United States Department of the Interior
Bureau of Land Management
Mount Lewis Field Office November, 2013

Mount Lewis Field Office
Bureau of Land Management
50 Bastian Road
Battle Mountain, NV 89820

Environmental Assessment

DOI-BLM-NV-B010-2013-0020-EA

Toiyabe West Wildlife Habitat Enhancement Project

The cover photo: **Early stage encroachment of pinyon and juniper trees (lower 2/3 of the photo) into a formerly treeless high elevation mountain brush community above the headwaters of Boone Creek, Toiyabe Mountains. Old growth trees intermixed with younger infilling trees can be seen on the ridge.**

Table of Contents

I. Introduction / Overview……4

Agency's Purpose and Need
Scoping
Map of Proposed Project Area
Issues
Land Use Plan Conformance

II. Description of the Proposed Action and Alternatives ……..7

Proposed Action
Design Features of the Proposed Action
No Action Alternative
Alternatives Considered but Eliminated from Further Analysis
- Alternative 1: Broadcast Fire
- Alternative 2: Mechanical Treatments Other than Hand Thinning
- Alternative 3: Herbicide Treatments

III. Affected Environment / Environmental Consequences ……..11

A. General Setting
B. Supplemental Authorities Table
C. Other Resources
D. Resources Present and Brought Forward for Analysis
- Air Quality
- Soils / Vegetation
- Forestry Resources
- Wildlife, Including Migratory Birds and Special Status Species
- Riparian and Wetland Zones / Water Quality
- Cultural Resources
- Noxious Weeds, Invasive and Non-native Species
- Native American Religious Concerns
- Visual Resources
- Recreation
- Socio-Economic Values
- Rangeland Resources / Grazing Management
- Wild Horses and Burros

IV. Cumulative Impacts ……33

A. Past, Present, and Reasonably Foreseeable Actions
B. Effects of Past, Present, and Reasonably Foreseeable Actions
1. Proposed Action
Air Quality
Soils / Vegetation / Rangeland Resources / Grazing Management
Forestry Resources
Wildlife, Including Migratory Birds and Special Status Species
Riparian and Wetland Zones / Water Quality
Cultural Resources
Noxious Weeds, Invasive and Non-native Species
Native American Religious Concerns
Visual Resources
Recreation
Socio-Economic Values
Wild Horses and Burros
2. No Action Alternative

Consultation, Coordination, Cooperation ……39

Literature Cited ……..40

I. Introduction/Overview

One of the most evident changes in vegetation of the Great Basin during the past 140 years has been the dramatic expansion of pinyon pine and juniper (*Pinus sp.* and *Juniperus sp.*) woodlands, both in range and density, within the sagebrush ecosystem. Numerous researchers have documented this woodland expansion and the resulting replacement of shrub-steppe communities (Cottam and Stewart 1940; Adams 1975; Burkhardt and Tisdale 1976; Nallion et al. 1993; Gedney et al. 1999; Tausch and West 1988; Miller and Rose 1995, 1999; Miller and Tausch 2001; Schaeffer et al. 2003; Reiner 2004; Miller et al. 2007; Miller et al. 2008).

A large amount of valuable wildlife habitat, particularly mid to high elevation mountain big sagebrush (*Artemisia tridentata* subspecies *vaseyana*) sites, is at risk of further encroachment (Connelly et al. 2004). As woodlands expand and trees begin to dominate sites, the shrub-grass-forb understory is essentially lost or greatly reduced through competitive exclusion (Tausch et al. 1981; Schaefer et al. 2003; Nallion et al. 1993; Weisberg and Greenwood 2007; Tausch et al. 2009). Though both pinyon and juniper eventually often dominate sites in the absence of disturbance, Weisberg and Greenwood (2007) suggest that Utah juniper (*Juniperus osteosperma*), because of its flexible rooting structure, has an especially strong effect on shrub cover relative to singleleaf pinyon (*Pinus monophylla*). Juniper's shallow roots, in addition to its deep roots, result in greater competitive ability for water in surface soil layers. Once pinyon-juniper domination has occurred, conversion back to more diverse plant communities is not a simple process.

As is the case with many other areas of the Great Basin Region, proliferation of pinyon and juniper trees on public lands managed by the Bureau of Land Management (BLM) Mount Lewis Field Office (MLFO) in central Nevada has decreased both the amount and the quality of wildlife habitat. A study conducted in the Simpson Park Mountains (Weisberg et al. 2007) helps to illustrate the problem. The Weisberg study found that woodland cover had increased 11 to 33 percent (depending on the scale examined) in just 30 years (between 1966 and 1995) primarily as result of infilling.

The MLFO proposes to thin (reduce the density of) or substantially remove pinyon pine and juniper trees from as much as 6,000 acres of important wildlife habitat on the western slope of the Toiyabe Mountain Range (Figure 1.). The proposed project area is located in central Nevada, approximately 20 miles north of the town of Austin, and lies within the Austin grazing allotment. MLFO would implement this project without impacting soils, non-target vegetation or cultural resources.

The primary purpose of this project is to enhance habitat for wildlife, particularly for greater sage-grouse (*Centrocercus urophasianus,* hereafter referred to simply as sage-grouse), whose numbers have declined throughout their range. Livestock and wild horses (*Equus caballus*) would also benefit from the project. Pinyon and juniper woodlands are expanding throughout the Great Basin region at the expense of shrubs, grasses, and forbs. Increases in both density and distribution of pinyon and juniper trees are especially evident (cover photo and Figures 2. and 3.) in the proposed project area, resulting in a decreased quantity and quality of habitat for several

wildlife species. As discussed more fully in the *Environmental Consequences* section, pinyon-juniper expansion has been especially deleterious for sage-grouse habitats and distribution. Removal of trees from selected portions of the project would help to reverse the degradation of remaining high-value wildlife habitats.

Long-term secondary benefits might include reduction of soil erosion rates, increased ground water, improved late-season spring discharge, increased availability of late season soil moisture and decreased probability of large, intense wildfires. These effects are discussed more fully as environmental consequences.

Currently, pinyon and juniper trees occupy more than 37,000 acres of the proposed project area. Some of this area represents *persistent woodlands*, where pinyon and juniper trees have been present for centuries. Many other sites within the proposed project area however, can be classified as *expansion woodlands*. Expansion woodlands occupy sites where pinyon-juniper is not normally found, but into which it expands over long periods in the absence of the site's normal disturbance regime (Intermountain Society of American Foresters, 2013). Within the proposed project area, persistent woodlands and expansion woodlands are intermixed in a complex mosaic.

Of the expansion woodlands within the proposed project area, 14,000 acres have not yet attained a canopy cover of 15%, and as such, are potentially treatable with chainsaws at relatively low cost. A subset of those areas (up to 6,000 acres), especially those areas shown by telemetry to be especially important for sage-grouse and other wildlife, would be targeted for treatment under the proposed action.

Agency's Purpose and Need

The MLFO's purpose for this proposed project is to retard or reverse pinyon and juniper encroachment on up to 6,000 acres of important wildlife habitat within the proposed project area.

This project is needed to enhance habitat for wildlife, particularly sage-grouse, because pinyon and juniper trees have increased in both distribution and density, and their encroachment reduces the suitability of the habitat for several wildlife species, including sage-grouse.

Secondary purposes for the proposed project are to 1) reduce the probability of habitat loss from large, historically abnormal, high intensity wildfire by reducing fuel loading and/or creating fuel breaks. This would be accomplished primarily through public and/or commercial collection of downed wood. 2) Maintain hydrologic and riparian function. As discussed in the environmental consequences section, the proposed action would help prevent adverse effects to soils, riparian resources and hydrologic function by maintaining watershed ability to capture, store, and release water in a manner that supports proper functioning systems.

Scoping

An interdisciplinary team of resource specialists met on November 14, 2012 and again on February 5, 2013 to discuss the proposed project and to identify relevant issues. A letter briefly describing the proposed action and inviting comments was mailed to interested individuals, organizations and other agencies on January 30, 2013. Visits to the proposed project site will be

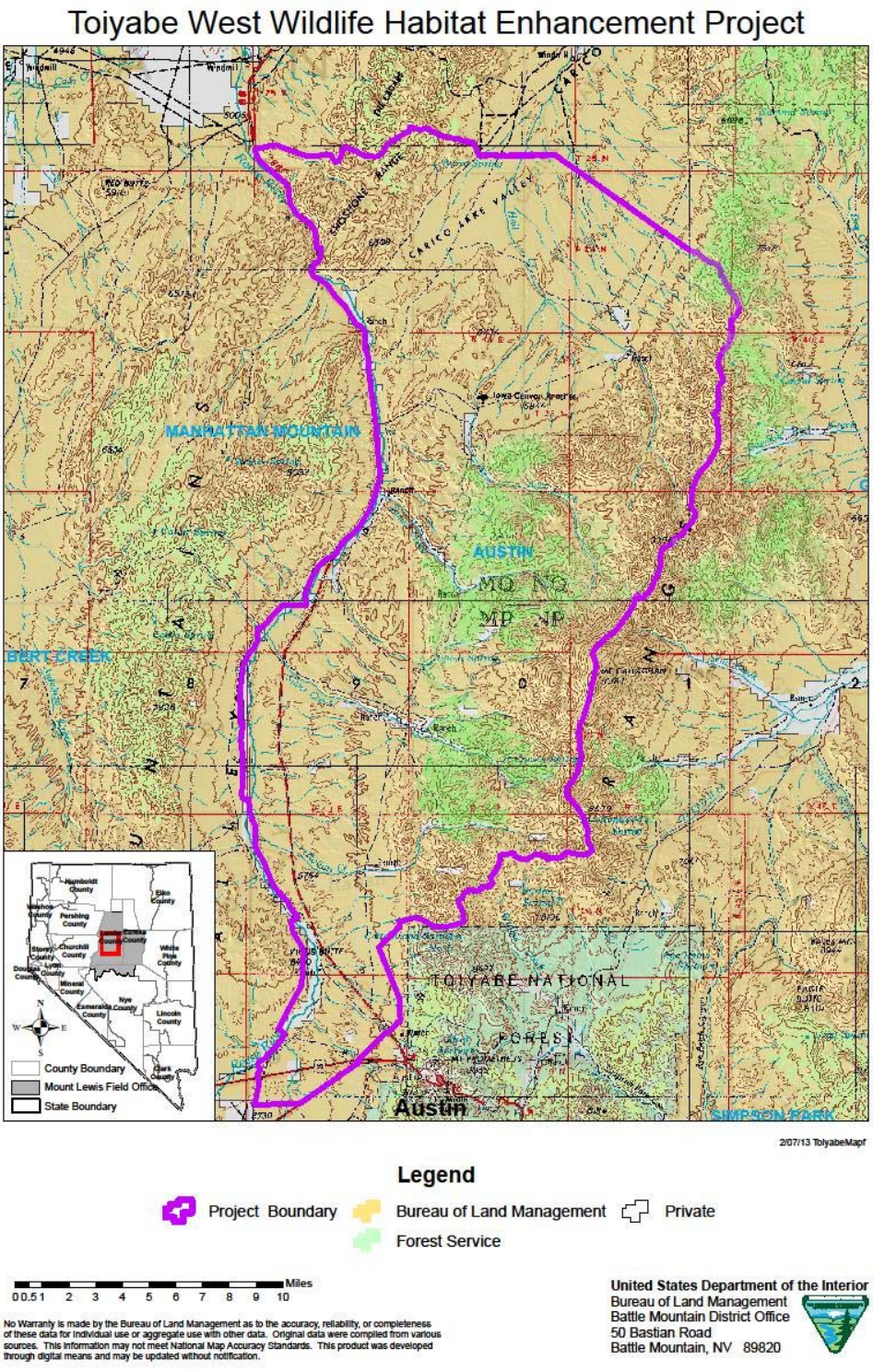

Figure 1. The proposed project area for targeted chainsaw thinning/removal of pinyon and juniper encroachment of high-value wildlife habitats. Treatment sites would be selected largely through identification of important sage-grouse habitats, as determined through telemetry, along with other criteria described under the *Proposed Action*.

conducted as public interest is expressed. Annual tours to similar previous project sites have been conducted to explain the purpose and need and to demonstrate results.

Issues

Issues that were identified as having relevance to the analysis of the proposed action and similar previous proposed actions are listed below and have been addressed in this document.

- Possible spread of cheatgrass (*Bromus tectorum*) as a result of site disturbance
- Need for post-treatment closure of treatment sites to livestock
- Accelerated establishment of pinyon and juniper seedlings as a result of reduced competition from established trees
- Fire danger from increased ground-level fuel loading post-treatment
- Need for transitional habitat between treated and untreated habitats for migratory birds
- Impacts to old-growth pinyon and juniper trees
- Impacts to cultural resources
- Impacts to pinyon and juniper obligate species

Land Use Plan Conformance

This action is in conformance with the Shoshone-Eureka Resource Management Plan Record of Decision (page 25), approved February 1986, and Shoshone-Eureka Rangeland Program Summary (page 2), approved October 1988.

Wildlife habitat objectives articulated in those documents are to:

1. Maintain and improve wildlife habitat …

2. Provide habitat sufficient to allow big game populations to achieve reasonable numbers in the long-term.

3. Improve and maintain habitat for state listed sensitive species and federally listed threatened or endangered species.

Fuels Reduction Objectives Part 2A Woodland Products (p-19) are to**:**

1. manage approximately 500,000 acres of pinyon-juniper woodland for commercial harvest of woodland products.

II. Description of the Proposed Action and Alternatives

Proposed Action

The MLFO proposes to thin (reduce the density of), or substantially remove, pinyon pine and juniper trees from as much as 6,000 acres of carefully selected wildlife habitats within the proposed project area (Figure 1.). Typical sites targeted for treatment would include important habitats for sage-grouse or other wildlife species that currently support healthy and diverse plant

communities but that are being invaded by pinyon or juniper trees. Such sites constitute expansion woodlands and are usually found at mid to high elevations (above 6,000 feet), on gentle to moderate slopes, and have deep, productive soils. Individual treatment sites would vary in size, but most would be smaller than 400 contiguous acres.

Potential treatment sites would be identified and prioritized in two ways. First, sage-grouse movements and habitat use are being monitored via satellite telemetry, which is providing site-specific information on key movement corridors as well as nesting and brood-rearing areas. Important sage-grouse habitats that are being encroached by pinyon and juniper trees would receive high priority for treatment. Secondly, areas associated with riparian resources (springs, seeps and especially wet meadows) that exhibit a pinyon-juniper encroachment problem would also be given a high priority for treatment.

Riparian areas are especially important for sage-grouse and other wildlife in central Nevada. Although such areas constitute a small percentage of the total habitat area, they provide a relative abundance of succulent forbs and insects crucial for sage-grouse chick survival (Atamian 2007, Casazza et al. 2013). Other research (Aldridge and Brigham 2001, Connelly et al. 2004, Crawford et al. 2004, Gregg 2006) suggests that loss of quality brood rearing habitat is a major factor in sage-grouse population declines. Since sage-grouse are known to avoid pinyon-juniper woodlands even at densities below 5% canopy cover (Casazza et al. 2010, Baruch-Mordo et al. 2013) removal of expansion woodlands from riparian areas would be expected to help maintain or restore sage-grouse spatial distribution. Of the expansion woodlands within the project area that have not yet attained 15% canopy cover, 6,700 acres lie within one half mile of springs, seeps or streams.

Trees would be cut down by crews on foot using chain saws. Felled trees would normally be left on the ground without further treatment (lop and scatter) in order to minimize costs. However, harvest of downed trees by the public and/or commercial operators would be encouraged in order to reduce woody fuels. The project would most likely be undertaken by crews from the Battle Mountain Bootstraps program. The Bootstraps program is a collaborative endeavor of the University of Nevada Cooperative Extension and the BLM. The program is designed to accomplish natural resource projects on public lands while teaching job skills and responsibility to young adults. The proposed project could, however, be completed by crews unrelated to the Bootstraps program if that option becomes necessary or feasible.

Most target sites would exhibit Phase I or early Phase II stages of pinyon-juniper encroachment (see text box below for phase descriptions) having less than 15% tree canopy cover. Habitats in late Phase II or Phase III conditions, especially those with greater than 30% canopy cover would not normally be targeted for treatment except under exceptional circumstances (such as to create movement corridors or connect habitats). Habitats in late Phase II or Phase III conditions are more expensive to treat, have poorer prospects for recovery, and result in more hazardous ground-level fuel loading.

Activity fuels generated by the proposed action would be disposed of through firewood and fence post collection by the public or commercial operators. (Activity fuels are those fuels resulting from, or altered by, forestry practices such as timber harvest or thinning, as opposed to

naturally created fuels.) In special cases, where treatment of more advanced encroachment is desirable, such as to create or maintain critical movement corridors for wildlife, BLM fire/fuels specialists would be consulted in an attempt to minimize or mitigate undesirable fuel conditions. In such specialized situations, limited use of techniques such as lop and scatter, pile burning or focused firewood harvesting might be employed to reduce ground-level fuel loading. Some material would be left on the landscape as ground cover for wildlife. Pile burning, if utilized, would employ burn piles not exceeding 10 feet by 10 feet and 6 feet high. Fine fuels would be placed on the interior of the pile with larger fuels on the exterior. Spring and fall are the preferred seasons for pile burning due to cooler weather and higher humidity. Pile burning, if conducted, would employ burn parameters designed to comply with National Air Quality Standards.

Trees larger than 20 feet in height and 12 inches diameter breast height (DBH) would not normally be cut down. Trees with nesting cavities, live or dead, would never be cut. Wherever possible, old growth trees (trees older than 140 years) would be identified by growth form and bark characteristics and marked for preservation.

• Phase I – trees are present but shrubs and grasses are the dominant vegetation that influence ecological processes (hydrologic, nutrient, and energy cycles) on the site;
• Phase II – trees are co-dominant with shrubs and herbs, and all three vegetation layers influence ecological processes on the site;
• Phase III – trees are the dominant vegetation and the primary plant layer influencing ecological processes on the site. Shrubs no longer dominate the understory.

from Tausch et al. 2009

Thinning of trees could begin as early as summer 2014 and would continue into the autumn until inclement weather limits access. Thinning would continue for multiple years as work priorities and funding allow. Though it is difficult to accurately predict how many man hours the project would entail, past experience has shown that a crew of 10 to 12 people can treat 700 - 1200 acres between June and October depending largely on the density of trees in the treatment area and the remoteness of the site. Although Bootstraps crews camp on-site, travel to and from the project location still expends considerable time.

Note: The proposed action ***does not*** constitute a comprehensive pinyon-juniper management plan for the proposed project area. A comprehensive plan would address not only expansion woodlands but would also address the dramatic infilling of persistent woodlands that has occurred over the past century and half. Such a plan would require considerably more resources than are currently available. Rather, the proposed action represents a relatively low cost, limited scope effort to retard or reverse early-stage pinyon and juniper encroachment of only the most important habitats for wildlife, especially those habitats most critical for sage-grouse, and will be limited almost exclusively to expansion woodlands as defined by the Intermountain Society of American Foresters (2013).

Design Features of the Proposed Action

To minimize impacts to migratory birds, site surveys would be conducted (from March through August) by a qualified biologist to determine the presence of nesting birds. Crew members would be trained to identify nesting bird behavior and instructed to inspect trees for nests before cutting. (To date this has been the most effective strategy for avoiding impacts to tree nesting birds.) Work areas would be surveyed for pinyon jay colonies to avoid impacts to that declining species, as recommended by Great Basin Bird Observatory (2013). Where active nests were found, protective buffer zones would be established until the young birds are fledged. In addition, trees with potential nesting cavities would not be cut down. Protective buffers would also be established around any active raptor nest, until young are fledged.

To minimize potential impacts to cultural resources, several practices would be employed. Prior to each field season, or as specific treatment sites are identified, the effects of the proposed action would be addressed through compliance with the National Historic Preservation Act (NHPA) as implemented through a national programmatic agreement and the BLM-Nevada State Historic Preservation Office (SHPO) protocol agreement. A staff archaeologist would evaluate the potential of the area for cultural resources, and would undertake a Class I or III inventory if necessary. To reduce the risk of unauthorized collection, field crews would be instructed by an agency archaeologist regarding the importance of cultural resources and the possible penalties under the Archeological Resources Protection Act for the destruction of archaeological resources. Further, to decrease the risk of inadvertent damage to fragile remains, crews would also be taught to recognize wood and brush cultural resources. Crew vehicles would be restricted to existing roads or jeep trails. No off-road vehicle travel would be allowed.

The proposed action will observe Prevention and Best Management Practices (BMPs) as incorporated by Battle Mountain District, Integrated Weed Management Plan (2009) to minimize the chances of introducing or spreading noxious weeds or invasive species. Active noxious weed control would take place on site by a certified pesticide applicator as weeds are discovered or identified.

To address Native American religious and cultural concerns, ongoing coordination with relevant tribes will be conducted.

To avoid the appearance of obvious human influence and to conform to visual resource management (VRM) standards, the edges of areas cut or thinned under the proposed action would be “feathered” and would follow the contours of the landscape.

No Action Alternative

Under the no action alternative, no action would be undertaken to reverse increases in pinyon-juniper encroachment of wildlife habitat within the proposed project area.

Alternatives Considered but Eliminated from Further Analysis

Alternatives considered but eliminated from further analysis in this Environmental Assessment (EA) include methods other than hand-removal of pinyon-juniper, such as broadcast fire, mechanical treatments and herbicide.

Alternative 1: Broadcast Fire

Broadcast fire is defined as prescribed burning activity where fire is applied generally to most or all of an area within well defined boundaries for reduction of fuel hazard, as a resource management treatment, or both. Although fire can be healthy for wildlife habitat, especially at higher elevations where plant communities often recover spontaneously, broadcast fire was eliminated from consideration for the Toiyabe West initiative primarily because fire treatments in Phase I and Phase II pinyon-juniper are difficult to restrict to the target fuels (pinyon-juniper trees). Unintended loss of understory vegetation would be detrimental in the short and mid-terms (15-25 years), to sage-grouse, which is the intended primary beneficiary of the project. In addition, cheatgrass can exhibit large increases in both biomass and seed production following fire (Chambers et al. 2007).

Broadcast fire would also leave standing dead trees on the landscape to serve as raptor perches and as a potential inhibition to sage-grouse movement and habitat use. Perhaps more importantly, broadcast fire would require some post treatment combination of fencing and/or livestock closure, which would add to the cost and complexity of the project.

Alternative 2: Mechanical Treatments Other than Hand Thinning

Mechanical pinyon-juniper thinning using tree shears or masticators mounted on wheeled or tracked equipment was also eliminated from further consideration as was chaining (dragging a length of ship's anchor chain between two bulldozers). While appropriate for use in some situations, mechanized equipment could result in greater disturbance to soils, vegetation and cultural resources, especially on steeper slopes than hand thinning. Soil disturbance can facilitate or exacerbate infestations of cheatgrass and other exotic annuals (Evans and Young, 1985, 1987, Vaitkus and Eddleman 1987, Davis et al. 1990, Owen et al. 2009). Moreover, mechanized treatments would offer little or no cost advantage given the proposed project environment (relatively small-scale, separated treatment areas) especially when the cost of additional archaeological effort is considered (more intensive archaeological surveys would likely be necessary due to greater potential ground disturbance). Chaining, once widely used for pinyon-juniper treatment, can be accomplished at low costs per acre on large scale projects, but in addition to the drawbacks discussed above, has the added disadvantages of being non-selective in tree removal and often fails to remove young trees.

Alternative 3: Herbicide Treatments

Herbicide treatments were also eliminated from consideration due to uncertain environmental effects to sage-grouse and other species. Connelly et al. (2000) recommended using herbicides within sage-grouse habitats only on an experimental basis until the long-term effects are known. Like broadcast fire, herbicide treatment would leave standing dead trees on the landscape which would serve as raptor perches and possibly as an inhibition to sage-grouse movement and habitat use.

III. Affected Environment/Environmental Consequences

A. General Setting

The proposed project area lies within the central Nevada portion of the Great Basin geographical province. The Great "Basin" is actually a collection of relatively high altitude, semi-arid valleys

separated by north-south trending mountain ranges. The proposed project area is located in central Nevada, 20 miles north of the town of Austin, and lies within the Austin grazing allotment (Figure 1.). Public lands, totaling 238,370 acres within the proposed project area, are managed by the MLFO of the BLM Battle Mountain District. Elevations range from 5,000 feet along the Reese River to more than 10,000 feet on Mount Callaghan. Average annual precipitation varies from eight inches in the valley to 22 inches at the higher elevations.

The proposed project area lies entirely within the Humboldt River Basin, which is itself contained entirely within Nevada, terminating in the Humboldt Sink. The proposed project area includes portions of three sub-basins which flow into Carico Lake Valley, the Upper Reese River Valley and the Middle Reese River Valley respectively.

Three generalized plant communities characterize the proposed project area: the salt desert shrub community, found at lower elevations, the Wyoming sagebrush (*Artemisia tridentata* subspecies w*yomingensis*) community that occupies middle elevations, and a mountain brush community at higher elevations. Pinyon and juniper trees occur most commonly at elevations between 6,000 and 7,000 feet, but have expanded both up-slope and down-slope during the last century in addition to becoming increasingly dense.

B. Supplemental Authorities Table

To comply with the National Environmental Policy Act (NEPA), the BLM is required to address specific elements of the environment that are subject to requirements specified in statute or regulation or by executive order, known as supplemental authorities, as outlined in the BLM NEPA Handbook (H-1790-1) and Instruction Memorandum NV-2009-030. The following table outlines these supplemental authorities, as well as other resources deemed appropriate for evaluation by the BLM, and denotes if the Proposed Action or No Action Alternative affects those elements.

Supplemental Authority[1]	Not Present[2]	Present/ Not Affected	Present/ May be Affected[3]	Rationale
Air Quality			x	See discussion in text
Area of Critical Environmental Concern (ACEC)	x			None present
Cultural/Historical			x	See discussion in text
Environmental Justice	x			No minority or low-income populations would be disproportionately affected by the proposed action or alternatives

Supplemental Authority[1]	Not Present[2]	Present/ Not Affected	Present/ May be Affected[3]	Rationale
Farmlands Prime or Unique	x			None present
Noxious Weeds/Invasive Non-native Species			x	See discussion in text
Native American Religious Concerns			x	See discussion in text
Floodplains	x			Unknown. Floodplains have not been mapped for Lander County by FEMA
Riparian/Wetlands			x	See discussion in text
Threatened and Endangered Species	x			None present
Migratory Birds			x	See discussion in text
Waste – Hazardous/Solid	x			None present
Water Quality			x	See discussion in text
Wild & Scenic Rivers	x			None present
Wilderness	x			None present
Forests and Rangelands (HFRA only)	NA			Healthy Forests Restoration Act (HRFA) criteria for expedited NEPA do not apply
Human Health and Safety	NA			Executive Order is 13045 pertains to protection of children from environmental health and safety risks.

1 See H-1790-1 (January 2008) Appendix 1 Supplemental Authorities to be Considered.
2 Supplemental Authorities determined to be Not Present or Present/Not Affected need not be carried forward for analysis or discussed further in the document.
3 Supplemental Authorities determined to be Present/May be Affected *must* be carried forward for analysis in the document.
4 Other Resources determined to be Not Present or Present/Not Affected need not be carried forward for analysis or discussed further in the document based on the rational provided.

C. Other Resources

Other resources of the human environment that have been considered for this EA are listed in the table below. Elements that may be affected are further described in the EA. Rationale for those elements that would not be affected by the Proposed Action can be found in the table below.

Other Resources	Not Present[4]	Present/ Not Affected	Present/ May be Affected	Rationale
Grazing Management			x	See discussion in text
Land Use Authorization		x		Present not affected, i.e. no new road or transmission line construction; no change to existing land use authorizations
Minerals		x		The proposed project has no potential to affect mineral resources
Paleontological Resources		x		The proposed project has no potential to affect paleontological resources
Recreation			x	See discussion in text
Socio-Economic Values			x	See discussion in text
Soils			x	See discussion in text
Special Status Species			x	See discussion in text
Vegetation			x	See discussion in text
Visual Resources			x	See discussion in text
Wild Horses and Burros			x	See discussion in text
Wildlife			x	See discussion in text

D. Resources Present and Brought Forward for Analysis

Air Quality

The proposed project area is within Lander County, which is in compliance with the National Ambient Air Quality Standards (NAAQS) for criteria pollutants. This is referred to as being in "attainment" of the NAAQS. The State of Nevada also has Ambient Air Quality Standards (NVAAQS) which include the same criteria pollutants plus a standard for hydrogen sulfide. The County is in compliance with all the NVAAQS. This proposed Federal action will have minor emissions associated with it. Effects of the proposed project on air quality are expected to be minimal, temporary and limited to fugitive dust from vehicle travel, chainsaw/vehicle emissions,

and possibly, smoke from pile burning. Pile burning, if conducted, would employ burn parameters designed to comply with National Air Quality Standards.

If a federal action causes emissions and occurs within a federal non-attainment or maintenance area, it is subject to the General Conformity regulations and must be determined by the action agency to conform to the applicable State Implementation Plan (SIP) before the action can be authorized. However, the proposed action (herein) is not subject to the General Conformity regulations because Lander County is in compliance of the NAAQS.

Soils / Vegetation

Soils of central Nevada vary according to such factors as parent rock, degree and direction of slope, drainage characteristics and amount of rainfall. Several dominant soil types, shallow to moderately deep, and having erosion potentials ranging from moderate to high, are found in the proposed project area of the northern Toiyabe Mountains. Soils in the elevations of 6,000 - 8,000 feet, where the project is proposed, are derived largely from volcanic or igneous rock parent material and consist mainly of well drained, cobbly, gravelly, and sandy loams (http://websoilsurvey.nrcs.usda.gov).

The soils of a given site, along with climate, slope and aspect, largely determine the type of *ecological site* and the plant community that can exist there. (An *ecological site* is a distinctive kind of land that differs from other kinds of land in its ability to produce a distinctive plant community and in its ability to respond similarly to management actions and natural disturbances).

Predominant ecological sites in the proposed project area include loamy 8-10 P.z. (precipitation zone), loamy slope 12-14 P.z., shallow calcareous slope 8-10 P.z., shallow calcareous loam 8-10 P.z., and claypan 12-14 P.z. Each of these sites produces a characteristic plant community. The potential plant community for a Loamy 8-10 P.z. ecological site, for example, includes Thurber's needlegrass (*Achnatherum thurberianum*), Wyoming big sagebrush, bluebunch wheatgrass (*Pseudoroegneria spicata*), globemallow (*Sphaeralcea ambigua*) and spiny hopsage (*Grayia spinosa*), while the potential plant community for a Loamy Slope 12-14 P.z. includes Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass, mountain big sagebrush, basin wildrye (*Leymus cinereus*), Thurber's needlegrass, hawksbeard (*Crepis sp.*), arrowleaf balsamroot (*Balsamorhiza sagittata*), helianthella (*Helianthella sp.*) and gromwell (*Buglossoides sp.*)

To generalize, Wyoming sagebrush and mountain brush communities typify vegetation of the proposed project area at mid and high elevations respectively. Tree species include Utah juniper, singleleaf pinyon, and curlleaf mountain mahogany (*Cercocarpus ledifolius*). Scattered stands of quaking aspen (*Populus tremuloides*), often in association with riparian areas, are present in portions of the project area. Shrubs of the area include Wyoming big sagebrush, mountain big sagebrush, low sagebrush (*Artemisia arbuscula*), spiny hopsage, bud sage (*Picrothamnus desertorum*), winterfat (*Krascheninnikovia lanata*) wax currant (*Ribes cereum*), snowberry (*Symphoricarpos sp.*), serviceberry (*Amelanchier alnifolia*), wild rose (*Rosa woodsii*), willow (*Salix sp.*), green ephedra (*Ephedra viridis*), green rabbitbrush (*Chrysothamnus viscidiflorus*) and elderberry (*Sambucus nigra*). Common perennial grasses include bluebunch wheatgrass, Sandberg bluegrass (*Poa secunda*), Thurber's needlegrass, Indian ricegrass (*Achnatherum*

hymenoides) and bottlebrush squirreltail (*Elymus elymoides*). A variety of perennial forbs such as lupine (Lupinus sp.), arrowleaf balsamroot, penstemon (*Penstemmon sp.*), phlox (*Phlox sp.*) hawksbeard, globemallow, milkvetch (*Astragalus sp.*) and several buckwheats (*Eriogonum sp*.) are present.

Environmental Consequences of the Proposed Action on Soils / Vegetation

In the long term, the proposed action would help to maintain and enhance diverse natural plant communities in good ecological condition, exhibiting strong soil/slope stabilizing characteristics. Reducing the spread of pinyon and juniper expansion woodlands, and/or their transition to increasingly tree-dominated states, is expected to sustain and stimulate herbaceous plant vigor, maintain water infiltration capacity, and reduce soil erosion potential (see Reid, et al. 1999, Pierson et al. 2007). Conifer competition with shrubs, grasses and forbs would be reduced, preserving and propagating these species, which are especially important for wildlife.

Woodland encroachment into sagebrush-steppe potentially amplifies runoff and erosion by altering site characteristics. The amount and distribution of ground cover, soil erodibility, and climate determine site resilience relative to soil and water retention. Sagebrush-steppe vegetation typically maintains 40-50% ground cover, has low erodibility, and resists soil loss by water. Tree encroachment into sagebrush-steppe promotes water and soil loss by increasing bare ground connectivity, and amplifying runoff. Initial tree encroachment (Phase I) minimally impacts runoff and erosion, but continued encroachment (to Phase II-III) may cause a shift from a resource-conserving to a non-conserving state. Sites on soils with inherently low infiltration and high erodibility may rapidly transform to a non-conserving state (particularly under drought conditions) as tree dominance (Phase III) promotes bare soil between trees as well as connectivity between bare areas. Runoff and erosion increase exponentially where bare soil exceeds 50% (Pierson et al. 2010). Tree removal aimed at maintaining and improving shrub and herbaceous cover and structure, can also increase infiltration and aggregate stability (Pierson et al. 2012).

The short-term impacts of the proposed project on soils and non-target vegetation would be minimal to non-existent. Soil compaction, erosion and disturbance to non-target vegetation (shrubs, grasses and forbs) by crews on foot would not be significant. Crew vehicles would be restricted to existing roads or jeep trails. No off-road vehicle travel would be allowed.

By targeting Phase I and early Phase II expansion woodlands, the proposed action would make efficient use of scarce resources while at the same time maintaining or maximizing recovery of understory vegetation. As Baughman et al. (2010) conclude, in the Great Basin, only sites in the early stages of encroachment are likely to recover successfully from the in situ (on site) seedbank. Avoiding treatment of areas with dense tree canopy cover, high stem density or high total above-ground biomass would reduce accumulation of excessive ground-level fuel loading.

From a fire/fuels perspective, the proposed treatments will help to maintain treated areas in the desirable Fire Regime Condition Class 1 and prevent transition to less desirable Fire Regime Condition Classes 2 and 3.

Fire/fuel professionals classify landscapes in terms of Fire Regime Condition Class. Vegetation communities in the desirable Condition Class 1 exhibit composition and structure that are intact and functioning, fire return intervals are within natural or historical norms, and risk of losing key ecosystem components is low. In Condition Class 3, at the other end of the spectrum, fire regimes have been substantially altered, fire frequencies may be well outside of historical norms, and the risk of losing key ecosystem components in large and intense fires is high, as is the risk of fire carryover into adjacent areas.

Environmental Consequences of the No Action Alternative on Soils / Vegetation

Under the no action alternative, increasing distribution and densification of pinyon-juniper expansion woodlands can be expected, along with the diminishing plant diversity, and accelerated soil erosion. Pinyon-juniper-induced reductions in understory vegetation can negatively affect hydrology to such an extent that even frequent small thunderstorms can generate runoff and soil erosion (Pierson et al. 2007; Petersen and Stringham 2008; Petersen et al. 2009; Cline et al. 2010; Pierson et al. 2010).

Forestry Resources

The proposed project area includes many thousands of acres of single-leaf pinyon pine and Utah juniper. Noncommercial harvest of live, as well as dead and downed pinyon or juniper for use as fuel wood, fence posts or Christmas trees, is permitted throughout the MLFO under the current Land Use Plan. Trees cut in association with the proposed project would be available not only for personal harvest but also for commercial use under a commercial deadwood permit. Commercial harvest of Christmas trees is also currently permissible within portions of the proposed project area. Both commercial and personal-use harvest of pinyon pine nuts occurs within the proposed project area. Good crops of pine nuts normally develop every three or four years.

The proposed project area supports numerous stands of quaking aspen (*Populus tremuloides*), some of which are being invaded by pinyon and juniper trees (Figure 2.). Quaking aspen habitats support a diversity of life forms and are highly valuable for numerous wildlife species. Aspen has declined dramatically across the west due to over use by livestock and/or wildlife and also as a result of conifer encroachment. Aspen stands (called clones) are thought to be ice age relicts and rarely establish under current climatic conditions (McDonough, 1985). These trees reproduce primarily by root suckering and cannot be re-established through normal seeding processes once lost from the landscape.

Quaking aspen is intolerant of shade, and in the absence of fire or other disturbance, can eventually be displaced by conifers. Conifer encroachment of aspen is not common in central Nevada as it is in many parts of the west, but is occurring in some parts of the proposed project area.

Figure 2. Early stage encroachment of a quaking aspen stand by pinyon/juniper in the proposed project area.

Curlleaf mountain mahogany (*Cercocarpus ledifolius*) is also an important component of the plant community in the proposed project area, providing valuable food and cover for a variety of wildlife species. Mountain mahogany is a slow growing, long lived, drought tolerant evergreen tree that can be found as single-species stands on rocky, high elevation ridges of the proposed project areas as well as in mixed stands with pinyon and juniper at mid elevations. The oldest mountain mahogany trees in the nearby Shoshone Range are estimated to be 1,350 years, (Dealy, 1975).

Mountain mahogany functions as a mid-seral (middle stages of natural plant succession) or late-seral species depending on the site. Mahogany tolerates shade poorly and may be replaced by conifers if overtopped.

Environmental Consequences of the Proposed Action on Forestry Resources

Because the proposed project would focus primarily on early stage expansion woodlands, and is not a comprehensive pinyon-juniper management plan (see note at the end of the Proposed Action section), its effects on forestry resources would be limited. The proposed project would however, reduce conifer competition with aspen and mountain mahogany in portions of the proposed project area, preserving and propagating these species, which are especially important for wildlife.

Environmental Consequences of the No Action Alternative on Forestry Resources

Pinyon and juniper expansion woodlands would increasingly expand beyond the range of natural variability. Aspen communities would continue to be invaded and eventually dominated or eliminated by pinyon and juniper trees.

Figure 3. Recent (within the last 60 years) down-slope expansion of trees into formerly treeless Wyoming sagebrush communities below the historical pinyon/juniper belt is common within the proposed project area.

Wildlife, Including Migratory Birds and Special Status Species

Common wildlife species found in the proposed project area include mule deer (*Odocoileus hemionus*), pronghorn antelope (*Antilocapra americana*), mountain lion (*Puma concolor*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), badger (*Taxidea taxus*), long-tailed weasel (*Mustela frenata*), gray and kit foxes (*Urocyon cinereoargenteus* and *Vulpes macrotis*), black-tailed jackrabbit (*Lepus californicus*), cottontail rabbits (*Sylvilagus sp*.), and sage-grouse. Numerous reptiles, birds (migratory and non-migratory), and small mammals occur here.

Common reptiles in the proposed project area include the Great Basin collared lizard (*Crotaphytus bicinctores*), long-nosed leopard lizard (*Gambelia wislizenii*) western fence lizard (*Sceloporus occidentalis*), sagebrush lizard (*Sceloporus graciosus*), horned lizard (*Phrynosoma sp.*), gopher snake (*Pituophis cateniferer*), and western rattlesnake (*Crotalus viridis*). Several bat species (which are listed in the special status species section) inhabit the proposed project area and several introduced trout species (discussed further below) inhabit streams in the proposed project area.

Migratory Birds

Migratory bird species utilize almost all of the proposed project area during some time of the year. Very common shrub nesting species include the sage thrasher (*Oreoscoptes montanus*), sage sparrow (*Amphispiza belli*), Brewer's sparrow (*Spizella breweri*), horned lark (*Eremophila alpestris*) and western meadow lark (*Sturnella neglecta*). The loggerhead shrike (*Lanius ludovicianus*), common nighthawk (*Chordeiles minor*), various wrens, warblers, larks and swallows are all common within the proposed project area.

Quaking aspen habitats within the proposed project area support diverse bird communities. Species that nest in aspen communities include the northern goshawk (*Accipiter gentilis*), broad-tailed hummingbird (*Selasphorus platycercus*), northern flicker (*Colaptes auratus*), house wren (*Troglodytes aedon*), American robin (*Turdus migratorius*), warbling vireo (*Vireo swainsonii*),

yellow-rumped warbler (*Dendroica coronata*), junco (*Junco sp.*), western wood pewee (*Contopus sordidulus*), lazuli bunting (*Passerina amoena*), and western tanager (*Piranga ludoviciana*). Aspen is especially important for northern goshawks, which nest exclusively in these trees throughout the Great Basin.

Fish

Several streams within the proposed project area support introduced trout. A 1995 Nevada Department of Wildlife (NDOW) stream survey found eastern brook trout (*Salvelinus fontinalis*) in Boone and Silver Creeks and rainbow trout (*Oncorhynchus mykiss*) in Hall Creek. A 1982 NDOW spot check of Iowa Creek found no fish, though a trout, likely a rainbow, was seen there incidentally by BLM biologists in 2012. A 1979 NDOW habitat survey of Italian Creek found no fish.

Hoofed Mammals:

Mule Deer

Though the seasonal movements of mule deer inhabiting the proposed Toiyabe West Project area are not completely understood, the area includes important fall, winter, spring and summer habitats for these animals. An ongoing study (initiated in 2010) of mule deer in the Simpson Park Mountains to the east is yielding valuable information about seasonal movements, habitat use and population dynamics of mule deer in central Nevada. Based on this study and on hunter harvested animals, central Nevada mule deer seemed to have had abnormally low fat reserves entering the fall/winter 2011/2012, as a result of extended drought and poor forage quality and availability.

Mule deer are nutritionally dependent on the shrubs and forbs that are characteristic of healthy and diverse Wyoming sagebrush/mountain brush communities that should dominate the project area. Vegetation that is important for mule deer includes serviceberry, snowberry, mountain mahogany, sagebrush, aspen, willows, wild rose, pinyon pine, juniper, eriogonum, arrowleaf balsamroot, penstemon, phlox, sorrel (*Rumex sp.*), hawksbeard, lupine, western yarrow (*Achillea millefolium*) and numerous other forbs. Stream-side and meadow habitats supporting riparian vegetation are important fawn-rearing areas.

Pronghorn

As is the case with most of central Nevada, the proposed project area supports a growing population of pronghorn that occupy the foothills and valley floor between the Toiyabe and Shoshone Ranges. Preferred habitat (diet, cover, etc) consists of 40-60% grasses, 10-30% forbs, and 5-20% shrubs. Low vegetative structure, averaging 15-24 inches in height is preferred (Bureau of Land Management 1980). Key vegetation species for pronghorn include bitterbrush (*Purshia tridentata*), silver sage (*Artemisia cana*), black sage (*Artemisia nova*), rabbitbrush, greasewood (*Sarcobatus vermiculatus*), ricegrass, needlegrasses, lupine, arrowleaf balsamroot, several buckwheat species, globe-mallow, phlox, locoweed (*Astragalus sp.*) and most other succulent (tender) forbs.

Special Status Species
BLM special status species (as defined by the BLM 6840 Manual as revised December, 2008) include federally recognized threatened, endangered, proposed, candidate and recently delisted species along with other plant and animal species requiring special management consideration, most notably species designated as "sensitive" by the Nevada BLM State Director.

No federally listed threatened, endangered, proposed or recently delisted species inhabits the proposed project area. In March, 2010 however, the U.S. Fish and Wildlife Service (USFWS) determined that the sage-grouse warrants range-wide listing under the Endangered Species Act, but that listing is precluded by higher listing priorities (i.e., other species in greater need of protection). As a result, the sage-grouse has now become a candidate species. A final decision on listing is expected in 2015.

BLM *sensitive species* that potentially occur within the proposed project area are listed in the following table:

MAMMALS	
Scientific Name	**Common Name**
Antrozous pallidus	pallid bat
Brachylagus idahoensis	pygmy rabbit
Corynorhinus townsendii	Townsend's big-eared bat
Eptesicus fuscus	big brown bat
Lasionycteris noctivagans	silver-haired bat
Lasiurus cinereus	hoary bat
Myotis ciliolabrum	small-footed myotis
Myotis evotis	long-eared myotis
Myotis lucifugus	little brown myotis
Myotis volans	long-legged myotis
Myotis yamanensis	Yuma myotis
Pipistrellus heperus	western pipestrelle
Tadarida braziliensis	Brazilian free-tailed bat
BIRDS	
Accipiter gentilis	northern goshawk
Aquila chrysaetos	golden eagle
Asio flammeus	short-eared owl
Asio otus	long-eared owl
Athene cunicularia	burrowing owl
Baeolophus griseus	juniper titmouse
Buteo regalis	ferruginous hawk
Buteo swainsoni	Swainson's hawk
Centrocercus urophasianus	greater sage-grouse
Falco mexicanus	prairie falcon
Gymnorhinus cyanocephalus	pinyon jay
Icteria virens	yellow-breasted chat
Lanius ludovicianus	loggerhead shrike
Leucosticte atrata	black rosy-finch
Melanerpes lewis	Lewis's woodpecker
Numnius americanus	long-billed curlew
Pooecetes gramineus	vesper sparrow
Pegadis chili	white faced ibis
Sphyrapicus nuchalis	red-naped sapsucker

AMPHIBIANS	
None	None
FISH	
None	None
PLANTS	
None	None

Several of these special status species are discussed here briefly:

Pygmy rabbits (*Brachylagus idahoensis*) are North America's smallest rabbits, and are the only rabbits that commonly construct their own burrows, usually in stands of tall, dense sagebrush in locations with deep, loose soils. Pygmy rabbits are patchily distributed throughout most of the Great Basin. Though locally common, these animals have apparently never been generally abundant during historical times, and may have undergone serious population declines and local extirpations in recent decades. Pygmy rabbits are sagebrush obligates and their decline is probably closely related to loss and degradation of sagebrush habitats. Very little is known about population dynamics of this species. Pygmy rabbits have been documented within the proposed project area (BLM 1994), and are known to inhabit many other central Nevada locations.

The **golden eagle (***Aquila chrysaetos***)** is Nevada's largest resident bird of prey, sometimes weighing over twelve pounds and having a wingspan that may exceed seven feet. This bird is highly adaptable, has worldwide distribution and is a common yearlong resident of central Nevada. Golden eagles feed primarily on small mammals – jackrabbits, cottontails and ground squirrels – though they are capable of taking larger prey.

Sage-grouse populations across the West have experienced significant long-term declines (Connelly et al., 2004) and concerns for sage-grouse habitat and populations have largely driven conservation efforts in sage-grouse country for the last decade. As noted earlier, the USFWS determined in March 2010, that the sage-grouse warrants range-wide listing under the Endangered Species Act, but that listing is precluded by higher listing priorities (i.e., other species in greater need of protection). As a result, the sage-grouse has now become a candidate species. A final decision on listing is expected in 2015.

The Proposed Toiyabe West Project lies within the Toiyabe Sage-grouse Population Management Unit (PMU) and includes some of the highest remaining concentrations of sage-grouse in central Nevada. The NDOW estimates that the fall 2011 population for Toiyabe PMU is between 3,500 and 4,500 sage-grouse. A number of sage-grouse leks (strutting/breeding grounds) occur in the foothills and valley to the west of Toiyabe Range and many of the birds are believed to summer at high elevations of these mountains. Satellite telemetry initiated in 2013 in the proposed project area is providing detailed answers about where the birds nest, raise their broods (young), and winter, along with information about routes that the birds follow from low elevation breeding grounds to high elevation summering areas. Of particular interest is how sage-grouse navigate through pinyon-juniper belts at mid elevations and the associated survival costs. Pinyon juniper encroachment was identified to be the greatest risk to sage-grouse in the Toiyabe PMU by the South Central Nevada Sage-grouse Conservation Plan (2005).

Pinyon jays (*Gymnorhinus cyanocephalus*) are obligates of pinyon pine woodlands, feeding principally on pine nuts, which they store in fall and consume during winter and spring. Pinyon jays prefer interface zones between sagebrush and pinyon-juniper woodlands, avoiding dense woodland interiors, especially those greater than 2 kilometers (1.2 miles) or so from the nearest edge or open area (Great Basin Bird Observatory 2011). Pinyon jay populations appear to be in a persistent, long-term decline across the intermountain West, perhaps paralleling region-wide infilling and transition of woodlands from Phase II to Phase III (personal communication with John Boone, Great Basin Bird Observatory).

The **juniper titmouse (***Baeolophus griseus***)** is a small bird that is an obligate inhabitant of pinyon-juniper woodlands, occurring as singles or pairs and does not typically form large flocks. Nests are normally located in juniper trees, constructed in rotten wood or existing cavities. The juniper titmouse diet consists of insects in late spring and summer, but is dominated by pine, juniper, and other seeds during the fall, winter, and early spring. Depending on treatment, thinning or selective cutting of pinyon-juniper for fuel wood and other uses may have slight positive benefits to the juniper titmouse (Albert et al. 1994). Because availability of natural or excavated cavities may be limiting in pinyon-juniper woodland (Cicero 1996), retention of older juniper trees with large, twisted trunks is especially important for juniper titmouse.

Environmental Consequences of the Proposed Action on Wildlife, Including Migratory Birds and Special Status Species

The proposed project would maintain and enhance habitat for a variety of wildlife species, especially sage-grouse, by reducing one of the most important threats to that habitat: encroachment by pinyon and juniper trees. While pinyon and juniper, especially old-growth stands, have important value as wildlife habitat, these trees, in the absence of periodic fire or other disturbance, often expand their distribution and proliferate at the expense of other plant community species (Tausch et al. 1981; Schaefer et al. 2003; Nallion et al. 2003; Weisberg and Greenwood, 2007; Tausch et al. 2009).

Wildlife diversity remains high while pinyon-juniper woodlands remain in Phases I and II and especially at woodland edges adjacent to treated areas (Rosenstock and Van Riper 2001). However, as pinyon-juniper woodlands transition to Phase III, shrub and grass seed production, important for a wide variety of birds and small mammals, diminishes, and even pine nut and juniper berry crops, important as winter food for birds and other wildlife, decline (Tausch et al. 2009). To date, research has not identified wildlife species obligate to closed (Phase III) juniper woodlands.

The proposed project would result in short-term, temporary disturbance to wildlife during the implementation phase. To minimize impacts to migratory birds, site surveys would be conducted (from March through August) by a qualified biologist to determine the presence of nesting birds. Crew members would be trained to identify nesting bird behavior and instructed to inspect trees for nests before cutting. (To date this has been the most effective strategy for avoiding impacts to tree nesting birds.)

Environmental Consequences No Action Alternative on Wildlife, Including Migratory Birds and Special Status Species

Pinyon and juniper trees would continue to encroach into high-value wildlife habitat, likely resulting in avoidance of this habitat by sage-grouse and in time excluding, by dominance, other plant species from the community and further degrading wildlife habitat. Increasing density and distribution of pinyon-juniper woodlands has been widely identified as a threat to sagebrush ecosystems. Connelly et al. (2004) assert that mountain big sagebrush sites within the Great Basin are at high risk of pinyon-juniper invasion, and indeed, large parts of the proposed project site are being encroached by thousands of trees, the great majority of which are less than 120 years old.

If left untreated, this encroachment would eventually result in the loss of high quality wildlife habitat through competitive exclusion of grasses, shrubs, forbs and other tree species such as quaking aspen and curlleaf mountain mahogany. Moreover, sage-grouse generally shun pinyon-juniper woodlands even before exclusion of other plant species occurs (Braun 1998). Studies in Colorado report avoidance of pinyon-juniper throughout the year and especially during breeding and summer periods (Commons et al. 1999). Atamian (2007) found that sage-grouse in central Nevada are intolerant of (strongly avoid) pinyon-juniper woodlands, especially during brood rearing. Casazza et al. (2010) found that sage-grouse avoided even early stage pinyon-juniper encroachment areas with fewer than 40 trees per hectare (about 16 trees per acre) and less than 5% canopy cover, and postulated that a reduction in sage-grouse spatial distribution resulting from encroachment may pose a significant risk to the persistence of populations. Knick et al. (2013) in a study of habitat suitability found that almost all active leks existed in areas containing little conifer or grassland cover in the surrounding landscape. The study concluded that two widespread trajectories of vegetation change (1. conversion of sagebrush shrublands to non-native grasslands and 2. conifer encroachment of sagebrush shrublands) are likely to further reduce habitat suitability across large areas of sage-grouse range.

Pygmy rabbits, another BLM sensitive species, might also be negatively affected by pinyon-juniper encroachment (National Park Service 2004) and would certainly be eliminated after sagebrush is excluded from the habitat. Even obligate inhabitants of pinyon-juniper woodlands such as the juniper titmouse and pinyon jay would decline in numbers as these woodlands approach Phase III densities.

Riparian & Wetland Zones / Water Quality

The proposed project area includes numerous small springs, some of which support sizable wet meadows and even perennial streams, including Italian, Silver, Boone, Iowa and Hall Creeks. According to the National Hydrography Dataset, the proposed project area includes 65 springs and 76 miles of perennial streams.

Environmental Consequences of the Proposed Action on Riparian & Wetland Zones / Water Quality

Maintaining watershed capacity to capture, store and release water in a manner that supports proper functioning systems is crucial to rangeland health. By maintaining understory vegetation, the proposed project would help to avoid adverse effects to soils, hydrologic function and riparian resources. Woodland encroachment into Great Basin sagebrush steppe has been directly

linked to plant community coarsening (Miller et al. 2000, 2001, 2007, 2008) amplified runoff and soil loss (Pierson et al. 2007; Petersen and Stringham 2008; Petersen et al. 2009; Cline et al. 2010; Pierson et al. 2010). Substantial erosion of the biologically and hydrologically important surface-soil horizon on rangelands inhibits infiltration, reduces soil water storage, and negatively impacts plant productivity (Blackburn and Skau 1974; Schlesinger et al. 1990; Abrahams et al. 1995; Turnbull et al. 2010). Recent rainfall simulation studies by Pierson et al. (2007, 2010, and 2013) reported accelerated erosion rates from areas between tree canopies (intercanopy) on late-Phase II–III woodland-encroached shrub steppe sites in the Great Basin. These studies attributed high soil loss from inter-canopy areas to woodland encroachment-induced bare ground connectivity, accumulation of high-velocity concentrated overland flow, rapid transport of rainsplash and flow detached sediment. Petersen et al. (2009) also found understory decline on woodland encroached sagebrush rangelands promoted runoff generation and suggested that long-term erosion from late-succession (e.g., Phase III) woodlands inhibits reversibility to the pre-encroachment ecologic structural-functional state (Briske et al. 2008).

In the short term, the proposed action would have little effect on riparian zones and water quality water quality, and even presents the possibility of increased runoff and erosion as canopy interception decreases from tree removal. However, by preservation and/or recovery of the understory, these effects would be expected to minimal or to reverse, with less runoff and more infiltration, especially with respect to the no action the alternative, where canopies would eventually expand to Phases II and III with resulting increases in bare ground.

The proposed action would help to prevent or reverse the encroachment of expansion pinyon and juniper woodlands into, and alteration of, important riparian habitats. Water quality would also be preserved and water quantity might increase as well. Pierson et al. (2007) found that the cutting of juniper stimulated herbaceous plant recovery, improved infiltration capacity, and protected the soil surface from even large thunderstorms, thereby preserving both water quality and quantity. Deboodt (2008) found that removal of all post-European age (< 140 years) juniper from an eastern Oregon watershed resulted in increased late-season spring flow, increased ground water, and increased availability of late season soil moisture.

Management of pinyon and juniper expansion woodlands within the proposed project area would also help to maintain stable stream channels and associated riparian communities. Runoff from pinyon-juniper dominated terrain can be many times greater than from non-pinyon-juniper dominated terrain (Pierson et al. 2007), which can lead to abnormally high peak discharges and flows that alter channel types via bed/bank incision and erosion. Managing pinyon and juniper within historic norms can help to restore natural flow paths and maintain natural discharges, thereby promoting hydrologic conditions that support stable channel types. No negative effects to riparian habitats would be expected to result from execution of the project.

<u>Environmental Consequences of the No Action Alternative on Riparian & Wetland Zones / Water Quality</u>

Increasing encroachment and dominance of portions of the Toiyabe West Project area by expansion pinyon and juniper woodlands would gradually result in deteriorating riparian condition through soil erosion, sediment loading, reduction of water quality and quantity, accelerated channel cutting and direct competitive exclusion of riparian plants. Decreased spring

flows, resulting in narrowed or shortened riparian areas might also be expected (depending on site specific soils and geology) from increasing pinyon and juniper encroachment.

Cultural Resources

The area associated with the proposed project is known to be both prehistorically and historically significant and, although not extensive, previous cultural resources inventories in the proposed project vicinity indicate that prehistoric, ethno-historic and historic cultural resources are present. A majority of sites are expected to be clustered around significant natural resources, particularly permanent water sources.

Prehistoric occupation of the region dates back to the early Holocene and may be associated with the Pluvial Lakes in Grass and Carico Lake Valleys. Certainly by the Archaic Period (~ 4500 BC), prehistoric populations were exploiting the mineral, vegetative and faunal resources of the region. Later, with a climate change and the incursion of pinyon pine into the upper reaches of central Nevada's many mountain ranges, pine nut gathering became important for Native American populations. This activity has persisted to the present day in some parts of the region. Prehistoric artifacts to be found in the proposed project area almost certainly include durable items such as stone tools, but will also include more fragile elements such as brush and wood structural remains, windbreaks, and harvesting sticks.

The first recorded penetration of central Nevada by people of European descent occurred in the 1820s (Jedediah Smith and Peter Skene Ogden) and was driven in large part by the search for beaver. Emigration to California through Nevada began in earnest during the mid-1840s, and increased dramatically with the discovery of gold in California in 1849.

The influx of gold-seekers and settlers into the California Territory necessitated a reliable mail route. The best known, though not the earliest of these was the Pony Express, active for just 18 months during 1860 and 1861 until the completion of a transcontinental telegraph line. The Pony Express, now a recognized National Historic Trail, crosses the Toiyabe Range several miles to the south of the proposed project area.

Organized mining began in central Nevada with the 1862 discovery of silver ore near present day Austin. Following in quick succession were valuable ore discoveries at Cortez and Bullion in 1863, and at Eureka in 1864. Today, numerous mine workings, habitation structures, and Carbonari platforms attest to the mining and prospecting history of the region. The development of agriculture, ranching, and transportation services in the region closely parallels mining history; the livestock industry along with vegetable and grain production was expanded primarily to support the mining and associated transportation industries.

Environmental Consequences of the Proposed Action on Cultural Resources

Because the proposed action would produce little or no ground disturbance, the proposed project is expected to have low potential to affect durable artifacts such as stone tools. However, unauthorized collection of surface artifacts by chainsaw crew members is always a possibility. Moreover, more fragile artifacts such as brush and wood structural remains, windbreaks and pine nut harvesting sticks could be damaged during project implementation or subsequent collection of downed wood by the public or by commercial operators, particularly as such components are not easily or often recognized by non-archaeologists.

To minimize potential impacts to cultural resources, several measures would be undertaken. Prior to each field season, or as specific treatment sites are identified, the effects of the proposed action would be addressed through compliance with the National Historic Preservation Act (NHPA) as implemented through a national programmatic agreement and the BLM-Nevada State Historic Preservation Office (SHPO) protocol agreement. A staff archaeologist would evaluate the potential of the area for cultural resources, and would undertake avoidance measures in accordance with appendices F and H of the Nevada State Protocol agreement. To reduce the risk of unauthorized collection, field crews would be instructed by an agency archaeologist regarding the importance of cultural resources and the possible penalties under the Archaeological Resources Protection Act for the destruction of archaeological resources.

Further, to decrease the risk of inadvertent damage to fragile remains, crews would also be taught to recognize wood and brush cultural resources. Ultimately, the proposed action would have a positive long term effect on cultural resources by helping to reduce accelerated and unnatural soil erosion associated with late-stage pinyon and juniper domination of plant communities that would eventually result if expansion woodlands are left untreated.

Environmental Consequences of the No Action Alternative on Cultural Resources

Failure to manage expansion pinyon-juniper woodlands (the no-action alternative) could have negative consequences. Accelerated run-off associated with pinyon-juniper dominance and loss of shrub and grass cover could increasingly put archaeological resources at risk. Archaeological sites, especially prehistoric sites, are very sensitive to soil erosion. In Bandolier National Monument, for example, transition of sparsely treed savannas to dense pinyon-juniper woodlands as a result of cumulative historical effects of overgrazing, fire suppression, and severe drought has resulted in rapidly eroding soils (Jacobs and Gatewood 1999, Hastings et al. 2003). The result has been that immense numbers of ceramic and lithic artifacts are literally being washed away (Allen, 2002). Additional discussion of accelerated soil erosion resulting from pinyon-juniper expansion and infilling is discussed under the *Soils and Vegetation* as well as under the *Riparian & Wetland Zones / Water Quality* sections of this document.

Noxious Weeds, Invasive and Non-native Species

Noxious weeds, invasive and non-native species are species that are highly competitive, highly aggressive, and spread easily. The BLM defines a noxious weed as, “a plant that interferes with management objectives for a given area of land at a given point in time.” The Battle Mountain District (BMD) recognizes the current noxious weed list designated by the State of Nevada Department of Agriculture (NDOA) statute, found in the Nevada Administrative Code (NAC), Chapter 555, Section 010 (NAC 555.010). An "invasive species" is defined as a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health (EO 13112, signed February 3, 1999).

The proposed project area is moderately infested by noxious weeds, invasive and non-native species. The BLM National Invasive Species Information Management System (NISIMS) contains infestation and treatment records of hoary cress (*Lepidium draba*), Russian knapweed (*Centaurea repens*), musk thistle (*Carduus nutans*) and scotch thistle (*Onopordum acanthium*).

Infestations of hoary cress (*Lepidium draba*) are common along road-sides and in fire scars. Russian knapweed, musk thistle and scotch thistle are found in areas of disturbance and often near riparian resources. Cheatgrass (*Bromus tectorum*), a long-established invasive annual grass species, is also widely distributed throughout the area.

Environmental Consequences of the Proposed Action on Noxious Weeds, Invasive and Non-native Species

The proposed action has little potential to create conditions favorable for the spread and establishment of noxious weeds, invasive and non-native species. Disturbance to soils and vegetation (other than the target tree species) by crews on foot carrying chain saws would be negligible. Nevertheless, the proposed action would observe Prevention and BMPs as incorporated by Battle Mountain District, Integrated Weed Management Plan (2009) to further minimize the chances of introducing or spreading noxious weeds or invasive species. Active noxious weed control would take place on site by a certified pesticide applicator as weeds are discovered or identified.

Environmental Consequences of the No Action Alternative on Noxious Weeds, Invasive and Non-native Species

The no action alternative would provide an increased risk for invasion of noxious weeds, invasive and non-native species. High levels of tree dominance would greatly reduce the diversity of perennial vegetation needed for resiliency following disturbance. High levels of tree dominance could also eventually result in larger, more intense wildfires, followed by the gradual invasion of noxious weeds, invasive and non-native species and displacement of native vegetation communities

Native American Religious Concerns

Various tribes and bands of the Western Shoshone have stated that federal projects and land actions can have widespread effects to their culture and religion as they consider the landscape as sacred and as a provider. The proposed project area lies within the traditional territory of the Western Shoshone. The land has been prehistorically and historically a provider of plant and animal foods as well as medicinal resources. Pine nut harvesting was particularly important in Shoshone subsistence and remains culturally important.

Environmental Consequences of the Proposed Action on Native American Religious Concerns

The low disturbance potential of the proposed project makes an adverse effect to any Native American religious site or religious practice very unlikely. Nevertheless, coordination with the relevant tribes would be ongoing to ensure that any concerns are addressed.

The tribes have generally voiced opposition to chaining projects, preferring instead, hand-thinning control of pinyon-juniper. Additionally, the tribes have expressed a desire to preserve older, mature, nut-bearing pinyon pine trees along with sufficient young trees to insure adequate future pine nut harvests. The proposed action, being a hand-thinning operation targeting young expansion woodlands, would respect those wishes. Because the proposed project would be limited in scope and scale, sufficient numbers of young trees would remain on the landscape to insure adequate future pine nut harvests (barring intense, widespread wildfires). The tribes have

also expressed interest in, and would be permitted to harvest, firewood from downed trees in the project area.

Although the possibility of disturbing Native American gravesites within the project area is extremely low, inadvertent discovery procedures must be noted. The Native American Graves Protection and Repatriation Act, section (3)(d)(1), states that the discovering individual must notify the land manager in writing of such a discovery. If the discovery occurs in connection with an authorized use, the activity, which caused the discovery, is to cease and the materials are to be protected until the land manager can respond to the situation.

Environmental Consequences of the No Action Alternative on Native American Religious Concerns

No effect to Native American religious sites would be anticipated to result from the No Action Alternative in the short term. In the longer term, pinyon-juniper domination, increasing erosion, and increasing risk of catastrophic fire, with resulting conversion to exotic annual plant species, would all have deleterious effects.

Visual Resources

The massive, rounded profile of 10,000 foot tall Mount Callaghan dominates the northern Toiyabe Range and the proposed project area. From a distance, the highest ridges of the Toiyabe Mountains appear largely barren. Except for the occasional stand of hardy curlleaf mountain mahogany, only plants of low growth form - low sage, a few grasses and short-statured forbs - can withstand the wind, the cold and the shallow, rocky soils of these high ridges. At slightly lower elevations, on gentler slopes and in swales, deeper, richer soils support mountain brush communities, dotted with stands of aspen. Beginning at slightly lower elevation, darker colored pinyon and juniper trees form belts at elevations between 6,000 to 8,000 feet. These belts have expanded both up and down-slope into adjacent areas during the last century and have also become increasingly dense.

Although the proposed project area includes visual resource management (VRM) classes 3 and 4, all potential treatment sites fall within VRM class 4. VRM class 4 is the least restrictive category. It is permissible for a management activity in this VRM class to draw attention as a dominant feature of the landscape, but attempts should be made to minimize the contrast by repeating the form, line, color, and texture of the characteristic landscape.

Environmental Consequences of the Proposed Action on Visual Resources

To conform to the VRM standards discussed above, the edges of the thinned areas under the proposed action would be “feathered” and would follow the contours of the landscape, in order to avoid the appearance of obvious human influence. Experience with similar pinyon-juniper thinning projects in the past has shown that the visual impacts are relatively unobtrusive in the short term and almost unnoticeable after two years, when needles have fallen from downed trees. In the long term, the proposed project would result in a visual aspect greatly preferable to one dominated and obscured by dense stands of conifers that would eventually result without the proposed action. Opportunities for wildlife viewing would also be preserved and enhanced by the proposed action. The overall appearance of the project area under the proposed action would be

one with fewer evergreen trees, an appearance more in keeping with the pre-settlement condition of the landscape.

Environmental Consequences of the No Action Alternative on Visual Resources
Visual resources would not immediately change from current condition if the proposed project is not implemented. Over time, pinyon-juniper domination would degrade the visual variety of the project area. Opportunities for wildlife viewing would be diminished as both visibility and the quality of the habitat (which would support less wildlife) decline.

Recreation
Recreational activity in and around most of the proposed project area is of a dispersed nature and includes such activities as camping, off-road vehicle use, hunting, hiking, horseback riding, wildlife viewing and rock hounding.

Environmental Consequences of the Proposed Action on Recreation
The proposed action, with its associated chain saw noise, could have immediate negative effects upon recreational opportunities in the proposed project area during implementation by detracting from the naturalness of the experience. Following treatment and in the long term, however, recreational opportunities such as hiking, horseback riding, wildlife viewing and hunting would be enhanced by the preservation of plant, wildlife, and aesthetic diversity.

Environmental Consequences of the No Action Alternative on Recreation
Under the no action alternative, wildlife and scenery-based recreational opportunities would decrease over time as the quality of wildlife habitat decreases. Other forms of recreation would be little affected.

Socio-Economic Values
A number of socio-economic values, important locally and regionally, are associated with the proposed project area. Traditional socio-economic activities within the project area include livestock grazing, mining and mineral exploration (though no mines are currently active inside the proposed project area), along with pine nut, fuel wood and fence post harvesting. Outdoor recreation, which includes hunting, hiking, camping, rock hounding, along with wildlife and wild horse viewing, has become increasingly important to local economies as well.

As of 2011, Lander County had a total population of 5,841 (www.census.gov) with a labor force of 2,833 persons and an unemployment rate of 7%. The proposed project would likely be undertaken through the Bootstraps program, a collaborative endeavor of the University of Nevada Cooperative Extension and the BLM. The program is designed to accomplish natural resource projects on public lands while teaching job skills and responsibility to young adults. Since a crew might typically treat 1,500 acres per year, a project life of four years is a reasonable expectation. The proposed project might be completed by crews unrelated to the Bootstraps program if that option becomes necessary or feasible.

Environmental Consequences of the Proposed Action on Socio-Economic Values

The proposed action would help to preserve socio-economic values associated with livestock grazing, pine nut harvesting, wildlife and wild horse viewing, hunting and hiking, and would promote fuel wood harvesting within the project area.

The project is expected to employ 12-15 young adults for the months of May through October beginning with the 2014 calendar year. The crews would be camping at the proposed project site for three to four nights per week. The Bootstraps Crew would likely be comprised of young adults from central and northern Nevada. Many past crew members have been Battle Mountain and Winnemucca residents, though a number of crew members have been recruited from the Duck Valley Native American community.

The proposed project would provide seasonal work for a relatively small crew for up to ten years and would not affect population growth in an area. Neither would the proposed project create or provide any infrastructure which would indirectly induce substantial population growth.

The crews would help to support local economies through the purchase of fuel, groceries, tools and equipment. This spending activity associated with the proposed project would have a small but positive effect on local businesses in Lander County.

The proposed action would have little effect, positive or negative, on the socio-economics of mining, mineral exploration and rock hounding.

Environmental Consequences of the No Action Alternative on Socio-Economic Values

Without the proposed action, the socio-economic potential of the proposed project area would likely decline. Opportunities for livestock grazing, pine nut harvesting, hunting, wildlife and wild horse viewing will diminish as carrying capacities of the range deteriorate and pinyon and juniper trees become increasingly dominant.

Rangeland Resources / Grazing Management

The proposed project area has been grazed by cattle and sheep since the mid-1800s and lies entirely within the Austin grazing allotment. The Austin Allotment boundary, which also serves as the proposed project boundary, is depicted as a purple line in Figure 1. As is the case generally over the entire West, sheep grazing has declined precipitously since the mid-1900s, and cattle are now the predominant livestock. As discussed further below, wild horses are present in the proposed project area.

Grazing management of the Austin Allotment is prescribed by the Austin Allotment Evaluation (BLM, 1994) and by the Austin Complex Permit Renewal, Final Decision (BLM, 2007). This document is intended to foster sound, sustainable livestock management that is consistent with other resource uses and values by establishing appropriate stocking rates (numbers of animals), seasons of use and other terms and conditions. Changes made in grazing management have resulted in improving range condition. Reduction of wild horse numbers to appropriate management levels during January 2009 and again during January 2011 is also contributing to improving range and riparian condition on portions of the proposed project area.

Environmental Consequences of the Proposed Action on Rangeland Resources / Grazing Management

In the short term (< 1 year) the proposed action would have minimal effect on range resources or livestock distribution. Treatment of pinyon-juniper in areas that are already tree-dominated (Phase III) may require post-treatment rest from livestock grazing to ensure recovery of depleted perennial understory vegetation, especially perennial bunchgrasses, and to reduce the likelihood of invasion by weedy annuals (Bates 2005, Tausch et al. 2009). However, the objective of the proposed action is to *prevent* pinyon-juniper domination before it occurs. Since sites to be treated retain understories that are largely intact, dramatic changes in understory plant composition or productivity are not anticipated and have not been observed on similar treated sites in the past. Moreover since ground disturbance by foot crews with chainsaws is minimal, and since little change in post-treatment livestock use is anticipated, significant increases in weedy annuals are not expected.

Though as Bates (2005) notes, grazing management following juniper control should be adaptive to changing environmental and resource conditions, past experience with similar pinyon-juniper treatments suggests that marked increase in livestock use of the treated area or distribution of livestock will not occur. Any marginal increase in use of the treatment site by livestock following pinyon-juniper removal will likely be offset by the effect of the toppled trees in creating micro safe sites for understory plants. Consequently, the need for post-treatment closure of treatment sites to livestock is not anticipated.

The reduced need for post-treatment closure to livestock is a significant advantage of treating Phase I and early Phase II pinyon-juniper sites. Because treatment sites typically amount to only a small portion of a pasture, post-treatment rest from grazing often conflicts with other grazing management objectives, adding cost and complexity to the project. In the long-term (> 1 year) the proposed action would maintain and enhance forage availability for livestock, wild horses and wildlife.

Environmental Consequences of the No Action Alternative on Rangeland Resources / Grazing Management

Over time, increasing domination of plant communities by pinyon and juniper would reduce, and eventually eliminate, livestock forage from large portions of the proposed project area.

Wild Horses and Burros

The proposed project area includes a substantial portion of the Callaghan Herd Management Area (HMA). The appropriate management level for the Callaghan HMA has been established at 134 - 237 animals. That population level was achieved through a gather completed in January, 2009 and was subsequently maintained by a gather in January of 2011. The current population estimate for the Callaghan HMA is 361 animals based on an inventory flight conducted in August 2012.

Environmental Consequences of the Proposed Action on Wild Horses and Burros

A short-term disruption of wild horse movements and habitat use might result from human activity and chainsaw noise associated with the proposed action during project implementation. In the long-term (> 1 year), habitat quality for wild horses would be enhanced as understory

vegetation, particularly grasses and forbs, are protected from competitive exclusion by pinyon and juniper.

Environmental Consequences of the No Action Alternative on Wild Horses and Burros
Under the No Action Alternative, pinyon and juniper encroachment and dominance of the project area would continue. Availability of forage and other habitat requirements for wild horses would decline.

IV. Cumulative Impacts

The Council of Environmental Quality (CEQ) regulations implementing the National Environmental Policy Act (NEPA) define cumulative impacts as: "…The impact on the environment which results from incremental impact of the action when added to other past, present, or reasonably foreseeable future actions regardless of what agency (Federal or Non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time" (40 CFR 1508.7).

The Cumulative Effects Study Area (CESA) for the proposed action and No Action Alternative will consist of the geographic area managed by the Mount Lewis Field Office (depicted in gray on the inset map, Figure 1.) Vegetation treatment projects similar to the proposed action (specifically, chainsaw removal of pinyon and juniper) that have occurred, and that are likely to occur within the foreseeable future (five to ten years), span the Mount Lewis Field Office from the Sulphur Springs Range on the eastern side of the Field Office to the Fish Creek Mountains on the western side. Resources analyzed here for cumulative impacts are those that were identified as potentially affected by the proposed action (and therefore presumably, are the same resources that would be affected by similar actions).

A. *Past, Present and Reasonably Foreseeable Actions*

Since European settlement of the CESA began in the mid-1800s, several major influences have contributed cumulatively to the need for the proposed action. These include the removal of native peoples (along with their frequent firing of vegetation) from the landscape, removal of fine fuels associated with the introduction of domestic livestock, and the direct suppression of wildfire. These influences have together, resulted in reduced fire frequency, which in turn contributed to widespread increases in pinyon and juniper distribution and density. Increases in pinyon and juniper have also been attributed to changes in climate and increases in atmospheric carbon dioxide (Weisberg and Bauer, 2006). Whatever the cause(s), pinyon and juniper have become more abundant on many sites at the expense of range and wildlife habitat.

The proposed project, in conjunction with similar past, ongoing and future vegetation treatment projects in the CESA (Tonkin Springs, 2005; Fish Creek Mountains, 2006-2007; Red Hills, 2006-2010; Seven Mile, 2010-2016; Sulphur Springs, 2009-2012; Roberts Mountain, 2008-2009; Bald Mountain, 2010-2012) is designed to counteract, in a limited, targeted way, the effects of dramatic changes, during the past 150 years, in pinyon and juniper dominance of the landscape. As such, the proposed action and similar projects would have modest but important beneficial cumulative effects at the CESA scale (though *very* beneficial site-specific effects).

The 3-Bars Ecosystem and Landscape Restoration Project, currently in planning, is a more ambitious, larger scale vegetation and riparian treatment initiative with potentially more significant beneficial impact within the CESA. An environmental impact statement (EIS) is presently being developed for that project.

While the proposed action and similar projects have a cumulatively beneficial effect, it should be noted that these projects are not, unfortunately, effectively counterbalancing pinyon-juniper expansion. The magnitude of the pinyon-juniper encroachment/expansion problem is such that management is simply not able, with currently available resources, to keep pace at the CESA or larger scales.

Other past, present, and reasonably foreseeable future actions applicable to the assessment area are identified below:

Project Type or Description	Past	Present	Future
Issuance of multiple use decisions and grazing permits for livestock management	x		x
Wild horse gathers/decisions	x		x
Construction of exclosures around springs or other riparian resources	x	x	x
Mineral Exploration	x	x	x
Mining associated with Phoenix, Tonkin Springs, Atlas and Mt. Hope Mines	x	x	x
Reclamation of Abandoned Mine Lands	x	x	x
Construction of fences	x	x	x
Spring development	x	x	x
Riparian habitat management	x	x	x
Invasive weed inventory/treatments	x	x	x
Vegetation rehabilitation treatments	x	x	x
Construction of communication towers and transmission lines	x	x	x
Geothermal Energy Exploration/Development	x	x	x
Wind Energy Exploration	x	x	x
Recreation, both organized events and dispersed usage	x	x	x
Harvest of forest products and hazardous fuels reduction projects	x	x	x

Future proposed projects within the CESA would be analyzed in appropriate environmental documents following site specific planning. Future project planning would also include public involvement.

B. *Effect of Past, Present, and Reasonably Foreseeable Future Actions*

1. Proposed Action

Air Quality

The proposed action and similar habitat enhancement projects would be expected to have minimal and temporary effects on air quality: fugitive dust from vehicle travel, vehicle

emissions, and possibly, smoke from pile burning. Pile burning, if conducted, would employ burn parameters designed to comply with National Air Quality Standards. No cumulative air quality effects would be expected.

Soils/Vegetation/Rangeland Resources/Grazing Management

As discussed in the *Environmental Consequences* section of this document, the proposed action and similar habitat enhancement projects, as well as wildfire rehabilitation, habitat restoration, improvements in livestock grazing practices, management of wild horses at appropriate management levels, and noxious weed and invasive species treatments would have positive cumulative effects in helping to maintain and facilitate a diverse natural plant community in good ecological condition, exhibiting strong soil/slope stabilizing characteristics.

Other past, present, and future actions such as mining, geothermal development, unregulated OHV use and sub-optimal management of livestock or wild horse grazing, cumulatively have the potential to adversely affect plant communities, and to compact soils, which in turn can reduce water infiltration rates and soil permeability, deplete micro biotic crusts, increase soil erosion, and facilitate the spread of noxious weeds as well as invasive and non-native species. The proposed project would not contribute to, and in fact would tend to mitigate, those effects. The proposed action and similar vegetation management projects are expected to cumulatively benefit rangeland health and to mitigate negative impacts, both direct and indirect, to soils and vegetation. Cumulatively, the proposed action and similar projects would maintain productive habitats and enhance forage availability for livestock, wild horses and wildlife.

Forestry Resources

Past, present and foreseeable future projects have had, are having, and will have both positive and negative cumulative effects on forestry resources. The energy demands of early mining, particularly the need for fuel wood in the smelting of ores, decimated forestlands in some portions of central Nevada. Indirect suppression of fire, through removal of native peoples and the introduction of livestock, along with later direct suppression of wildfire by the land management agencies and others, have allowed pinyon and juniper forests to expand in range and to increase dramatically in density. Changes in climate and atmospheric carbon dioxide may have contributed to the phenomenon. At some point however, this greatly increased canopy biomass will likely result in catastrophic wildfires that will devastate forest resources. Undesirable, invasive, and highly flammable weed species often dominate and persist following high intensity wildfires.

High intensity wildfires that exhibit high resistance to control can occur after pinyon and juniper forests reach canopy closure. Crown cover exceeding 50% is sufficient to carry high-intensity fire during dry or windy periods (Miller and Tausch, 2001). The majority of Great Basin woodlands are expected to reach canopy closure within the next 40 to 50 years (Miller et al. 2008).

The proposed action and similar past, present and future habitat manipulation projects discussed previously under "A. *Past, Present and Reasonably Foreseeable Actions*" would help to preserve forestry resources while at the same time promoting maximum diversity of the plant community.

Thinning/removal of pinyon and juniper trees can prevent the canopy closure that can eventually result in forestry resource devastating crown fires.

Wildlife, Including Migratory Birds and Special Status Species

The most relevant cumulative effects result from the sum of similar habitat enhancement projects. Projects such as wildfire rehabilitation, sage-grouse habitat improvement projects, construction of wildlife guzzlers, vegetation rehabilitation, and invasive weed treatments are cumulatively beneficial for wildlife and wildlife habitat for all of the reasons previously discussed under *Wildlife* in the *Environmental Consequences* section. These projects are implemented to enhance rangeland condition, riparian/wetland health and functionality, improve water quality and preserve forestry resources, all of which benefit wildlife species and associated habitat. The primary difference between these projects individually and collectively is a matter of scale.

A number of other ongoing and foreseeable human activities in the area, most notably geothermal development, wind energy exploration, mining, mineral exploration and increased OHV use, could result in cumulatively adverse impacts to wildlife, special status species, and migratory birds. These activities can potentially result in loss of habitat, habitat fragmentation, and disruption of movement patterns. The proposed project and similar projects would tend to mitigate negative impacts of these activities.

Riparian & Wetland Zones / Water Quality

As discussed in the *Environmental Consequences* section, the proposed project would help to maintain and enhance riparian resources by reducing pinyon and juniper encroachment into meadows and stream sides and aspen stands. The proposed action, in conjunction with improved livestock and wild horse management practices, has direct beneficial effects for riparian/wetland zones and associated water quality. Noxious weed and invasive species treatments and wildfire rehabilitation aid in maintaining the health, viability, and functionality of wetland and riparian zones. These activities and projects, in conjunction with the proposed action, cumulatively aid in the improvement of riparian/wetland zones by allowing the riparian area to improve in functionality (improved vigor of vegetative species, enhanced stream bank stability and sediment filtration, etc.). Water quality also benefits from improvements in wetland/riparian functioning.

Activities such as mining and increasing OHV can impact the availability of surface waters and/or can degrade riparian resources and water quality. The dewatering operations which are sometimes a part of mining operations, if not properly mitigated, can affect or even eliminate wetland and riparian areas. Loss of wetland and riparian resources adversely affect wildlife species by impacting the health of sensitive areas that wildlife depend upon. Increasing OHV-based recreation can impact riparian areas through increased erosion, channeling, loss of riparian vegetation, and reduced functionality of the entire system. However, the cumulative impacts associated with the proposed action would not contribute to those impacts. The cumulative impacts of the proposed action and those of past, present, and reasonably foreseeable similar actions are expected to have positive consequences for riparian resources.

Cultural Resources

Some past actions that involved significant ground disturbance, especially those prior to the passage of the Antiquities Act of 1906, have likely had negative cumulative effects to cultural resources. During recent decades, increasing awareness of cultural resources has led to greater efforts to identify and mitigate impacts. Standard operating procedures and best management practices designed to minimize cumulative impacts to cultural resources are now undertaken for all present and future ground disturbance projects.

The proposed action has low potential to impact cultural resources or to contribute measurably to the cumulative impacts of past, present, and reasonably foreseeable future actions. Changes in grazing management, wild horse gathers, the construction of spring and upland exclosures, fencing projects, spring development, habitat management, in conjunction with the implementation of the proposed action result in effects that are, on balance, cumulatively beneficial to cultural resources. Such projects help to minimize the effects of trampling and erosion that would otherwise result from livestock, wild horses and wildlife use.

Noxious Weeds, Invasive and Non-native Species

As noted previously, the proposed project area is moderately infested by noxious weeds, invasive and non-native species. Infestations of musk thistle, scotch thistle, Russian knapweed and hoary cress (all designated as noxious weeds by the State of Nevada) occur commonly within the CESA. A complete inventory of noxious weeds has not been completed for the CESA, but weeds are predictably concentrated in areas of heavy disturbance, such as along roadsides and wildfire scars. Cheatgrass, a long-established invasive annual grass species, is also present and widely distributed.

While past, present and reasonably foreseeable future actions that cause disturbance to soils and vegetation might promote the cumulative proliferation of noxious weeds and invasive species, adherence to the District's Integrated Weed Management Plan and incorporated BMPs, in combination with proper grazing management, wild horse gathers, riparian fencing, habitat restoration, wildfire suppression and rehabilitation, and noxious weed treatments can be expected to mitigate those impacts.

The proposed project, in combination with and similar past, present and future projects, would tend to reduce the cumulative effects associated with high levels of tree dominance, increased potential size and intensity of wildfires and the resulting gradual invasion of noxious weeds, invasive and non-native species and displacement of native vegetation communities.

Native American Religious Concerns

The cumulative effects of the proposed action and similar habitat manipulation projects would have the effect of indirectly preserving sacred Native American sites from pinyon and juniper domination, increased soil erosion and potential catastrophic wildfire. As such, these projects would have a positive cumulative effect with respect to Native American religions concerns. The proposed action would tend to counteract negative cumulative effects of mining and some other soil displacing activities upon Native American Religious Concerns within the CESA by maintaining rangeland and forest health. Cumulatively the proposed action and similar projects

would help to ensure the sustainability of pine nuts, fuel wood, and medicinal plants, among other resources.

Visual Resources

Past, present, and reasonably foreseeable projects such as transmission lines, roads, fences, and mines arguably have negative cumulative impacts for visual resources. However, for the reasons discussed in the *Environmental Consequences* section of this document, the proposed action would be beneficial for visual resources at the project site level and, when combined with similar actions, would have positive cumulative effects for visual resources at the CESA scale.

Recreation

As Nevada's human population increases, recreational demand will increase within the CESA. The cumulative impacts associated with the proposed action and similar past, present, and reasonably foreseeable future actions would have generally positive cumulative benefits for recreation by preserving wildlife, ecological heath of the environment and aesthetic appeal. The cumulative effects of some types of projects, such as fencing, might detract from a recreational experience. Mining activities may also affect recreational experiences by reducing the amount of public land available or accessible for recreation.

Socio-Economic Values

The proposed project, along with similar vegetation treatment projects would cumulatively help to preserve social and economic values associated with hunting, hiking camping, wildlife and wild horse viewing, rock hounding, firewood harvesting, livestock grazing, and pine nut harvesting. The proposed project would not create long-term population increases or other socio-economic stresses on local communities cumulatively.

Wild Horses and Burros

Cumulatively, projects such as the proposed action and other habitat improvement projects, are beneficial not only to wildlife but for wild horses and burros as well. These projects/activities are implemented to maintain or improve plant community diversity, enhance riparian/wetland health and functionality, improve water quality and increase water quantity, all of which benefit wild horses and their habitats.

2. No Action Alternative

Without the proposed action and similar past, present and reasonably foreseeable future actions, predictable cumulative effects throughout the CESA would include reduced quality of wildlife habitat, declining health and diversity of vegetative communities, degradation of ecological condition of rangelands, downward trend and condition of riparian/wetland zones and water quality, and accelerated erosion. Failure to cumulatively manipulate increasingly dense stands of pinyon and juniper through projects such as the proposed action could also result in eventual catastrophic wildfires which could devastate forest resources, Native American religious sites, cultural resources, visual resources, and would favor the establishment of invasive plant species and noxious weeds.

List of Preparers

• Cultural Resources	John Kinsner	MLFO
• Native American Religious Coordination	Mike Stamm	MLFO
• Lands and Realty	Jonathan Kramer	MLFO
• Visual Resources, Recreation	Ethan Arky	MLFO
• Wild Horses and Burros	Shawna Richardson	MLFO
• Fire/Fuels Management	Josh Tibbetts	BMDO
• Range, Vegetation, Soils	Adam Cochran	MLFO
• Hydrology, Riparian Resources	Alden Shallcross	MLFO
• Noxious Weeds, Invasive, Non-native Species	Kent Bloomer	MLFO
• Minerals	Andrea Dolbear	MLFO
• Forestry	Josh Tibbetts	BMDO
• Wildlife and Fish	Ethan Ellsworth	MLFO
• Threatened & Endangered Species	Ethan Ellsworth	MLFO
• NEPA Compliance	Gloria Tibbetts	BMDO
• Socio-Economics	Gloria Tibbetts	BMDO
• Public Outreach	Karen Weiss	BMDO
• GIS/ Mapping	Kathy Graham	BMDO
• Air Quality	David Jones	NSO

Consultation, Coordination, Cooperation

• Wildlife and Fish	Jeremy Lutz	NDOW
• Permittees	Silver Creek Ranch Inc. James Gallagher Ellison Ranching	

Literature Cited

Abrahams, A. D., Parsons, A. J., & Wainwright, J. 1995. Effects of vegetation change on interrill runoff and erosion, Walnut Gulch, southern Arizona. Geomorphology 13: 37-48.

Adams, A. W. 1975. A brief history of juniper and shrub populations in southern Oregon. Wildlife Research Report Number 6, Research Division, Oregon State Wildlife Commission, Corvallis, OR. 33 p.

Albert, S. K., N. Luna, and A. L. Chopito. 1994. Deer, small mammal, and songbird use of thinned piñon-juniper plots: preliminary results. U.S. For. Serv. Gen. Tech. Rep. GTR-RM-258:54-64.

Aldridge, C. L., and R. M. Brigham. 2001. Nesting and reproductive activities of a declining northern fringe population. The Condor 103:537-543.

Allen, C. D. 2002. Runoff, erosion and restoration studies in piñon-juniper woodlands of the southeastern Jemez Mountains. USGS Fort Collins Science Center, Jemez Mountains Field Station, Los Alamos, NM.

Atamian, M. T. 2007. Brood ecology and sex ratio of greater sage-grouse in East-Central Nevada. M.S. Thesis. University of Nevada. Reno.

Baruch-Mordo, S., J. S. Evans, J. P. Severson, D. E. Naugle, J. D. Maestas, J. M. Kiesecker, M. J. Falkowski, C. A. Hagen, and K. P. Reese. 2013. Saving sage-grouse from the trees: A proactive solution to reducing a key threat to a candidate species. Biological Conservation 167: 233-241.

Bates, J. D. 2005. Herbaceous response to cattle grazing following juniper cutting in Oregon. Rangeland Ecology amd Management. 58: 225-233.

Baughman, C., T. A. Forbis, and L. Provencher. 2010. Response of two sagebrush sites to low-disturbance, mechanical removal of piñyon and juniper. Invasive Plant Science and Management 3: 122-129.

Blackburn, W. H., and C. M. Skau. 1974. Infiltration rates and sediment production of selected plant communities in Nevada. Journal of Range Management 27: 476-480.

Bowers, M. H., and H. Muessig. 1982. History of central Nevada: An overview of the Battle Mountain District. Dennett, Muessig and Associates. Iowa City.

Braun, C. E. 1998. Sage-grouse declines in Western North America: what are the problems? Proceedings of the Western Association of State Fish and Wildlife Agencies. 78: 139-159.

D. D. Briske, B. T. Bestelmeyer, T. K. Stringham, and P. L. Shaver 2008. Recommendations for development of resilience-based state-and-transition models. Rangeland Ecology & Management 61: 359-367.

Bureau of Land Management. 1994. Austin Allotment Evaluation. Battle Mountain District.

Bureau of Land Management. 1988. 6840 Manual. Special Status Species Management. Washington. D.C.

Bureau of Land Management. 1980. Habitat Management Guides for the American Pronghorn Antelope. Technical Note 347. Denver.

Bureau of Land Management. 2007. Austin Complex Permit Renewal, Final Decision. Battle Mountain District.

Burkhardt, J. W., and E. W. Tisdale. 1976. Causes of juniper invasion in southwestern Idaho. Ecology 57: 472-484.

Casazza, M. L., P. S. Coates, and C. T. Overton. 2010. Brood habitat selection and success: Linking habitat selection to brood success in greater sage-grouse: a multi-scale modeling approach. Pre-print in press. U.S. Geological Survey, Western Ecological Research Center, Dixon Field Station.

Chambers, J. C., B. A. Roundy, R. R. Blank, S. E. Meyer, and A. Whittaker. 2007. What makes Great Basin sagebrush ecosystems invasible by *Bromus tectorum*? Ecological Monographs 77:117–145.

Cline, N., B. A. Roundy, F. B. Pierson, P. Kormos, and C. J. Williams. 2010. Hydrologic response to mechanical shredding in a juniper woodland. Rangeland Ecology &Management 63:467–477.

Commons, M. L., R. K. Baydack, and C. E. Braun. 1999. Sage-grouse response to pinyon-juniper management in Proceedings: Ecology and management of pinyon-juniper communities within the intermountain west. USDA Forest Service, RMRS-P-9.

Connelly, J. W., S. T. Knick, M. A. Schroeder and S. J. Stiver. 2004. Conservation assessment of greater sage-grouse and sagebrush habitats. Western Association of Fish and Wildlife Agencies.

Connelly J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines to manage sage-grouse populations and their habitats. Wildlife Society Bulletin 28:967–985.

Cottam, W. P., and G. Stewart. 1940. Plant succession as a result of grazing and of meadow desiccation by erosion since settlement in 1862. Journal of Forestry 38:613-626.

Crawford, J. A., R. A. Olson, N. E. West, J. C. Mosley, M. A. Schroeder, T. D. Whitson, R. F. Miller, M. A. Gregg, and C. S. Boyd. 2004. Ecology and management of sage-grouse and sage-grouse habitat. Journal of Range Management 57:2-19.

Davenport, D. W., D. D. Breshears, B. P. Wilcox, and C. D. Allen. 1998. Viewpoint: Sustainability of pinon-juniper ecosystems - a unifying perspective of soil erosion thresholds. Journal of Range Management 51:231-240.

Davis, J. N and K. T. Harper. 1990. Weedy annuals and establishment of seeded species on a chained juniper-pinyon woodland in central Utah. Proceedings-Symposium on cheatgrass invasion, shrub die-off, and other aspects of shrub biology and management. United States Department of Agriculture, Forest Service, Intermountain Research Station General Technical Report INT-276.

Dealy, J. E. 1975. Ecology of curlleaf mountain-mahogany (*Cercocarpus ledifolius* Nutt.) in eastern Oregon and adjacent areas. Corvallis, OR: Oregon State University. 161p. Thesis.

Deboodt, T. L. 2008. Watershed response to western juniper control. Ph.D. dissertation. Oregon State University.

Evans, R. A., and J. A. Young. 1987. Control, plant succession, and revegetation in western juniper woodlands. p. 301-304. In: Everett, R.L., (ed.). Proc.-Pinyon-juniper conference. USDA Forest Serv. Gen. Tech. Rep. INT-215.

Evans, R.A., and J.A. Young. 1985. Plant succession following control of western juniper with Picloram. Weed Science 33:63-68.

Gedney, D. R, D. L. Azuma, C. L. Bolsinger and. N. McKay. 1999. Western juniper in eastern Oregon. Gen. Tech. Rep. NW-GTR-464. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 53 p.

Great Basin Bird Observatory. 2013. Draft recommendations for avoiding pinyon jay colonies in Nevada in light of widespread pinyon-juniper treatments.

Great Basin Bird Observatory. 2011. Trends and habitat use of pinyon-juniper songbirds and their implications for woodland management.

Gregg, M. A. 2006. Greater sage-grouse reproductive ecology: Linkages among habitat resources, maternal nutrition, and chick survival. Dissertation, Oregon State University, Corvallis, USA.

Hastings, B. K., F. M. Smith and B. Jacobs. 2003. Soil loss from a rapidly eroding pinyon-juniper woodland in Bandelier National Monument, New Mexico: response to slash mulch treatment. J. Environmental Quality 32:1290-1298.

Intermountain Society of American Foresters. 2013. Management of pinyon-juniper woodland ecosystems. A position paper.

Jacobs B. F. and R.G. Gatewood. 1999. Restoration studies in degraded pinyon-juniper woodlands of north-central New Mexico. USDA Forest Service Proceedings. RMRS-P-9.

McDonough, W. T. 1985. Sexual reproduction, seeds and seedlings, in Aspen: Ecology and management in the western United States. General Technical Report RM-119 Fort Collins, CO. USDA Forest Service.

Miller, R. F., and J. A. Rose. 1999. Fire history and western juniper encroachment in sagebrush steppe. Journal of Range Management. 52:550-559.

Miller, R., F and J. A. Rose. 1995. Historic expansion of *Juniperus occidentalis* (western juniper) in southeastern Oregon. Great Basin Naturalist. 55:37-45.

Miller R. F., T. J. Svejcar, and J. R. Rose. 2000. Impacts of western juniper on plant community composition and structure. Journal of Range Management 53:574–585.

Miller, R. F., and R. J. Tausch. 2001. Role of fire in juniper and pinyon woodlands: a descriptive analysis. Tall Timbers Research Station Miscellaneous Publication No. 11:15-30.

Miller, R. F., J. D. Bates, T. J. Svejcar, F. B. Pierson, and L. E. Eddleman. 2007. Managing western juniper: Asking the right questions to select appropriate management actions. Utah State University. Logan, Utah.

Miller, R. F., R. J. Tausch, D. E. McArthur, D. D., Johnson, and S. C. Sanderson. 2008. Age structure and expansion of piñon-juniper woodlands: a regional perspective in the Intermountain West. Forest Service. Rocky Mountain Research Station Paper 69.

Nallion, D., K. Memmott, and S. Monson. 1993. A comparison of understory species at three densities in a pinyon-juniper woodland in: Proceedings; Ecology and management of pinyon-juniper communities within the interior West. Forest Service RMRS-P-9.

National Park Service. 2004. Pygmy rabbits found in the park. The Midden (Great Basin National Park Newsletter) spring 2004.

Owen, S.M., C. H. Sieg, C. A. Gehring, and M. A. Bowker. 2009. Above and belowground responses to tree thinning depend on the treatment of tree debris. Forest Ecology and Management 259: 71-80.

Petersen, S. L., & Stringham, T. K. 2008. Infiltration, runoff, and sediment yield in response to western juniper encroachment in southeast Oregon. Rangeland Ecology & Management, 61:74-81.

Petersen, S. L., T. K. Stringham, and B. Roundy. 2009. A process-based application of state-and-transition models: a case study of western juniper (*Juniperus occidentalis*) encroachment. Rangeland Ecology & Management 62:186–192.

Pierson, F. B., C. J. Williams, S. P. Hardegree, P. E. Clark, P. R. Kormos, and O. Z. Al-Hamdan. 2013. Hydrologic and erosion responses of sagebrush steppe following juniper encroachment, wildfire, and tree-cutting. Rangeland Ecology & Management 66:274-289.

Pierson, F. B., Williams, C. J., Kormos, P. R., and Al-Hamdan, O. Z. 2012. Hydrologic Response of Sagebrush Steppe to Woodland Encroachment and Subsequent Tree Removal: Implications for Assessing Sagebrush Steppe Hydrologic Stability and Resiliency. In: Abstracts of the 65th Annual Meeting of the Society for Range Management. Spokane, WA.

Pierson F. B., C. J. Williams, P. R. Kormos, S. P. Hardegree, P. E., Clark, and B. M. Rau. 2010. Hydrologic vulnerability of sagebrush steppe following pinyon and juniper encroachment. Rangeland Ecology & Management 63:614-629.

Pierson F. B., J. D. Bates, T. J. Svejcar, and S. P. Hardegree. 2007. Runoff and erosion after cutting western juniper. Rangeland Ecology & Management 60:285-292.

Rau, B.M., Tausch, R., Reiner, A., Johnson, D.W., Chambers, J.C. and Blank, R.R. 2012. Developing a model framework for predicting effects of woody expansion and fire on ecosystem carbon and nitrogen in a pinyon-juniper woodland. Journal of Arid Environments 76: 97-104.

Reid, K. D., B. P. Wilcox, D. D. Breshears, and L. MacDonald. 1999. Runoff and erosion in a piyon-juniper woodland: Influence of Vegetation Patches. Soil Science 63:1869-1879.

Reiner, A. L. 2004. Fuel load and understory community changes associated with varying elevation and pinyon-juniper dominance. MS thesis. University of Nevada, Reno.

Rosenstock, S. S., and C. Van Riper. 2001. Breeding bird responses to juniper woodland expansion. Journal of Range Management 54: 226-232.

Schaeffer, R. J., D. J. Thayer and T. S. Burton. 2003. Forty-one years of vegetation change on permanent transects in northeastern California: Implications for Wildlife. Calif. Fish and Game 89:55-71.

Schlesinger, W. H., J. F. Reynolds, G. L. Cunningham, L. F. Huenneke, W. M. Jarrell, R. A. Virginia, and W. G. Whitford, 1990. Biological feedbacks in global desertification. Science 247: 1043-1048.

Tausch, R. J., R. F. Miller, B. A. Roundy, and J. C. Chambers. 2009. Pinyon and juniper field guide: Asking the right questions to select appropriate management actions: U.S. Geological Survey Circular 1335, 96 p.

Tausch, R. J., and N. E. West, 1988. Differential establishment of pinyon and juniper following fire. American Midland Naturalist 119: 74-184.

Tausch, R. J.; N. E. West, A. A. Nabi. 1981. Tree age and dominance patterns in Great Basin pinyon-juniper woodlands. Journal of Range Management 34: 259-264.

Turnbull, L., J. Wainwright, R. E. Brazier, and R. Bol. 2010. Biotic and abiotic changes in ecosystem structure over a shrub-encroachment gradient in the Southwestern USA. Ecosystems 13: 1239-1255.

Vaitkus, M. R., and L. E. Eddleman. 1987. Composition and productivity of a western juniper understory and its response to canopy removal. p. 456-460. In: Everett, R.L., (ed.). Proc.-Pinyon-juniper conference. USDA Forest Serv. Gen. Tech. Rep. INT-215.

Weisberg, P. J., L. Emanuele and R. B. Pillai. 2007. Spatial patterns of pinyon-juniper expansion in central Nevada. Rangeland Ecology & Management 60:115-124.

Weisberg, P. J. and D. Greenwood, 2007. Landscape analysis of tree mortality and pinyon-juniper woodland structure in the Great Basin: a report to BLM.

Weisberg, P.J. and J.M. Bauer. 2006. Fire history and stand structure of a central Nevada pinyon-juniper woodland. Executive summary and final report to the Bureau of Land Management, Nevada State Office.