U.S. Department of the Interior
Bureau of Land Management

Environmental Assessment
DOI-BLM-ID-B030-2013-0009-EA

ARS South Mountain Juniper Research

10/23/2014

U.S. Department of the Interior
Bureau of Land Management
Owyhee Field Office
20 1st Ave. West
Marsing, ID 83639

Environmental Assessment # DOI-BLM-ID-B030-2013-0009-EA
ASR South Mountain Juniper Research

Table of Contents

Environmental Assessment # DOI-BLM-ID-B030-2013-0009-EA
ARS South Mountain Juniper Research

1.0 Introduction

The proposed ARS South Mountain Research Project is a joint effort between the Bureau of Land Management (BLM) Owyhee Field Office, Agricultural Research Service (ARS), and private landowners. The ARS is planning to study hydrological response to juniper treatment in four watersheds of first order intermittent streams in the Juniper Creek drainage in the South Mountain area of western Owyhee County, Idaho.

The ARS has monitored these watersheds since 2007 for weather inputs, streamflow, suspended sediment, snow accumulation and melt, and western juniper distribution. The next step is to evaluate the effects of juniper removal on snow accumulation and melt, stream flow and sedimentation, and vegetation recovery in juniper encroached sagebrush habitat in the four watersheds. The goal is to use landscape scale juniper treatment that mimics natural processes to model and assess hydrologic and vegetative impacts. The data derived from pre- and post-treatment monitoring will be essential to test and validate landscape-scale models developed to predict potential treatment effects on water, vegetation, and soil resources in other systems affected by juniper encroachment. Results of this research and management collaboration can be used in subsequent NEPA analyses and increase efficiency and success of juniper control treatments throughout the Intermountain West.

1.1 Background

Western juniper (*Juniperus occidentalis* var. *occidentalis*) currently dominates over 3.6 million hectares (nearly 9 million acres) of rangeland in the northern Great Basin sagebrush steppe. Although western juniper is a native species (its native range includes parts of California, Washington, Oregon, and Idaho), over 90% of the current distribution represents expansion from pre-settlement habitat (USDA Forest Service 1981; Gedney et al.1999; Miller et al. 1999; Johnson 2005; Miller and Tausch 2001). Western juniper historically inhabited rimrock or shallow, rocky outcrops; however, it has expanded beyond these areas into mountain big sagebrush and other mountain shrub communities. Juniper expansion is categorized into three phases:

- Phase I – tree cover expands, but shrubs and herbaceous plants remain the dominant cover and control on ecological processes;
- Phase II – tree cover increases to 10-50%, shrub and herbaceous cover decline due to resource competition, bare ground area increases, and trees begin influencing key ecological processes;
- Phase III – bare ground is extensive and tree cover stabilizes, is the dominant cover type (> 75% shrub mortality), and exerts the primary control on ecological processes.

The BLM Owyhee Field Office and Boise District have previously established juniper management as a high priority in southwestern Idaho in the Owyhee Resource Management Plan (ORMP) (1999). The 288,000-acre Juniper Mountain Restoration Area in western Owyhee

County is specifically targeted for broad scale restoration of native sagebrush/bunchgrass habitat for multiple resource objectives including restoration of watershed health, improvement of biodiversity, enhancement of wildlife habitat and a sustainable forage base for livestock, and fuels reduction (BLM 1999, 2006).

Sagebrush sites consisting of shrubs, herbaceous vegetation, and litter as described by the ecological site potential are expected to safely capture and store water and protect soil surfaces from erosion. The reference plant community across the proposed study area was chiefly mountain big sagebrush, deep rooted perennial grasses, and perennial forbs with minor amounts of other perennial grasses and mountain shrubs based on soil composition and physical site characteristics (NRCS 2014). However, these vegetation communities are currently in Phase III juniper encroachment; juniper cover is up to 80%, herbaceous cover ranges from 5-20% and shrub cover is 1-12% (Bates et al. 2011).

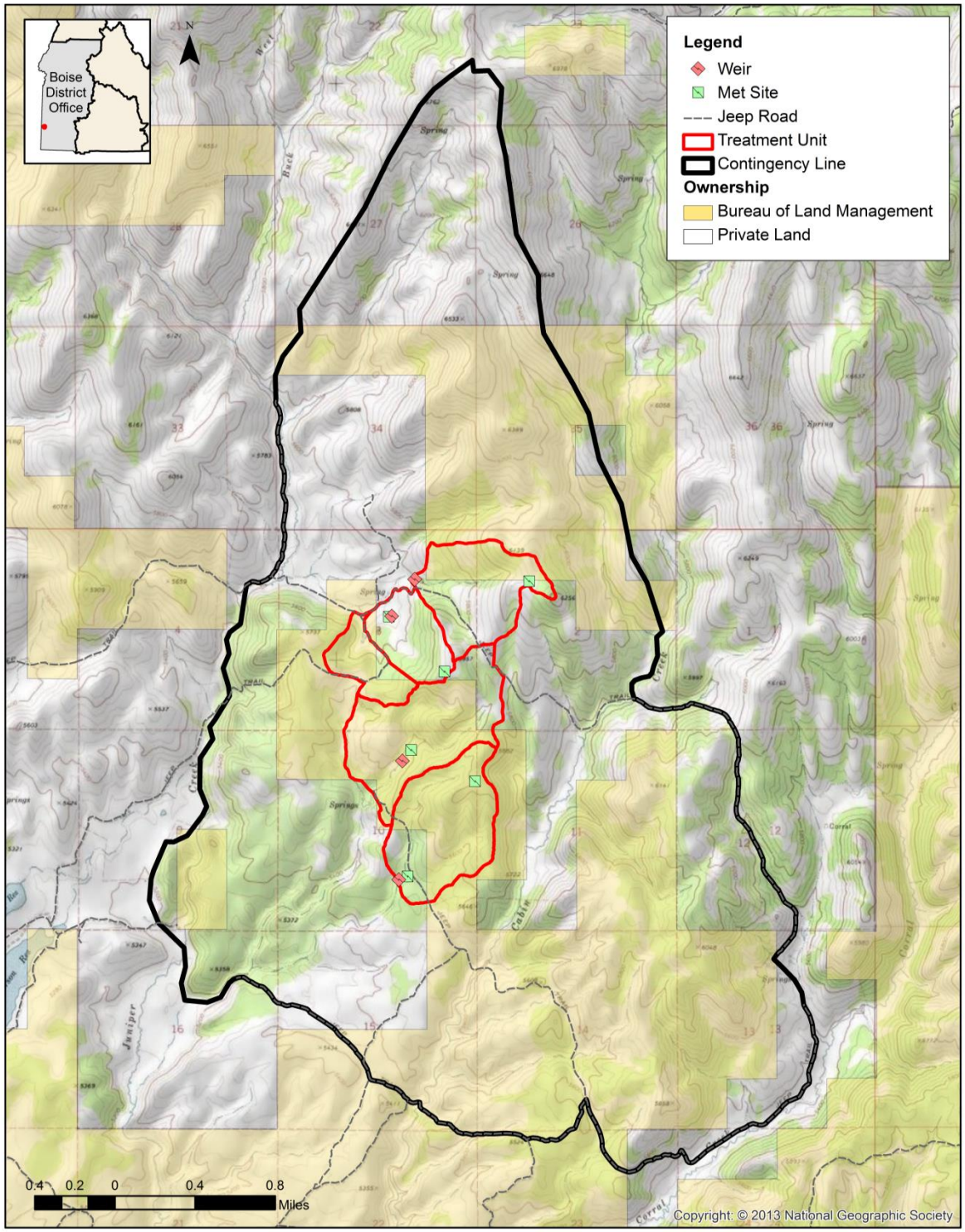
Degradation of understory vegetation and surface soils on juniper-dominated hill slopes promotes rapid runoff generation and amplified downslope soil loss. The shift from intact sagebrush to juniper-dominated, degraded conditions represents a transition from a resource conserving state to one in which long-term soil erosion perpetuates site deterioration. This ecological change is considered difficult to reverse without intensive management action.

Recent research suggests that tree cutting and prescribed-burning of degraded, juniper-dominated rangelands can stimulate understory vegetation recovery, enhanced infiltration, and stabilize surface soils over time (Pierson et al. 2007, 2013; Williams et al. 2013). For example, a study in eastern Oregon found soil erosion from simulated thunderstorms produced 85 times more soil erosion on Phase III juniper woodlands than on well-vegetated sites where junipers had been removed by cutting 10 years earlier (Pierson et al. 2007).

Juniper treatment and sagebrush-steppe recovery could have significant impacts on snow accumulation and redistribution, timing and amount of streamflow, and soil stability and health that can only be evaluated at a watershed scale. While the potential for recovery of grass and shrub habitat with western juniper control is fairly well documented in this region, the hydrologic impacts of western juniper and snow distribution, especially at the landscape scale are less well understood. To understand the potential effects of targeted restoration and to meet resource objectives in this area, watershed level evaluations need to be completed.

The ARS installed instrumentation in four drainages in the Juniper Creek watershed and has been gathering hydrological and meteorological data since 2007 (Map 1). Data collection has included measurements of precipitation, stream flow, and sediment transport. The ARS research would examine the effects to watershed health and sagebrush steppe habitat from removal of encroaching juniper at a landscape scale. See Appendix A, ARS NWRC South Mountain Juniper Research Program, for details.

Map 1 - Project Area



1.2 Need for and Purpose of Action

Currently, the four study basins proposed by ARS are severely encroached by western juniper (Phase III). The purpose of this project is to provide ARS the opportunity to evaluate and model the effects of juniper removal on snow accumulation, snowmelt, and snowdrift, stream flow and sedimentation, and vegetation recovery at the landscape scale. The BLM's goal is to use landscape scale juniper treatment that mimics natural processes, specifically girdling/cutting and prescribed fire to remove 100% of juniper from these watersheds, thereby creating conditions necessary for ARS to conduct this research. This project provides the BLM an opportunity to eliminate Phase III juniper from a small area on South Mountain as well as benefit from ARS's research which will be valuable for future project planning and landscape planning needs.

1.3 Decision to Be Made

The Owyhee Field Manager (Authorized Officer) will decide whether or not BLM will conduct juniper treatments in the South Mountain project area to assist in ARS's research.

1.4 Summary of Proposed Action

The BLM Owyhee Field Office, in partnership with ARS, is proposing to treat juniper on 458 acres of BLM land and 272 acres of private land to study the hydrologic impacts of juniper removal in severely juniper encroached areas. Juniper treatment would include a combination of cutting/girdling and prescribed fire. Treatments would be implemented incrementally over 7-10 years (starting fall 2014) in five treatment units (TU) (Map 1). The contingency area (established roads and strategic terrain features) would be utilized for fire suppression as a protection measure in the unlikely event that prescribed fire escapes a proposed TU (Map 1). Personnel from ARS would implement juniper cutting on private land. The BLM would manage cutting on BLM land and prescribed burning on both BLM and private land.

The research project requires 100% juniper mortality across the four study watersheds with identical treatment throughout the entire study area. The proposed cutting and girdling of juniper would create a fuel bed conducive to uniform consumption of juniper by fire in order to achieve 100% juniper mortality. Treatments would be initiated in one watershed each year during summer and fall seasons. Initiating juniper treatments sequentially in different years allows the development of modeling datasets for pre- and post-treatment, and comparison of individual treated watersheds during the multi-year conversion. The proposed action would be completed in three steps:

1. Cut smaller diameter juniper and girdle larger diameter juniper, allow one year for stressed trees to dry out.
2. Conduct prescribed broadcast burn of the watershed.
3. Cut, limb, and/or remove standing trunks that remain after the prescribed fire.

In accordance with the ORMP, LVST Management Action #7, the treatment area would be rested from grazing for a minimum of two growing seasons. Grazing rest would occur following the prescribed fire through herding, closures, building 0.5 mile of new fence, and relocating 1.0

mile of existing fence as illustrated in Map 3. Objectives to be met prior to resuming grazing are identified in the Proposed Action Section 2.3.2.

1.5 Location and Setting

The study area is approximately 20 miles south of Jordan Valley, Oregon and four miles northeast of Cliffs, Idaho on the Mud Flat Road in western Owyhee County. Elevation ranges from 5400 to 6200 feet above sea level (Map1). Slope ranges from 10-40% with steeper slopes in the North part of the proposed treatment area closer to South Mountain while the Southern proposed treatment area is more rolling terrain. Ridge tops at higher elevations tend to be rockier with more open vegetation of sparse juniper and continuous grass cover while immediately off the ridge dense juniper with some sagebrush and grass understory is present. There are two private cabins near the proposed treatment areas, one each near Treatment Units 1 and 4 (Map 2).

1.6 Conformance with Applicable Land Use Plan

This proposed action is in conformance with the Vegetation, Water Resources, Livestock Grazing Management, and Wildlife Habitat objectives of the Owyhee RMP, 1999. Management actions supporting these objectives are as follows:

- Improve or maintain herbaceous vegetation species to attain composition, density, canopy and ground cover, structure and vigor appropriate for the site. (WATR 1:2, ORMP p.11)
- Implement a juniper abatement plan for appropriate sites on which juniper is invading. (WATR 1:5, ORMP p. 11)
- Implement prescribed burning practices in areas where it is determined that burning would improve rangeland health and increase native plant biodiversity in western juniper and big sagebrush vegetation types. (VEGE 1:3, ORMP p.12)
- Prescribed burning practices will be used in areas where it is determined that burning would improve rangeland health and increase biodiversity in big sagebrush and western juniper vegetation communities. Livestock grazing will be adjusted to ensure successful prescribed burns. Areas prescribed to be burned may require rest prior to burning and will require rest after burning for a minimum of two (2) growing seasons. (LVST 1:7, ORMP p.24)
- Design and implement vegetation treatments to improve habitat where juniper or shrub density is contributing to unsatisfactory habitat conditions. Rest all burns from livestock grazing for a minimum of two (2) growing seasons following treatment. (WDLF 1:5, ORMP p.16)

Currently the majority of the project area is Phase III juniper which means juniper trees are the dominant vegetation with reduced herbaceous component in the vegetation composition. Without significant herbaceous understory soil stability is decreased; thus, erosion and sedimentation of the watersheds increases. Removing juniper would allow for the existing herbaceous vegetation to reestablish and increase native plant biodiversity in sagebrush steppe vegetation types without the need for restoration following the treatments.

1.7 Relationship to Statutes, Regulations, and Other Requirements

Executive Order 13186 expressly requires that Federal agencies evaluate the effects of proposed actions on migratory birds (including eagles) pursuant to NEPA "or other established environmental review process;" restore and enhance the habitat of migratory birds, as practicable; identify where unintentional take reasonably attributable to agency actions is having, or is likely to have, a measurable negative effect on migratory bird populations; and, with respect to those actions so identified, the agency shall develop and use principles, standards, and practices that will lessen the amount of unintentional take, developing any such conservation efforts in cooperation with the Service.

Cultural Resource Laws and Executive Orders

BLM is required to consult with Native American tribes to "help assure (1) that federally recognized tribal governments and Native American individuals, whose traditional uses of public land might be affected by a proposed action, will have sufficient opportunity to contribute to the decision, and (2) that the decision maker will give tribal concerns proper consideration" (USDI BLM 2004). Tribal coordination and consultation responsibilities are implemented under laws and executive orders that are specific to cultural resources which are referred to as "cultural resource authorities," and under regulations that are not specific which are termed "general authorities." Cultural resource authorities include: the National Historic Preservation Act of 1966, as amended (NHPA); the Archaeological Resources Protection Act of 1979 (ARPA); and the Native American Graves Protection and Repatriation Act of 1990, as amended (NAGPRA). General authorities include: the American Indian Religious Freedom Act of 1979 (AIRFA); the National Environmental Policy Act of 1969 (NEPA); the Federal Land Policy and Management Act of 1976 (FLPMA); and Executive Order 13007-Indian Sacred Sites. The proposed action is in compliance with the aforementioned authorities.

Southwest Idaho is the homeland of two culturally and linguistically related tribes: the Northern Shoshone and the Northern Paiute. In the latter half of the 19th century, a reservation was established at Duck Valley on the Nevada/Idaho border west of the Bruneau River. The Shoshone-Paiute Tribes residing on the Duck Valley Reservation today actively practice their culture and retain aboriginal rights and/or interests in this area. The Shoshone-Paiute Tribes assert aboriginal rights to their traditional homelands as their treaties with the United States, the Boise Valley Treaty of 1864 and the Bruneau Valley Treaty of 1866, which would have extinguished aboriginal title to the lands now federally administered, were never ratified.

Other tribes that have ties to southwest Idaho include the Bannock Tribe and the Nez Perce Tribe. Southeast Idaho is the homeland of the Northern Shoshone Tribe and the Bannock Tribe. In 1867 a reservation was established at Fort Hall in southeastern Idaho. The Fort Bridger Treaty of 1868 applies to BLM's relationship with the Shoshone-Bannock Tribes. The northern part of the BLM's Boise District was also inhabited by the Nez Perce Tribe. The Nez Perce signed treaties in 1855, 1863 and 1868. BLM considers off-reservation treaty-reserved fishing, hunting, gathering, and similar rights of access and resource use on the public lands it administers for all tribes that may be affected by a proposed action.

1.8 Scoping and Development of Issues

On February 8, 2013 a meeting was held with ARS to discuss their research and the objectives of the project. On March 21, 2013 a meeting was held in Jordan Valley to discuss the project objectives with the county commissioner, private land owners from the project area, ARS representatives from Boise, ID and Burns, OR, the Owyhee BLM Field Office Assistant Manager, the Boise BLM District Manager, the Boise BLM Fire Management Officer, as well as Boise BLM Fuels representatives. The Scoping Document for this EA #DOI-BLM-ID-B030-2013-0009-EA, "ARS South Mountain Juniper Research", was sent out to interested parties and posted on the NEPA register on April 15, 2013 for a 30 day comment period ending May 15, 2013.

Two separate interested parties responded. One was a resident of Jordan Valley, Oregon whose comments were in favor of the proposal to remove juniper from the project area. The other was a resident of Boise, ID who suggested studying and gathering data of the effects of natural (lightning caused) fires on the environment. This suggested alternative was considered and is discussed below.

On May 21, 2013 a site tour of the project area included ARS personnel, representatives from the Owyhee Field Office (including the Assistant Field Office Manager, Supervisory Rangeland Management Specialist, and Rangeland Management Specialist), Owyhee County Commissioner, one of the three affected land owners, Boise BLM NEPA Specialist, as well as Boise BLM Fuels Fire Management Officer and Fuels Specialist. This site tour generated productive discussions regarding the proposed action and potential issues by interested parties which are addressed in this EA.

2.0 Description of the Alternatives

2.1 Alternative Development Process

Since this proposal is for a research project with a specific prescription of 100% juniper mortality in order to study how rain and snow accumulates and flows out of each basin including sedimentation, the range of alternatives is limited to either treating the juniper to meet the research objectives or not implementing treatments. There are different approaches to treating juniper encroachment for habitat and shrubland restoration. Some of these methods are considered below but fell short of meeting the scope of the project.

2.2 Alternatives Considered But Not Analyzed in Detail

Through the scoping process there were three alternatives proposed which were not analyzed in this EA. The following is the rationale for why these alternatives are not analyzed in detail.

One alternative considered was mechanical treatment such as mastication. This did not fit within the scope of the research because of topography and ground disturbance created by heavy machinery within the watersheds would affect the soil erosion and sedimentation aspects of the study.

Another alternative considered was hand cutting and leaving the trees without implementing a prescribed fire. This would not meet the objectives of the study because the juniper left on the ground would impact the snowpack and snowdrift in the watersheds. Recent studies by Bates and Svejcar (2006) found that in dense juniper areas unburned debris tended to smother perennial forbs and most perennial grasses, and reduced their establishment due to decreased light levels. They also found that perennial grass density and cover increased faster under burned debris than unburned debris.

The third alternative considered was to study the effects of natural (lightning caused) fires on the environment. This would not fit the scope of the research project because natural fire may not occur within the bounds of the study area. Any lighting fires outside of the study area would not work either because ARS would not have hydrological and meteorological monitoring equipment established at the location of the fire. The purpose of the proposed cutting and girdling of the juniper is to create a fuel bed that is conducive to uniform consumption of juniper in order to achieve 100% juniper mortality required by the study. Without a significant wind event, natural fire does not behave in Phase II or III juniper in a way that would eliminate 100% of the trees in a watershed because there is little understory comprised of the herbaceous fine fuels that are the primary carrier of fire. The resulting natural fire would be a patchwork of partially burned and unburned juniper trees creating a mosaic throughout the watershed. If there is a natural fire within the study area the BLM will manage the fire in an effort to meet the objectives of the ARS study. Furthermore, the BLM's Emergency Stabilization and Rehabilitation (ESR) program implements monitoring and data gathering of natural fires where there is an ESR plan in place.

2.3 Description of the Alternatives

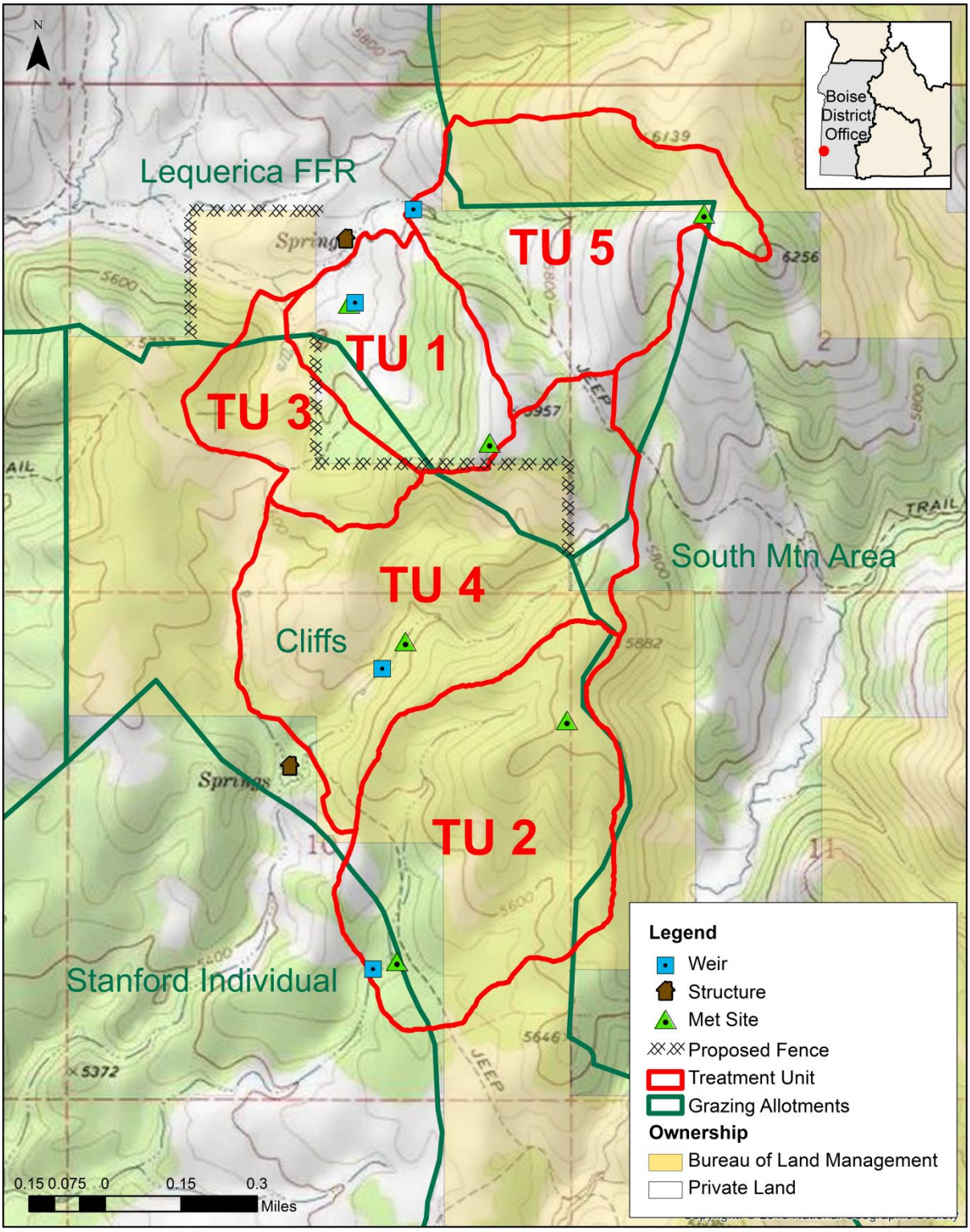
2.3.1 Alternative A – No Action (Continue Present Management)

No juniper treatments would occur and the proposed research would not take place on BLM land as a result. The proposed ARS study could potentially continue on private land located within the four watersheds; however, research conducted on that small a scale (private land only versus watershed wide) would be insufficient to produce meaningful data and would not meet the research objectives.

2.3.2 Alternative B – Proposed Action (Juniper Treatment)

The study area is divided into 5 Treatment Units (TU) encompassing four basins in the Juniper Creek watershed and one treatment unit (TU3) adjacent to the study basin boundaries that may have an impact on snow drift accumulation inside the study area (Map 2). Treatment Unit 3 is an area of dense trees comprised primarily of Phase III juniper.

Map 2 - Proposed Fenceline and Treatment Units



Identical juniper treatments are proposed for all four basins and TU3 for a total of five treatment units. Implementation of the treatment would require 2 to 3 years in each treatment unit. Juniper treatments would be initiated one treatment unit each year, successively over 7 to 10 years. The sequence in which each treatment unit is initiated would be staggered to minimize the possibility of burning one unit adjacent to a unit that was recently cut and could be receptive to spot fires.

Site preparation of each treatment unit would be identical. Because of the lack of continuous ground fuels or herbaceous and shrub understory throughout the project area, unit preparation consists of cutting and girdling juniper stands within the respective treatment areas. The combination of cutting and girdling provides a fuel layer that is receptive to ignition, can carry fire into tree crowns, and generally limits (controls) where prescribed fire will burn in more dense stands of junipers. Cutting consists of felling trees 6 inches in diameter at breast height (DBH). Trees greater than 6 inches DBH would be girdled which consists of limbing trees to shoulder height and girdling around the bowl of the tree to sever the cambium. Girdling prevents the need for felling the larger trees, thereby reducing ground fuel loading to a treated area, and resulting in less soil heating when the slash is burned. Girdling is also less visually intrusive than felling as girdled trees look as though they were naturally killed by fire, drought, or beetles.

Once treatment units are cut and girdled, units will be allowed to dry for a period of time (generally 5-12 months depending on weather) to ensure fuels are dry enough to carry fire. Prescribed burning would be carried out in spring (April to June) or early fall (September to October) with the option of black lining the unit prior to the prescribed broadcast burn. Black lining entails burning a buffer within the unit along the control line. The purpose of a black line is to reduce fuels through burning so that the main prescribed fire does not burn as intensely along the control lines, thus creating more favorable holding conditions for fire crews. See Broadcast Burning Standard Operating Procedures below.

Due to the mosaic nature of fire not all juniper trees within the units would be killed during the burning process and any live trees remaining would have to be girdled or felled to ensure 100% mortality. In the years following the prescribed burn there may be a need to limb or remove standing juniper trunks remaining after the burn which have the potential to impact the snow distribution within the watershed thus affecting the results of ARS's research.

Standard Operating Procedures (SOPs) for ARS South Mountain Juniper Treatments

Hand Cutting and Girdling Treatments

- Pre-burn juniper felling, cutting branches or girdling would be used to increase surface fuels where needed to carry fire.
- Undercarriages of ATVs/UTVs would be cleaned before entering the treatment units to reduce the introduction of noxious weed seed.
- Pickups and larger vehicles associated with cutting treatments as well as support vehicles would be restricted to established roads and trails.
- Trees would be cut to a stump height of eight inches or less.
- No live branches would remain on the stump after the juniper tree is cut.
- Cutting crew camp locations would be pre-approved by the Authorized Officer.

- Any new raptor nests discovered during treatment activities would be reported within 24 hours by phone or email to the Owyhee Field Office Wildlife Biologist. Protection of these nest sites will be handled on a case-by-case basis and decision to proceed will be made by the Authorized Officer.
- Maintenance activities consisting of hand cutting young juniper that come in after the initial cutting, girdling, and/or broadcast burning treatments may occur.
- Identified National Register of Historic Places (NRHP) eligible archaeological sites found within the cutting areas will be treated in a manner that does not adversely affect their NRHP eligibility characteristics. Acceptable treatment options within archeological sites will be made in consultation with the Idaho SHPO and approved by the Authorized Officer.

Broadcast Burning

- To minimize heat and smoke exposure to fire holding crews, existing natural and human made fire breaks would be used where possible. While minimizing ground disturbance that would result from establishing new control lines, there may be situations that require the use of dozer or hand line for portions of the control lines. These sections would be limited to locations away from the weirs so as to not impact the sedimentation and hydrological aspects of the ARS research.
- On short portions of existing roads, dozers or graders may be needed to clean out vegetation which could compromise the roads usefulness as firelines, and to improve small portions of these roads which may be inaccessible to vehicles associated with burning efforts. No widespread road grading is anticipated nor is the use of this equipment outside of existing roads.
- Pretreatment by fire crews would involve appropriate measures to protect the four weirs located at the bottom of each watershed, the six remote weather stations that are located throughout the entire project area, and the two private cabins located in close proximity to the control lines of TU1 and TU4 to prevent damage to these sites (see Map 2). Specific resources needing additional protection are addressed in their respective sections.
- Fire engines, dozers, support vehicles, and ATV/UTVs would be used to contain the fire within control lines. Travel would be restricted to existing trails when possible, but may require some off-road travel.
- In accordance with BLM prescribed fire policy, a contingency area is proposed outside the burn perimeters to act as a buffer should a fire burn outside the perimeters (see Map 1). If this happens, the fire would be suppressed in the contingency area and burning operations could then continue in the treatment area.
- The undercarriage of all vehicles involved in the prescribed burn would be cleaned before traveling to the project area to reduce the introduction of noxious weed seed. Additionally, increased weed treatments would occur on known sites within broadcast burn areas.
- Burning would be conducted in accordance with the Idaho-Montana Airshed Group guidelines. Permission from the Airshed group is required prior to ignition to ensure local air quality standards would be met.
- NRHP eligible archeological sites with combustible features would be protected during the deployment of prescribed fire by reducing vegetation within and around the sites,

black-lining resources and use of appropriate ignition techniques. Fire engines, dozers, support vehicles and UTVs/ATVs will not be allowed to drive on or through any site unless it is on an existing road. The Fuels Archaeologist will review burn plans prior to project implementation.

Wildlife

- New fences would be marked in accordance with current specifications identified in IM No. ID-100-2011-001 (USDI BLM 2011) and guidelines specified in BLM IM 2012-043 (USDI BLM 2012) to reduce collisions by sage-grouse and impacts to other wildlife species.
- Pretreatment fire crews would consult the Owyhee Field Office Wildlife Biologist to determine appropriate measures in order to prevent disruptive activities to raptor nests. The BLM field office manager can grant an exception to seasonal restrictions in cases where the nest has been destroyed (e.g., by wind, lightning, wildfire), is currently inactive, based on raptor species and variations in nesting chronology, topographic features (e.g., intervening ridge between treatment activities and nest), or other factors that are biologically reasonable. For instance, because nesting raptors may be shielded from disturbance by vegetation and/or topographic features, buffer areas may be individually developed and modified based on 3D analytical methods and/or landscape features (e.g., viewshed analysis, physiographic barriers such as cliffs and canyons).
- Broadcast burning would not be conducted within BLM-stipulated buffer zones of active raptor nests during the breeding season unless adjustment of the buffer is applicable based on a biologically reasonable exception as identified in the pretreatment SOP above. Buffer zones would be dependent on species, seasonal timing restrictions, and nest site activity status (See Table 1– Raptor Timing and Buffer Stipulations below).

Table 1. Raptor Timing and Buffer Stipulations

Species	Timing[1]	Breeding Season Nest Site Buffer (miles)[2]
Bald Eagle	Feb 1 – July 31	0.5 – 1.0
Peregrine Falcon	Feb 1 – July 31	1.0
Feruginous Hawk	Feb 1 – July 31	1.0
Golden Eagle	Feb 1 – July 31	0.5
Northern Goshawk	Feb 1 – July 31	0.5
Prairie Falcon	Feb 1 – July 31	0.5
Red-tailed Hawk	Feb 1 – July 31	0.33
Swainson's Hawk	Feb 1 – July 31	0.25
Burrowing Owl	Feb 1 – July 31	0.25

[1]Indicates timeframes for prohibiting broadcast/blackline burning and hand cutting/girdling around nest sites with active breeding attempts or until dispersal of young.

- Any new raptor nest discovered during treatment activities would be reported within 24 hours by phone or email to the Owyhee Field Office Wildlife Biologist. Protection of these nest sites will be handled on a case-by-case basis.
- Spring burning (black lining) would be implemented prior to nesting of migratory birds, which would be determined by a wildlife biologist.

Range Projects (Fences)

Any new fences located on BLM land would conform to the specifications for standard livestock fences in deer/elk/pronghorn habitat, in accordance with the ORMP and Boise District Office fence specifications and fence marking guidelines (USDI BLM 2011). Techniques to minimize disturbance during and as a result of construction would be employed as practicable. Fence construction is anticipated to be a partnership between the BLM, ARS, and permittees.

The following fences would be constructed (Map 3):

- Lequerica FFR 1 – Roughly 0.5 miles of new, permanent fence surrounding BLM lands within the Lequerica FFR allotment would be constructed (fencing the BLM land from the private land). Portions of the BLM lands within this area are part of TUs 1 and 3. This fence would allow for two years rest from grazing following the implementation of the prescribed fire.
- Lower Cliffs Field 1/Lequerica FFR 2 – About one mile of fence where the northern boundary of BLM land in Lower Cliffs Field 1 is adjacent to the private land in Lequerica FFR 2 would be relocated. Currently, the existing fence separating these two pastures/allotments follows terrain features, not the BLM and private boundary. This section of fence would be removed and permanently relocated to the BLM/private boundary and re-built with new materials to BLM specifications outlined above.

Livestock Grazing

Approximately 458 acres of BLM land would be burned affecting three grazing allotments (Map 2). The Owyhee RMP requires rest from livestock grazing on BLM land following the prescribed fire for a minimum of two growing seasons, or longer, dependent on vegetation recovery. Rest would be accomplished by permittees herding livestock away from the burned pastures, building permanent fence (see Range Projects above), or a combination of both practices. Due to the small amount of BLM land to be treated within each allotment, along with limited to no use by livestock currently, AUM reductions would not be made. Further, an increase in AUMs would not be authorized following the removal of juniper. Refer to section 3.3 Livestock Grazing for more detail.

Before grazing resumes on BLM land in the three allotments, the following objectives must be met:

- Foliar cover of perennial grasses, excluding Sandberg bluegrass *(Poa secunda)*, shall meet or exceed 10%.
- Desirable perennial grasses (e.g., bluebunch wheatgrass) shall be a minimum of 4-inches tall, on average.

- Qualitative assessments of the following factors to evaluate readiness for grazing resumption:
    - Perennial plant vigor
    - Perennial plant seed production
    - Precipitation during the non-growing (winter) and growing (spring through early summer) seasons has provided sufficient soil ground moisture to allow for natural regrowth of desirable plants
    - Erosion potential

Once BLM monitoring data indicate vegetation recovery objectives have been met, grazing would resume at full active use levels. If objectives have not been met after two growing seasons, the reasons for failure to obtain objectives would be identified by a BLM interdisciplinary (ID) team. Depending on the ID team's findings, the temporary livestock grazing closure may be extended. However, if the ID team determines livestock grazing would not hinder future achievement of vegetation objectives, or that objectives are unattainable, the Field Office Manager may authorize livestock grazing resumption at full active use levels in accordance with the grazing permit. Factors to be considered in this evaluation include: 1) amount of total precipitation, 2) amount of growing season precipitation, 3) how close are the burned areas to meeting vegetation recovery criteria at the end of the first and second growing seasons, and 4) what benefits, if any, an additional growing season of rest might provide.

3.0 Affected Environment and Environmental Consequences

3.1 Vegetation and special status plants

3.1.1 Affected Environment – Vegetation and special status plants

Vegetation

There are currently three main original plant communities in the project area which have been severely suppressed by juniper encroachment (Bates et al. 2011);

- Mountain-big sagebrush/bitterbrush/Idaho fescue.
- Mountain big sagebrush-mountain snowberry /Columbia needlegrass /Idaho fescue.
- Mountain big sagebrush/Letterman's needlegrass /bluebunch wheatgrass plant communities.

These plant communities are representative of plant associations found between 5,000 and 6,000 feet elevation in southwestern Idaho and are consistent with the Loamy 13-16 ecological site description (NRCS 2014), but are currently severely suppressed by Phase III juniper encroachment (i.e., have been converted to western juniper woodlands). Phase III juniper encroachment is characterized by extensive bare ground, where western juniper is the dominant cover type (> 75% shrub mortality), and largely controls ecological processes.

According to Bates et al. 2011, current herbaceous cover ranges from 5-20% and shrub cover is only 1-12%. Juniper cover and density varies according to site potential. Juniper cover ranges from 30-80% (53 $\pm$ 16 %) and densities of trees taller than 2 m ranges from 60 to 340 trees per acre (163 $\pm$ 9 trees/ac). Trees less than 2 m tall average 130 $\pm$ 17 trees per acre (Bates et al.

2011). Tree density of this degree is consistent with Phase III juniper encroachment.

Shrubs, herbaceous vegetation, and litter cover on intact sagebrush sites safely capture and store water and protect surface soils from erosion (Pierson et al. 2007, 2013; Williams et al. 2013, Pierson et al. 1994). However, degradation of understory vegetation and surface soils on juniper-dominated hillsides promotes rapid runoff generation and amplified downslope soil loss (Petersen and Stringham 2008; Pierson et al. 2007, 2010; Williams et al. 2013). The shift from intact sagebrush to juniper-dominated, degraded conditions represents a transition from a resource conserving state to one in which long-term soil erosion perpetuates site deterioration.

This ecological change is considered difficult to reverse without intensive management action (Miller et al. 2005; Pierson et al. 2007; Briske et al. 2008; Petersen et al. 2009; Pierson et al. 2010; Williams et al. 2013). Juniper dominance also can lengthen the natural fire cycle, but when fires do occur, they tend to be relatively hot crown fires that cause additional soil degradation and loss of native grass and shrub seeds for natural recovery (Miller and Rose 1995; 1999; Bates et al. 2000; Miller et al. 2000).

Special Status Plants

The BLM conducted a survey for special status plants on June 11-12, 2013. No special status species or their habitat was found within the proposed project boundary. Non-native grass and forb occurrence was rare and limited to disturbance areas.

3.1.2 Environmental Consequences – Vegetation and Special Status Plants

3.1.2.1 Alternative A – No Treatment

Current conditions within the project area (Phase III juniper cover with suppression of shrub and grass species) would continue without treatment. Low levels of ground cover by herbaceous vegetation and high levels of bare ground would persist leaving the study area vulnerable to erosion and decreased site productivity for future plant communities. Continued long-term juniper dominance would result in further degradation of site conditions; the area would be unable to support historical native plant communities, even if restoration efforts are made. Research to determine vegetation response to removal of juniper in Phase III encroachment would not occur, and the benefits of modelling treatments in these systems to better inform future management decisions would not be achieved.

3.1.2.2 Alternative B – Proposed Action

Burkhardt and Tisdale (1969) research conducted in west central Owyhee County, Idaho occurred in vegetation representative of the ARS South Mountain project area. Bates and Miller, 1998, Bates et al., 2000, and Bates et al., 2005 studies took place in the Steen Mountains in Southeast Oregon in vegetative communities with juniper cover of 228 juniper trees per acre, which is within the range of juniper cover at the South Mountain project site. Sagebrush-steppe vegetation communities recovered naturally following juniper treatments with a pretreatment density of only 2-3 perennial bunchgrasses per square meter (Bates et al., 2005). In the proposed treatment area, shrub herbaceous and bunchgrass understory is present, indicative of early Phase III degradation, and sufficient for natural recovery.

The Bates 2011 study site, located within half a mile of the proposed treatment area, showed significant natural vegetation recovery following cutting and prescribed fire.

Studies of large-scale juniper control in eastern Oregon and southwestern Idaho have shown relatively rapid shrub-steppe vegetation recovery two to three years after juniper cutting with or without prescribed fire (Burkhardt and Tisdale, 1969; Bates and Miller, 1998; Bates et al., 2000; Miller et al., 2000; Bates et al., 2005). Partial juniper cutting has been successful in this region for minimizing mechanical treatments necessary to create a surface fuel layer that can carry prescribed fire during relatively mild fire-weather conditions in early fall (Bates et al. 2011). Juniper cutting and prescribed-fire treatments at this relatively early stage of soil degradation would allow for natural vegetation recovery with minimal additional soil disturbance from more extensive mechanical treatments (mastication, 100% tree cutting) and rangeland seeding applications (drill seeding, cultivation). Based on previous research, and given current soil conditions, original plant communities would likely recover without the need for reseeding following juniper treatment (Bates et al. 2000, 2005).

Direct effects to vegetation by the proposed 1.5-miles of fence (1 mile of existing fence to be relocated and 0.5 mile of new fence) would be localized and consist of small disturbance areas. This localized disturbance may displace some desirable vegetation, but areas conducive for weed invasion would be small. The primary disturbance would be within approximately 15 feet to either side of the fence; a total of 5.5 acres would be affected, or less than 1% of the total treatment area. Indirect effects from fence construction would be minor, consisting of an alteration of trailing patterns due to the new fence. Post burn vegetation recovery would benefit from pasture rest and herding. No special status plants were found in the project area so proposed fence will not impact any special status plants or their potential habitat.

The South Mountain area has low potential for sagebrush conversion to cheatgrass based on elevation, precipitation, and site conditions (USDI-BLM 2010). Measures to minimize the potential spread of non-native species and noxious weeds would be employed and are identified in the Standard Operating Procedures in section 2.3.2.

The understanding of juniper woodland development and its impacts to hydrological and ecosystem function and vegetation response to treatment would provide important information benefitting future management and restoration of sagebrush steppe habitat.

3.2 Watershed, Soils, and Water Quality

3.2.1 Affected Environment – Watershed, Soils, and Water Quality

The current status of the study area consists of Great Basin shrublands that have been converted to juniper woodland (Phase III). Productive shrubs, herbaceous vegetation, and litter cover on well-vegetated and intact sagebrush sites intercept and store rainfall, promote infiltration, stabilize surface soils, and attenuate the downslope movement of water and sediment (Blackburn 1975; Pierson et al. 1994). Native sagebrush/bunchgrass plant communities in the elevation range typical of this treatment area produce very little surface erosion even under historically infrequent conditions of extreme rainfall intensity (Pierson et al. 2007, 1994, 2008, 2009).

Encroachment of sagebrush communities by juniper commonly alters plant community structure such that runoff and erosion propagate long-term losses of soil resources (Petersen et al. 2009). Juniper encroachment, once initiated, is sustained by high infiltration rates, enhanced soil water storage, and entrapment of nutrient rich soils underneath and/or adjacent to tree canopies (Miller et al. 2005; Pierson et al. 2010, 2013; Williams et al. 2013). Coarsening of the plant community structure with escalating tree dominance enhances fine-scale (0-2 m^2) runoff and erosion by rainsplash and sheetflow (splash-sheet) processes in interspaces between trees and shrubs (Petersen and Stringham 2008; Pierson et al. 2007, 2010; Williams et al. 2013; Pierson et al. In review).

Runoff generated in bare interspaces promotes concentrated flow at the patch scale (10-40 m^2) and amplifies downslope sediment transport (Pierson et al. 2010, 2013; Williams et al. 2013). Water and soil losses at the patch scale further inhibit herbaceous productivity and propagate bare ground connectivity (Davenport et al. 1998; Miller et al. 2005; Petersen et al. 2009). Wind and water erosion proliferate with increasing bare ground over broader scales, potentially irreversibly degrading a site beyond a resource conservation threshold. This soil loss or erosion feedback is common in the later succession stages (mid-Phase II to Phase III) of woodland encroachment and is generally considered irreversible without intensive and expensive management action (Miller et al. 2005; Pierson et al. 2007; Briske et al. 2008; Petersen et al. 2009; Pierson et al. 2010; Williams et al. 2013). Long-term soil loss from sagebrush steppe is a paramount concern for ecosystem health in the Great Basin (Miller et al. 2011) and has negative ramifications on flora, sagebrush obligate fauna, and local economies reliant on rangeland ecosystem goods and services (Knick et al. 2003; Aldrich et al. 2005; Miller et al. 2005; Davies et al. 2011).

3.2.2 Environmental Consequences - Watershed, Soils, and Water Quality

3.2.2.1 Alternative A – No treatment

Phase III juniper encroachment (juniper woodland) would persist causing excessive additional runoff and erosion that would reinforce juniper dominance, decrease sagebrush steppe resilience, and make it more difficult to achieve restoration objectives in the future (Briske et al. 2006, 2008; Petersen et al. 2009). Juniper encroachment would eventually lead to irreversible landscape-scale degradation (Davenport et al. 1998; Miller et al. 2005; Petersen et al. 2009). Research to determine watershed and soil response to removal of juniper in Phase III encroachment would not occur, and the benefits of modelling treatments in these systems to better inform future landscape management decisions would not be achieved.

For sagebrush-woodland conversions in the Great Basin, an ecohydrologic threshold exists separating the two stable states. The sagebrush-to-woodland threshold would be crossed where runoff and erosion processes degrade soils to the point where they no longer support recruitment of desirable plant species (Pierson et al. 1994; Briske et al. 2008). This functional shift is thought to occur along the succession gradient between Phase II and Phase III woodlands after which understory cover declines below a structural threshold due to resource competition with trees (Johnson and Miller 2006; Miller et al. 2008). Previous work by Pierson et al. (2007) has shown that Phase III juniper systems of similar age in eastern Oregon still have the capacity to recover with mechanical treatment and prescribed fire. The likelihood of reestablishment of a sagebrush steppe functional state depends on the time spent in the woodland phase and presence

of residual plant species, seeds, and the degree of soil degradation (Briske et al. 2006; Petersen et al. 2009). Eventually, these systems would degrade to the point that they could not recover even with major restorative intervention.

3.2.2.2 Alternative B – Proposed Action

Recent research has shown that juniper removal by burning, cutting, and/or mastication improves infiltration and soil retention on woodland-encroached sites (Pierson et al. 2007, 2013; Williams et al. 2013). Pierson et al. (2013) and Williams et al. (2013) found runoff and erosion from areas under juniper canopies were increased 4-fold and 20-fold, respectively, the first year following burning and that erosion from intercanopy areas was increased 2-fold one year after fire. However, juniper treatment enhanced intercanopy herbaceous vegetation by the second year post-treatment and the subsequent improvement in infiltration reduced the soil loss rate more than 10-fold. However, Pierson et al. (2007) found tree cutting increased intercanopy herbaceous cover within 10-years and that the enhanced intercanopy vegetation and ground cover resulted in negligible intercanopy runoff and erosion from simulated high intensity rainfall. In contrast, the bare intercanopy in un-cut woodlands yielded high rates of soil loss from simulated rainfall (Pierson et al. 2007).

The purpose of this action is, specifically, to determine the effects of the removal of juniper from watersheds in this area according to the research ARS has been completing. Expectations from partial juniper cutting, followed by prescribed fire are increased soil cover by herbaceous and shrub vegetation in the first few years, and long-term improvement in infiltration and reduced soil erosion. Such is expected to improve, over the long term, the overall condition of the watersheds.

Effects from the proposed fence line would occur as a small, localized disturbance (1.5 miles in730 acres of treatment). This short-term, small area disturbance would result from fence construction and minor changes in livestock trailing, causing some soil compaction and potential weed invasion due to vegetation disturbance. Pasture rest and herding following burn activities would reduce soil erosion until shrub and herbaceous vegetation establish and stabilize soils.

The understanding of juniper woodland development and its impacts to hydrological and ecosystem function would likely provide important information that would benefit future watershed and soil management and lead to better management of sagebrush steppe habitat.

3.3 Livestock Grazing Management

3.3.1 Affected Environment – Livestock Grazing Management

The proposed study area encompasses portions of the Cliffs allotment, Lequerica FFR, and the South Mountain Area allotments (Table 2; Map 2 – Allotment Boundaries; Map 3 – Pasture Boundaries).

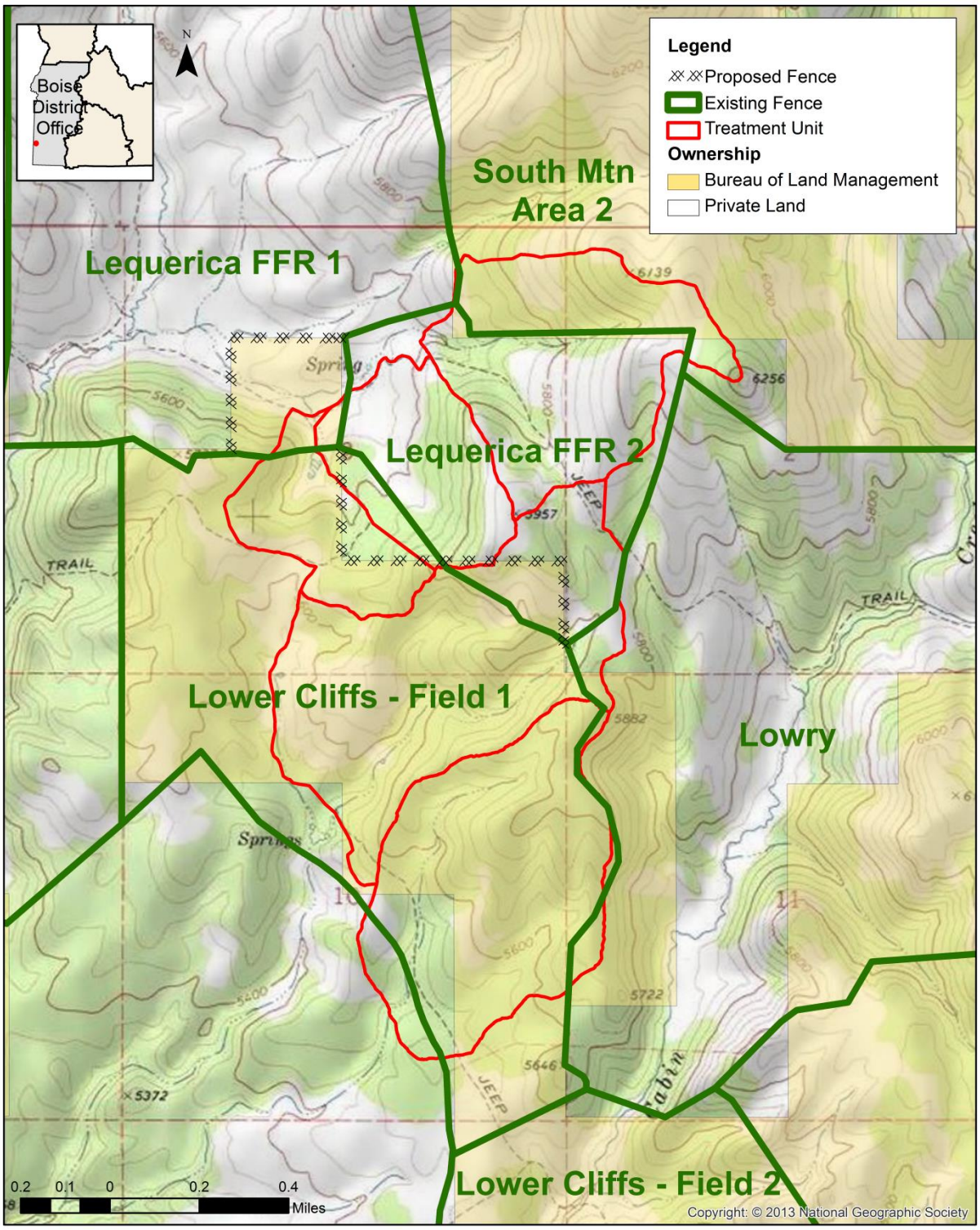
Table 2. Allotments, Pastures, Acres, and AUMs

Allotment	Affected Pastures	Pasture Acres	Total Pasture Acres	AUMs[1]	Total Allotment Acres
Cliffs	Lower Cliffs-Field 1[2] Lower Cliffs-Field 2	637 9,088	9,725	742	21,866
Lequerica FFR	Lequerica FFR 1 Lequerica FFR 2	715 247	962	11	962
South Mountain Area	S. Mtn Area 2 Lowry	8,294 830	9,124	745	17,327

[1]AUM – animal unit month; AUMs presented pertain to affected pastures only.
[2]Only Lower Cliffs – Field 1 would be affected by prescribed burn treatment; however, both are presented here because they are used concurrently by livestock and AUMs reflect Total Pasture Acres.

The Cliffs allotment is split into three pastures (Cherry Creek, Lower Cliffs, and Upper Cliffs) and is grazed by three operators from 4/1-7/15. The project is proposed in the Lower Cliffs pasture which is grazed from 6/1-7/15 and authorized 742 AUMs. The Lequerica FFR allotment is authorized 11 AUMs of grazing from 12/1 – 12/31, but includes a term and condition that the number of livestock and season of use is at the operator's discretion providing no negative impacts to rangelands occur. The South Mountain Area allotment is grazed from 6/1-9/30 with 745 AUMs by four operators. The grazing permit for the Cliffs allotment was renewed in 2000 and the grazing permits for the South Mountain Area and Lequerica FFR allotments were renewed in 2013.

Map 3 - Pasture Boundaries and Proposed Fenceline



3.3.2 Environmental Consequences – Livestock Grazing Management

3.3.2.1 Alternative A – No Treatment

Alterative A would not authorize the treatment of juniper and hydrologic research. There would be no impact to livestock use or AUMs in the short term (< 2 years) because livestock use would not be altered. In the long term (> 10 years) the continued spread of juniper could result in a decrease in water and forage for livestock. However, due to the small acreage of BLM land within the affected allotments the additional loss of forage and water would be minor since juniper density is already high in these allotments.

3.3.2.2 Alternative B – Proposed Action

A total of 458 acres of BLM land in three grazing allotments would undergo a series of prescribed burning to treat Phase III juniper as part of a watershed-level study conducted by ARS. All burned BLM acres would be closed to livestock grazing for a minimum of two growing seasons, or until the suite of grazing resumption objectives have been met (see 2.3.2 Proposed Action - Standard Operating Procedures - Livestock Grazing).

Four burn treatments would occur in the Cliffs Allotment (Lower Cliffs – Field 1) and would affect approximately 365 acres of BLM land (<4%) of the 9,725-acre Lower Cliffs pasture (Table 3). The BLM land in the Lower Cliffs pasture that would be affected by the fire (Field 1) is fenced separately from the rest of this pasture. Because this is a multi-year project with multiple phases, Lower Cliffs – Field 1 would be rested from livestock use for a minimum of two growing seasons after the last treatment. The BLM may require rest from livestock use in the burned areas longer depending on vegetation recovery.

In the Lequerica FFR Allotment, approximately 30 acres of BLM land (3%) would be burned over three treatments within the 962-acre allotment (Table 4). In order to exclude livestock from the burned area on BLM lands, 0.5 mile of new fence would be constructed on the private/BLM land boundary in Lequerica FFR 1 (Map 3). Additionally, an existing portion (1 mile) of boundary fence between Lequerica FFR 2 and the Lower Cliffs – Field 1 would be moved to the proper boundary location (Map 3; 2.3.2 Proposed Action – Standard Operating Procedures – Range Projects). This is a multi-year project with multiple phases; therefore, all fencing would be permanent. The livestock operator would rest these portions of BLM lands for a minimum of two growing seasons after the last treatment. The BLM may extend the livestock grazing closure depending on vegetation recovery.

Three treatments in the South Mountain Area allotment would affect approximately 63 acres (<1%) of BLM land in the 9,124 acres of South Mountain Area 2 and Lowry pastures (Table 5). Because no fence is proposed, a survey to determine livestock use was completed in 2013. During the survey little to no livestock use was observed in the BLM portion of South Mountain Area 2 or Lowry pastures. Therefore, periodic herding by the operator should be sufficient to keep the few cattle that may use this area off the treated areas while they recover.

Table 3. Affected Allotments, Number of Treatments, BLM Acres Involved, and Closure Method

Allotment	Number of Treatments	BLM Acres Affected (% of Pasture/Allotment)	Closure Implementation Method
Cliffs	4	365 (3.8)	Existing fence
Lequerica FFR	3	30 (3.1)	New fence – 0.5 mile
South Mountain Area	3	63 (0.7)	Herding

Overall, the proposed project would have a minimal impact to livestock grazing, and livestock grazing would have negligible or no impacts on rangelands in the project area.

In the short and long term this project could produce minor improvements to grazing opportunities within the affected allotments, but the juniper treatments represent small portions of land within these allotments (458 acres versus 19,811 acres within the 3 allotments, or about 2.3%). At each treatment location there is a potential for increased forage production due to the removal of juniper and sagebrush. The increased forage and palatability could increase livestock use at these locations for the first two years or longer, post treatment; however, these areas would be closed to grazing until burned vegetation has recovered. Therefore, livestock should have no impact to recovery of vegetation in the short term or to maintenance of vegetative communities over the long term.

Because the fire will burn through existing allotment boundary fences, there is the potential for damage. The BLM, permittees, and ARS would work cooperatively to fix damaged fences after the fire. Once the newly proposed fences are constructed approximately 90% of the BLM lands would be rested from livestock for a minimum of two growing seasons, facilitated by existing and proposed fencing. On the rest of the BLM lands, herding would be used to ensure these areas would not be grazed for the minimum two growing seasons post treatment. However, livestock grazing would continue in the remaining pastures of the allotment with possible adjustments to the terms and conditions of the permits. Therefore, there would be no effects to livestock grazing.

The new fences would have little impact on current grazing management. The proposed 0.5-mile fence in Lequerica FFR 1 would exclude only 40 acres (4%) of the 960 acre allotment, so the current authorized grazing system would not be impacted. The proposed Lower Cliffs fence would relocate existing fence to the accurate boundary between BLM land and private. Fence relocation would allow for 16 acres of the Cliffs allotment that are currently on the Lequerica FFR 2 side of the fence to be included in the Cliffs allotment, and would allow for 20 acres of the Lequerica FFR 2 allotment that are currently on the Cliffs side of the fence to be included in the Lequerica FFR 2 allotment. There would be an immediate direct cost to the BLM for the materials and construction of the fence. Estimated cost for 1.5 miles of four wire barbed steel fence including contractor installation and materials is $10,650 per mile.

Direct effects to vegetation by the proposed 1.5 miles of fence would be localized and consist of small disturbance areas. This localized disturbance may displace some desirable vegetation, but areas conducive for weed invasion would be small. The primary disturbance would be within approximately 15 feet to either side of the fence; a total of 5.5 acres would be affected, or less than 1% of the total treatment area. Indirect effects from fence construction would be minor,

consisting of an alteration of trailing patterns due to the new fence. Post burn vegetation recovery would benefit from pasture rest and herding.

3.4 Wildlife/Special Status Animals

3.4.1 Affected Environment – Wildlife/Special Status Animals

The project area is located within the Owyhee Uplands and Canyons Level IV Ecoregion (McGrath et al. 2002). This ecoregion is described as providing important habitat composed of sagebrush grasslands; however, western juniper woodlands have developed across the project and surrounding area (Phase III juniper encroachment). The dominant vegetation type in the project area is juniper, which can be an important seasonal habitat component for a few species but one that reduces habitat quality for many others. As juniper has developed into woodlands and become dominant in the project area, the value and quality of habitat has been degraded for most wildlife species including greater sage-grouse (hereafter sage-grouse), golden eagle, prairie falcon, mule deer, pronghorn antelope, black-tailed jackrabbit, cottontail rabbit, and several species of migratory birds. Although dominated by juniper, the project area does have limited areas with a mosaic of vegetation and habitat types including native grasses and forbs, low sagebrush, developed ponds, springs and meadows, and patches of big sagebrush and bitterbrush.

Completion of the study would provide greater understanding of effects from western juniper expansion and woodland development on the hydrologic system and to ecosystem health. Understanding the effects of juniper expansion to water infiltration, stream flow and sedimentation, and vegetation recovery after treatment would be beneficial for understanding the effects of expansion to ecosystems, including the effects to wildlife and their habitat. Such knowledge would aid in developing projects to counter the effects and improve conditions across the landscape to benefit wildlife and ecosystem health.

The wildlife analysis for this EA does not include all species occurring in the project area. Current environmental conditions are described for seven different species of wildlife. Species being analyzed have been documented or likely utilize the project area to some extent and were selected based on their special status and their utility in representing potential effects to similar species. Effects to similar species may still be identified but not in the same detail as the main species selected for analysis. The species include:

- Greater Sage-grouse
- Golden Eagle
- Mule Deer
- Belding's Ground Squirrel
- Brewer's Sparrow
- Common Garter Snake
- Western Toad

Greater Sage-grouse

On March 23, 2010, the U.S. Fish and Wildlife Service (FWS) determined sage grouse warrant protection under the Endangered Species Act, but the species was precluded from listing due to other species of higher priority. In the Great Basin, habitat loss as a result of wildfire is the

leading cause of sage-grouse declines. Sage-grouse in the vicinity of the project area are part of the Northern Great Basin (NGB) population, which is within the Snake River Plain Sage-grouse Management Zone (SMZ). The NGB population is considered large and the area of this population includes portions of northern Nevada, southeast Oregon, southwest Idaho, and northwest Utah (Garton et al. 2011). The project area is part of the Owyhee Sage-grouse Planning Area (SGPA).

Due to the level of juniper woodland development, the project area is not classified as sage-grouse habitat as illustrated on the 2012 sage-grouse habitat maps for preliminary priority habitat (PPH) or preliminary general habitat (PGH), or using the habitat class (Map 4). Table 4 provides the habitat type and acres of PPH and PGH within a 10 mile radius of the project area (in Idaho).

Sage-grouse sign was observed within the project area on June 11, 2013 (Michael McGee, BLM Biologist, Personal Observation,), however the level of use is expected to be low due to limited sign observed and the level of woodland development. Sage-grouse use of the area would likely occur during the summer or early fall because in spring these birds would be near a lek and the area does not provide suitable winter habitat. Meadows and springs within the project area could provide excellent brood rearing habitat if a landscape level juniper treatment was implemented.

Map 4 - Sage-Grouse Map

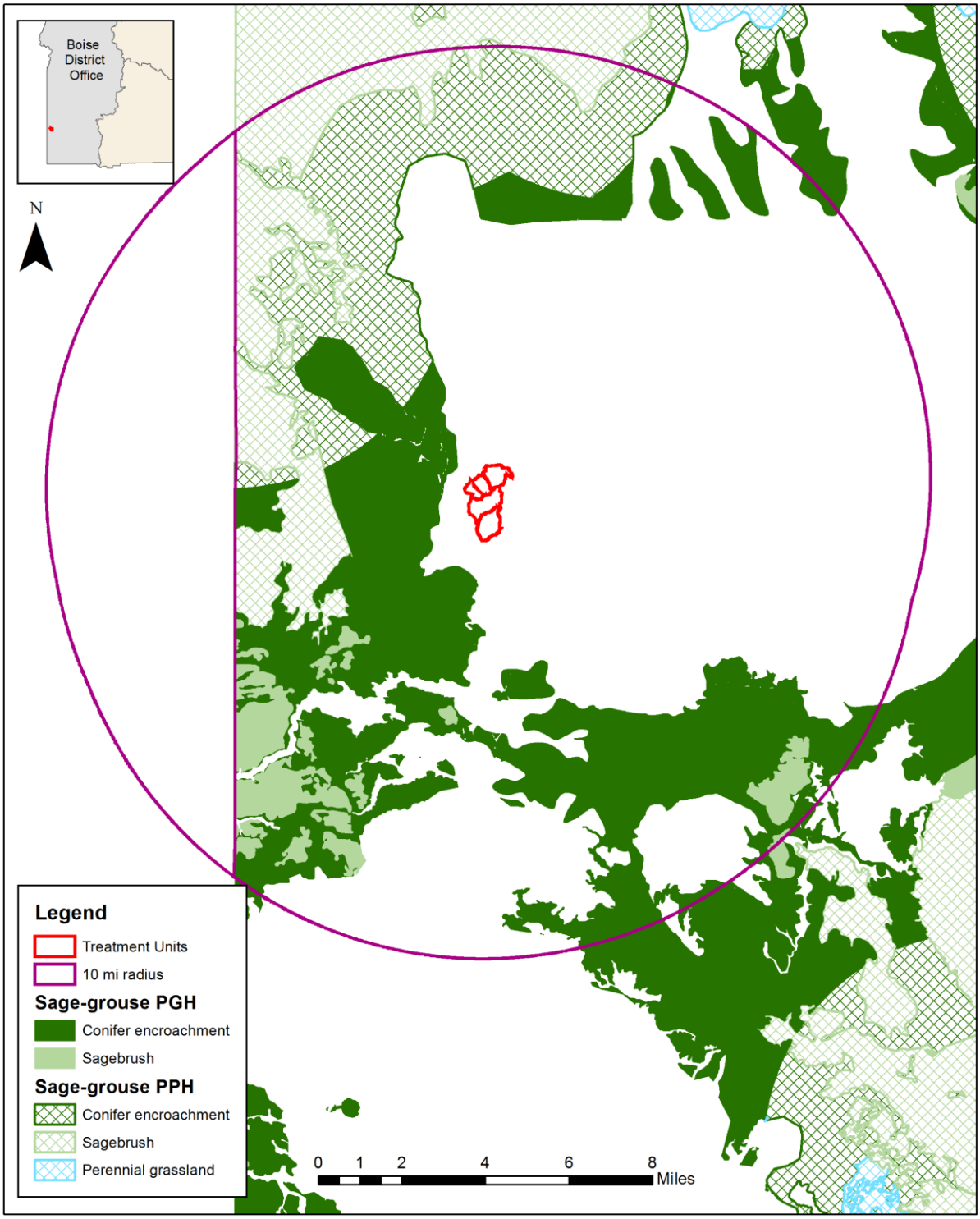


Table 4. Habitat type and acres of PPH and PGH within a 10 mile radius of the project area (in Idaho).

Habitat Type	PPH	PGH
Sagebrush	15,798	5,567
Perennial Grassland	0	0
Conifer Encroachment	21,657	41,990
Total Acres Within 10 Mile Radius (in Idaho)	37,453	47,555
Acres of unsuitable Habitat Within 10-Mile Radius	79,992	

The closest lek is approximately 6.5 miles of the project area. A total of seven leks are between 6.5 to 10 miles of the project area. Six of those leks have an undetermined status, and one is considered occupied (Table 5). Each of the leks has some level of juniper encroachment and they are like islands mostly surrounded by encroaching stands of juniper.

Table 5. Survey data for sage-grouse leks within 10 miles of the project area.

Lek #	Latest year of birds observed and # number of males counted	Latest date of lek survey and # number of males counted	Management Status
BE01	2010/9	2011/0	Occupied
PV01	1995/6	2011/0	Undetermined
PV02	2005/17	2012/0	Undetermined
CR07	1978/5	2013/0	Undetermined
CR17	1977/10	2008/0	Undetermined
CF02	1994/2	1994/2	Undetermined
CF03	1994/2	2008/0	Undetermined

The Idaho Sage-grouse Advisory Committee (2006) cited the Connelly et al.'s (2004) estimate that 35% of sagebrush habitats are at high risk of displacement by juniper within the next 30 years. Additionally, The Owyhee County Sage-grouse Local Working Group Plan (2013 as amended) identifies loss of habitat from juniper encroachment as one of the major threats to sage-grouse habitat in the county. Sagebrush steppe habitat in the project area has been reduced and degraded due to the increased levels of western juniper.

Golden Eagle

Golden eagles are afforded protection under the Bald and Golden Eagle Protection Act. Golden eagles nest on cliffs and rocky outcrops throughout the west and commonly occur in southwest Idaho. Suitable nesting habitat may be present in the North Fork Owyhee River canyon, which is approximately 3 miles from and within foraging distance of the project area. However, golden eagles prefer to forage in open shrub steppe, sagebrush and grassland habitats and foraging habitat within the project area is relatively limited due to the predominance of juniper woodland habitat.

Mule Deer

The project area provides nearly yearlong habitat for mule deer and is within 2.5 miles of winter range. The project area is within Game Management Unit (GMU) 40, which at one time supported very high numbers of deer. Liberal harvests levels were allowed until the early 1970s

when an area decline in deer populations led to more conservative harvest numbers (IDFG 2013). The deer in GMU 40 use habitat in Oregon and they may use habitat in Nevada as well. This interstate mixing of deer populations makes evaluation of the status of Idaho's herd in GMU 40 very difficult (IDFG 2013). The Mule Deer Annual Report (IDFG 2013) states: "in GMU 42, there has been a substantial encroachment of juniper into former summer and winter ranges. In several areas where juniper has replaced more important browse species, the number of wintering deer has been reduced from several thousand to a few hundred deer." While these statements were referring to GMU 42, GMU 40 borders the northern edge of GMU 42 and the level of juniper encroachment that has occurred in the project area is comparable to GMU42. Therefore, the impacts of juniper encroachment to mule deer in GMU 40 would be expected to reflect the impacts that have occurred in the neighboring GMU 42.

The impacts of juniper to mule deer habitat in this portion of Idaho were identified as an issue in the 1969 Juniper Mountain Wildlife Habitat Management Plan (USDI-BLM 1969). While juniper does provide hiding and thermal cover for mule deer, it provides poor structure for deer fawning cover. Antelope pass through open stands but prefer shrub grassland communities. Elk frequent open juniper stands and may use dense stands during severe winter conditions but elk densities increase after treatments to reduce juniper canopy cover. Bighorn sheep prefer open habitats but they do use juniper for shade on hot days (Miller 2001). Within the project area, forage for elk, deer, and antelope has decreased because of juniper encroachment.

Belding's Ground Squirrel

This species is usually found in fairly open habitat, preferring grassy meadows, bottom lands, and sagebrush flats that are close to water. This squirrel feeds primarily on grasses, leaves of meadow plants, and seeds (Groves et al. 1997). This species usually hibernates from late September to May or June. Suitable habitat is present within the project area but because this squirrel prefers open habitat, increasing levels of juniper have negative effects. Miller et al. (2005) identifies that the greatest impact of juniper on small mammals is potentially via indirect effects on understory plant species. As juniper become more dominant and shrub-steppe vegetation decreases, the majority small mammals are negatively impacted. Miller (2001) states that small mammal abundances closely follow the response of shrubs, grasses, and wildflowers to reductions of juniper and that understory seed production increases following reduction of the tree overstory, providing food for both small mammals and birds.

Brewer's Sparrow

Several species of migratory birds were observed within the project area. Lazuli bunting, lark sparrow, and green-tailed towhee were species observed that are less reliant on sagebrush, but are dependent on shrubland habitat. Among birds, shrubland and grassland species are declining faster than any other group of species in North America (Dobkin and Sauder 2004). Brewer's sparrow is heavily reliant on sagebrush steppe for nesting and foraging (Paige and Ritter 1999). Although juniper encroachment has lowered the habitat quality for most of these species, many are relatively common. The project area does provide good winter habitat for some species of birds including American robin and Townsend's solitaire.

Common Garter Snake

This snake lives in many different environments throughout Idaho and is generally close to water (Groves et al. 1997). Adults eat toads, frogs, salamanders, and fish. Suitable habitat is present

within the project area; however it is and will continue to be degraded as juniper becomes better and more densely established. Petersen and Stringham (2008) found that less water is available to sustain understory and intercanopy plant growth in areas with high juniper cover and that accelerated runoff and erosion in juniper dominated sites can lead to extensive degradation to the hydrology of those sites.

Western Toad

This species inhabits a wide variety of habitat from desert sagebrush to mountain meadows and is distributed throughout Idaho (Groves et al. 1997). Western toads are closely associated with water for breeding in the spring, which often occurs in seasonal ponds (Bull 2006). This species can travel a relatively long distance from breeding sites to summer habitat. A study in southeastern Idaho (Bartlett et al. 2004) documented one toad travelling 1.5 miles from breeding habitat to its summer habitat. Suitable habitat is present within the project area; however as identified above, it is and will continue to be degraded as juniper becomes better and more densely established.

3.4.2 Environmental Consequences – Wildlife/Special Status Animals

Species that exist in the project and surrounding area are those that prefer sagebrush steppe habitat. Juniper does provide important seasonal habitat for a few species but too much juniper degrades habitat and negatively impacts many species. Across southwest Idaho there has been a steady increase in juniper and a subsequent decrease in sagebrush steppe and grassland habitat.

The potential impacts to wildlife from implementation of the project alternatives for any species are relatively the same. This is because the effect of juniper encroachment to wildlife is generally some form of habitat degradation whether it is a loss of forage, cover, diversity, or structure. Therefore, increases in juniper across the landscape generally lead to worsening habitat conditions and reductions of juniper where it has encroached generally lead to improved habitat for most wildlife in the project area. The probability of impacts during implementation is low due to the timing, low number of acres to be treated, and the SOPs. Most species will be able to easily move to safety during the prescribed fire. Because the effects from the alternatives will be relatively the same, a comprehensive analysis for each species is not necessary.

3.4.2.1 Alternative A – No Action

Implementation of juniper removal across the project area would not occur and the study would not be completed. Results that could lead to improved wildlife management would not be realized. Juniper would continue to become established and dominant across the project area producing poor and worsening habitat conditions for wildlife in the project area.

The project area comprises a very small portion of the larger landscape that is already dominated by juniper. Therefore, the overall impact of continued expansion of juniper woodlands in the project area would be negligible to species that utilize the broader landscape and are highly mobile. Landscape use level species in this area include large mammals and birds including raptors and sage-grouse. However, species with small home ranges such as reptiles, small mammals, and amphibians would be negatively impacted by the continued spread of juniper into the small areas of remaining habitat within the project area.

3.4.2.2 Alternative B – Proposed Action

The prescribed fire could cause a minimal level of wildlife mortality but not to a level that would lead to measureable effects at the population level. Other than the low potential of mortality, the prescribed fire is expected to have minimal direct effects to wildlife other than temporary disturbance. There would be minimal direct effects due to the small size of the project area, the time of year the fire would occur, and because wildlife have evolved and adapted to natural events such as wildfire. Most wildlife in the project area would avoid the prescribed fire (i.e., sage-grouse, deer, and elk) by simply leaving the area or by taking refuge (i.e., small mammals, reptiles). The proposed 1.5 miles of new fence would be built to meet the wildlife standards and marked in accordance with current marking specifications identified in IM No. ID-100-2011-001 (USDI BLM 2011) and guidelines specified in BLM IM 2012-043 (USDI BLM 2012) to reduce collisions by sage-grouse and impacts to other wildlife species. Wildlife can be impacted from fences through collisions and entanglement but fence design and marking can reduce these impacts.

Any reduction of juniper in areas that could provide meadow, riparian, grassland, or shrub steppe habitat would benefit the species in and surrounding the project area especially those species with small home ranges. Species that utilize large areas would also benefit from the maintenance of habitat diversity across the landscape.

The understanding of juniper woodland development and its impacts to hydrological and ecosystem function would likely provide important information that would benefit future wildlife management and lead to better management of sagebrush steppe habitat.

3.5 Cultural Resources

3.5.1 Affected Environment – Cultural Resources

The project area is just east of Cliffs, Idaho and south of South Mountain. The historic General Land Office map for the area, Township 9 South, Range 5 West dated 1909, shows two residences and one road within the entire township/range. Neither residence was along the road. The closest community was Cliffs, Idaho, a small community based on ranching. Ranches and homesteads were settled in this area by 1907. Earlier residents, dating back to the 1860s, were concentrated to the north in the South Mountain, Silver City, Flint and DeLamar towns and Mining Districts.

The South Mountain area became known for its abundance of wood resources, which were being depleted around the mining districts to the north. A 12 mile road was constructed from the community of Flint to South Mountain to access timber for the Flint Mines (Adams 2003 p. 83). According to Raymond's 1877 mining report on South Mountain (p. 229), "Timber is scarce in the immediate vicinity; but on the other side of the mountain, five to six miles northeast of the town, there is a large amount of fir." Raymond continues with, "All the charcoal needed for the furnaces has to be packed a distance of ten miles…from the nearest place, where juniper is found in almost unlimited quantity." The 1908 Township 9 South Range 5 West General Land Office (GLO) Map survey field notes also suggest a relative abundance of juniper and mountain mahogany, as well as shrubs, in the project area. Cultural resource surveys conducted for this project revealed that charcoal production was an historic activity that took place. Charcoal

production areas appear to have only been used once indicating that it was easier to make charcoal where the wood was instead of bringing the wood to centralized charcoal kilns. The charcoal production sites are somewhat scattered across the project area perhaps suggesting that the available timber was only thick in patches across the landscape. In general, very little archival information exists concerning the project area, and very little information concerning charcoal production in Owyhee County was found in archival documents.

The project area lies near the boundary of two distinct American Indian cultural groups, the Great Basin and the Columbia Plateau with inhabitants most likely from Northern Shoshone and Northern Paiute tribal ancestors (Palmgren 1999). Great Basin cultural material dominates and based on projectile point typology, use of the area may date as far back as 10,000 years. The local American Indian population developed a seasonal subsistence cycle that centered on fishing, root and seed gathering. Short term or seasonal camps were generally located along large rivers and major tributaries. People generally wintered along the Snake River. Early use of the area by American Indians appears to have been minimal. No long term habitation sites have been identified in the past or during the surveys for this project. A few small temporary campsites have been identified in the general area but only isolated stone tool fragments were found within the project area, indicating that the area was most likely used as a transitory hunting location.

Previous cultural resource work in the project area and vicinity has been minimal. Only 19.4 acres of the 730 acre project area was previously surveyed. No sites were recorded. A total of 53 acres has been previously surveyed in the entire T9S, R5W. A total of six cultural resource sites have been previously recorded in T9S, R5W. Site types include three log cabin sites with artifact scatters, one rock shelter with Native American artifacts, one small Native American camp site and one isolated projectile point.

For this proposed project, a total of 858.4 acres were surveyed; 324.1 acres of BLM managed lands and 534.3 acres of private land. Eleven new historic sites were recorded and one previously recorded site was rerecorded and reevaluated. Of the eleven new sites, eight are charcoal production sites and two are residential sites that are most likely associated with charcoal production. The final newly recorded site is a segment of historic road that may or may not be associated with charcoal production.

Of the newly recorded sites, seven were determined not eligible for listing on the National Register of Historic Places (NRHP) because they do not retain characteristics that would make them eligible for listing. Two sites were left unevaluated since they may contribute to our understanding of the life of a remote charcoal burner in the Owyhee Mountains, and two sites were determined eligible for the NRHP as they reflect the charcoal production process that may be unique in the Owyhee Mountains. The four unevaluated and eligible sites would be protected from adverse impacts during project implementation. Mitigation measures have been developed so that the characteristics of these sites that make them eligible will be retained. The previously recorded site, a historic cabin, was determined ineligible for listing on the NRHP as it was torn down and replaced with a new cabin. No cultural resources were found along the proposed fence lines.

3.5.2 Environmental Consequences – Cultural Resources

3.5.2.1 Alternative A – No Action

There would be no treatments so cultural resources recorded during the surveys for this project would not be impacted. Further juniper encroachment, from not doing the proposed project, will have no adverse effects on sites within the project area.

3.5.2.2 Alternative B – Proposed Action

Four cultural resource sites would require mitigation to protect them from adverse effects during implementation of the proposed project. Mitigation measures would be designed under consultation with the Idaho State Historic Preservation Office. Mitigation measures include but are not limited to limbing tree branches close to sites, removing small diameter trees, covering burnable features with structural protection wrap, black lining around sites and leaving green trees around sites to create a buffer of trees that may not readily burn. With these mitigation measures in place there would be no adverse effect to any eligible or unevaluated cultural resource sites.

An indirect effect from the proposed project would be a slight increase in forage resulting in the possibility of a slight increase in livestock using an area for a longer period of time. Of the four sites requiring mitigation, one site would be avoided completely due to its location on the edge of the burn area; therefore, there would be no increase in forage and no expected increase in livestock use. Two sites are predominately in open areas with dispersed low growing vegetation due to thin soils. Fire is not expected to carry well through these sites, so there would be little or no increase in palatable vegetation to concentrate livestock use here; therefore, these sites would not be impacted.

The final site is a charcoal production site with combustible materials. That site is slated for a variety of mitigation measures that may include limbing trees and leaving green trees around the site that would not readily burn. In addition, the site's combustible elements would be protected from burning with structure protection wrap. In general, the production of charcoal appears to have sterilized soil where intense burning took place resulting in little to no vegetation growth. Although palatable vegetation may increase outside the site there would not be a measurable increase within the site, thus livestock use would not increase within the site. There should be no increase in livestock use that would result in adverse effects to cultural resources from the proposed project.

3.6 Air Quality

3.6.1 Affected Environment – Air Quality

The IDEQ has the primary responsibility to carry out the requirements of the Federal Clean Air Act (CAA) in Idaho. The primary mechanism for implementation is known as the State Implementation Plan, which EPA requires each state to prepare. Additional smoke management requirements are found in a Smoke Management Program. The Boise District Fuels program, which implements prescribed fires on the Owyhee Field Office, is part of the Idaho-Montana Airshed Group. This is a Smoke Management Program comprised of Federal, State, local land management agencies and forest products industry which monitors and coordinates smoke

emissions and approves burning in Idaho. The Burn Boss implementing the prescribed burn is required to request approval from the ID-MT Airshed Group every day that burning occurs. If the Airshed Group determines the air quality is not acceptable and the planned prescribed fire would have negative impact, approval would be denied and burning would not happen.

Lands within the Owyhee Field Office boundary (including the South Mountain Juniper Research Project area) are designated as Class II airsheds, which allows moderate deterioration associated with moderate, well controlled industrial and population growth. Additionally, the BLM manages designated wilderness areas as Class II unless they are reclassified by the State as a result of the procedures prescribed in the CAA per BLM Manual (USDI BLM 2012). The Jarbidge Wilderness Area (approximately 90 miles southeast) is the closest Class I designated area. Three additional wilderness areas are closer to the project area but have not been designated Class I. The North Fork Owyhee Wilderness is 3 miles east, the Pole Creek wilderness is 15 miles east, and the Owyhee River Wilderness is 24 miles south of the project area.

Currently, air quality parameters are in compliance and exceeding Federal and State standards due to a lack of emission sources throughout much of the area and its rural setting. The major emission sources in the area would be seasonal burning of farm fields. Most livestock operations in the area contribute small amounts of particulate matter into the atmosphere. Large feed lot operations can contribute a major source of ammonia (IDEQ 2010), but these types of operations are not located near or within the project area.

Carbon Sequestration

Current knowledge of carbon storage and movement in the Great Basin is limited. The most relevant research on the carbon movement within these systems is being conducted by Ben Rau at the University of Nevada, Reno through the SageSTEP Project. Rau et al. (2010) reported that woodland encroachment has caused an increase in above and below ground woody biomass which acts as a temporary carbon sink. This could be misconstrued as evidence that woodland encroachment is beneficial in offsetting some of the effects of climate change. Decades of fire suppression have caused build-ups of woody fuels on landscapes throughout the west which results in massive carbon emissions when high-severity wildfires occur. High severity fires have been more common over the past twenty years. Rau estimated that these increases in high-severity wildfires are off-setting the carbon stored by expanding woodlands. Also, these wildfires may be releasing much of the carbon stored due to fire suppression from 1910 to the present. While more information is needed to determine the exact balance, it is known that the increasingly common high-intensity fires are more detrimental to ecosystems, require more time and money for recovery, and volatize more carbon than low intensity fire (Rau et al. 2010).

3.6.2 Environmental Consequences – Air Quality

3.6.2.1 Alternative A – No Action

Currently air quality in this area is in compliance with and meeting Federal and State standards. This trend would continue with the no action alternative.

3.6.2.2 Alternative B – Proposed Action

The use of prescribed fire during juniper treatment projects would result in a moderate short term negative effect on air quality and visibility, in the immediate area, during and immediately following the actual activity. Air quality effects would be in the form of smoke and dust emissions which are predominantly in the Particulate Matter (PM) 10 µm and PM 2.5 µm size range. This activity is not expected to exceed any State and/or Federal air quality standards based on the types of fuels and size of burns. The five units proposed to be treated are 87, 196, 64, 225, and 158 acres. The smoke impact of these units when burned individually over the course of five years would be minimal. Smoke would be noticeable over a wide area of western Owyhee County for 1 to 2 days following the burns. No Class I airsheds would be affected. The North Fork Owyhee and Pole Creek Wilderness areas may see short term, 1-2 days, localized smoke. The Owyhee River Wilderness to the south is less likely to be impacted. The area would continue to comply with and meet Federal and State Air Quality attainment standards over the long term, months and years following the burn.

Although the prescribed burning would be intense enough to achieve 100% juniper mortality, the fire will keep primarily to the canopies, due to girdling techniques, and would only burn needles and small diameter branches. If all the trees were felled, the flame front would be longer duration, consume more of the trunk and branches, thus emitting more carbon, and the intensity of the fire could potentially sterilize the soil making recovery of herbaceous and sage-steppe vegetation more difficult. A recent report from the Association for Fire Ecology (AFE), the International Association of Wildland Fire, the Tall Timbers Research Station, and The Nature Conservancy states that prescribed fire promotes long term carbon sequestration (AFE 2013).

The intensity of the prescribed fires would be expected to be lower than wildfire, and therefore release less carbon initially because less fuel would be consumed. Prescribed fire also reduces the probability of high-intensity wildfire; therefore, this may result in a slight indirect long-term reduction in carbon emissions. Additional carbon would be slowly released from incompletely consumed trees as they decompose, but some of the material may be returned and stored in the soil and converted to humus over time (Rau et al. 2010).

More important, however, is a long-term carbon storage effect resulting from the relatively large amount of juniper root biomass (carbon) that would be held in the soil, as opposed to aboveground biomass whose carbon would be returned to the atmosphere from burning or aboveground decomposition (Rau et al. 2010). In addition, the rapid recovery of deep-rooted grasses (and other herbaceous species) from the reduction in juniper competition would increase soil carbon storage from the growth and die back of perennial grass root systems each year.

Although the scale of this project is small (730 acres) relative to the South Mountain landscape, the proposed juniper treatments would be expected to have a long-term indirect effect of decreased carbon emissions and increased soil carbon sequestration by reducing high-intensity wildfires, slowing the rate of carbon turnover, and providing long-term carbon storage for the below-ground juniper biomass (roots). Most importantly, juniper treatments would restore the shrub steppe communities whose rapid root turnover would store carbon in the soil.

The proposed range improvements would have no effect on air quality.

4.0 Cumulative Effects

4.1 Cumulative Effects Applicable to All or Most Resources

4.1.1 Scope

Cumulative effects of most resources analyzed are considered on the watershed scale and encompass the project boundary for watershed treatment units T1 through T5 (Map 2). The area considered for Wildlife can vary greatly by species and their distribution across the landscape. Therefore, a 10-mile area surrounding the proposed treatment area is the scope for analysis for fish and wildlife resources. Ten miles greatly exceeds the range of many species, but may encompass only some habitat types and partial annual ranges for large and/or highly mobile species (e.g., big game, raptors, and migratory birds). The scope for Air Quality covers Owyhee County, ID and Malheur County, OR. The area considered for cumulative effects is representative of the scale of the proposed treatment area relative to the South Mountain landscape. The entire treatment area is 730 acres, of which only 458 acres of BLM land would be affected by the proposed alternative. The analysis timeframe includes past activities that have created the present conditions, and future activities planned within the next 15 years.

4.1.2 Past, Present, and Reasonable Foreseeable Future Actions

Past, present, and future activities include grazing, fire suppression, wood cutting, recreation (hunting, OHV, etc.), and the Bruneau Owyhee Sage-grouse Habitat (BOSH) project. The impacts of these activities on resources analyzed in this EA are summarized in Table 6, and briefly discussed below. The terms for magnitude of effects are defined as:

- None – activity does not affect the resource analyzed in the proposed alternative;
- Negligible – effects of activity on the resource analyzed are indiscernible with insignificant change;
- Minor – activity affects only a very small percentage of the resource analyzed or has only a temporary effect on the resource in a larger area;
- Moderate – activity affects more than a small percentage but less than a majority of the area with noticeable changes in resource analyzed; and
- Major – activity substantially affects resource analyzed within a majority of the area.

Table 6. Likely Effects of Past, Present, and Foreseeable Future Activities in Cumulative Impact Area

Resource	Grazing	Fire Suppression	Wood Cutting & Recreation (hunting, OHV, etc.)	BOSH
Vegetation & Special Status Plants	Minor -	Moderate +	Negligible	None
Watershed, Soils, & Water Quality	Minor -	Moderate +	Negligible	None

Resource	Grazing	Fire Suppression	Wood Cutting & Recreation (hunting, OHV, etc.)	BOSH
Livestock Grazing Management	Negligible	Negligible	Negligible	None
Wildlife & Special Status Animals	Negligible	Negligible	Negligible	None
Cultural Resources	Negligible	Negligible	Negligible	None
Air Quality	Negligible	Negligible	Negligible	Negligible

+/- Delineates overall positive (+) or negative (-) effect; these attributes were applied to "Minor" and greater impact categories.

Although they are different activities, wood cutting and recreation have been combined in the above table due to the remote access of the project. The only roads into the project area are through private land and permission from land owners must be granted for use. For all resources analyzed in the proposed action there is very little cumulative effect on wood cutting and recreation in the proposed treatment area. If and when these activities occur in the treatment area, they are infrequent and isolated primarily to the local land owners, and ARS's usage of UTV/Snow-Cats to monitor the weirs once a month.

The BOSH project is in the planning phase. It will encompass approximately 1.5 million acres targeting Phase I juniper expansion and possibly some Phase II areas. The BOSH project covers large portions of the Bruneau and Owyhee Field Offices therefore it is mentioned in the cumulative impacts for this project. However, the BOSH project does not overlap the Phase III juniper sites of the ARS South Mountain Juniper Research project, so there would be no cumulative impacts to resources aside from low impact to Air Quality. It is possible that there would be targeted jackpot burning if Phase II juniper is included in the final BOSH NEPA analysis. Due to the vastness of the BOSH project and it not coinciding with ARS South Mountain Juniper Research proposed treatment area, mitigation of smoke impacts would be accomplished by dilution over a large area with infrequent, short duration smoke production events.

4.2 Cumulative Effects – Vegetation and Special Status Plants

Current Conditions

All watersheds within the South Mountain Juniper Research Area are currently in a vegetation state typical of Phase III juniper encroachment. These areas would have historically been in a natural fire cycle of 25-30 years that would have maintained a juniper cover of less than 10%, primarily confined to areas of rocky outcrops or other landscape features that had insufficient ground fuels to carry a wildfire. Historical wildfire would maintain a natural successional cycle of grass and grass-shrub phases that would be periodically reset without significant juniper encroachment as described in section 3.1.2.1.

Alternative A – No Treatment
The treatment would not occur and would therefore not contribute to cumulative impacts associated with other past, present and reasonably foreseeable future actions occurring within the cumulative effects boundary area. The short-term cumulative effect of continued fire suppression and current grazing management activities would maintain all watersheds in the treatment area in conditions of Phase III juniper. Phase III juniper conditions are relatively resistant to beneficial, low-intensity wildfire as juniper suppression of the understory reduces surface and ladder fuels that would normally carry fire in the intercanopy zone. Maximum densities of current juniper and reduced understory as described in section 3.1.2.1 would likely continue until such time as extreme atmospheric conditions and natural wildfire ignition would allow for a high intensity crown fire, a long-term cumulative impact with moderate effects, that would remove most of the vegetation and heat the upper soil layers to a degree that would kill propagules of remaining understory species and decrease soil quality for future vegetation through soil erosion (Miller and Rose 1995; 1999; Bates et al. 2000; Miller et al. 2000).

Alternative B – Proposed Action
The proposed juniper treatments, fire suppression, livestock grazing, and fence construction would contribute additively to vegetation and soil disturbance in the short-term, with possible increase of non-native plant species. However, in the long-term, the juniper treatment would result in an increase in perennial grasses, forbs, and shrubs. Moderate improvements to plant community structure and density would reduce erosion risk when coupled with past, present and reasonably foreseeable actions occurring within the watershed. Late Phase III juniper suppresses this type of ground vegetation, but maintains a significant amount of bare-ground in the juniper intercanopy zone. The prescribed fire treatment proposed in this alternative of girdling the juniper and burning them while they are standing is not expected to scarify the upper soil layers of vegetative propagules. As described in section 3.1.1, previous research has shown aggressive recovery of understory species within 2-3 years of the partial cutting and prescribed fire treatment and long-term soil protection from increased canopy cover (Burkhardt and Tisdale, 1969; Bates and Miller, 1998; Bates et al., 2000; Miller et al., 2000; Bates et al., 2005).

4.3 Cumulative Effect – Watershed, Soils, and Water Quality

Current Conditions
All watersheds within the South Mountain Juniper Research Area are currently in a vegetation state typical of Phase III juniper encroachment. Phase III juniper encroachment results in overall lower soil protection due to incomplete canopy cover from overstory vegetation, and suppression of understory vegetation in the intercanopy zone. This condition maintains significant bare ground that allows for surface runoff and erosion from even low intensity storm events (Petersen and Stringham 2008; Pierson et al. 2007, 2010; Williams et al. 2013). Enhanced erosion in Phase III juniper leads to irreversible soil losses that may not allow for vegetation recovery to pre-encroachment levels of native grass and shrub species (Miller et al. 2005; Pierson et al. 2007; Briske et al. 2008; Petersen et al. 2009; Pierson et al. 2010; Williams et al. 2013).

Alternative A – No Treatment
Under continuation of current management, the study area would remain in Phase III juniper encroachment until such time that a catastrophic crown fire removes most or all vegetation from

the study area. Persistence of Phase III status would result in a continuation of excessive runoff and erosion eventually crossing an ecohydrologic threshold where the remaining soils no longer support recruitment of historical plant speices (Briske et al. 2006, 2008; Petersen et al. 2009). Ongoing livestock grazing would result in minor impacts to remaining understory and inter-canopy bunchgrass, which could ultimately contribute to a minor increase in soil erosion and sedimentation of streams when combined with the other actions.

Alternative B – Proposed Action

The proposed juniper treatments, livestock grazing, fence construction, and fire suppression would contribute cumulatively to increased vegetation disturbance and erosion risk in the cumulative effects area in the short term (1-2 years). However, the proposed action would have moderate positive cumulative impacts over the long term (3-13 years) when coupled with past, present and reasonably foreseeable actions occurring within the watershed and would result in increased shrub, forb, and grass canopy cover to reduce further erosion/soil loss to minimal levels even under extreme rainfall events (Burkhardt and Tisdale, 1969; Bates and Miller, 1998; Bates et al., 2000; Miller et al., 2000; Bates et al., 2005).

The effects of livestock grazing and range improvements are minor due to the scale of the project within each of the allotments. Grazing effects include loss of bunchgrasses, more exposed soil, degraded riparian areas, and degraded water quality due to sediment, temperature and/or fecal coliform. In the short-term, with grazing rest the initial two or more years, erosion due to grazing would be eliminated, allowing herbaceous vegetation to establish and aid in soil stabilization following the prescribed fire. Long-term effects of grazing following rest could contribute to increased erosion and sedimentation in areas where vegetation takes longer than 2-3 years to recover.

4.4 Cumulative Effects – Livestock Grazing Management

Current Conditions

Livestock grazing in the region dates back to the late 1800's and remains the dominant land use of the cumulative effects area. Prior to the 1934 Taylor Grazing Act, unregulated livestock grazing affected the vegetation resources within the cumulative effects area by reducing the primary understory plants. However, since that time, BLM regulations have led to improved resource conditions.

Alternative A – No Treatment

The treatment would not be implemented, therefore would not contribute to cumulative impacts when assessed against other past, present and reasonably foreseeable future actions. However, current livestock grazing, fire suppression, wood cutting and recreation would continue in the analysis area at current levels which would have negligible effects to livestock grazing management in the cumulative impacts area.

Alternative B – Proposed Action

The treatment could contribute to minor adverse cumulative impacts in the short-term (< 2 years) to livestock grazing practices as a result of grazing closures. However, due to the small amount of grazing acres affected and likelihood that AUMs would not need to be reduced, the

cumulative impact when coupled with other potential fire or other natural disaster-related grazing closure would be negligible. In the long-term (>5 years) the project would produce moderate overall benefits to vegetative conditions in the context of livestock grazing when coupled with other past, present and reasonably foreseeable future actions that improve rangeland health and functionality.

4.5 Cumulative Effects – Wildlife & Special Status Species

Current Conditions
The project area provides habitat for a wide variety of species, most of which are associated with sagebrush steppe habitat. Western juniper has encroached and overtaken sagebrush steppe habitat so that it now dominates within the project area. Juniper is continuing to spread into the remaining patches of sagebrush steppe. The spread of juniper has degraded habitat conditions for many species.

Alternative A – No Treatment
The likelihood of cumulative effects associated with the no action alternative on past, present and reasonable foreseeable future activities would be negligible due to the small area being treated.

Alternative B – Proposed Action
Because any effects that could occur from the proposed action would be positive, there would be no negative cumulative impacts. Additionally, the treatment would not lead to measurable cumulative impacts due to the small project size.

4.6 Cumulative Effects – Cultural Resources

Current Conditions
The scope of the cumulative effects analysis is the project area for the duration of the project. Four unevaluated or National Register of Historic Places (NRHP) eligible sites within the project area would be mitigated to avoid adverse effects from the proposed project. The total sum acreage of these four sites is 1.23 acres, less than a 0.2% of the project area. See Affected Environment, Section 3.5.1 above for more details on current conditions.

Alternative A – No Treatment
Currently there are no adverse effects occurring to any cultural resource site from current livestock grazing and wood cutting/recreation activities. Because the location of fire suppression activities cannot be predicted cumulative effects cannot be determined. The future BOSH project will have no cumulative effects to cultural resources in the project area since cultural resource sites will be avoided or mitigated from adverse impacts.

Alternative B – Proposed Action
The proposed project is a one-time event, although conducted in different areas for a number of consecutive years. No other potential projects are proposed for the area. With the mitigation measures in place to protect unevaluated and NRHP eligible sites there would be no measurable

cumulative effects to any site when considering other past, present and reasonably foreseeable actions within the project boundary.

4.7 Cumulative Effects – Air Quality

Scope
The scope of this analysis would include Owyhee County and Malheur County. The short term timeframe would occur for a month before and after the prescribed burns to allow for any drift of smoke from this burn and any neighboring prescribed burns or wildfires. Planned burn areas include Trout Springs, Pole Creek, Silver City, Reynolds Creek, Vale District BLM and Oregon State Lands.

Current Condition
Air quality is generally good, except for short-term effects from prescribed fire and wildfire events. Dairy/feedlot operations contribute to localized air quality effects.

Alternative A – No Treatment
Future prescribed burning in Owyhee and Malheur counties (e.g., BOSH) could minimally increase particulate matter (fine particles) and decrease visibility in the short term. Dairy/feedlot operations throughout the analysis area could impact air quality at a small, localized scale. Overall, low level cumulative impacts to air quality from these activities would be negligible over the long term (>1 month).

Alternative B – Proposed Action
Impacts would be identical to Alternative A, except the proposed project would add slightly more particulate matter and decrease visibility in the short term. All impacts combined would still produce negligible long term impacts to air quality in the analysis area. Livestock grazing, fire suppression, wood cutting, and recreation would have negligible to no impact on air quality in the cumulative effects area.

5.0 Consultation and Coordination

5.1 Public Comment

Landowners and interested public were notified of a twenty day public comment period beginning September 4, 2014 and ending September 24, 2014. During that time the BLM received responses from four interested parties. Owyhee Cattlemen's Association (OCA) and Idaho State Department of Agriculture (ISDA) responses were both positive and in favor of the proposed juniper treatments.

Idaho Conservation League (ICL) response was in support of the juniper treatments but brought forward a few points which are listed and addressed in Table 7 below.

Table 7. Idaho Conservation League Comments and BLM Responses

ICL Comment	BLM Response
The EA does not reference a statistical model being used to guide experimental design.	A discussion of the research design and future monitoring ARS intends to implement has been added as an Appendix to the EA.
The BLM should seek to understand any additional or underlying causes for hydrologic change (juniper encroachment).	The research is looking specifically at the hydrological response of four watersheds to juniper removal, therefore is not designed to consider the impact grazing, suppression, climate change, and/or changes in historic vegetation conditions may have on the hydrologic changes of the four watersheds.
ICL is concerned about new soil disturbance and spread of noxious weeds from mechanical equipment.	Soil disturbance would be minimal due the potential impact consequent erosion might have on the weirs and research findings. Noxious weed spread is addressed in the Standard Operating Procedures in Section 2.3.2.
ICL is concerned about how soil productivity may be affected by chipping.	Chipping or mastication is discussed in Section 2.2, Alternatives Considered but not Analyzed in Detail.
ICL is concerned about how the increase in hazardous fuels from slash will be managed safely.	The slash would be managed with prescribed fire the year following cutting and girdling. See Section 2.3.2 Standard Operating Procedures.

The fourth response was from Western Watershed Project (WWP) requesting an extension of the twenty day comment period to thirty days, and referring BLM to apply WWP's comments previously submitted for Pole Creek EA and Trout Springs EAs to this project. The Authorized Officer granted the extension (ending October 4, 2014) and requested WWP to make comments specific to the ARS South Mountain Juniper Research EA. The BLM did not receive any further comments from WWP. Comments for Pole Creek and Trout Springs EAs are not relevant to this project for two reasons: 1. The ARS South Mountain Juniper Research is not a grazing permit renewal, and 2. This project is for research purposes and is targeting a relatively small area, 458 acres BLM land and 272 acres private (730 acres total), versus the landscape scale addressed in the Pole Creek and Trout Springs EAs. WWP also stated they requested a site visit in 2013; however, upon further review, no site visit requests by WWP were recorded in the project record.

5.2 List of Preparers

Name	Title	Function
Courtney Wyatt	Fuels Technician	Team Lead, Air Quality
Karen Kumiega	Archaeologist	Cultural Resources
Mike McGee	Wildlife Biologist	Fish and Wildlife, Special Status Animal Species
Pete Torma	Rangeland Management Specialist	Livestock Grazing Management
Stuart Hardegree (ARS)	Plant Physiologist	Vegetation, Special Status Plants, Watershed, Soils, Water Quality

Name	Title	Function
Fred Pierson (ARS)	Research Leader	Vegetation, Special Status Plants, Watershed, Soils, Water Quality
Lara Hannon	Natural Resource Specialist/Acting NEPA Specialist	EA review and administration
Seth Flanigan	NEPA Specialist	EA review and administration

5.3 List of Agencies, Organizations, and Individuals Consulted

Record of Boise District BLM Interdisciplinary (ID) Team Meetings with land owners and other publics. This does not include meetings with ID team members only.

Meeting Date	Location	Attendance	Discussion Topics
3/21/2013	Jordan Valley, OR	Jerry Hoagland, Mike Stanford, Tim Lowry, Fred Pierson, Stuart Hardegree, Ron Hartzmann, Tony Svejcar, Jon Bates, Lance Okeson, Jim Fincher, Andy Delmas, Ben Sitz, Michele McDaniel	Discussed ARS research and proposed alternative and juniper treatments.
5/21/2013	South Mountain, Juniper Creek Drainage	Jerry Hoagland, Mike Stanford, Tim Lowry, Fred Pierson, Stuart Hardegree, Ron Hartzmann, Lance Okeson, Ben Sitz, Michele McDaniel, Tina Ruffing, Pete Torma, Karen Kumiega, Courtney Wyatt	Site tour of previous ARS juniper treatments, project site, weir, weather stations, proposed firelines. Discussed scoping comments, proposed alternative, grazing, streams, and juniper management objectives.
9/4/2013	Jordan Valley, OR	Tim Lequerica, Lance Okeson	Discussed project objectives with landowner that could not be present to previous meetings.

6.0 Literature Cited

Adams, Mildretta, 2003 - *Sagebrush Post Offices, A History of Owyhee County*. Owyhee Publishing Company Inc., Homedale, ID.

Aldrich, G. A., J. A. Tanaka, R. M. Adams, and J. C. Buckhouse . 2005. Economics of western juniper control in central Oregon. Rangeland Ecology and Management 58:542-552.

Association for Fire Ecology (AFE). 2013. The Merits of Prescribed Fire Outweigh Potential Carbon Emission Effects. September 2013. Available online: http://fireecology.org/wp-content/uploads/AFEs-Prescribed-Fire-Position-Paper-2013.pdf [Accessed October 25, 2013]

Bartelt, P.E., C.R. Peterson, and R.W. Klaver. 2004. Sexual differences in the post-breeding movements and habitats selected by western toads (Bufo boreas) in southeastern Idaho. Herpetologica 60:455-467.

Bates, J.D., K.W. Davies and R.N. Sharp. 2011. Shrub-steppe early succession following juniper cutting and prescribed fire. Environmental Management 47:468-481.

Bates, J.D. and R.F. Miller. 1998. Understory patterns in cut western juniper (*Juniperus occidentalis* ssp. *occidentalis* Hook.) woodlands. Great Basin Naturalist 58:363-374.

Bates, J.D., R.F. Miller and T.J. Svejcar. 2000. Understory dynamics in cut and uncut western juniper woodlands. Journal of Range Management 53:119-126.

Bates, J.D., R.F. Miller and T.J. Svejcar. 2005. Long-term successional trends following western juniper cutting. Rangeland Ecology and Management 58:533-541.

Bates, J. and T. Svejcar. 2006. Herbaceous response to burning of cut juniper. Pages 4-5 *in* D. Bohnert and J. D. Bates, editors. Research Progress Report 2005: Eastern Oregon Agricultural Research Center, Burns. SR 1057. Oregon State University Agricultural Experiment Station, Corvallis, OR. Available online: http://extension.oregonstate.edu/catalog/html/sr/sr1057/003herbaceous.pdf [accessed October 22, 2013].

Blackburn, W. H., and C. M. Skau. 1975. Infiltration rates and sediment production of selected plant communities in Nevada. Journal of Range Management 27:476-480.

Blackburn, W. H. 1975. Factors influencing infiltration and sediment production of semiarid rangelands in Nevada. Water Resources Research 11:929-937.

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

Briske, D. D., S. D. Fuhlendorf, and F. E. Smeins . 2006. A unified framework for assessment and application of ecological thresholds. Rangeland Ecology and Management 59:225-236.

Bull, E. L. 2006. Sexual differences in the ecology and habitat selection of Western Toads (Bufo boreas) in northeastern Oregon. Herpetological Conservation and Biology 1:27–38.

Burkhardt, J.W. and E.W. Tisdale. 1969. Nature and successional status of western juniper vegetation in Idaho. Journal of Range Management 22:264-270.

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. Unpublished Report. Cheyenne, Wyoming.

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

Davies, K. W., C. S. Boyd, J. L. Beck, J. D. Bates, T. J. Svejcar, and M. A. Gregg. 2011. Saving the sagebrush sea: an ecosystem conservation plan for big sagebrush plant communities. Biological Conservation 144:2573-2584.

Dobkin, D. S., and J. D. Sauder. 2004. Shrubsteppe landscapes in jeopardy. Distributions, abundances, and the uncertain future of birds and small mammals in the Intermountain West. High Desert Ecological Research Institute, Bend, OR.

Garton, E. O., J. W. Connelly, J. S. Horne, C. A. Hagen, A. Moser, and M. A. Schroeder. 2011. Greater Sage-Grouse Population Dynamics and Probability of Persistence. Pp. 293-382 in S. T. Knick and J. W. Connelly (Editors). Greater Sage-grouse: Ecology and Conservation of a Landscape Species and Its Habitats. Studies in Avian Biology (Vol.38), University of California Press, Berkeley, CA.

Gedney, D.R., D.L. Azuma, C.L. Bolsinger, and N. McKay. 1999. Western Juniper in Eastern Oregon. USDA Forest Service General Technical Report NW-GTR-464. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 53 p.

Groves, C. R., B. Butterfield, A. Lippincott, B. Csuti, and J. M. Scott. 1997. Atlas of Idaho's wildlife; integrating Gap Analysis and Natural Heritage Information. Idaho Dept. Fish and Game, Non-game and Endangered Wildlife Program, Boise, ID. 372 p.

Idaho Department of Environmental Quality (IDEQ). 2010. Mission Website. http://www.deq.idaho.gov/about/deq_purpose.cfm [Accessed September 22, 2010]

Idaho Sage-grouse Advisory Committee. 2006. Conservation Plan for the Greater Sage-grouse in Idaho.

Johnson, D.D. 2005. The influence of environmental attributes on temporal and structural dynamics of western juniper woodland development and associated fuel loading characteristics. M.S. Thesis, Oregon State University, Corvallis, OR.

Johnson, D.D., and R. F. Miller. 2006. Structure and development of expanding western juniper woodlands as influenced by two topographic variables. Forest Ecology and Management 229:7-15.

Knick, S. T., D. S. Dobkin, J. T. Rotenberry , M. A. Schroeder, M. W. Vander Haegen, and C. Van Riper III. 2003. Teetering on the edge or too late? Conservation and research issues for avifauna of sagebrush habitats. Condor 105:611-634.

McGrath C.L., Woods A.J., Omernik, J.M., Bryce, S.A., Edmondson, M., Nesser, J.A., Shelden, J., Crawford, R.C., Comstock, J.A., and Plocher, M.D. 2002. Ecoregions of Idaho (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,350,000).

Miller, R.F. 2001. Managing western juniper for wildlife. Woodland Fish and Wildlife. MISC0286 Washington State University Cooperative Extension, Pullman, WA.

Miller, R. F., J. D. Bates, T. J. Svejcar, F. B. Pierson, and L. E. Eddleman. 2005. Biology, Ecology, and Management of Western Juniper (*Juniperus occidentalis*). Corvalis, Oregon, USA: Oregon State University Agricultural Experiment Station, Technical Bulletin 152. 82 p.

Miller, R. F., R. J. Tausch, E. D. McArthur, D. D. Johnson, and S. C. Sanderson. 2008. Age structure and expansion of piñon-juniper woodlands: A regional perspective in the Intermountain West. Fort Collins, CO, USA: US Department of Agriculture, Forest Service, RMRS-RP-69. 15 p.

Miller, R. F., S. T. Knick, D. A. Pyke, C. W. Meinke, S. E. Hanser, M. J. Wisdom, and A. L. Hild . 2011. Characteristics of sagebrush habitats and limitations to long-term conservation. In: S. T. Knick and J. W. Connelly [EDS.]. Greater sage-grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology, Volume 38. Berkeley, CA, USA: University of California Press. p. 145-184.

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

Miller, R.F., T.J. Svejcar and J.A. 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. The role of fire in pinyon and juniper woodlands: a descriptive analysis. In: K.E.M. Galley, and T.P. Wilson [Eds.]. Proceedings of the Invasive

Species: the Role of Fire in the Control and Spread of Invasive Species. Miscellaneous Publication no. 11; Tallahassee, FL: Tall Timbers Research Station. p. 15-30.

Miller, R.F., R.J. Tausch, and W. Waichler. 1999. Old-growth juniper and pinon woodlands. In: S.B. Monsen, R. Stevens, R.J. Tausch, and R.F. Miller [compilers]. Proceedings: Ecology and Management of Pinon-juniper Communities within the Interior West. USDA Forest Service Proceedings RMRS-P-9; Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 375-384.

NRCS. 2014. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed [8/14/2014].

Owyhee County Sage-grouse Local Working Group. 2013. Sage-Grouse Management Plan, Owyhee County, Idaho. Adopted June 2000. Updated and amended 2004 & 2013.

Paige, C., and S. A. Ritter. 1999. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Boise, Idaho: Partners in Flight Western Working Group.

Palmgren, Lois 1999 – Bruneau and Owyhee Field Offices Background Document. On file at the Bruneau Field Office.

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

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

Pierson, F. B., S. S. Van Vactor, W. H. Blackburn, and J. C. Wood. 1994. Incorporating small scale spatial variability into predictions of hydrologic response on sagebrush rangelands. In: Variability in rangeland water erosion processes, Soil Science Society of America Special Publication 38. Madison, WI, USA: Soil Science Society of America. p. 23-34.

Pierson, F. B., W. H. Blackburn, and S. S. Van Vactor. 2007. Hydrologic impacts of mechanical seeding treatments on sagebrush rangelands. Rangeland Ecology and Management 60:666-674.

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

Pierson, F. B., P. R. Robichaud, C. A. Moffet, K. E. Spaeth, S. P. Hardegree, P. E. Clark, and C. J. Williams. 2008. Fire effects on rangeland hydrology and erosion in a steep sagebrush-dominated landscape. Hydrological Processes 22:2916-2929.

Pierson, F. B., C. A. Moffet, C. J. Williams, S. P. Hardegree, and P. E. Clark. 2009. Prescribed-fire effects on rill and interrill runoff and erosion in a mountainous sagebrush landscape. Earth Surface Processes and Landforms 34:193-203.

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 and Management 63:614-629.

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 and Management 66:274-289.

Pierson, F. B., C. J. Williams, P. K. Kormos, and O. Z. Al-Hamdan. In review. Short-term effects of tree removal on infiltration, runoff, and erosion in woodland-encroached sagebrush steppe. Rangeland Ecology and Management In review.

Rau, B. M., R. Tausch, A Reiner, D. W. Johnson, J. C. Chambers, R. R. Blank, and A. Lucchesi. 2010. Influence of prescribed fire on ecosystem biomass, carbon, and nitrogen in a pinyon juniper woodland. Rangeland Ecology and Management 63:197-202.

Raymond, R. W. 1877 – Statistics of Mines and Mining in the States and Territories West of the Rocky Mountains: 8th Annual Report. Washington: Government Printing Office.

USDA Forest Service, 1981. Atlas of United States Trees. Volume 1. Conifers and Important Hardwoods. USDA Forest Service Miscellaneous Publication No. 1146. U.S. Department of Agriculture, Forest Service.

USDI-BLM 1999. Owyhee Resource Management Plan. Lower Snake River District BLM. 206pp.

USDI-BLM 2006. Juniper Mountain Landscape Restoration Strategy. Bureau of Land Management, Owyhee Field Office. 27 pp.

USDI-BLM 2010. Rapid ecological assessment of the Northern Basin and Range and Snake River Plain. BLM/OC/ST-10/002+1636. Denver, CO. 43pp.

USDI-BLM 2011. Fence Marking Guidelines. Instruction Memorandum No. ID-100-2011-001, Boise District Office BLM. Boise, ID.

USDI BLM. 2012. Greater sage-grouse interim management policies and procedures. Instruction Memorandum IM 2012-043, Washington Office BLM. Washington, D.C.

USDI BLM. 2012. Greater sage-grouse interim management policies and procedures. Instruction Memorandum IM 2012-043, Washington Office BLM. Washington, D.C.

Williams, C. J., F. B. Pierson, O. Z. Al-Hamdan, P. R. Kormos, S. P. Hardegree, and P. E. Clark. 2013. Can wildfire serve as an ecohydrologic threshold-reversal mechanism on juniper-encroached shrublands? Ecohydrology DOI: 10.1002/eco.136

7.0 Appendix A - ARS NWRC South Mountain Juniper Research Program

Principal Collaborators:

- USDA-ARS Northwest Watershed Research Center (NWRC), Boise, ID
- USDA-ARS Eastern Oregon Agricultural Research Center (EOARC), Burns, OR
- Bureau of Land Management Idaho State Office, Boise District, Owyhee Field Office
- Owyhee County land owners and permittees

Background and Introduction

Wildland fire played a fundamental role in the development and maintenance of Intermountain West shrub-steppe plant communities that contain relict stands of mature western juniper (*Juniperus occidentalis* var. *occidentalis* Hook) (Brown, 2000; Payson et al., 2000). Historical patterns of fire frequency maintained these systems in a successional cycle that was most often terminated at the grass/shrub stage (Figure 1; Miller and Rose, 1995; 1999). Disruption of this cycle has led to shrub-dominated stands that are susceptible to large-scale catastrophic fires, and to fire-resistant juniper communities that exhibit low levels of structural and species diversity (Miller and Rose, 1995; 1999; Bates et al., 2000; Miller et al., 2000). Western juniper now dominates over 9 million acres of rangeland in the Intermountain West (USDA Forest Service, 1981; Gedney et al., 1999; Miller and Tausch, 2001), over 90% of which represents expansion from pre-settlement habitat (Miller et al., 1999; Johnson, 2005). The potential for recovery of grass and shrub species with western-juniper control has been relatively well documented in the region (Burkhardt and Tisdale, 1969; Bates et al., 1998; Bates et al., 2000; Miller et al., 2000; Bates et al., 2005). Hydrologic impacts of western juniper, especially at the landscape scale, are less well understood (Miller et al., 2005). New methodologies are also needed to map and monitor both old-growth relict stands, and to monitor and model patterns of current and future woodland expansion (Miller et al., 2005; Johnson and Miller, 2006).

Pierson et al. (2007) documented western-juniper impacts on infiltration, runoff and erosion on a site with a restricted soil layer, but studies of this type need to be expanded to survey regional variability in site conditions, and at larger landscape scales. Limited studies are available describing the fundamental hydrologic and erosion processes impacted during the advancement of juniper encroachment and under common juniper control treatments. Hydrologic impacts of western juniper at the watershed scale must currently be inferred from studies and data generated from south-central and south-western rangelands (Wilcox, 2002; Wilcox et al., 2003). Wilcox (2002) concluded that woody-plant control in areas that receive less than 500 mm of annual rainfall are unlikely to affect stream-flow yield. Western-juniper woodlands in the Intermountain West, however, receive their primary precipitation input as snow. Unlike rainfall; snow distribution, redistribution, ablation, and melt patterns are highly affected by vegetation and topography (Marks et al., 1992; 1999; 2002; Wigmosta et al., 1994; Liston and Elder, 2006). Differences in canopy structure of typical shrub-steppe vegetation vs. juniper-woodland may impact snow accumulation and drift patterns, yielding significant changes in the timing and amount of stream-flow subsequent to juniper control and vegetation recovery. A major current limitation to simulating vegetation and topographic effects on snow hydrology and melt patterns is the difficulty in characterizing canopy structure and variability at the basin scale (Garen et al., 1999; Marks et al., 1999; Garen and Marks, 2005).

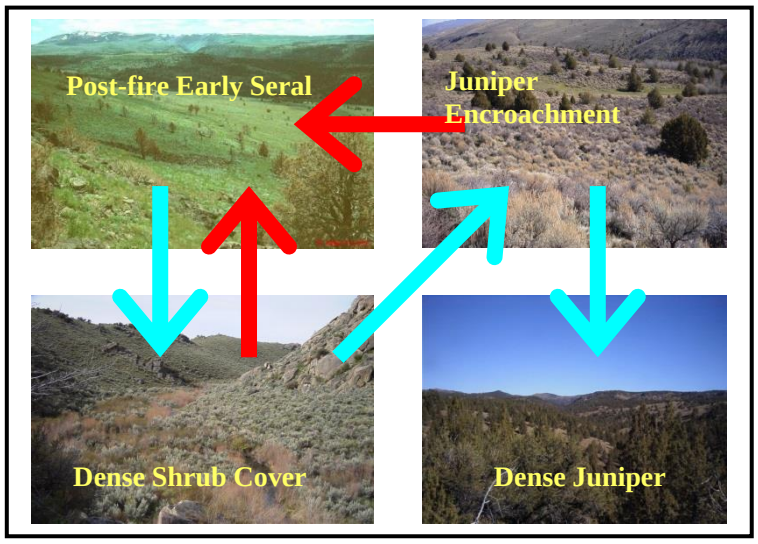


Figure 1 - Fire cycle in mountain sagebrush with juniper encroachment. Historically, these systems had a natural fire cycle of 20-25 years which would restrict juniper to rocky areas and ridges that are naturally resistant to fire. Removal of fire from these systems has disrupted normal successional patterns, increased fuel loads in sagebrush systems, and ultimately led to dominance of fire resistant juniper communities on millions of acres.

Airborne LiDAR (Light Detection and Ranging) is an emerging remote sensing tool for characterizing topography and plant-canopy characteristics, but has primarily been used in forested vegetation types (Drake et al., 2002; Popescue et al., 2002; Riano et al., 2004). Streutker and Glenn (2006) and Mundt et al. (2006) have recently used LiDAR to measure canopy characteristics of sagebrush-steppe vegetation, which is at the lower size-limit that can be characterized by current LiDAR technology (Streutker and Glenn, 2006; Mundt et al., 2006). As relict stands of western juniper are correlated with unique topographic characteristics (Burkhardt and Tisdale, 1969; Vasek and Thorne, 1977; Holmes et al., 1986; Miller and Rose, 1995; Waichler et al., 2001), and patterns of juniper expansion have been shown to be correlated with topography (Johnson and Miller, 2007), LiDAR is a very effective remote sensing tool for landscape-scale monitoring of western juniper status and invasion trajectory. LiDAR may also be very useful in parameterizing hydrologic models for predicting juniper impacts and treatment effects on timing and amount of stream-flow in snow-dominated systems. A LiDAR flight was conducted at the South Mountain Watershed Experiment Area in 2007 and the results published by Sankey et al. (2013)

NWRC scientists have an extensive background in hydrologic modeling and monitoring, at plot, field and landscape scale (Flerchinger et al., 1994; Pierson et al., 1994; Flerchinger and Pierson, 1997; Marks et al., 1998; Marks et al., 1999; Flerchinger and Cooley, 2000; Marks and Winstral, 2001; Pierson et al., 2001a; Marks et al., 2002; Pierson et al., 2002; Winstral et al., 2002; Flerchinger and Hardegree, 2004; Seyfried et al., 2005; Seyfried and Wilcox, 2006; Pierson et al., 2007) and have operated an intensive watershed-scale field program in the Intermountain sagebrush steppe for over 45 years (Hanson et al., 2001; Marks et al., 2001; Pierson et al., 2001b; Seyfried et al., 2001a; 2001b; 2001c; 2001d; Slaughter et al., 2001; Flerchinger et al., 2007).

The proposed project is closely coordinated with the concurrent project plan for the ARS rangeland research unit in Burns, Oregon (NP215 CRIS 5360-11630-005-00D) which is focusing on juniper ecology, juniper control systems and vegetation response. Research proposed for this project is also complementary to previous and ongoing work in the area of fire effects, rangeland restoration, juniper management and hydrologic processes conducted by ARS rangeland research units in the region (Reno, NV; Logan, UT; Dubois, ID; Tucson, AZ) and their collaborators in the Intermountain west. NWRC is also conducting extensive research in the area of LiDAR remote sensing and snow hydrology (NP211 CRIS 5362-13610-006-00D, Snow and Hydrologic Processes in the Intermountain West).

General Research Approach
Improve guidelines and methods for monitoring and assessing impacts of juniper encroachment and management on plant, soil and water resources in sagebrush-steppe ecosystems to enhance efficiency and success in action agency planning and implementation of juniper-control treatments throughout the Intermountain West.

Objective: Develop long-term infrastructure for monitoring phase-III juniper impacts and juniper control by mechanical treatment and prescribed fire on watershed-scale soil, water and vegetation resources.

Rationale: Long-term, watershed-scale data are needed to establish landscape-scale impacts of western juniper on soil, water, vegetation and animal resources in the sagebrush-steppe.

Experimental Design: Four watersheds in western Owyhee County, Idaho were instrumented in 2007, by NWRC in collaboration with the EOARC (ARS-Burns, OR), to monitor and telemeter streamflow and suspended sediment concentrations. A meteorological network was also deployed to monitor precipitation, air temperature, humidity, wind speed and direction, solar radiation and snow depth. The intent of this program is to monitor and model hydrologic variables in these systems for a sufficient time to calibrate these watersheds against each other, and to develop and test hydrologic models for predicting timing and amount of streamflow as a function of meteorological inputs. After an extended calibration period (6-10 years), one watershed each year will undergo treatment to remove the juniper. After all of the watersheds have been treated, these systems will be monitored for an additional 6-10 year period to measure post-treatment changes in hydrology, erosion and vegetation cover. By initiating juniper treatments sequentially in different years, we will develop modeling datasets for pre and post-treatment, and for comparison of individual treated and untreated watersheds during the 4-year conversion interval. NWRC will collect these data, conduct monthly and quarterly quality control checks, and will summarize the data annually for subsequent analysis and modeling. In addition to the base data collection, NWRC will conduct an annual snow survey and will collaborate with EOARC in monitoring vegetation characteristics.

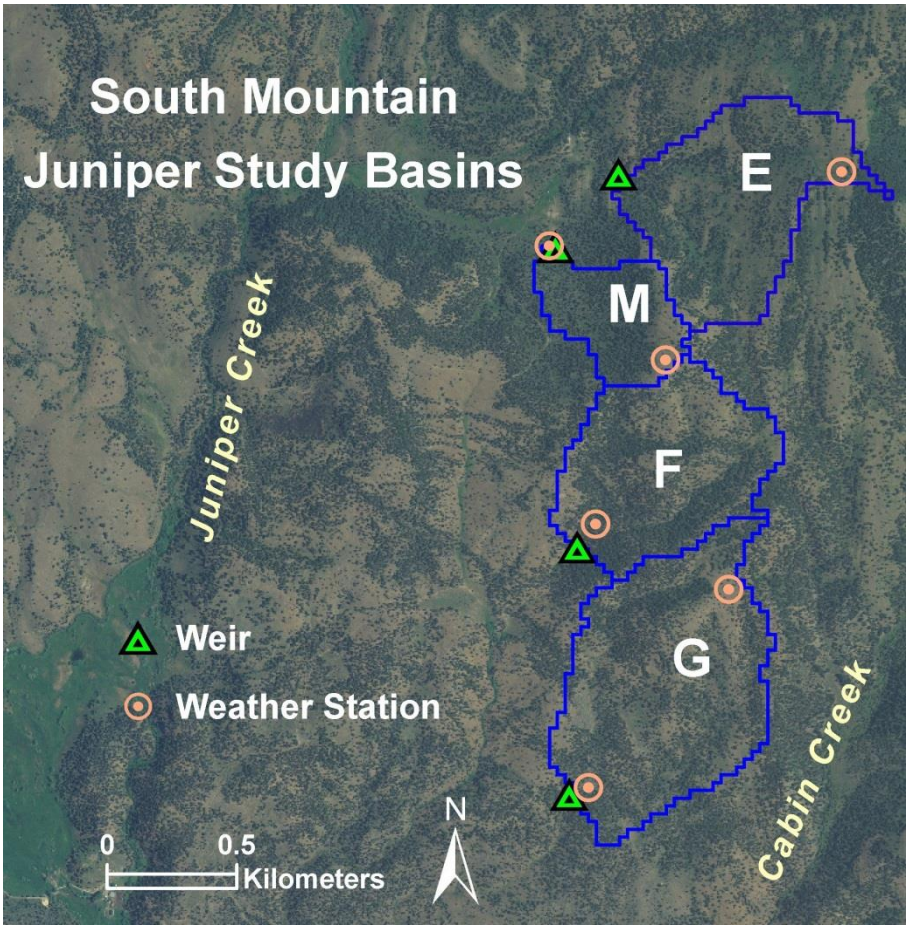


Figure 2 – South Mountain Juniper Study Basins

Contingencies: Southern Idaho and the Great Basin periodically undergo periods of extended drought. If there is an extended drought period in the next 10-15 years, this study may need to be extended until the full range of potential weather and climate is experienced. Wildfires periodically sweep through the area where we are conducting this study. A large-scale crown fire in this area could destroy our instrumentation network and would probably cause us to terminate the study. If a fire occurs after a suitable period of calibration, we may be able to use the fire as the juniper control treatment and could still model pre and post-fire hydrologic impacts.

Literature Cited

Bates, J.D., R.F. Miller, and T.J. Svejcar. 1998. Understory patterns in cut western juniper woodlands. Great Basin Naturalist 58:363-374.

Bates, J.D., R.F. Miller, and T.J. Svejcar. 2000. Understory dynamics in cut and uncut western juniper woodlands. Journal of Range Management 53:119-126.

Bates, J.D., R.F. Miller, and T.J. Svejcar. 2005. Long term success trends following western juniper cutting. Rangeland Ecology and Management 58:533-541.

Brown, J.K. 2000. Introduction and fire regimes. In: J.K. Browns, and J.K. Smith [eds.]. Wildland Fire in Ecosystems: Effects of fire on Flora. General Technical Report RMRS-GTR-42-volume 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 1-7.

Burkhardt, J.W., and E.W. Tisdale, 1969. Nature and successional status of western juniper vegetation in Idaho. Journal of Range Management 22:264-270.

Drake, J.B., R.O. Dubayah, D.B. Clark, R.G. Knox, J.B. Blair, M.A. Hofton, R.L. Chazdon, J.F. Weishampel, and S.D. Prince. 2002. Estimation of tropical forest structural characteristics using large-footprint LiDAR. Remote Sensing of the Environment 79:305-319.

Flerchinger, G.N., and K.R. Cooley, 2000. A ten-year water balance of a mountainous semi-arid watershed. Journal of Hydrology 237:86-99.

Flerchinger, G.N., and F.B. Pierson. 1997. Modeling plant canopy effects on variability of soil temperature and water: model calibration and validation. Journal of Arid Environments 35:641-653.

Flerchinger, G.N., and S.P. Hardegree. 2004. Modelling near-surface temperature and moisture for germination response predictions of post-wildfire seedbeds. Journal of Arid Environments 59:369-385.

Flerchinger, G.N., D. Marks, S.P. Hardegree, A. Nayak, A.H. Winstral, M.S. Seyfried, F.B. Pierson, and P.E. Clark. 2007. 45 Years of Climate and Hydrologic Research Conducted at the Reynolds Creek Experimental Watershed. In: J.R. Rogers [Ed.]. Environmental and Water Resources: Milestones in Engineering History. ASCE Environmental and Water Resources Institute (EWRI) National History & Heritage Committee. Reston, VA: American Society of Civil Engineers. p. 135-143.

Garen, D., and D. Marks, 2005. Spatially distributed energy balance snowmelt modelling in a mountainous river basin. Journal of Hydrology 315:126-153.

Garen, D., D. Woodward, and F. Geter. 1999. A user-agency's view of hydrologic, soil erosion and water quality modeling. Catena 37:277-289.

Gedney, D.R., D.L. Azuma, C.L. Bolsinger, and N. McKay. 1999. Western Juniper in Eastern Oregon. USDA Forest Service General Technical Report NW-GTR-464. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 53 p.

Hanson, C.L., D. Marks, and S.S. Van Vactor. 2001. Long-term climate database, Reynolds Creek Experimental Watershed, Idaho, USA. Water Resources Research 37:2839-2842.

Holmes, R.L., R.K. Adams, and H.C. Fritts. 1986. Tree ring chronologies of western North America: California, eastern Oregon and northern Great Basin. Chronology Series VI. Laboratory of Tree Ring Research, University of Arizona, Tucson.

Johnson, D.D. 2005. The influence of environmental attributes on temporal and structural dynamics of western juniper woodland development and associated fuel loading characteristics. M.S. Thesis, Oregon State University, Corvallis, OR.

Johnson, D.D., and R.F. Miller. 2006. Structure and development of expanding western juniper woodlands as influenced by two topographic variables. Forest Ecology and Management 229:7-15.

Liston, G., and K. Elder. 2006. A distributed snow-evolution modeling system (SnowModel). Journal of Hydrometeorology 7:1259-1276.

Marks, D., and A. Winstral. 2001. Comparison of snow deposition, the snowcover energy balance, and snowmelt at two sites in a semi-arid mountain basin. Journal of Hydrometeorology 2:213-227.

Marks, D., J. Domingo and J. Frew. 1999. Software Tools for Hydro-Climatic Modeling and Analysis: Image Processing Workbench, ARS-USGS Version 2. ARS Technical Bulletin 99-1, (Electronic Document: http://www.nwrc.ars.usda.gov.ipw).

Marks, D., J. Dozier, and R. Davis. 1992. Climate and energy exchange at the snow surface in the alpine region of the Sierra Nevada 1. Meteorological measurements and monitoring. Water Resources Research 28:3029-3042.

Marks, D., A. Winstral, and M. Seyfried. 2002. Simulation of terrain and forest shelter effects on patterns of snow deposition, snowmelt and runoff over a semi-arid mountain catchment. Hydrological Processes 16:3605-3626.

Marks, D., K.R. Cooley, D.C. Robertson, and A. Winstral. 2001. Long-term snow database, Reynolds Creek Experimental Watershed, Idaho, USA. Water Resources Research 37:2835-2838.

Marks, D., J. Kimball, D. Tingey and T. Link. 1998. The sensitivity of snowmelt processes to climate conditions and forest cover during rain on snow: A case study of the 1996 Pacific Northwest flood. Hydrological Processes 12:1569 1587.

Marks, D., J. Domingo, D. Susong, T. Link, and D. Garen. 1999. A spatially distributed energy balance snowmelt model for application in mountain basins. Hydrological Processes 13:1935-1959.

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., 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 R.J. Tausch. 2001. The role of fire in pinyon and juniper woodlands: a descriptive analysis. In: K.E.M. Galley, and T.P. Wilson [Eds.]. Proceedings of the Invasive Species: the Role of Fire in the Control and Spread of Invasive Species. Miscellaneous Publication no. 11; Tallahassee, FL: Tall Timbers Research Station. p. 15-30.

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

Miller, R.F., R.J. Tausch, and W. Waichler. 1999. Old-growth juniper and pinon woodlands. In: S.B. Monsen, R. Stevens, R.J. Tausch, and R.F. Miller [compilers]. Proceedings: Ecology and Management of Pinon-juniper Communities within the Interior West. USDA Forest Service Proceedings RMRS-P-9; Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 375-384.

Miller, R.F., J.D. Bates, T.J. Svejcar, F.B. Pierson and L.E. Eddleman. 2005. Biology, Ecology and Management of Western Juniper (*Juniperus occidentalis*). Oregon State University Agricultural Experiment Station Technical Bulletin 152. Corvallis, OR: 77 p.

Millspaugh, J., and J.M. Marzluff [Eds]. 2001. Radio tracking and animal populations. San Diego: Academic Press. 474 p.

Mundt, J.T., D.R. Streutker, and N.F. Glenn. 2006. Mapping sagebrush distribution using fusion of hyperspectral and LiDAR classifications. Photogrammetric Engineering & Remote Sensing 72:47-54.

Payson, T.E., R.J. Ansley, J.K. Brown, G.J. Gottfried, S.M. Haase, M.G. Harrington, M.G. Narog, S.S. Sackett, and R.C. Wilson. 2000. Fire in western shrubland, woodland, and grassland ecosystems. In: J.K. Brown, and J.K. Smith [Eds.]. Wildland Fire in Ecosystems: Effects of fire on Flora. Gen. Tech. Rep. RMRS-GTR-42-volume 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 121-159.

Pierson, F.B., D.H. Carlson, and K.E. Spaeth. 2002. Impacts of wildfire on soil hydrological properties of steep sagebrush-steppe rangeland. International Journal of Wildland Fire 11:145-151.

Pierson, F.B., P.R. Robichaud, and K.E. Spaeth. 2001a. Spatial and temporal effects of wildfire on the hydrology of a steep rangeland watershed. Hydrological Processes 15:2905-2916.
Pierson, F.B., J.D. Bates, T.J. Svejcar, and S.P. Hardegree. 2007. Runoff and erosion after cutting western juniper. Rangeland Ecology and Management 60:285-292.
Pierson, F.B., W.H. Blackburn, S.S. Van Vactor, and J.C. Wood. 1994. Partitioning small scale spatial variability of runoff and erosion on sagebrush rangeland. Water Resources Bulletin 33:1081-1089.
Pierson, F.B., C.W. Slaughter, and Z.K. Cram. 2001b. Long-term stream discharge and suspended-sediment database, Reynolds Creek Experimental Watershed, Idaho, United States. Water Resources Research 37:2857-2861.
Popescue, S.C., R.H. Wynne, and R.F. Nelson. 2002. Estimating plot-level tree heights with LiDAR: Local filtering with a canopy-height based variable window size. Computers and Electronics in Agriculture 37:71-95.
Riano, D., F. Valladares, S. Condes, and E. Chuvieco. 2004. Estimation of Leaf Area Index and covered ground from airborne laser scanner (LiDAR) in two contrasting forests. Agricultural and Forest Meteorology 124:269-275.
Sankey, T., R. Shrestha, J.B. Sankey, S. Hardegree and E. Strand. 2013. Lidar-derived estimate and uncertainty of carbon sink in successional phases of woody encroachment. Journal of Geophysical Research: Biogeosciences 118:1144-1155.
Seyfried, M.S., and B.P. Wilcox. 2006. Soil water storage and rooting depth: key factors controlling recharge on rangelands. Hydrological Processes 20:3261-3276.
Seyfried, M.S., C.L. Hanson, M.D. Murdock and S.S. Van Vactor. 2001a. Long-term lysimeter database, Reynolds Creek Experimental Watershed, Idaho, USA. Water Resources Research 37:2853-2856.
Seyfried, M., R. Harris, D. Marks, and B. Jacob. 2001b. Geographic database, Reynolds Creek Experimental Watershed, Idaho, United States. Water Resources Research 37:2825-2829.
Seyfried, M.S., M.D. Murdock, C.L. Hanson, G.N. Flerchinger, S.S. Van Vactor. 2001c. Long-term soil water content database, Reynolds Creek Experimental Watershed, Idaho, USA. Water Resources Research 37: 2847-2851.
Seyfried, M.S., G.N. Flerchinger, M.D. Murdock, C.L. Hanson, and S.S. Van Vactor. 2001d. Long-term soil temperature database, Reynolds Creek Experimental Watershed, Idaho, USA. Water Resources Research 37:2843-2846.
Seyfried, M.S., S. Schwinning, M.A. Walvoord, W.T. Pockman, B.D. Newman, R.B. Jackson, and F.M. Phillips. 2005. Ecohydrological control of deep drainage in arid and semiarid regions. Ecology 86:277-287.
Slaughter, C.W., D. Marks, G. Flerchinger, S. Van Vactor, and M. Burgess. 2001. Thirty-five years of research data collection at the Reynolds Creek Experimental Watershed, Idaho, United States. Water Resources Research 37:2819-2823.
Streutker, D.R., and N.F. Glenn. 2006. LiDAR measurement of sagebrush steppe vegetation heights. Remote Sensing of Environment 102:135-145.
USDA Forest Service, 1981. Atlas of United States Trees. Volume 1. Conifers and Important Hardwoods. USDA Forest Service Miscellaneous Publication No. 1146. U.S. Department of Agriculture, Forest Service.
Vasek, F.C., and R.F. Thorne. 1977. Transmontane coniferous vegetation. In: M.G. Barbour and J. Major [Eds.]. Terrestrial Vegetation of California. New York, NY: John Wiley and Sons. p. 797-832.

Waichler, W.S., R.F. Miller, and P.S. Doescher. 2001. Community characteristics of juniper woodlands. Journal of Range Management 54:518-527.
Wigmosta, M.S., L. Vail, and D.P. Lettenmaier. 1994. A distributed hydrology-vegetation model. Water Resources Research 30:1665-1679.
Wilcox, B.P. 2002. Shrub control and streamflow on rangelands: a process based viewpoint. Journal of Range Management 55:318-326.
Wilcox, B.P., D.D. Breshears, and C.D. Allen. 2003. Ecohydrology of a resource-conserving semiarid woodland: effects of scale and disturbance. Ecological Monographs 73:223-239.
Winstral, A., K. Elder, and R.E. Davis. 2002. Modelling the effects of wind induced snow redistribution with terrain-based parameters to enhance spatial snow modeling. Journal of Hydrometeorology 3:524-528.

Principle Contacts:

USDA - Agricultural Research Service - Northwest Watershed Research Center, 800 Park Blvd., Suite 105, Boise, Idaho 83712

- Fred Pierson, Hydrologist, Research Leader, 208-422-0720, fred.pierson@ars.usda.gov
- Stuart Hardegree, Plant Physiologist, 208-422-0728, stuart.hardegree@ars.usda.gov
- Mark Seyfried, Soil Scientist, 208-422-0715, mark.seyfried@ars.usda.gov
- Gerald Flerchinger, Hydraulic Engineer, 208-422-0716, gerald.flerchinger@ars.usda.gov
- Danny Marks, Hydrologist, 208-422-0721, danny.marks@ars.usda.gov

USDA - Agricultural Research Service - Eastern Oregon Agricultural Research Center, 67826-A Hwy. 205, Burns, OR 97720

- Tony Svejcar, Rangeland Scientist, Research Leader, 541-573-890, tony.svejcar@oregonstate.edu
- Jon Bates, Rangeland Scientist, 541-573-8932, jon.bates@oregonstate.edu
- Chad Boyd, Rangeland Scientist, 541-573-8939, chad.boyd@oregonstate.edu