Southern Nevada Complex Emergency Stabilization and Rehabilitation Final Report

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BLM

Southern Nevada Complex Emergency Stabilization and Rehabilitation Final Report

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NOTE

Due to the size of the complete report, the Ely District Bureau of Land Management is only presenting the Executive Summary, Table of Contents, List of Tables, List of Figures, List of Appendices, and List of Acronyms on the BLM Website. To request a CD containing the full version of the report, contact the Emergency Stabilization and Rehabilitation Coordinator at the Ely District Bureau of Land Management at 775-289-1800.

Executive Summary

BACKGROUND

Between June 22, 2005 and July 10, 2005, the 11 fires that make up the Southern Nevada Complex (SNC) burned 739,037 acres in southeastern Nevada, southwestern Utah and northwestern Arizona. The Ely District Bureau of Land Management (BLM) manages 597,096 acres across four of the SNC fires—the Delamar fire (168,007 acres), the Duzak fire (214,038 acres), the Halfway fire (66,487 acres), and the Meadow Valley fire (148,564 acres). The location and spatial extent of the Ely BLM burned areas are displayed in Figure 1. The Southern Nevada Complex Emergency Stabilization and Burned Area Rehabilitation (SNCESBAR) Final Report looks at the Emergency Stabilization and Rehabilitation (ESR) efforts on the Ely BLM managed lands.

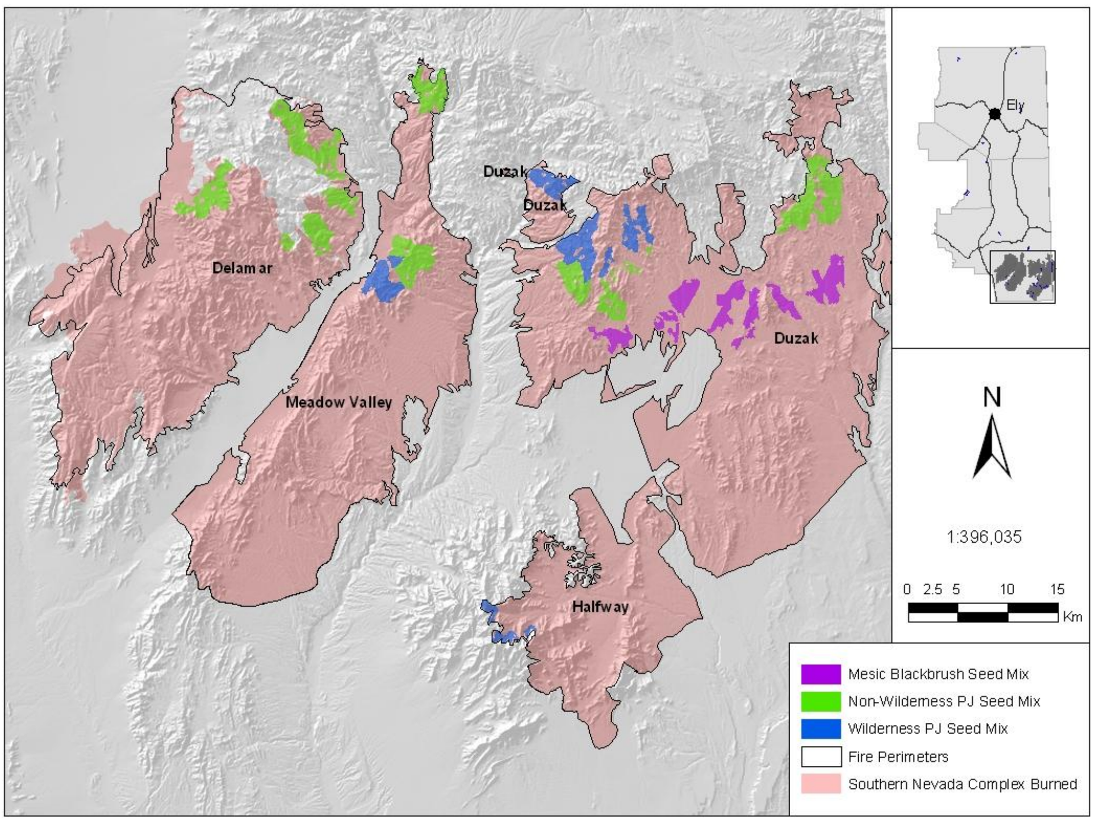

Figure S-1. Location and spatial extent of the Southern Nevada Complex fires.

The SNC fires were initiated on June 22, 2005 by dry lightning storms and spread quickly due to high fuel loads and winds. Heavy rains during the previous winter and spring (resulting in more than 400% of normal rainfall from January through April 2005) allowed for unusually high production of non-native annual grasses (predominantly red brome and cheatgrass) that were able to carry fire through areas of normally sparse vegetation. These fine fuels served as ladder fuels between grasses, forbs, shrubs and trees of at least 12 vegetation communities in the Mojave Desert and Great Basin regions.

The SNC fires exhibited extreme fire behavior. Initial fire starts grew rapidly. Many times starts had grown to 1000 acres or more before initial attack. The situation was complicated by restrictions to suppression activities as a result of environmental concerns about endangered desert tortoise habitat. Initially this limited the use of engines and dozers to existing roads. The most common suppression tactics were retardant and water drops, backfires, and using roads and geographic features. Hand line construction was limited by fast moving fire and high rates of spread.

The eleven SNC fires burned nearly 740,000 acres in the Mojave Desert during the summer of 2005, more than the nearly 722,000 acres of fire this desert experienced in the preceding 25 years combined (Brooks and Matchett 2006). It was a significant ecological event for the Mojave Desert and presents many land management challenges in southern Nevada and for the Ely District BLM.

GEOGRAPHIC SETTING

The SNC fires burned primarily in the Basin and Range Physiographic Province, in relatively narrow north-south-trending mountain ranges separated by wider sediment-filled basins. The exception to this trend is the Clover and Mormon mountain ranges. The Clover Mountains trend east west, forming a boundary between the Great Basin desert to the north and the Mojave Desert to the south. The Mormon mountains are almost circular. SNC elevations range from about 2,000 feet in the southeastern valleys to over 8,500 feet in the North Pahranagat Range.

Average annual rainfall is 4-20 inches across the SNC depending on elevation, and precipitation is highly variable from one year to the next. The SNC experiences an arid to semi-arid climate. Summers tend to be hot, dry and windy, and freezing temperatures often occur during the winter, particularly in higher elevation regions. Lightning events are common, particularly in July and August during the monsoon season, and are a primary source of wildfire ignition.

Surface water resources in the area are limited and groundwater is scarce. Most stream channels within the SNC are ephemeral, flowing only during and immediately after rainfall events. Major flooding is caused by winter storms or rain-on-snow events in the higher elevations. Flash flooding can occur in any area at any time of year but is most probable during the summer and fall. Meadow Valley Wash is the only perennial stream within the SNC boundaries.

The dominant soil orders found within the burned areas are mineral soils low in organic matter with layers that are highly variable in thickness, texture, rock fragment content, and physical and chemical properties. Processes involving sand and dust transport play an important roll in shaping the landscape and the ecosystem of the Mojave.

A variety of vegetation communities occur within the boundaries of the SNC (Fig. 2). Their distribution is greatly influenced by rainfall and topography. The southern end of the fires occurred within the Mojave Desert of the Sonoran Basin and Range MRLA, while the northern end of these fires occurred within the Southern Nevada Basin and Range MRLA (NRCS 2002 referenced in: USDI National Interagency BAER Team 2005).

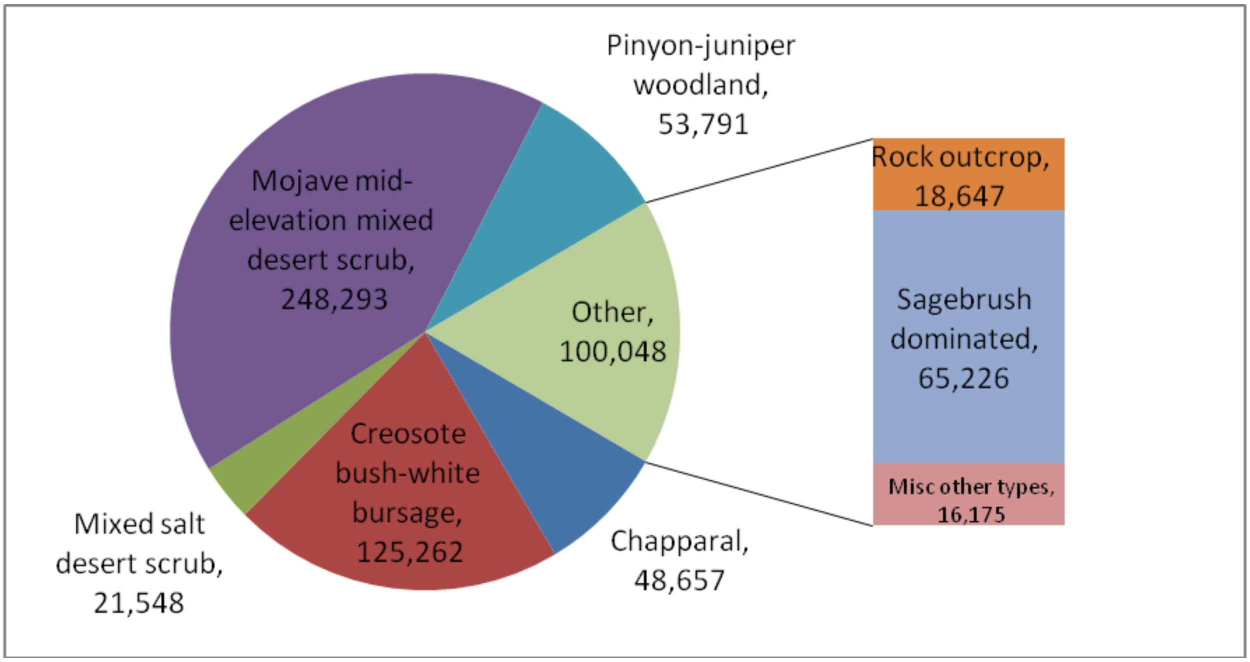

Figure S-2. Vegetation types burned by the SNC fires in the Ely District. Numbers reflect acres burned.

Additional physiographic information on the SNC fires can be found in Chapter 1 of the full report.

BURNED AREA ASSESSMENT

Prior to the SNC, the largest fire the Ely BLM District had experienced was the 1999 Delamar Fire that burned 22,592 acres. Due to the size and scope of the SNC fire, and BLM staff limitations both locally and regionally, a national Burned Area Emergency Response (BAER) team was called in to assist with the initial assessment of SNC fire damage to BLM lands and development of the Emergency Stabilization (ES) plan.

BAER Team resource specialists were tasked with assessing potential risks to life, property, and natural and cultural resources from the SNC fires and identifying potential treatments. Resources assessed included: vegetation, soils and watershed, wildlife, cultural, operations, and recreation.

Resource Assessment Findings

BAER Team vegetation specialists determined that a majority of the SNC burned area experienced low to moderate vegetation mortality (71%) with some areas of unburned to very low (15%), moderate (13%), or high mortality (1%). Vegetation mortality rates within these classes ranged from 6 to 60%, 0 to 5%, 61 to 85% and 86 to 100% respectively. While fire intensity varied throughout the burned area, the rapid rate of fire spread resulted in consumption of most of the grasses and herbaceous species, and some of the shrubs and scattered trees.

The majority of the high vegetation mortality class fell in those plant communities of the Mojave Desert that are not adapted to fire. Of particular concern was approximately 300,000 acres of blackbrush (*Coleogyne ramosissima*)-dominated communities burned in the SNC fires. While many species can resprout following fire, blackbrush is not a fire-tolerant species and generally never resprouts. In addition, much of the burned area occurred in rangelands, where non-native invasive species were present pre-fire, and in pinyon-juniper woodlands which often support very little herbaceous understory. Across the SNC, the spread of noxious and non-native invasive species was anticipated.

BAER Team soil and watershed specialists found that most of the burned area experienced low soil burn severity with some areas of moderate to high severity. [Soil burn severity relates specifically to effects of the fire on soil conditions (e.g., amount of surface litter and duff, infiltration rate, erodibility, and soil structure).] Roads on federal lands in the SNC were considered to be at a slight increased risk of flooding or being inundated with flood debris during intense storm events post-fire, and there were increased concerns for high dust concentrations that could create near “white-out” conditions. However, no significant values at risk from post-fire erosion or runoff were identified within the burned areas of the four SNC fires managed by the Ely BLM.

Many potential risks to life, property, and natural resources were identified downstream of the Duzak and Meadow Valley fires in large part because these fires burned watersheds that drain into Meadow Valley Wash, Beaver Dam Wash and the Virgin River, the majority of whose channels were rearranged by floods resulting from a January 2005 rain-on-snow event, increasing concerns for cumulative effects from post-fire flooding.

BAER Team wildlife specialists anticipated long term effects on livestock grazing from the SNC fires. Areas of particular concern were the Mojave Desert ecosystem where low precipitation results in lengthy recovery times and pinyon-juniper woodlands which often support very little herbaceous understory. Both of these ecosystems were considered susceptible to a post-fire conversion to non-native annuals that offer little forage. The SNC fires burned across 27 allotments and four Herd Management Areas (HMAs) in the Ely District.

There are seven federally listed species (T&E) and one Candidate species that occur within the SNC or downstream receiving water bodies and riparian areas. Only the desert tortoise was expected to be adversely impacted by the fires. In addition, the SNC further diminished important mule deer and elk habitats, especially in blackbrush and pinyon-juniper communities in mid-to upper elevations. These habitats are declining in amount and quality range wide, due to drought, fire and fragmentation.

There are 148 cultural resource sites located within the SNC lands managed by the Ely BLM. BAER Team cultural specialists found no indication that any of the sites were impacted by the fire or suppression activities and none appeared to be threatened by erosion. However, there were concerns for site looting and off-highway vehicle (OHV) damage.

BAER team operations specialists identified an increased chance of public exposure to potential hazards from the SNC fires (e.g. abandoned mines, hazardous materials, road washouts, and public safety sign damage) and an increased workload associated with implementing the SNC ES Plan.

No developed recreation sites exist within the SNC burned areas managed by the Ely BLM District. However BAER Team recreation specialists found that many opportunities for dispersed, primitive, and unconfined forms of recreation were impacted by the fires, including quail hunting, pine nut collecting, heritage tourism, geocaching, hiking, OHV touring, and to a lesser extent some desert bighorn sheep, mule deer, and small mammal hunting.

A more detailed representation of resource assessment findings can be found in Chapter 1 of the full report.

TREATMENT RECOMMENDATIONS AND IMPLEMENTATION

In response to resource assessment findings, BAER Team resource specialists identified 27 individual specifications/treatments for the 597,096 burned acres within the Ely BLM District. Due to concerns about long-term blackbrush loss, resource specialists at the Ely BLM wrote a Burned Area Rehabilitation (BAR) Plan in the fall of 2005 focused on reestablishing blackbrush.

A majority of the proposed and implemented ES and BAR specifications/treatments are considered minor for the purposes of reporting and analysis. These include: Native American Consultation, Implementation Leaders, Wilderness Access Hand Seeding, Post-Emergent Herbicide Application Along Roads in Burned Area, Lop and Scatter, Model Flow and Sediment Delivery to Meadow Valley Wash and Beaver Dam Wash, Stateline Boundary Exclusion Fencing, Exclosure Fencing, Known Cultural Site Assessment, Wild Horse and Burro Gather, Public Safety Hazard Assessment, Replace and/or Install Public Safety Signs, Temporary Administrative Vehicle Route Closure, Wilderness Track Seeding, Hand Seeding in Desert Tortoise ACEC Habitat, Intensive Rehabilitation Islands, Wildlife Water Source Rehab, Noxious Weed and Invasive Plant Control and Revegetation, Seed Collection for Desert Tortoise Areas of Critical Environmental Concern, Minor Facilities Repair and Replacement, Wild Horse Census, and Wildlife Water Developments Repair. Not all of the treatments recommended by the BAER team were approved or funded. See Chapter 2 in the full report for detailed information on approval and implementation of the treatments above.

The majority of the SNCESBAR Final Report (Chapters 3-9) focuses on three treatments: 1) the post-fire hand seeding treatments in desert tortoise critical habitat; 2) aerial seeding treatments in blackbrush and pinyon-juniper communities; and, 3) the analyses of treatment effectiveness from monitoring data collected between 2006 and 2008. These chapters are summarized below.

Effectiveness of Post-Fire Seeding in Desert Tortoise Critical Habitat Following the 2005 Southern Nevada Fire Complex

The Southern Nevada Fire Complex burned more than 32,000 acres of designated desert tortoise Critical Habitat and an additional 403,000 acres of Mojave Desert habitat characterized as potentially suitable for the tortoise (Fig. 3). To accelerate the re-establishment of plants commonly used by tortoises for food and shelter, the BLM seeded native annual and perennial (grass, forb and shrub) species in burned desert tortoise Critical Habitat in 2005 and 2006.

The United States Geological Survey (USGS) was tasked with monitoring vegetation and tortoise responses for three years after burned tortoise habitat was seeded to determine whether: 1) non-native annual plant production was reduced, and native annuals increased on sites seeded with native species; 2) perennial plant density and canopy cover were augmented by seeding; and, 3) tortoise activity, as indicated by detection of recent tortoise sign (live tortoises, active burrows, fresh scat, and tracks), increased in seeded areas. They also monitored seed banks to determine if viable seeds from the seed mix persisted one and two years following application and, they monitored monthly precipitation to evaluate vegetation responses among the broadly distributed sites on the SNC.

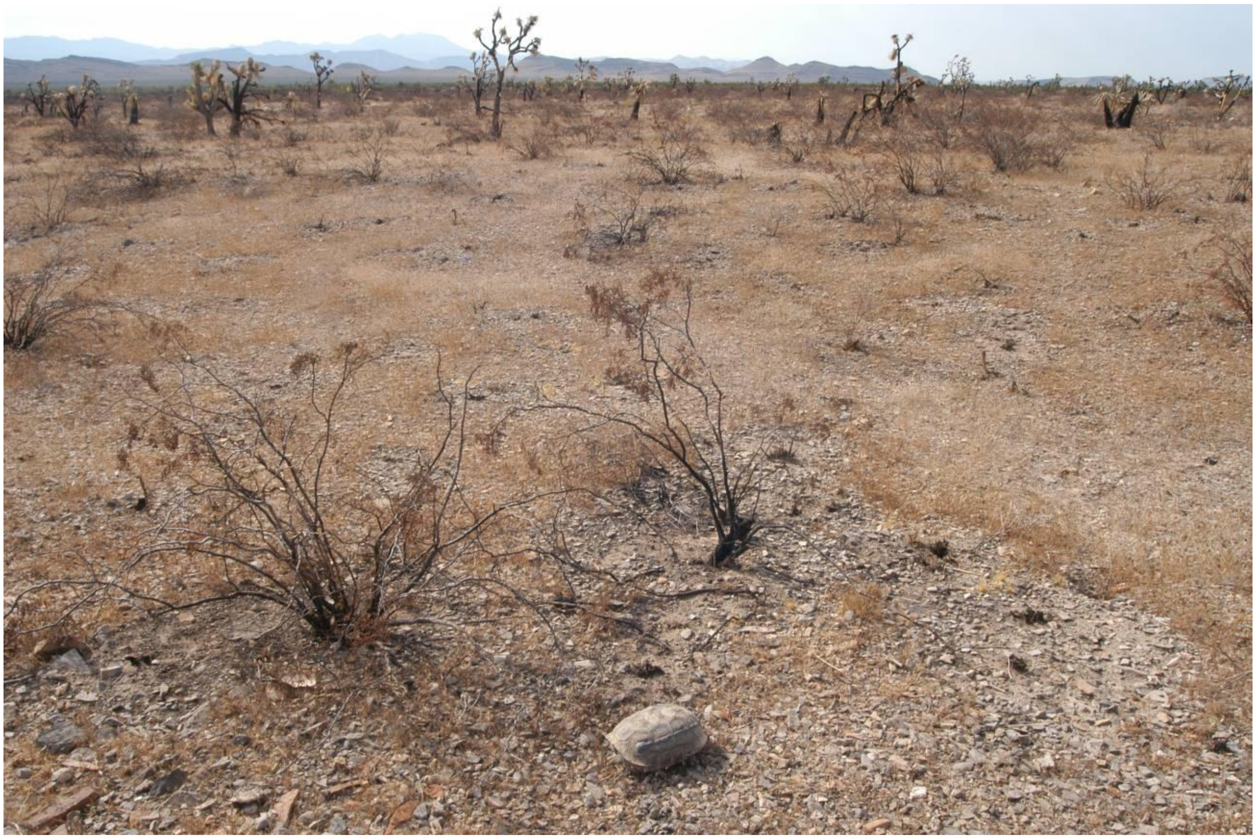

Figure S-3. A desert tortoise is faced with a dramatically altered habitat following the 2005 Dry Rock Fire (Photo: L. A. DeFalco).

Within the three-year ESR monitoring period the USGS found that seedling densities of seeded perennial species were 33% higher in seeded areas than in unseeded areas, particularly for the disturbance-adapted desert globemallow (*Sphaeralcea ambigua*) and desert marigold (*Baileya multiradiata*) which displayed rapid seedling emergence and establishment. They also found that seeding augmented perennial seed banks by four- to six-fold within a year of seed applications compared with unseeded areas, demonstrating that seeding increased the long-term recovery potential of seeded burn sites. Seeded annuals, in contrast, did not increase significantly in seed banks or biomass production, likely due to low seeding rates of these species. Production of non-native annuals that helped carry the fires was not reduced by seeding efforts but instead was strongly correlated with site-specific rainfall, as were native annual species.

Tortoises were observed moving along fire boundaries, using vegetation and burrows as shelter in unburned habitat while foraging and basking within burned areas where more herbaceous forage is available. Tortoise activity was not enhanced in seeded areas during the three years following seeding.

The USGS suggested that maximizing seeding rates and reducing seed residence time with seasonally-appropriate application may improve establishment of native annuals and fast-establishing perennials and deserves further research. They also noted that desert tortoise activity in burned areas was likely hindered during the three year monitoring period by lack of shelter sites, and that longer-term monitoring of both canopy cover and tortoise activity is necessary to determine the effectiveness of seeding for tortoise habitat restoration.

See Chapter 3 in the full report for more details on the effectiveness of post-fire seeding in desert tortoise critical habitat following the SNC fires.

Delineation of Final Aerial Seeding Polygons and Sampling Design for Aerial Seeding and Natural Regeneration Treatment Effectiveness Monitoring

The BAER team called for aerially seeding a total of 47,000 acres on the four Ely District SNC Fires, in order to stabilize soils and control the spread of invasive non-native species. They delineated potential seeding polygons covering more than 82,000 acres (32,200 ha) in pinyon-juniper and close to 50,000 acres (20,000 ha) in mesic blackbrush (Fig. 4). They also recommended monitoring ES treatment effectiveness for vegetation recovery, seeding success, and noxious and invasive non-native weed expansion.

Using the BAER team potential seeding areas, digital aerial photographs, ground reconnaissance and some GIS data layers provided by the United States Geological Survey Earth Resources Observation and Science Center (USGS EROS), BLM and Eastern Nevada Landscape Coalition (ENLC) staff delineated 30 seeding polygons, covering 47,000 acres in pinyon-juniper and mesic blackbrush communities, across all four fires. Thirteen polygons were seeded with a Non-Wilderness PJ Seed Mix, eight with a Wilderness PJ Seed Mix, and nine with a Mesic Blackbrush Seed Mix. Seeding polygons ranged in size from 103 acres to 5,589 acres.

The USGS Western Ecological Research Center (WERC), BLM, and ENLC designed three primary sampling methodologies to monitor treatment effectiveness, following the application of the aerial seeding treatments. These methodologies were brushbelt (BB) macroplots (designed to specifically compare seeded and unseeded conditions in demonstration plots), additional aerial seeding coverage (AA) macroplots (designed to maximize sampling coverage of environmental heterogeneity of the aerial seeding polygons including topographical variables, soils, and pre-fire vegetation) and, natural regeneration plots (used to evaluate the majority of the burned area that was not seeded). In addition to the three primary sampling methodologies, monitoring crews also conducted qualitative assessment write-ups and ocular cover estimates to increase coverage of non-seeded burned areas and help ground truth remote sensing tools being developed and evaluated for their utility on the SNC and on fires in rangeland/arid ecosystems more generally.

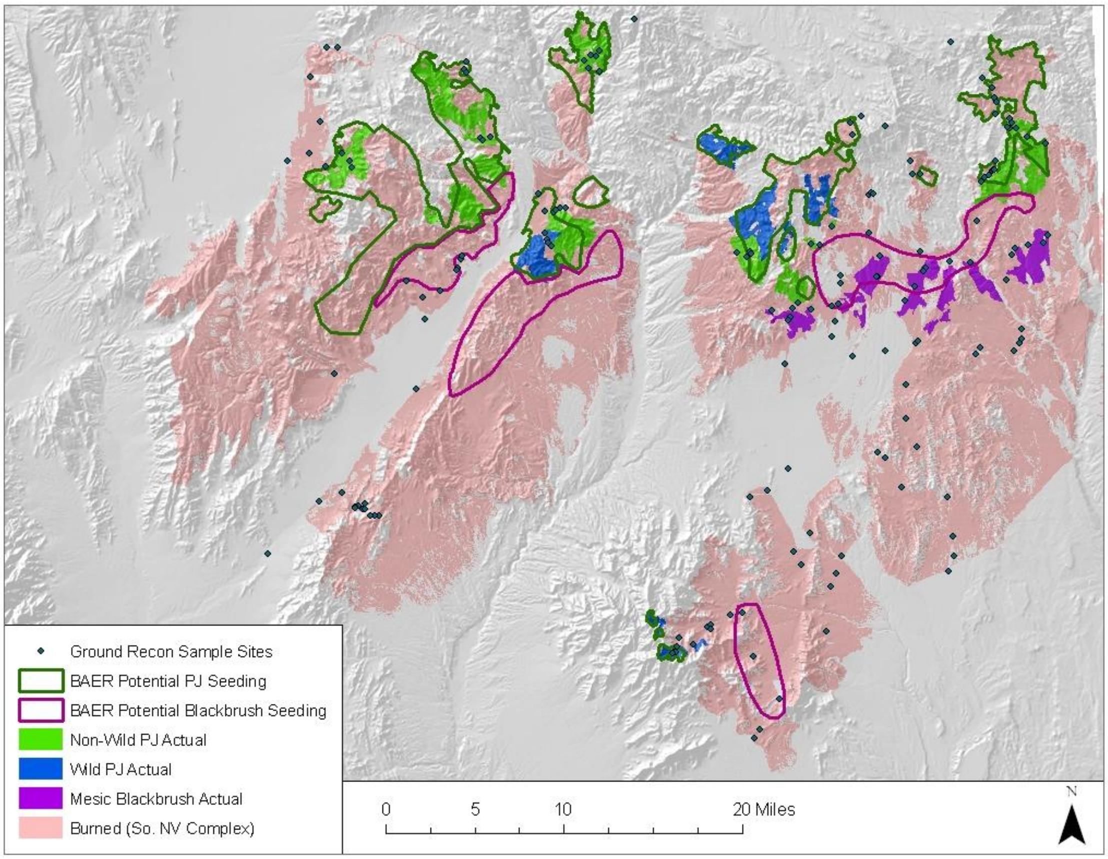

Figure S-4. Comparison of BAER team potential seeding areas to polygons actually seeded. Reconnaissance photo points were used to delineate actual seeding polygons from the BAER team potential seeding areas.

See Chapter 4 in the full report for more details on the delineation of the final aerial seeding polygons on the SNC and sampling design for aerial seeding and natural regeneration treatment effectiveness.

Establishment of Aerial Seeding Treatments in Blackbrush and Pinyon-Juniper Sites Following the 2005 Southern Nevada Complex

The USGS was also tasked with evaluating the level of seeded species establishment in the 47,000 acres of mesic blackbrush and pinyon-juniper aerially seeded within the four Ely BLM managed SNC fires. Objectives were to determine if: (1) the seeded species met planned seeding density objectives; (2) seeded species diversity, frequency, and density increased; and, (3) seeded species diversity, frequency, and density differed among vegetation types and between seeded and unseeded areas over the three year monitoring period. The USGS also discussed establishment patterns and their implication for future post-fire seeding projects in similar ecotypes of the Mojave Desert.

Over the three year ESR monitoring period, the USGS found that the seeded species comprised a minor component of the post-fire vegetation communities. On average, densities of seeded species were 2-3 orders of magnitude lower than the desired levels of three seeded perennial species m^{-2} in mesic blackbrush and five seeded perennial species m^{-2} in pinyon-juniper. Frequency, density and diversity of seeded species were greater in the two pinyon-juniper communities, especially non-wilderness pinyon-juniper, compared to mesic blackbrush. This was not restricted to seeded plots though; rather, it was an overall effect of vegetation type. Although density of the seeded species was low, there was some evidence that aerial seeding increased establishment of the seeded species. There was, however, no consistent trend over time in establishment and persistence of seeded species within the plots.

Sixteen species were used in the pinyon-juniper and mesic blackbrush seed mixes. Among the seeded species that were detected, *Elymus elymoides*, *Poa secunda*, and *Agropyron cristatum* were the most widespread. Several species also appeared to have a much higher chance of establishment in at least one of the vegetation types evaluated. Notable examples for mesic blackbrush included *Achnatherum hymenoides*, *Sanguisorba minor*, and *Sporobolus cryptandrus*. For non-wilderness pinyon-juniper, *Agropyron cristatum* appeared in more seeded than unseeded, and for wilderness pinyon-juniper *Achnatherum hymenoides* and *Pleuraphis jamesii* appeared in more seeded than unseeded plots. More information is needed on how establishment rates vary with the seasonal timing of seeding, species composition of seed mixes, application rates, and among vegetation types and years of contrasting climatic conditions. However, these species should be considered for systematic evaluations of their likelihood of establishment in the Ely BLM District.

Only the BB plots data (designed to specifically compare seeded and unseeded conditions in demonstration plots) was used in the USGS evaluation of seeded species establishment. Analyses were further confined to species richness, frequency of occurrence, and density of the seeded species. This was ostensibly so the analyses could be focused on comparisons of seeded species establishment in seeded versus unseeded areas, and so the USGS could evaluate how these comparisons varied among vegetation types. It should be noted that Ely District ESR staff do not agree with the USGS approach to analyzing the aerial seeding monitoring data particularly the exclusion of much of the collected data.

See Chapter 5 in the full report for more details on the establishment of aerial seeding treatments in blackbrush and pinyon-juniper sites following the SNC.

Vegetation Trends following the 2005 Southern Nevada Fire Complex

The USGS was also tasked with analyzing the spatial and temporal plant succession patterns in the four Ely District SNC Fires, especially in relation to dominance by non-native grasses and forbs. Their primary focus was on distribution and abundance patterns of cheatgrass (*Bromus tectorum*), red brome (*Bromus rubens*), and red-stemmed filaree (*Erodium cicutarium*). Specific objectives were to analyze: (1) the relationship of vegetation structure and species composition with topographic, disturbance, and rainfall variables; (2) the spatial and temporal patterns of abundance of cheatgrass, red brome, and *Erodium* in different vegetation communities, as well as their relationships to gradients in elevation, precipitation, and disturbance; and, (3) the correlation between patterns of native herbaceous and woody species with abundance of cheatgrass, red brome, and *Erodium*, and discuss how this is likely determining succession trajectories in these post-fire communities.

Analyses were focused on four vegetation types arranged along an elevation gradient in the Mojave Desert. They included wilderness and non-wilderness pinyon-juniper vegetation types which occur at the highest elevations, followed by the mesic blackbrush vegetation types at middle elevations, and the thermic blackbrush and upper elevation creosotebush scrub (referred to as the "natural regeneration" vegetation type) at the lower elevations. The USGS found that precipitation had an extremely important influence on succession patterns and species composition in the vegetation communities studied. It was the primary factor responsible for higher levels of recruitment of woody species and native bunchgrasses and increased species richness and stem density of native and non-native annual species. Precipitation was not, however, an important factor in regeneration of woody stems. It was not just the amount of rainfall that occurred in a given year that influenced species composition, but the timing of it as well. Species composition in all of the vegetation types was dramatically affected by the amount of rainfall that occurred in the early or latter periods of the wet season.

Density of shrubs and trees (resprouts and mature individuals) was higher in pinyon-juniper communities than natural regeneration and mesic blackbrush communities in all years. Burn severity was not consistently associated with vegetation responses. The densities of some species were highest at low fire severity values, whereas others were highest at high fire severity values.

Although they comprised less than 10% of the herbaceous flora, stems of non-native grasses and forbs dominated post-fire vegetation communities on the SNC. Collectively cheatgrass, red brome, and *Erodium* made up 90% or more of the stems in the BB monitoring plots, and one or more of these species dominated the post-fire flora regardless of year, elevation zone, vegetation type, or burned area. These species, however, showed very different spatial and temporal patterns. Red brome and *Erodium* dominated lower elevation communities (with peak densities between 800 and 1200 meters) and had higher abundances in areas with low or, at most, average amounts of precipitation. In contrast, cheatgrass dominated higher elevation communities (with a peak density at 1800 m), and its abundance increased dramatically as precipitation increased.

There was evidence that competition from these three, non-native species was intense enough that it was likely suppressing woody regeneration (by both seedlings and resprouts) and species richness of native perennial grasses. Only on the rare occasion that density of cheatgrass, red brome, and *Erodium* was low and rainfall was high were seedlings of woody perennials abundant. However, competition from the Brome grasses and *Erodium* was not a factor in suppressing regeneration of native herbaceous species. Species richness of native annual forbs and density of native perennial forbs actually had a positive relationship with density of cheatgrass, red brome, and *Erodium*. [This likely reflected a common response to an increase in resource availability, regardless of whether species were native or not (Stohlgren et al. 1999).]

The USGS concluded that suppression of woody regeneration could be enough to allow the SNC communities to remain dominated by non-native annual species over time. Alternatively, if these areas do not undergo further disturbances for several decades or regeneration or woody species is not impeded by grazing, succession could lead to shrub-dominated communities. The USGS found it difficult to say whether richness and stem densities of other species would increase if stem density of the two Bromes and *Erodium* was substantially reduced.

See Chapter 6 in the full report for more details on vegetation trends following the SNC.

General Vegetation Trends and Seeded Species Establishment: A Descriptive Analysis Using Data from AA Macroplots

Monitoring of ESR treatments is usually conducted for three growing seasons post-fire. In situations where monitoring funds are limited, and in large fire years where burned acreage is extensive, trade-offs must be made between more intensive monitoring strategies that provide a detailed examination of why ESR treatments succeed or fail and more extensive monitoring strategies that provide coarse information on what conditions are found on the ground over a large area. The BLM utilized both more intensive and more extensive monitoring strategies on the SNC fires. The cover data collected from the AA plots is an example of the latter and was used to capture the environmental heterogeneity present across the SNC over the first three growing seasons.

The AA plot data revealed a landscape dominated by a mix of different plant types, including both perennials and annuals and natives and non-natives. The data also drew a fairly strong distinction in plant dominance between burned higher elevation pinyon-juniper woodlands and burned mesic blackbrush communities. At the higher elevations, a mix of different plant guilds dominated, and most sites included a co-dominant perennial. In many cases, this was due to resprouting shrub species (e.g. *Quercus turbinella*, *Garrya flavescens*, *Amelanchier utahensis*, etc.). At lower elevations sites, in mesic blackbrush, the landscape was dominated primarily by the non-native forb *Erodium*. These lower elevations also tended to have a perennial component, including resprouting shrubs (e.g. *Yucca baccata* and *Purshia* glandulosa), and in some areas perennial grasses such as *Aristida purpurea* were returning in high abundance by year 3 post-fire.

In general, seeded species are only establishing at very low densities on the SNC. The exception is a few localized areas in which crested wheatgrass (*Agropyron cristatum*) is found at high densities in the Clover Mountains portion of the Non-Wilderness PJ Seed Mix. Although, seeded species had increased in presence over the three-year period across all three seed mixes (Fig. 5), they had not provided meaningful competition against non-native annual grasses or forbs as of year 3 post-fire.

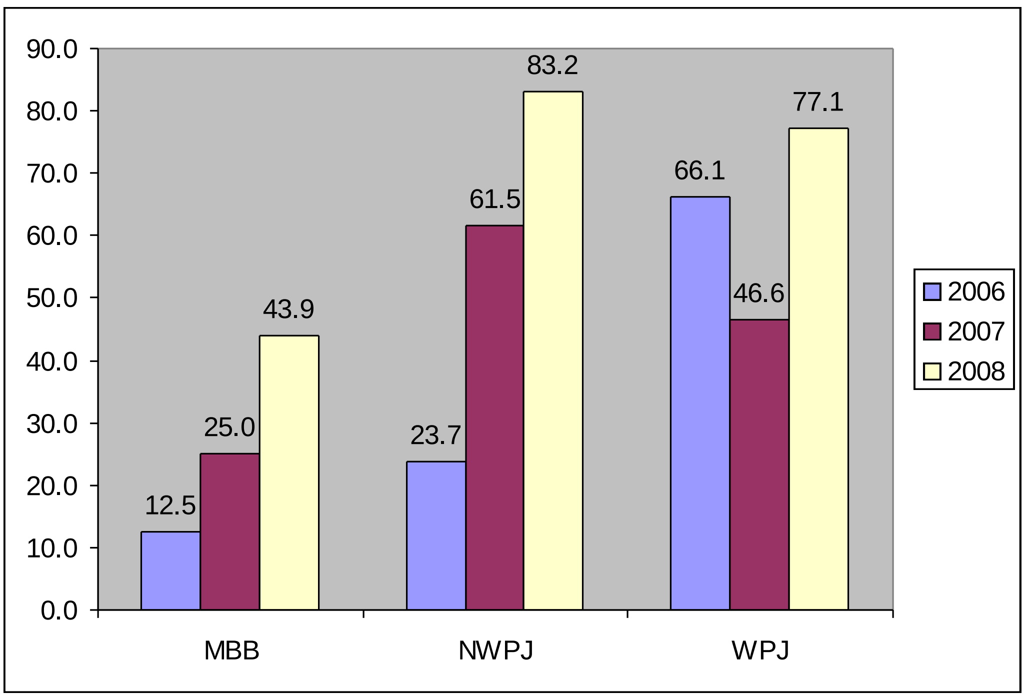

Figure S-5. Percentage of sampled AA macroplots with seeded species present within the Mesic Blackbrush Seed Mix (MBB), Non-Wilderness PJ Seed Mix (NWPJ), and Wilderness PJ Seed Mix (WPJ), 2006-2008.

Over the three-year monitoring period, annual grass dominance declined in both pinyon-juniper and mesic blackbrush sites. In the PJ seed mix polygons, there was a shift from areas dominated solely by annual grasses to areas dominated by a mix of perennials and exotic annuals. In the lower elevations, this shift was more from annual grasses to *Erodium* dominance. It is very difficult to predict what the future post-fire plant community makeup will look like on the SNC. This is due to the high variability of dominance within the burned areas and the drastic changes from year to year. Many of the perennial species establishing in both of the PJ seed mixes are resprouters and are fairly resilient to fire. It is possible that these species are increasing in abundance, in the absence of the non-resilient species which cannot return as quickly.

See Chapter 7 in the full report for more details on general vegetation trends and seeded species establishment using data from the AA macroplots.

Soil Erosion Risks Following the 2005 Southern Nevada Fire Complex

One of the primary land management concerns in the Mojave Desert is the potential for increased dominance by non-native annual grasses following wildfires. These concerns are largely focused on competition of non-native grasses with native plants, their effects on fire regimes, and their cumulative effects on wildlife habitat (Brooks and Pyke 2001, Brooks and Esque 2002). Their relationship to soil erosion remains largely unevaluated in the Mojave Desert. The USGS evaluated the indirect evidence for fire effects on soil erosion potential on the SNC, using cover data from the BB macro-plots (including basal gap, living perennial and annual vegetation canopy cover, and litter) collected in postfire years 1, 2, and 3 in pinyon-juniper and mesic blackbrush communities.

Analysis of the data revealed no notable fire effects on basal gaps between perennial plants, which already comprise about 98% of the total ground surface in unburned areas. Any post-fire basal gap changes probably had a negligible effect on soil erosion potential. Annual plant cover was significantly reduced in pinyon-juniper communities, but not in mesic blackbrush, in year 1 post-fire. Based on current and past results, the USGS suggests that post-fire reductions in total annual plant cover may increase soil erosion potential from flowing water during the first year post-fire (at least in the higher elevation pinyon-juniper zones), but probably not beyond the first year. Declines in perennial cover were more notable, especially in blackbrush vegetation, as were declines in litter and duff cover particularly in pinyon-juniper vegetation. Reduced perennial cover has major implications for wind erosion (Herrik et al. 2005b). Although quick recovery of annual plant cover may help mitigate some of the effects of perennial cover loss, annuals cannot replace the coarse physical structure and windbreaks that only perennial plants [(which may take many decades to re-establish following Mojave Desert fires (Brooks and Minnich 2006)] provide. The loss of litter in pinyon-juniper communities can affect both wind and water erosion potential post-fire. The only litter recovery observed by year 3 post-fire was in blackbrush where litter from non-native annual grasses showed increases.

See Chapter 8 in the full report for more details on soil erosion risks following the SNC.

Remote Sensing Assessments and Application

Remote sensing technologies were first utilized for the SNC fires by the BAER team in July 2005 to generate the final soil burn severity map and several subsequent burn area analyses. The Ely BLM requested a more in-depth assessment of remote sensing capabilities for a range of post-fire uses, including assessing pre- and post-fire vegetation changes, selecting seeding sites, and assessing post-treatment vegetation changes.

The SNC geospatial database subsequently created allows the evaluation of overall post-fire vegetation greenness and estimation of recovery in terms of the "return" to pre-fire or "background" greenness levels. Ely BLM and ENLC staff used the greenness and burn severity map products to assist in making seeding treatment location decisions for the SNC and, along with numerous other GIS data layers, overall treatment decision making.

More evaluation is required, but Landsat 30 meter data appear to be sensitive to seasonal fluctuations of annual grasses and perhaps perennial plants in the vicinity of the SNC. These data also appear to have potential for monitoring greenness change within seeded and non-seeded paired-plots. However, further study is needed in treatments exhibiting significant seeded species establishment, in order to determine how sensitive Landsat 30 meter data is to vegetation greenness increases and seeding effectiveness in rangeland/arid ecosystems. Landsat 30 meter data and related map products may also prove valuable to land managers making "grazing or range readiness" determinations after large fires with limited quantitative information at a landscape scale. However, it should be noted that this estimation technique does not specifically take into account how vegetation may have changed in composition or structure over time. Rather, it is just a comparison of the overall vegetation greenness to previous (pre-fire) levels. The importance of including map products that are representative of field conditions at the anticipated time of ground visits to proposed seeding sites was reinforced by the SNC experience.

See Chapter 9 in the full report for more details on remote sensing assessments and application relevant to the SNC.

DISCUSSION

Ely District BLM staff learned a number of lessons in the process of creating and implementing the SNC ES and BAR Plans. These lessons are outlined below beginning with 1) lessons learned (how we would do things differently with regards to specific tasks), followed by 2) management considerations for future (landscape scale) fires, and 3) future work needed. All of the lessons, management considerations and future work have the potential to improve planning and implementation effectiveness on future fires managed in the Ely District.

Lessons Learned

Identifying Seeding Polygons. Identifying seeding polygons on large-scale fires presents challenges, because a combination of GIS and ground-truthing must be used to practically assess seeding sites. In the case of the SNC, we used course-scale GIS data. While rather extensive ground reconnaissance of the burned areas was conducted, individual areas proposed for treatment could not be thoroughly evaluated, given time constraints for implementing treatments in seasonally effective windows. As a result, a small portion of the mesic blackbrush seeding treatment dipped into potential desert tortoise habitat. This resulted in non-native species inadvertently being seeded into desert tortoise habitat.

In addition, based on ground-truthing, DOQQs (aerial photos) were found to be the most accurate of a variety of GIS and remote sensing-derived datasets in delineating the presence of trees in PJ woodlands. However, this method was not so good at distinguishing interior chaparral communities from pinyon-juniper woodlands and meant some interior chaparral areas that were not intended for seeding (because they will regenerate naturally) were seeded. Burned mesic blackbrush communities were more difficult than PJ woodlands to delineate using GIS. Ground reconnaissance was therefore crucial in differentiating burned blackbrush from other burned vegetation types.

Scientists and land managers working on the SNC fires are also realizing that BARC-derived indices of burn severity and vegetation mortality, commonly used in post-fire resource assessments, do not always work well for shrub-dominated desert scrub ecosystems. This is especially true with blackbrush (*Coleogyne ramosissima*)-dominated communities. Because these shrub communities tend to have very low vegetation biomass pre-fire, overall biomass consumption is low. BARC imagery correlates low consumption with low vegetation mortality. Blackbrush is extremely flammable, however, and is usually completely consumed by even low severity fires. This was the case in the SNC. While most of the burned blackbrush communities on the SNC were rated as low vegetation mortality by BARC-derived indices, these areas actually had nearly 100% vegetation mortality and a very high ecological burn severity. This further highlights the importance of ground reconnaissance in blackbrush communities and perhaps further work refining BARC-derived indices in ecosystems with low vegetation biomass.

Unburned Reference Plots. The SNC contained a number of unburned plots. These plots were only monitored in year 1 post-fire. They provided valuable insight into what vegetation structure and species composition may have been like in the burned areas if the

SNC fires had not occurred. In the future, unburned reference plots should be monitored as long as vegetation recovery is monitored, if at all possible, to allow succession trajectories in the burned areas to be compared to those in unburned areas.

Seedling Planting. A number of seedlings were grown out for planting on the SNC. A large number of the seedlings molded during transport and storage, because we were unaware that the bare root seedlings needed to remain in cool storage from the time they were picked up to the time they were planted. The blackbrush seedlings fared particularly poorly from this treatment while fourwing saltbush and spiny hopsage fared better during transport and storage. The fourwing and spiny hopsage seedlings did extremely well after planting until grasshoppers defoliated the spiny hopsage plants. It is unknown how this ultimately affected spiny hopsage seedling survival. Thirty-two blackbrush seedlings survived and continue to grow. The blackbrush seedlings that survived were healthy when they arrived, suggesting that blackbrush seedling survival can be improved if transport and storage methods are improved. Lastly, of six treatments tested for improving seedling available moisture, tree shelters proved to be the most successful aid to blackbrush establishment on the SNC. We recommend their continued use in future seeding plantings.

Improving Seeding Success and Post-Fire Vegetation Recovery. The SNC fires destroyed many fences used to control livestock. Unfortunately, less than half of the originally planned fence repairs were completed due to funding, staff workload and contracting limitations. As a consequence, cattle were reported on the burned areas of at least 14 of the 27 allotments on the Ely BLM managed SNC fires between 2006 and 2008, including within mesic blackbrush seeding polygons. Feral cattle further complicated the situation. There is a need to improve implementation and enforcement of fencing treatments or reassess implementing unprotected seedings in the future.

Staffing Issues. A number of issues hampered the implementation of the SNC ES and BAR Plans. The 2005 fire season was very busy with five other fires to stabilize in the Ely District in addition to the SNC fires. 2006 was also busy with 44 fires requiring stabilization. Staff workloads were overwhelming. The ES plan proposed funding a dedicated Implementation Coordinator. This position was not funded. Funding this position and filling it in a timely manner could have improved the successful implementation and administration of the SNC ES and BAR treatments. In addition, the ESR program has no base funding. This leads to continual staff turnover. The loss of experienced staff presents a larger issue in the program that needs to be addressed.

Scale Issues. The scale and remote nature of the SNC led to all sorts of logistical issues that affected the successful stabilization and rehabilitation of these fires. Scale affects the ability to effectively assess resource impacts, plan and implement treatments and monitor and manage treatments. It affects physically covering distances with regards to implementing treatments, particularly ground-based treatments. This exacerbates time, staff and funding constraints. In addition, the cost of effectively stabilizing and rehabilitating fires of this magnitude means making tough choices and prioritizing treatments and treatment areas. Landscape scale fires also increase the manpower needed to implement treatments and the workload of a number of different programs including contracting. Contracting can cause significant hurdles to treatment implementation on projects of this scale, particularly when you have a number of large contracts all requiring quick turnaround. The situation is further exacerbated by the timing of fires in the Great Basin and Mojave that often occur near or after contracting deadlines for a given fiscal year.

Monitoring Issues. The scale and remote nature of the SNC also caused issues with monitoring protocols. Due to time and funding constraints, some of the sampling methodologies developed for the SNC had to be modified over the three-year sampling period. These changes (particularly the change from line-point intercept to ocular cover estimates) may have weakened the strength of some of our analyses and certainly caused conflict between the USGS (who was analyzing the BLM data) and ESR program staff. This conflict generally surrounded a lack of understanding on the part of the USGS as to: 1) what it takes to implement intensive monitoring protocols in terms of time, people and dollars; and 2) the need for monitoring which allows land managers to answer landscape scale management questions. Landscape scale fires highlight the need for balance between the ideal and the realistic approach to monitoring. They also highlight the need for a review of current ESR and BLM monitoring policy objectives. The reality of implementing intensive and effective monitoring over large areas, for example, requires considerable human and financial resources and, therefore, a commitment by policy managers to significantly enhanced funding for monitoring.

Policy managers also need to look at extending the three year ESR monitoring period. Land managers typically believe that seeding treatments can take more than three growing seasons to establish. Therefore, three years is probably not long enough to detect the establishment of adult plants from seedings or temporal trends in establishment of seeded species/vegetation recovery particularly in arid lands. Serious consideration should be given to adopting a design similar to that used by the National Park Service for fire effects monitoring collected at intervals of 1, 2, 3, 5, 7, 10, and 15 years post-fire (USDI National Park Service 2001).

Management Considerations for Future Fires

Improving Seeding Success and Post-Fire Vegetation Recovery. USGS findings suggest that seeding communities in the Mojave that are intolerant of fire with a wider variety of woody species could increase rates of woody cover recovery and, potentially, reduce abundance of non-native annual grasses and forbs over time. This is worth consideration for future fires.

Another modification to seeding treatments worth exploring is the pattern and extent of seeding. The USGS suggests that seeding many smaller areas, instead of blanket seeding larger areas, could potentially enhance seeding success. The smaller seeded areas would create vegetated islands that, over time, serve as colonizing sources of seeded species into the surrounding landscape. In addition, given cheatgrass, red brome, and *Erodium* abundance appears to vary across a precipitation gradient, one or more of these species may dominate in all years. Therefore, yet another approach to seeding may be to target specific vegetation types (or specific elevation zones) in years with a particular rainfall pattern (e.g. seed higher elevation areas in dry years but not wet years), and/or limit seeding to when field examinations show low populations of annual grasses or forbs. This would increase treatment implementation costs, but it could improve treatment success and reduce ecological costs.

Collecting seed bank data in burned and unburned areas in future projects could also be a relatively easy and inexpensive way of quantifying if, for example, non-native annuals were significant components of the aboveground vegetation, the seed bank, or both pre-fire and help in evaluating seeding sites, post-fire succession patterns and effectiveness of seeding treatments.

In addition, rather than evaluating aerial seeding as successful or unsuccessful based on pre-determined desired densities of established plants (the current approach), a new approach that identifies and evaluates the conditions under which post-fire aerial seeding would have the greatest likelihood of success could be very beneficial.

Application of annual grass-specific herbicides prior to seedings might also help to reduce competition of the non-native annual grasses with seeded species. It is something to consider in future BAR treatments and smaller ES treatments where categorical exclusions may allow practical implementation of herbicide and seeding treatments in the one year treatment window.

Future Work Needed

Improving Seeding Effectiveness. Results of post fire seeding in desert tortoise habitat on the SNC suggest that broadcast seeding has strong potential to provide herbaceous plants for forage and long-term perennial plant cover to support tortoise recovery in burned habitats. Maximizing seeding rates, focusing on a combination of native species that can withstand disturbance conditions (including species that are found in adjacent unburned areas), and reducing seed residence time with seasonally-appropriate application may improve establishment of native annuals and fast-establishing perennials more generally post-fire and deserves further research.

In addition, more information is needed on how seeded species establishment rates vary with the seasonal timing of seeding, species composition of seed mixes, application rates, and among vegetation types and years of contrasting climatic conditions. Establishment of small scale field and/or greenhouse competition and resource availability experiments would allow us to better evaluate not just what the post-fire succession patterns are in the Ely District, but the relative importance of different mechanisms producing the patterns, and should be considered.

Sixteen species were used in the aerial seed mixes applied to the SNC fires. Of these, several species appeared to have a much higher chance of establishment in the first three years in at least one of the vegetation types evaluated. The best establishing native species were Indian ricegrass, bottlebrush squirreltail, galleta grass and sandberg bluegrass. The best establishing non-native species were crested wheatgrass and small burnet. These species should be considered as candidates for systematic evaluations of their likelihood of establishment in the Ely district in the future.

Improving Treatment Effectiveness Monitoring. Remote sensing may provide a lower cost method for monitoring vegetation trends in burned areas that are seeded versus those that are not seeded. However, additional study is required to assess whether the resolution and frequency of remote sensing coverage is sufficient to detect vegetation trends that may occur among burned and unburned areas, and areas where different management treatments are applied.

CONCLUSION

The SNC was a significant ecological event for the Mojave Desert and continues to present many land management challenges in southern Nevada and for the Ely District BLM. In the past 25 years, invasive non-native exotics such as cheatgrass and red brome have invaded the desert southwest providing fuels that carry fire in areas that historically did not carry fire. This trend is expected to continue. Lessons learned on the SNC and recommendations for future actions will hopefully improve future approaches to landscape scale ESR efforts.

Complete chapters and additional materials, including appendices, maps, tables, figures and raw monitoring data can be found in the complete SNCESBAR report, available on the Ely District BLM internal website or on CD.

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LITERATURE CITED

Brooks, M. L., and T. C. Esque. 2002. Alien plants and fire in Desert Tortoise habitat of the Mojave and Colorado Deserts. *Chelonian Conservation and Biology* 4:330-340.

Brooks, M. L., and J. R. Matchett. 2006. Spatial and temporal patterns of wildfires in the Mojave Desert, 1980-2004. *Journal of Arid Environments* 67:148-164.

Brooks, M. L., and R. A. Minnich. 2006. Southeastern deserts bioregion. *In*: N. Sugihara, J. W. Van Wagtendonk, J. Fites, and A. Thode [EDS.]. Fire in California Ecosystems. University of California Press, Berkeley, California, USA. p. 391-416.

Brooks, M. L. and D. A. Pyke. 2001. Invasive plants and fire in the deserts of North America. Pages. *In*: K. E. M. Galley and T. P. Wilson, editors. Proceedings of the Invasive Species Workshop: the Role of Fire in the Control and Spread of Invasive Species. Fire Conference 2000: the First National Congress on Fire Ecology, Prevention, and Management., Tallahassee, Florida: Tall Timbers Research Station, Tall Timber Research Station Miscellaneous Publication No. 11. p. 1-24.

Stohlgren, T. J., D. Binkley, G. W. Chong, M. A. Kalkhan, L. D. Schell, K. A. Bull, Y. Otsuki, G. Newman, M. Bashkin, and Y. Son. 1999. Exotic plant species invade hot spots of native plant diversity. *Ecological Monographs* 69:25-46.

USDI Bureau of Land Management. 2005. Southern Nevada Complex Fires Burned Area Rehabilitation Plan. Ely and Las Vegas Field Offices and Nevada State Office, NV, USA. 35 p.

USDI National Interagency Burned Area Emergency Response Team. 2005. Southern Nevada Complex Burned Area Emergency Stabilization Plan. Mesquite, NV, USA. 212 p.

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AA – Additional Aerial Seeding Coverage Plot
ACEC – Area of Critical Environmental Concern
AFB – Air Force Base
AIC – Akaike's Information Criterion
AICc - Akaike's Information Corrected Criterion
ANOVA – Analysis of Variance
ATV – All-Terrain Vehicle
AUM – Animal Unit Month
AVHRR - Advanced Very High Resolution Radiometer
AWiFS - Advanced Wide Field Sensor
BAER – Burned Area Emergency Response
BAR - Burned Area Rehabilitation
BARC - Burned Area Reflectance Classification
BB – Brushbelt
BLM – Bureau of Land Management
BRD – USGS Biological Resources Discipline
BRRC – *Bromus madritensis* (red brome) Cover
BRTC – *Bromus tectorum* (cheatgrass) Cover
CART – Classification and Regression Tree
CBI – Composite Burn Index
CCA – Canonical Correspondence Analysis
DEM – Digital Elevation Model
dNBR – Differenced Normalized Burn Ratio
dNDVI - Differenced Normalized Difference Vegetation Index
DOQQ - Digital Orthophoto Quarter Quadrangle
DM - Demonstration
DRG – Digital Raster Graphic
DWMA - Desert Wildlife Management Area
EAGEC - Exotic Annual Grasses and *Erodium cicutarium*
EAGS - Exotic Annual Grasses and Shrubs
EANA - Exotic Annuals and Native Annuals.
ENLC – Eastern Nevada Landscape Coalition
EROC – *Erodium cicutarium* (storksbill) Cover
EROS – USGS Earth Resources Observation and Science Center
ES – Emergency Stabilization
ESR, ES&R – Emergency Stabilization and Rehabilitation
FY – Fiscal Year
GBI – Great Basin Institute
GIS – Geographic Information Systems
GLM – Generalized Linear Model
GPS – Global Positioning System
HMA – Herd Management Area
IAGC – Invasive Annual Grass Cover
IAGD – Invasive Annual Grass Density

IGO – Intra-Governmental Order
JFS – Joint Fire Science
KS Test - Kolmogorov-Smirnov Test
LCM – Livestock Compliance Monitor
MBB – Mesic Blackbrush
MEAP - Mixed Exotic Annuals and Perennials
MFT – Multiway Frequency Tables
MLRA – Major Land Resource Area
MODIS - Moderate Resolution Imaging Spectroradiometer
MP - Mixed Perennials
MRLC – Multi-Resolution Land Characteristics
MSL – Mean Sea Level
MTBS – Monitoring Trends in Burn Severity
NAIP - National Agriculture Imagery Program
NAP - Native Annuals and Perennials
NBR – Normalized Burn Ratio
NCC – Nevada Conservation Corps
NDOW – Nevada Department of Wildlife
NDVI - Normalized Difference Vegetation Index
NIR – Near Infrared
NOAA – National Oceanic and Atmospheric Administration
NPS – National Park Service
NR – Natural Regeneration or National Register
NWPJ – Non-Wilderness Pinyon-Juniper
NWS – National Weather Service
OHV – Off Highway Vehicle
PJ – Pinyon-Juniper
PRNC – Perennial Cover
PRND – Perennial Density
QA – Qualitative Assessment
RdNBR – Relative Differenced Normalized Burn Ratio
ReGAP – Regional Gap Analysis Project
RS – Remote Sensing
RSAC – USFS Remote Sensing Applications Center
SCA – Student Conservation Association
SHRC – Shrub Cover
SLC – Scan Line Corrector
SNC – Southern Nevada Complex
SNPLMA – Southern Nevada Public Land Management Act
SOW – Statement of Work
SWIR – Short Wave Infrared
T&E – Threatened and Endangered
TM – Landsat Thematic Mapper
TVGC – Total Vegetation Cover
USFS – United States Forest Service
USFWS – United States Fish and Wildlife Service

USGS – United States Geological Survey
USDA – United States Department of Agriculture
USDI – United States Department of the Interior
VIF – Variance Inflation Factors
VNIR – Visible/Infrared
WERC – USGS Western Ecological Research Center
WO – BLM Washington Office
WPJ – Wilderness Pinyon-Juniper