resource has been provide by the agency at both the Regional and National Forest level. For example, during the drought of 2002 livestock numbers and season of use were reduced throughout the project area. Some allotments were completely destocked while others reduced by as little as 20%.

The effects of utilizing fire as a natural process within the project area to currently authorized livestock grazing activities.

Livestock grazing effect to fire as a natural process are the same for all the alternatives with current livestock grazing management in place. The effects of livestock grazing for all the alternatives would continue with existing management systems in place within the project area.

Livestock grazing predominantly affect fire by reducing the amount of fine ground fuel available for burning. Current grazing management systems effects to fire within the project area are short lived and limited in size. The effect is normally limited to one pasture in an allotment, until that pasture can regrow. This effect lasts typically between two to six weeks depending on climate conditions. The effect is short lived because this area is grazed from May through October which is the same time in which the forage is typically growing. It is also limited in scope because of conservative 30-40% utilization levels used in these grazing management systems in the project area. This conservative use leaves 60-70% of the plants available for fire spread or mulch. These utilization guidelines have been followed for these allotments over the last 20 years with few exceptions (2200 Coconino and Kaibab District Range inspections and utilization data, Hannemann personnel observations). The exceptions were always corrected the following year by resting the pasture, deferring use, reducing grazed periods, and/or reducing livestock numbers. The Peaks and Slate Allotments located on the north side of the San Francisco Peaks are good examples of how utilization guidelines have been followed while allowing fires to burn through them. The 1996 Horseshoe Fire and Hochderffer Fire burned within these allotments in pasture that were grazed the previous year.

Seasonal and annual adjustments in livestock number and season of use to match forage production through adaptive management is another way that current grazing management systems allow fire to play its natural role in the environment. By making these adjustments fine fuels are available for burning.

Common to Action Alternatives (Alternative B-E)

Livestock grazing management and livestock forage

Appendix 6 of the wildlife report (see Noble 2014, unpublished data) provides details to how the action alternatives would change understory vegetation. Tree thinning and prescribed burning would increase understory vegetation. Understory species and composition would change primarily by increasing shade intolerant understory species and decreasing shade tolerant species. Understory species would also be increased because the reducing of pine needles and the increase in nutrient cycling provided by burning. All these factors would improve forage production for livestock within the treatment areas.

Alternatives B, C, D, and E would directly decrease tree density by mechanical tree thinning and prescribed burning. Overall stand tree basal areas may not measurably change all treatment areas but an increase in the groupy/clumpy arrangement would substantially increase herbaceous species production by creating openings between these groups. The indirect effect of cutting trees in a groupy/clumpy arrangement would increase herbaceous vegetation because of the overall increase in sunlight that reaches the soil. The increase in forage would have a short term (within three years) and long term 10-year beneficial effect to livestock grazing. In research within the project area: herbaceous production dropped from greater than 650 pounds per acre to 100 pounds per acre when basal area increased above 50 square feet/acre (Pearson and Jameson 1967). In another study, grasses increased by more than a 470 percent cover in high-intensity timber harvest units compared to a 53 percent increase in control units compared to pretreatment measurements (Stoddard et al. 2011). Griffis et al. (2001) also found abundance of native grasses increased significantly with treatment intensity through thinned and burned stands.

There are 17 pastures on 11 allotments that would not have any treatments within the planning area for these alternatives: Black Bill (3), Casner/Kelly (1), Chalender (1), Elk

Springs (2), Hat (1), Lake Mary (1), Maxwell Springs (1), Walnut Canyon (1), Wild Bill (1), Windmill (1), and Windmill West (4). Therefore, there is no effect to these pastures.

The increase in forage within treatment areas would improve allotment conditions and allow for more flexibility in grazing management systems. Livestock distribution would improve because forage is more available in uplands compared to more typical grazing areas like meadows. The increase in forage would either drop utilization rates within a pasture or increase pasture graze periods. An increase in pasture graze periods would allow for additional pasture rest or deferment in other pastures within an individual allotment. The increase in forage could also increase the level of permitted and/or annually authorized grazing.

Prescribed burning would have an adverse effect to livestock grazing by removing forage available to livestock. This effect is short term until the forage plants can regrow, typically within one year. This effect would be offset by the long term increase in forage. The prescribed burning would be phased through the planning period to minimize impacts to an individual allotment. There is no need for pasture rest prior to prescribed burning because sufficient fine fuels will exist as a result of the 30-40% livestock and wildlife utilization guideline applied throughout the analysis area. Pastures may be rested prior to prescribed burning, in coordination with range specialist, but it not a requirement to reach burning objectives. The allotments within the project area have the ability to rest a main pasture for one year after a burn with little impact to overall allotment grazing management. However, some allotment may have to temporarily reduced livestock numbers or season of use because of the combined impacts of these prescribed burns with other factors like wildfires and drought. If the burned areas do not recover within a year then livestock would likely continue to run in the same pastures, reducing the amount of rotational grazing on an allotment. This may also lead to a temporary reduction in livestock numbers or a reduction in length of grazing season to maintain the health of the grazed pastures until the treatment area recovers and rotational grazing is restored. Adaptive management would continue to be used to adjust livestock numbers to meet annual forage production, with or without the burns. After approximately 10 years of implementation, it is expected that the increase in forage from these treatments would allow livestock numbers or grazing seasons to return to current levels on most allotments. Grazing of the Peaks and Slate Allotments after the 1996 Horseshoe and Hochderffer Fires are examples of how this can be successfully implemented. The burned pastures were rested in these allotments with little impact to the livestock operation and impacts to the understory vegetation (Hannemann, personnel observations and 2200 Coconino District Files). The 2014 Slide Fire is another example. The remainder of the allotment is being grazing while the burned pastures are being rested until range readiness has been determined. These examples are wildfires. Prescribed fires will have mitigations and designs in place to reduce the severity of the burns (Fire Specialist Report, Lata 2014).

The removal of trees during the timber thinning operations would have little effect on livestock grazing. Mitigations would be implemented to maintain structural range improvements and keep livestock within designated pastures during this operation. Pastures may be deferred during the timber operation to minimize equipment and livestock conflicts but it is not mandatory. Timber sales have been conducted throughout the project area for many years with few impacts to livestock grazing operations. Pasture deferment may be necessary after the treatments, but pasture rest is not normally required after this treatment alone, demonstrated in timber sales throughout the project area (A-1, Woody, and Kachina Timber sales, Hannemann personal observations and 2210 Coconino District Files).

Other actions besides thinning and burning

Spring restoration, ephemeral channel restoration, road decommissioning, road reconstruction, and aspen restoration are projects common to all actions alternatives.

There are 74 springs within in the project area that would be treated. Where livestock are affecting these springs, livestock exclosures may be built with up to four miles of fence to protect the riparian vegetation. These exclosure areas would not be available for livestock grazing. However; these exclosures are not large enough and are not amassed in any particular pasture to reduce pasture stocking rates. In addition, by the time these exclosures are completed, it is anticipated the increase in pasture forage by the tree thinning and burning would help to offset the forage lost within the exclosures. Current spring water rights for livestock watering would be maintained for these projects. However, structural water improvements may be adjusted to improve the natural flow of water and riparian vegetation. These projects would not have a measureable impact on the capacity of allotment or grazing management.

There are up to 39 miles of ephemeral drainages that would be restored within the project area. No livestock exclosures would be built for this work, so there would be no adverse impact to livestock. The ephemeral drainage improvements would have a benefit to livestock grazing management by increasing forage by improving bank stability and decreasing the amount of sediment to downstream stock tanks.

The aspen restoration projects in the action alternatives would include up to 82 miles of fence that would exclude livestock. These exclosure areas would not be available for livestock grazing. However, the majority of these exclosures are not large enough and are not amassed in any particular pasture to reduce pasture stocking rates. In addition, by the time these exclosures are completed, it is anticipated the increase in pasture forage by the tree thinning and burning would help to offset the forage lost within the exclosures. These projects would not have a measureable impact on the capacity of allotment or grazing management.

Road decommissioning of 904 miles within the project area would have a beneficial effect to livestock grazing by growing additional forage the old road bed. Constructing 245 miles of temporary roads and then decommissioning these roads after use would have a temporary adverse effect to livestock grazing when the forage on the road was disturbed. Opening 272 miles of currently decommissioned roads and then decommissioning these roads after use would have a temporary adverse effect to livestock grazing when the forage on the road was disturbed. Reconstructing up to ten miles of road would have no effect on livestock grazing. None of these road projects would have a measureable impact on the capacity of allotment or grazing management.

Common to Alternative C and E

In response to comments on the DEIS, approximately 39,000 acres of goshawk habitat would have canopy cover measured at the stand level where there is a preponderance of VSS 4, 5 and 6. The vegetation analysis (McCusker et al. 2014) indicates there would be reduced stand diversity and the post-treatment basal area would remain high (ranging from 80 to 210 BA). The percent of SDI max would likely be in excess of 55 and stands would be at risk from stand density-related mortality. Canopy cover would be continuous except for natural gaps within the stand. There would be little to no grass or shrub response. The fire ecology analysis (Lata 2014) indicates although there may be an increase in potential crown fire to individual stands, desired conditions would continue to be met and the project area would be subject to less than 10 percent crown fire. Stand size range from approximately 4 acres to 324 acres with the average stand size being 35 acres. The spatial arrangement of the stands is not contiguous and no individual pasture would have more than X percent of allotment acres impacted. Although movement towards the desired condition would be considerably less on these acres, it represents improved conditions when compared to no action. No measurable direct, indirect or cumulative impacts to grazing are expected from managing 39,000 acres (dispersed across the 988,764-acre landscape) at the stand level because the acres represent less than 5 percent of the livestock allotments within the project area.

Alternative A (No Action)

Livestock grazing management and livestock forage

In alternative A there would be no changes in current management and the forest plans would continue to be implemented. Those forest plan actions and allocations are incorporated by reference. Approximately 166,897 acres of current and ongoing vegetation treatments and 195,076 acres of prescribed fire projects would continue to be implemented within and adjacent to the project area. Approximately 43,041 acres of vegetation treatments and 58,714 acres of prescribed fire and maintenance burning would be implemented within and adjacent to the project area by the Forests in the foreseeable future (within 5 years).

Because no project-related treatments would occur on approximately 600,000 acres, trees would remain dominantly even-aged and primarily of mid-size with little large or small trees. Trees would remain evenly spaced throughout the forest. Tree density would remain and increase to continue the probability for increase in tree mortality from insects, disease, and fire. This increase in trees and no prescribed burning into the future would reduce the amount of understory vegetation, and affect species composition by reducing shade intolerant understory species and increase shade tolerant species. Understory species would also be reduced because the buildup of pine needles and the lack of nutrient cycling provided by burning. Appendix 6 of the wildlife report gives a complete review of these effects.

The reduction in understory vegetation would reduce the amount of forage available to livestock. Over time, livestock numbers would be reduced until the number of trees were removed. This reduction in forage and decrease in livestock numbers has been recorded through the last 100 years throughout the project area (page 21 of this report). There is no reason to believe that this trend would not continue under Alternative A.

In alternative A, approximately 431,000 acres of prescribed fire would not occur. Without these acres of prescribed burning, no pasture rest periods after burning would be necessary. Grazing management would continue without this impact.

Even with projects that are implemented under the forest plans, alternative A does not adequately reduce the increased risk of uncharacteristic wildfire through thinning or prescribed burning. Eighty-four percent of the project area is currently at risk from wildfire and this is projected to only increase in the future. These uncharacteristic wildfires can burn with high severity and burn through multiple pastures burning fences and other structural range improvements. Uncharacteristic wildfire would have an adverse impact on livestock grazing management and forage until the area recovers and structural improvements are replaced. See the fire ecology report for additional information (Lata 2014).

Unavoidable Adverse Effects, Irreversible and Irretrievable Commitment of Resources, Compliance with the forest plan(s).

There are no unavoidable adverse effects in Alternative A related to livestock grazing. There are also no irreversible and irretrievable commitments of resources.

Alternative A is in compliance the Coconino and Kaibab National Forest Plans for livestock grazing.

Alternative B (Proposed Action)

Livestock grazing management and livestock forage

Alternative B uses mechanical thinning tree and burning treatments on 384,966 acres and burning only treatments on 198,364 acres within the project area over the next 10 years (Table 6). Alternative B would affect all grazing allotments within the project area and 184 main summer pastures with thinning and burning treatments. Ten pastures would be affected by burning only treatments. Table 6 displays the total acres of thinning and burning within each allotment. Thinning treatments by allotment vary from 0 to 35,180 acres. Burning only treatments by allotment vary from 0 to 18,802 acres. Thinning and burning treatments would have a benefit to livestock grazing management by an increase in forage (also see effects common to all action alternatives). Up to two pastures per year per allotment would have an adverse effect to livestock grazing management and forage until the burn area shows range readiness (see effects common to all action alternatives).

Alternative B reduces the risk of uncharacteristic wildfire through thinning 384,966 acres and burning 583,330 acres within the project area over the next 10 years. These treatments would reduce heavy fuel loading, break up the tree canopy, raising the tree canopy, and burning fine ground fuels (Fire Report, Lata 2014). These actions would reduce the risk of uncharacteristic wildfires can burn with high severity and can burn through multiple pastures, burning fences and other structural range improvements adversely affecting livestock management.

Unavoidable Adverse Effects, Irreversible and Irretrievable Commitment of Resources, Compliance with the forest plan(s).

There are no long term unavoidable adverse effects in Alternative B related to livestock grazing because effects are short term in nature and doesn’t affect grazing permit capacity.

There are also no irreversible and irretrievable commitments of resources because forage grows back in the next growing season after treatments or after managed grazing.

Alternative B is in compliance the Coconino and Kaibab National Forest Plans for livestock grazing.

Table 6. Total allotment pastures, Alternative B treatments by allotment and main pasture

Allotment	Total Allot. Main Pastures	Main Pastures within project	# of Main Pastures with Proposed Treatment	Acres of Thin and Burn Treatments	Acres of Burning Only
A-1 Mountain	5	5	5	3,106	1,867
Anderson Springs	12	7	6, 1 burn only	3,835	1,529
Angell	8	3	3 burn only		5,699
Anita	5	5	5	26,669	8,885
Apache Maid	9	9	8, 1 burn only	8,881	3,667

Allotment	Total Allot. Main Pastures	Main Pastures within project	# of Main Pastures with Proposed Treatment	Acres of Thin and Burn Treatments	Acres of Burning Only
Bar T Bar	3	3	3	5,078	1,040
Bellemont	8	8	5, 3 burn only	2,476	4,401
Big Springs	1	1	1	11,416	749
Black Bill	4	4	1	6	
Cameron	3	3	3	3,230	3,414
Casner/Kelly Seep	10	10	9	17,832	3,456
Chalender	3	3	2	12	15
Corva	3	2	2	839	48
Cowboy Tank	1	1	1	0	
Crater	3	3	3	676	530
Davenport Lake	4	4	4	5,325	1,967
Elk Springs	4	4	2	773	231
Garland Prairie	1	1	1	3,493	3,394
Government Mtn.	9	9	9	11,812	4,071
Government Prairie	7	7	7	7,830	4,392
Hat	14	9	8	9,470	4,497
Homestead	3	3	3	1,741	734
Juan Tank	3	2	2	1,545	1,472
Kendrick Mountain	4	4	4	4,206	1,614
Lake Mary	8	8	7	8,102	1,707
Maxwell Springs	5	5	4	9,882	1,821
Mooney Mountain	1	1	1	11,242	2,619
Moritz Lake	6	6	5, 1 burn only	6,020	10,735
Mud Springs	3	3	3	9,761	1,860
Peaks	6	5	4, 1 burn only	12,949	18,802
Pickett/Padre	6	3	3	9,375	1,112
Pine Creek	3	3	3	2,351	1,774
Pomeroy	1	1	1	525	18
Rain Tank	5	1	1	292	154
Seven C Bar	1	1	1	9	167
Sitgreaves	4	4	4	10,908	5,138
Slate Mountain	3	3	3	11,176	7,197
Smoot Lake	5	1	1	56	
Spitz Hill	4	4	4	5,761	2,204
Squaw Mountain	1	1	1	4,540	2,395
Tinny Springs	8	8	8	35,180	8,900
Tule	8	8	8	34,249	5,995
Twin Tanks	1	1	1	5,416	1,505
Walnut Canyon	4	4	3	4,449	1,074
Wild Bill	4	4	3	17,070	4,354
Windmill	13	13	12	30,573	9,372
Windmill West	12	12	8	16,145	2,556
Woody Mountain	1	1	1	117	1
No Grazing Area	-	-	-	9,439	49,954
Totals	240	211	184, 10 burn only	385,837	199,088

Alternative C

Livestock grazing management and livestock forage

Alternative C uses mechanical thinning tree and burning treatments on 431,049 acres and burning only treatments on 155,061 acres within the project area over the next 10 years (Table 7). Alternative C would affect 192 main summer pastures with thinning and burning treatments. Two pastures would be affected by burning only treatments. Table 7 displays the total acres of thinning and burning within each allotment. Thinning treatments by allotment vary from 0 to 36,187 acres. Burning only treatments by allotment vary from 0 to 17,227 acres. Thinning and burning treatments would have a benefit to livestock grazing management by an increase in forage. Up to two pastures per year per allotment would have an adverse effect to livestock grazing management and forage until the burn area shows range readiness (see effects common to all action alternatives).

Alternative C reduces the risk of uncharacteristic wildfire through thinning 431,049 acres and burning 586,110 acres within the project area over the next 10 years. These treatments would reduce heavy fuel loading, break up the tree canopy, raising the tree canopy, and burning fine ground fuels (Fire Report, Lata 2014). These actions reduce the risk of uncharacteristic wildfires that can burn with high severity and can burn through multiple pastures burning fences and other structural range improvements adversely affecting livestock management.

Unavoidable Adverse Effects, Irreversible and Irretrievable Commitment of Resources, Compliance with the forest plan(s).

There are no long term unavoidable adverse effects in Alternative C related to livestock grazing because effects are short term in nature and doesn’t affect grazing permit capacity.

There are also no irreversible and irretrievable commitments of resources because forage grows back in the next growing season after treatments or after managed grazing.

Alternative C is in compliance the Coconino and Kaibab National Forest Plans for livestock grazing.

Table 7. Total allotment pastures, Alternative C treatments by allotment and main pasture

Allotment	Total Allot. Main Pastures	Main Pastures within project	# of Main Pastures with Proposed Treatment	Acres of Thin and Burn Treatments	Acres of Burning Only
A-1 Mountain	5	5	5	3,363	1,609
Anderson Springs	12	7	7	5,364	
Angell	8	3	2, 1 burn only	295	5,404
Anita	5	5	4, 1 burn only	26,749	8,805
Apache Maid	9	9	9	9,018	4,164
Bar T Bar	3	3	3	5,266	853
Bellemont	8	8	7	7,034	51
Big Springs	1	1	1	10,798	396
Black Bill	4	4	1	6	
Cameron	3	3	3	3,237	3,407
Casner/Kelly Seep	10	10	9	18,444	3,262
Chalender	3	3	2	13	14
Corva	3	2	2	839	48
Cowboy Tank	1	1	1	0	
Crater	3	3	3	680	526
Davenport Lake	4	4	4	6,824	468

Allotment	Total Allot. Main Pastures	Main Pastures within project	# of Main Pastures with Proposed Treatment	Acres of Thin and Burn Treatments	Acres of Burning Only
Elk Springs	4	4	2	994	9
Garland Prairie	1	1	1	6,677	210
Government Mtn.	9	9	9	14,607	1,280
Government Prairie	7	7	7	11,830	392
Hat	14	9	9	9,690	4,277
Homestead	3	3	3	1,877	598
Juan Tank	3	2	2	1,655	1,362
Kendrick Mountain	4	4	4	4,287	1,654
Lake Mary	8	8	7	8,918	891
Maxwell Springs	5	5	4	10,912	792
Mooney Mountain	1	1	1	11,576	2,461
Moritz Lake	6	6	6	7,053	9,702
Mud Springs	3	3	3	10,186	1,911
Peaks	6	5	5	14,532	17,227
Pickett/Padre	6	3	3	10,139	325
Pine Creek	3	3	3	2,406	1,718
Pomeroy	1	1	1	528	15
Rain Tank	5	1	1	292	154
Seven C Bar	1	1	1	91	85
Sitgreaves	4	4	4	13,282	2,763
Slate Mountain	3	3	3	14,251	4,122
Smoot Lake	5	1	1	56	
Spitz Hill	4	4	4	7,873	92
Squaw Mountain	1	1	1	4,676	2,259
Tinny Springs	8	8	8	36,187	9,140
Tule	8	8	8	34,482	4,921
Twin Tanks	1	1	1	5,416	1,505
Walnut Canyon	4	4	3	4,765	757
Wild Bill	4	4	3	21,081	343
Windmill	13	13	12	31,199	9,676
Windmill West	12	12	8	16,974	1,735
Woody Mountain	1	1	1	118	0
No Grazing Area	-	-	-	15,963	43,828
Totals	240	211	192, 10 burn only	432,503	155,213

Alternative D

Livestock grazing management and livestock forage

Alternative D uses mechanical thinning tree treatments on 384,966 acres and burning only on 178,441 acres within the project area over the next 10 years. Alternative D would affect 184 main summer pastures with thinning and burning treatments. Ten pastures would be affected by burning only treatments. Nine pastures that have mechanical treatments do not have burning. Table 8 displays the total acres of thinning and burning within each allotment. Thinning treatments by allotment vary from 0 to 35,180 acres. Burning only treatments by allotment vary from 0 to 18,402 acres. Thinning and burning treatments would have a benefit to livestock grazing management by an increase in forage. Up to two pastures per year per allotment would have an adverse effect to livestock grazing management and forage until the burn area shows range readiness. The nine pastures that do not have burning would not need to be rested from livestock grazing but would not have added benefit of an increase in forage that burning provides.

Alternative D reduces the risk of uncharacteristic wildfire through thinning 384,966 acres and burning 178,441 acres within the project area over the next 10 years. These treatments reduce heavy fuel loading, break up the tree canopy, raising the tree canopy, and burning fine ground fuels (Fire Report, Lata 2014). These actions reduce the risk of uncharacteristic wildfires can burn with high severity and can burn through multiple pastures, burning fences and other structural range improvements adversely affecting livestock management.

Unavoidable Adverse Effects, Irreversible and Irretrievable Commitment of Resources, Compliance with the forest plan(s).

There are no long term unavoidable adverse effects in Alternative D related to livestock grazing because effects are short term in nature and doesn't affect grazing permit capacity.

There are also no irreversible and irretrievable commitments of resources because forage grows back in the next growing season after treatments or after managed grazing.

Alternative D is in compliance the Coconino and Kaibab National Forest Plans for livestock grazing.

Table 8. Total allotment pastures, Alternative D treatments by allotment and main pasture.

Allotment	Total Allot. Main Pastures	Main Pastures within project	# of Main Pastures with Proposed Treatment	Acres of Thin Only	Acres of Burning Only
A-1 Mountain	5	5	5	3,106	1,867
Anderson Springs	12	7	6, 1 burn only	3,835	1,529
Angell	8	3	3 burn only		5,699
Anita	5	5	4, 1 burn only	26,669	8,885
Apache Maid	9	9	9	8,881	512
Bar T Bar	3	3	3, 1 no burn	5,078	1,040
Bellemont	8	8	5, 3 burn only	2,476	4,401
Big Springs	1	1	1, 1 no burn	11,416	749
Black Bill	4	4	0	6	
Cameron	3	3	3	3,230	3,414
Casner/Kelly Seep	10	10	9, 2 no burn	17,832	1,012
Chalender	3	3	2, 1 no burn	12	15
Corva	3	2	2, 1 no burn	839	48
Cowboy Tank	1	1	0	0	
Crater	3	3	3	676	530
Davenport Lake	4	4	4	5,325	1,967
Elk Springs	4	4	2	773	231
Garland Prairie	1	1	1	3,493	3,394
Government Mtn.	9	9	9	11,812	3,888
Government Prairie	7	7	7	7,830	4,392
Hat	14	9	8	9,470	4,497
Homestead	3	3	3, 1 no burn	1,741	734
Juan Tank	3	2	2	1,545	1,472
Kendrick Mountain	4	4	4	4,206	1,312
Lake Mary	8	8	7	8,102	1,683

Maxwell Springs	5	5	4	9,882	1,821
Mooney Mountain	1	1	1	11,242	2,303
Moritz Lake	6	6	5, 1 burn only	6,020	10,735
Mud Springs	3	3	3	9,761	723
Peaks	6	5	4, 1 burn only	12,949	18,402
Pickett/Padre	6	3	3	9,375	1,111
Pine Creek	3	3	3	2,351	1,774
Pomeroy	1	1	1	525	18
Rain Tank	5	1	1	292	154
Seven C Bar	1	1	1	9	167
Sitgreaves	4	4	4	10,908	5,138
Slate Mountain	3	3	3	11,176	7,197
Smoot Lake	5	1	1, 1 no burn	56	
Spitz Hill	4	4	4	5,761	2,204
Squaw Mountain	1	1	1	4,540	2,395
Tinny Springs	8	8	8	35,180	2,827
Tule	8	8	8	34,249	5,995
Twin Tanks	1	1	1	5,416	1,505
Walnut Canyon	4	4	3	4,449	1,074
Wild Bill	4	4	3	17,070	4,350
Windmill	13	13	12	30,573	5,799
Windmill West	12	12	8	16,145	1,168
Woody Mountain	1	1	1	117	0
No Grazing Area	-	-	-	9,439	49,019
Totals	240	211	184, 10 burn only, 9 no burn	385,837	179,152

Alternative E

Livestock grazing management and livestock forage

Alternative E uses mechanical thinning tree treatments on 403,218 acres and burning only on 177,801 acres within the project area over the next 10 years. Alternative E would affect 192 main summer pastures with thinning and burning treatments. Ten pastures would be affected by burning only treatments. Nine pastures that have mechanical treatments do not have burning. Table 8 displays the total acres of thinning and burning within each allotment. Thinning treatments by allotment vary from 0 to 35,554 acres. Burning only treatments by allotment vary from 0 to 18,139 acres. Thinning and burning treatments would have a benefit to livestock grazing management by an increase in forage. Up to two pastures per year per allotment would have an adverse effect to livestock grazing management and forage until the burn area shows range readiness. The nine pastures that do not have burning would not need to be rested from livestock grazing but would not have added benefit of an increase in forage that burning provides.

Alternative E reduces the risk of uncharacteristic wildfire through thinning 403,218 acres and burning 581,019 acres within the project area over the next 10 years. These treatments reduce heavy fuel loading, break up the tree canopy, raising the tree canopy, and burning fine ground fuels (Fire Report, Lata 2014). These actions reduce the risk of uncharacteristic wildfires can burn with high severity and can burn through multiple pastures, burning fences and other structural range improvements adversely affecting livestock management.

Unavoidable Adverse Effects, Irreversible and Irretrievable Commitment of Resources, Compliance with the forest plan(s).

There are no long term unavoidable adverse effects in Alternative E related to livestock grazing because effects are short term in nature and doesn't affect grazing permit capacity.

There are also no irreversible and irretrievable commitments of resources because forage grows back in the next growing season after treatments or after managed grazing.

Alternative E is in compliance the Coconino and Kaibab National Forest Plans for livestock grazing.

Table 9 Total allotment pastures, Alternative E treatments by allotment and main pasture.

Allotment	Total Allot. Main Pastures	Main Pastures within project	# of Main Pastures with Proposed Treatment	Acres of Thin Only	Acres of Burning Only
A-1 Mountain	5	5	5	3,363	1,609
Anderson Springs	12	7	7	3,892	1,472
Angell	8	3	2, 1 burn only	295	5,404
Anita	5	5	4, 1 burn only	26,749	8,805
Apache Maid	9	9	9	8,808	3,740
Bar T Bar	3	3	3	4,354	1,765
Bellemont	8	8	5, 2 no burn	6,205	673
Big Springs	1	1	1	9,925	1,269
Black Bill	4	4	1	6	
Cameron	3	3	3	3,237	3,407
Casner/Kelly Seep	10	10	9	18,408	2,880
Chalender	3	3	2	11	16
Corva	3	2	2	824	62
Cowboy Tank	1	1	1	0	
Crater	3	3	3	536	670
Davenport Lake	4	4	4	5,346	1,946
Elk Springs	4	4	2	762	242
Garland Prairie	1	1	1	6,676	211
Government Mtn.	9	9	9	13,513	2,370
Government Prairie	7	7	7	11,547	675
Hat	14	9	7, 2 no burn	9,000	4,968
Homestead	3	3	3	979	1,496
Juan Tank	3	2	2	1,391	1,626
Kendrick Mountain	4	4	4	3,847	1,974
Lake Mary	8	8	7	8,672	1,137
Maxwell Springs	5	5	4	10,858	846
Mooney Mountain	1	1	1	11,576	2,285
Moritz Lake	6	6	6	6,575	10,180
Mud Springs	3	3	3	9,666	1,894
Peaks	6	5	4, 1 burn only	13,613	18,139
Pickett/Padre	6	3	3	7,539	2,925
Pine Creek	3	3	3	1,481	2,643
Pomeroy	1	1	1	466	77
Rain Tank	5	1	1	292	154
Seven C Bar	1	1	1	91	85
Sitgreaves	4	4	4	11,960	4,086
Slate Mountain	3	3	3	13,139	5,234
Smoot Lake	5	1	1	56	
Spitz Hill	4	4	4	7,655	310

Squaw Mountain	1	1	1	3,669	3,266
Tinny Springs	8	8	8	35,554	8,112
Tule	8	8	8	30,007	9,395
Twin Tanks	1	1	1	4,854	2,067
Walnut Canyon	4	4	3	4,197	1,326
Wild Bill	4	4	3	20,331	1,093
Windmill	13	13	12	31,059	8,886
Windmill West	12	12	8	16,594	2,107
Woody Mountain	1	1	1	118	0
No Grazing Area	-	-	-	14,833	44,560
Totals	240	211	187, 11 burn only, 4 no burn	404,526	178,090

Conclusions of Alternative's Effects

Livestock grazing management and livestock forage

Alternative C would provide for the biggest increase in forage and best long-term improvements in grazing management, closely followed by Alternative B and then E. Alternative D has the same thinning treatments as Alternative B but burning is much less. Alternative A would result an increase in tree density, increased risk of uncharacteristic wildfire, and reduced forage production over time. A good representation of these alternative differences is displayed in Figure 8 of the Understory Report. This figure displays the understory biomass differences based on modeled changes in tree basal area over the next 40 years.

The effect to livestock grazing management is less in Alternative D because of the reduced amount of burning. Allotments B, C, and E have similar amount of burning and would have more effect on grazing management. However, the number of main pastures affected by burning is 184 for Alternatives B, C, and E. Alternative D's less burning reduces the alteration of grazing management schedules by nine pastures. Alternative D also reduces the long term benefit of increased forage that burning provides with a reduction of burning on roughly 400,000 acres. No burning would occur in Alternative A so it would not have an effect on grazing management.

All alternatives are in compliance with the Coconino and Kaibab National Forest Plan standards and guidelines for livestock management.

Livestock grazing affects to understory species

Livestock grazing management restoration effects to understory species is the same for all alternatives.

Cumulative Effects

The area considered for cumulative effects analysis includes 100 percent of the acres within allotments that occur within the project area. This is a logical boundary because changes to grazing management in one pasture of an allotment affect the management in the entire allotment. The project area occupies an average of 65% of each allotment that the project area intersects, with several being wholly within the project area and the minimum occupancy of a single allotment being less that .01 percent.

The time frame for these combined effects is 10 years, 10 years in the future because changes in condition and trend in the vegetation depend on the presence of favorable growing conditions after cattle leave the pasture. If growing conditions are favorable, plant height and canopy cover would completely recover from the impacts of the proposed forest management activities within one year. If growing conditions are not favorable, plant recovery would occur more slowly (up to two to three years). Vegetation recovery from the other activities and natural events may take this long depending on annual weather conditions particularly annual precipitation.

Continuation of current management (implementation of forest plans), absent the proposed treatments, would result in further reductions in forage production over time with the increase in trees. Past restoration projects (Cumulative List of Projects) within the project area have increased forage and understory vegetation. Forest Service policy has changed over time and the Forests are now allowed to be managed for un-evened age stands and allow fire to return to its nature role in the ecosystem. Current grazing management conducted utilizing adaptive management procedures in order to meet objectives established in existing allotment management plans, is also part of the existing baseline. The baseline includes the vegetation and prescribed fire projects from 2001 to 2010 including 140,614 acres of mechanical thinning and 119,751 acres of burning within the project boundary, most on the same locations. The baseline also includes the use of up-to-date grazing systems and adaptive management on all the allotment acres of the cumulative effects and the use of over 20 livestock/elk exclusions to protect aspen and over 15 exclosures to protect riparian areas.

Areas included with the cumulative effects analysis area, external to National Forest System lands, are primarily lands under private ownership and lands under the jurisdiction of the State of Arizona, and the National Park Service. Grazing on adjacent forest land is grazed very similarly to grazing within the project area. Livestock grazing occurs in the majority of these areas except within the Walnut Canyon National Monument. Private lands within communities are not typically utilized by livestock with the exception of horses. Private lands outside of communities typically provide forage for livestock consisting mostly of small livestock operations, but can provide for larger livestock operations when the private land is in larger blocks. State lands are also utilized by livestock with many of these state lands managed in conjunction with Forest Service allotments. There are no indications that livestock use within these areas is going to change dramatically during the next 10 years. In addition, these lands are not large enough that livestock use could be moved to these areas to offset the effects of the proposed treatments.

Livestock grazing management and livestock forage

The cumulative effect to livestock grazing management and livestock forage for Alternative A is no change in the short term but a long term decrease in forage with an increase in trees. Within the cumulative effects boundary 588,182 acres related to the 4FRI project boundary would not be treated and would have no change in the short term but there would be a long term decrease in forage with an increase in trees. When other current and foreseeable projects are considered, an additional 146,891 acres will be treated (31,492 mechanical thinning and burning, 49,466 acres of thinning only and 65,933 acres of burning acres only) and affect 15 percent of the allotment acres. Livestock grazing management will be affected by these treatments in the same manner as the other alternatives. Pastures will be rested and deferred as these treatments are completed. With less treatment acres, pastures rotations will be less affected.

The Alternatives B-E proposed treatments and the other current/foreseeable projects generally overlap in time and space (see cumulative effects report, Table 7). When 4FRI acres are combined with vegetation and prescribed burning projects – 74 percent of the cumulative effects boundary (89 percent of all allotments) would have reduced forage. However this would be a short term effect with a typical duration of one year after burning. In the long term, forage would increase these same acres of the cumulative effects boundary. In terms of grazing management, even though 705,695 acres have reduced forage for a period of one year, this would not affect grazing management because mitigation restrictions would apply to all planned and ongoing projects. No more than one main pasture per allotment would be burned per year on the majority of the allotments and would not add to the grazing management effects because these mitigation restrictions also apply to these on-going projects.

Livestock grazing impacts to fire

The cumulative effect of livestock grazing to meeting an objective of restoring fire to the landscape for Alternative A would be no change because of the minimal and managed direct or indirect effect of current grazing (see effects analysis). The same is true for Alternatives B-E, with minimal and managed direct and indirect effects of livestock management with these proposed treatments (see effects analysis). The ability to meet fire objectives in in Alternative B-E when considered with on-going and foreseeable projects that includes 65,933 acres of prescribed burning (see cumulative effects report) would not be affected due to the current grazing management strategies that are in place and the use of adaptive management.

Livestock grazing impacts to understory

The cumulative effect of livestock grazing to achieving increased understory response for Alternative A would be no change because of the minimal and managed direct or indirect of current grazing (see effects analysis). The same is true for Alternatives B-E, with minimal and managed direct and indirect effects of livestock management with these proposed treatments. The ability to achieve increased understory response in Alternative B-E when considered with on-going and foreseeable projects that includes 31,492 mechanical thinning and burning, 49,466 acres of thinning only and 65,933 acres of burning acres only treatments (see cumulative effects report) would not be affected due to the current grazing management strategies in place and with the use of adaptive management. Livestock grazing would adapt to changes in forage conditions through time.

Climate change – All Alternatives

Climate change is expected to result in extreme weather conditions and periods of drought. In alternative A there would be no treatments. In all alternatives, 31,492 mechanical thinning and burning, 49,466 acres of thinning only and 65,933 acres of burning acres only vegetation treatments would occur as part of ongoing and foreseeable treatments (see Table 7, cumulative effects report) within the cumulative effects boundary. Eighty-nine percent of the allotments would have increased forage from vegetation and prescribed fire treatments in the long term. Collectively, there would be the no discernible additive (adverse) effects or benefits that were offset by the increase in forage, decrease in moisture, or increase in temperature. Livestock grazing would continue to use adaptive management to match forage production with livestock numbers in a grazing management system.

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Attachment 1. Objection Resolution Response

Attachment 2. Objection Resolution Literature Review

Sierra Club Objection 0009
Objection Reference Review

1. **Baaker et al. 2010**:

   "Livestock grazing may decrease understory biomass and density, reducing competition with conifer seedlings and reducing the ability of the understory to carry low-intensity, low-severity fire. The increase in small tree density has, in part, led to the amount of forest acres burned in recent history. Simultaneously, grazing increases the presence of exotic plant species (Bakker et al. 2010).

   Review Response: Bakker et al. 2010 was included in appendix F, cumulative effects. The literature was reviewed and our interpretation of what Bakker et al. is somewhat different than what was received in comments on the DEIS. In the 4FRI project area some exotic species were present but they were smaller annual plants that probably were not grazed. Our review of the Bakker report indicates Bakker does not specify that this condition was present forest-wide. Current range monitoring information that supports the existing condition was used to inform the analysis.

2. **SRM Journal 1979**: "Specifically, changes in the soil's surface structure and its ability to accept, hold, and release water can be caused by compaction caused by trampling. The nutrient cycling function of the soil is interrupted by removal of vegetation that impacts above ground nutrient inputs into the system. Finally, the soil's resistance to erosion is affected by changes in plant density, composition, and protective vegetative ground cover that are part of the organic components in the soil".

   Review Response: Comment responses indicated this reference was from the range specialist report. However, we could not be found this citation in the range specialist report.

3. **Allen et al. 2002:** "It is likely that the unregulated grazing in the 1860's to 1920's in the project area contributed to changes in vegetation. As heavy grazing was eliminated though time the plant composition responded"..

   Review response: This references were added to the FEIS Appendix, Cumulative Effects discussion and addressed as other science that had been presented in response to comments on the DEIS. Please note, our review of this reference does not provide the same interpretation. While livestock grazing is a factor that has affected tree density, it is not the only (or main) driver. The lack of fire is the predominant driver.

4. **Belsky and Blumenthal 1997:**

   "Logging, grazing, and fire suppression are the primary factors that, when combined, have allowed landscape patterns to become homogenized, shifting fire regimes across much of the project area from frequent, low-intensity/low severity surface fires to infrequent, high-intensity/high severity crown fires (Belsky and Blumenthal 1997). "Livestock can also compact soils, decreasing the soils' ability to absorb water and increasing erosion (Belsky and Blumenthal 1997).

Review Response: This references were added to the FEIS Appendix, Cumulative Effects discussion and included in the range references and addressed as other science that had been presented in response to comments on the DEIS.

5. **Madany and West 2013**. Livestock Grazing-Fire Regime Interactions within Montane Forests of Zion National Park,Utah. Ecology, Vol. 64, No. 4 (Aug., 1983), pp. 661-667Published by: Ecological Society of AmericaStable URL: http://www.jstor.org/stable/1937186.

   Context: The disruption of historical fire regimes by introduced ungulates has been well documented for southwestern ecosystems.

   Review Response: This is a a study in southern Utah (Zion National Park) that found that heavy livestock grazing was a more important factor than fire suppression alone in causing tree encroachment in ponderosa pine forests". It was included in Appendix F, Cumulative Effects as other science presented in comments on the DEIS and added to the range report references.

6. **Kerns et al. 2011**: "USDA research has found that releasing the vegetative understory from grazing can cause a more significant change than reintroducing fire to the landscape: "If a goal of ecological restoration in these forests is increased cover of native perennial plants, and the potential for increased native perennial grass reproduction, then cattle grazing exclusion, or a change in cattle management, could provide critically important options in restoration plans".

   Review Response: This reference was added to the FEIS Appendix, Cumulative Effects discussion and addressed as other science that had been presented in response to comments on the DEIS.

7. **Allen et al. 2001 "**It is likely that the unregulated grazing in the 1860's to 1920's in the project area contributed to changes in vegetation. As heavy grazing was eliminated though time the plant composition responded**".**

   Review Discussion: Allen et al. 2001 was added to the FEIS Appendix, Cumulative Effects discussion (with very minor modifications) and addressed as other science that had been presented in response to comments on the DEIS. However, we want to clarify that while livestock grazing is a factor that has affected tree density, it is not the only (or main) driver. The lack of fire is the predominant driver.

8. **Belsky and Blumenthal 1997:** "Historically, these grasslands had less than 10 percent tree cover. Impacts from grazing, logging, and fire suppression practices that started in the late 1800s are still discernable on the landscape today. These practices reduced or eliminated the vegetation necessary to carry low-intensity surface fires across the landscape, thereby altering the natural fire regimes and allowing uncharacteristic forest succession to take place. These conditions have been further exacerbated by soil erosion and increases in invasive, nonnative plants, low-density rural home development, and grazing. The grassland cover type has experienced some degree of conifer (pinyon, juniper, and ponderosa pine) encroachment over the last 100 years as a result of fire exclusion, grazing, and agricultural use.

"Past grazing has in part facilitated invasion by grazing-tolerant, less palatable weedy species by reducing native perennial grass cover. These exotic weedy species have displaced native perennial grasses in parts of the intermountain west because the native plants are not adapted to frequent and close grazing. These effects can be mitigated through sound range management practices and through regulation of cattle through legal instruments such as Annual Operating Instructions". "These conditions have been further exacerbated by soil erosion and increases in invasive, nonnative plants, low-density rural home development, and grazing".

Review Discussion: These references and statements were added to the FEIS Appendix, Cumulative Effects discussion and addressed as other science that had been presented in response to comments on the DEIS. They were not included in the range specialist report as a reference because our analysis does not support the conclusion that grazing is the sole reason for these issues.

9. **Kimball and Schiffman 2003**: "Many native species are not adapted to frequent ungulate grazing in combination with fire. Grazing is not an effective means of reducing exotic plant cover, and instead can drive non-native plants to compensate and increase growth and reproductive potential in ways that native species cannot".

   Review Discussion: There is unresolved disagreement on the use of this reference. This reference was added to Appendix F, Cumulative Effects, as other science presented in comments to the DEIS. However, this reference was not added to the range or botany references because the study was conducted in a relict grassland in California. The non-native grass was red brome which is sometimes grazed by cattle but not palatable. This does not apply to all of the non-natives that are found in the 4FRI project area. at least not true here for all our non-natives.

10. **Arnold, 1950**. Changes in ponderosa pine bunchgrass ranges in northern Arizona resulting from pine regeneration and grazing. Journal of Forestry 48: 118-126.

    Review Discussion: This citation has been added to the cumulative effects appendix as a reference. This citation is currently in chapter 1 of the FEIS and the silviculture report. This citation was used in the range report (as early as the DEIS) as a reference to support the conclusion that trends in the understory have improved where tree density does not limit recovery.

11. **Cooper, C. F. 1960**. Changes in vegetation, structure, and growth of southwestern pine forests since white settlement. Ecological Monographs 30(2): 129-164.

    Review Discussion: This citation has been added to the cumulative effects appendix as a reference. Appendix F is incorporated by reference into the range report. This citation is currently in chapter 1 of the FEIS and the silviculture report. This citation was used in the range report (as early as the DEIS) as a reference to support the conclusion that trends in the understory have improved where tree density does not limit recovery.

12. **Bakker and Moore 2011**.

    Review Discussion: This citation (2011) could not be located. The range report had included Baker and Moore 2007 as early as the DEIS. The Sierra Club objection was reviewed and no reference to Bakker and Moore 2011 was found.

13. **Ganey, J.L., J.P. Ward, and D.W. Willey. 2011**. Status and ecology of Mexican spotted owls in the Upper Gila Mountains Recovery Unity, Arizona and New Mexico. USDA Rocky Mountain Research Station General Technical Report RMRS-GTR-256WWW.

    Review Discussion: This citation is currently in chapter 1 of the FEIS and the wildlife report. It will be added to the range report references.

14. **Hebblewhite, M., C.A. White, C.G. Nietvelt, J.A. McKenzie, T.E. Hurd, J.M. Fryxell, S.E. Bayley, and P.C. Paquet. 2005**. Human activity mediates a trophic cascade caused by wolves. Ecology 86: 2135-44.

    Review Discussion: This citation has been added to the purpose and need and to the cumulative effects appendix as a reference. The citation was originally presented in the large tree retention and old tree protection strategy developed by the 4FRI stakeholders.

15. **Ripple, W.J., and R.L. Beschta. 2007**. Restoring Yellowstone's aspen with wolves. *Biological Conservation* 138: 514-19.

    Review Discussion: This citation is appropriate to be added to the purpose and need and cumulative effects appendix as a reference. The citation was originally presented in the large tree retention and old tree protection strategy developed by the 4FRI stakeholders.

16. **Ripple, W.J., and R.L. Beschta. 2011**. Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction. *Biological Conservation* 145: 205-13.

    Review Discussion: This citation is appropriate to be added to the purpose and need and cumulative effects appendix as a reference. The citation was originally presented in the large tree retention and old tree protection strategy developed by the 4FRI stakeholders.

17. **Savage, M. and T. W. Swetnam. 1990**. Early 19th-century fire decline following sheep pasturing in a Navajo ponderosa pine forest. Ecology 71(6): 2374-2378.

Review Discussion: This citation has been added to the cumulative effects appendix as a reference. This citation was used in the range report as a reference to support the conclusion that trends in the understory have improved where tree density does not limit recovery. It has been cited since the DEIS was published.

18. **Reisner, M.D., J.B. Grace, D.A. Pyke, and P.S. Doescher. 2013.** Conditions favouring Bromus tectorum dominance of endangered sagebrush steppe ecosystems. Journal of Applied Ecology 50:1039-1049.

Review Discussion: This study is specific to Great Basin sagebrush community in Oregon and did not include a measure of livestock utilization or mention of a grazing system so it was not included.

19. **Wisdom, M.J. and J.C. Chambers. 2009**. A landscape approach for ecologically based management of Great Basin Shrublands. Restoration Ecology 17:740-749.

Review Discussion: This study is specific to Great Basin shrublands and not pertinent to the project area. For this reason, it was not included in botany or range references.