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JEFFERSON FIRE RECOVERY: OPTIONS AND RECOMMENDATIONS FOR STABILIZING THE BURNED AREA AND ADDRESSING HABITAT CONSERVATION

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Executive Summary

The Jefferson Fire was human-caused and started on the afternoon of July 13, 2010. The fire burned approximately 108,000 acres covering about 80,000 acres on the INL Site. Nearly half of the burned area on the INL Site had burned in 1995, 1996, 1999 and 2000. Wildland fires have the potential to alter ecosystems across the landscape and over a long-time scale. Because of these broad-scale effects, there are a number of issues that must be addressed when considering a recovery plan. These issues include habitat conservation for sensitive species, expected outcomes of the natural recovery process of plant communities including sagebrush, wind erosion and soil stability, and artificial methods to accelerate sagebrush recovery.

Some guidance for addressing post-fire stabilization and rehabilitation is available in the Wildland Fire Management Environmental Assessment, the Draft Candidate Conservation Agreement and the charter for the National Environmental Research Park. These documents provide objectives for resource management and include conservation measures that could be employed to minimize long-term effects of fire suppression activities as well as effects of the fire itself.

In planning for successful post-fire stabilization and rehabilitation, it is important to define specific goals and objectives. There is a need to understand and identify both short-term and long-term objectives. Short-term objectives should address reducing the risk of further degradation of natural resources. Long-term objectives should address the ability of the burned area to recovery to stable natural communities and provide habitat for sensitive species.

A number of actions are recommended to ensure post-fire stabilization and to minimize impact to sensitive ecological resources. They include the following.

- Soil berms created during containment line construction should be pulled back to re-contour the containment lines.
- Barricades and signs should be installed where containment lines intersect roads.
- The areas of the burn that are within grazing allotments should be closed to livestock until vegetation recovery goals have been met.
- There is the potential for noxious weeds to invade into the burned area. The area south of the burn and the burn itself should be surveyed for the presence of noxious weeds and any infestations located should be controlled.
- INL Site boundary signs and grazing boundary signs destroyed in the fire should be replaced.
- An information and education campaign should be initiated on the INL Site to inform workers of the risks for human caused fires to impact the INL Site.

- Satellite imagery should be obtained and used to develop maps of the areas affected by the fire and suppression actions. These maps would be used to support further stabilization and rehabilitation actions.
- Because of the loss of habitat for sensitive species and the resulting habitat fragmentation, it is recommended that a plan be developed to construct habitat corridors to minimize the effect of fragmentation. This would include using the satellite imagery, topographic information to guide corridor placement to be most effective and efficient.
- It is also recommended that an inventory of areas on the INL Site in low ecological condition be completed. This would include a focus on unburned areas to identify areas in low condition, but with sagebrush intact for habitat improvement activities. An effective and efficient approach to conserving habitat for sensitive species is to protect existing good habitat and improve low condition areas.
- A monitoring plan for the burned area needs to be developed. These monitoring activities would be used to determine the progress of recovery and the effectiveness or stabilization and rehabilitation actions. This monitoring plan would use existing long-term or recently inventoried plots as its foundation.
- A number of research opportunities present themselves with this burn. Several are recommended because of their potential to provide additional understanding of the recovery process for groups of species not previously considered in similar fire recovery projects. This new understanding could be valuable in enhancing stabilization and rehabilitation efforts in the future.

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Background

The Jefferson Fire was human-caused and started on the afternoon of July 13. The fire burned approximately 108,000 acres covering about 80,000 acres on the INL Site. Nearly half of the newly burned area on the INL Site had burned in 1995, 1996, 1999 and 2000. These areas were dominated by needle and thread grass (*Hesperostipa comata*), Indian ricegrass (*Achnatherum hymenoides*), and green rabbitbrush (*Chrysothamnus viscidiflorus).* The remaining area that burned occurred mostly in communities dominated by Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*). The vegetative communities in all burned areas were predominately in good condition. The fine fuels (grasses) had high moisture content due to early season precipitation, and most of these grasses were still green and growing.

Weather conditions during the fire were characterized by extremely high winds. At the time of ignition, the CITRC meteorological station reported winds at 38 mph with gusts up to 53 mph. Later in the afternoon the wind was reported to be gusting to more than 60 mph.

Resource Issues to be Considered

Wildland fires have the potential to alter ecosystems at the landscape scale and over a long-time scale. Because of these large-scale effects, there are a number of issues that must be addressed when considering a recovery plan. In the following sections, we describe these issues. We also discuss the science available to help understand these issues in the context of developing a fire recovery plan.

Habitat for Sensitive Species

Since 1999, multiple petitions have been submitted to the U.S. Fish and Wildlife Service (FWS) demanding that the agency list Greater Sage-Grouse (*Centrocercus urophasianus*) (hereafter sage-grouse) as threatened or endangered. In March 2010, FWS issued a finding that sage-grouse warranted protection under the Endangered Species Act (ESA), but were precluded by higher listing priorities. Thus, these birds are currently classified as a candidate species.

In 2005, the FWS published a 90-day finding in response to a petition to list the pygmy rabbit (*Brachylagus idahoensis*) as threatened or endangered. The FWS concluded the petition did not provide substantial evidence to warrant federal protection under the ESA. In response, a complaint was filed and the U. S. District Court subsequently found the FWS had acted contrary to applicable law when it issued its finding. Consequently, a new 90-day finding was published in 2008, in which the FWS announced the pygmy rabbit may warrant federal protection under the ESA and that a full status review was merited. A 12-month finding for this species is currently pending.

Loss of sagebrush due to wildland fire is considered one of the highest threats to sage-grouse and pygmy rabbits on the INL Site. Since 1994, over 170,000 acres have been affected by fire on the

INL Site. This represents about 31% of the total area of the INL Site and a substantial impact to the conservation of sage-grouse and pygmy rabbit through loss of sagebrush. Conversion to non-native annual grasses, such as cheatgrass (*Bromus tectorum)* following fire, another threat to sage-grouse and pygmy rabbit, has not been documented on the INL Site except where pre-fire disturbance or firefighting efforts have resulted in the loss of herbaceous perennial cover.

Natural Recovery Process

Over the past 15 years there has been a substantial amount of research regarding the natural recovery processes following wildland fire on the INL Site. The results of this research indicate that the plant community after a fire will be a reflection of the community present before the fire with the exception of big sagebrush (Buckwalter 2002, Blew and Forman in press). Areas that were diverse, stable, native ecosystems before the fire will be diverse, stable, native ecosystems after the fire. Areas dominated by non-native invasive species after a fire were likely in poor condition prior to the fire.

The key to long-term ecological stability after fire is the quick recovery of re-sprouting native perennial species. Although big sagebrush is a critical component forhabitat of many species of concern, and sagebrush steppe is defined by the presence of this shrub, sagebrush steppe ecosystems require a species-rich and vigorous herbaceous understory to impart resistance to invasion and resiliency following disturbance (Anderson and Inouye 2002).

Soil Stability and Wind Erosion

Soil stability and erosion become important considerations following wildland fire in sagebrush steppe. Past experience with burned areas on the INL Site indicate substantial movement of soil by wind (Sankey et al. 2009a, Sankey et al. 2010). Indeed, wind erosion has resulted in management concerns for INL Site employee safety, as well as increased costs associated with the effects of dust originating on the burn affecting INL facility operations. Sankey et al. (2009b) concluded that mechanical seeding to help reduce wind erosion would be of little utility, because little soil erosion occurred following spring emergence of herbaceous vegetation. Additionally, this spring emergence by re-sprouting native perennials would happen prior to emergence and establishment of anything mechanically seeded.

Hoover et al. (in prep) reported that the spatial patterning at the micro-scale of soil nutrient resources and other soil characteristics is retained following fire and subsequent erosion. They concluded that plant diversity is increased in this ecosystem by the microsite patterns of coppice and interspace. Management that maintains this patterning is important for maintaining post-fire plant diversity. This includes maintenance of the surface crust formation on the interspaces, which contributes to the stability and resilience of the microscale spatial patterning of resources and plant community composition. They concluded that plant invasions or introductions in the form of drill seeding could impact diversity by homogenizing the observed spatial distribution of soil resources.

Sagebrush Recovery

Natural recruitment of Wyoming big sagebrush can be a slow process on the time scale at which rangelands are managed. In fact, 50 to 120 years may be required for sagebrush cover on a burned site to reach levels comparable to nearby unburned areas (Baker 2006). Colket (2002) found that it took nearly 90 years for sagebrush on the INL Site to reach densities similar to areas sampled outside of the burn scar.

Although several specific aspects of the recruitment process have been investigated, such as annual variation in seed production (Harniss and McDonough 1976, Young et al. 1989), persistence of seed in the seed bank (Young and Evans 1989, Meyer 1994), seed dispersal patterns (Johnson and Payne 1968, Young and Evans 1989), microclimatic conditions necessary for germination (Johnson and Payne 1968, Meyer and Monsen 1992, Meyer 1994), and weather conditions required for establishment (Young and Evans 1989, Maier et al. 2001), overall spatial patterns of big sagebrush reestablishment across large burns (typically tens of thousands of acres) have not been well characterized.

Research on the INL Site addressing large-scale spatial patterns of natural sagebrush recruitment (Blew and Forman in press) indicate that seed dispersal may not be as important of a limiting factor for sagebrush recruitment as appropriate microsites and environmental conditions for establishment. Successful establishment of sagebrush depends on above average summer precipitation and favorable microclimatic conditions (Young et al. 1990, Boudell et al. 2002). Above average precipitation likely contributes to successful recruitment by creating favorable microsites at greater distances from the burn edge. Because weather patterns, like wet cool summers, strongly influence seedling establishment and are highly variable in arid and semi-arid environments, planting sagebrush seed has a low probability of success. Therefore, using management approaches that focus on overcoming establishment limitations (i.e. summer drought that limit root development) may be a more effective approach to increasing recruitment than using approaches that emphasize overcoming seed dispersal limitations.

Sagebrush Planting

Accelerating the rate at which sagebrush becomes reestablished in post-fire plant communities is an important consideration for conservation management goals. Currently, seeding is the preferred method of assisted big sagebrush recovery across its range (Shaw et al. 2005). Several reseeding methods have been used in sagebrush steppe rangelands over the past several decades in an attempt to hasten sagebrush reestablishment subsequent to wildland fires. These seeding methods include aerial seeding, hydroseeding, broadcasting, cultipacking, and drilling (Shaw et al. 2005). The effectiveness of various seeding methods is not well understood, and in some cases seeding may cause negative impacts to the post-fire plant community. For example, a study conducted on the effects of drill seeding in southeast Idaho indicate that drilling likely does more harm than good as it can impact the root systems of resprouting native perennial species and further disturb soils, thereby reducing native, perennial plant cover in sagebrush communities that had an intact native, perennial understory prior to the fire (Ratzlaff and Anderson 1995). Moreover, successful establishment of seeds planted using drill seeding has been quite low (Boltz 1994). More recently, research on the INL Site found that the soil disturbance associated with drill seeding could reduce diversity in this rangeland ecosystem by disrupting the spatial distribution of soil nutrients and moisture, and homogenizing those resources (Hoover et al in press).

Aerial broadcast seeding of Wyoming big sagebrush has been used extensively in southern Idaho over the past fifteen to twenty years (Lysne 2005). This seeding technique has some distinct advantages over other common reseeding methods, including; fewer labor and equipment requirements, no soil disturbance, and the ability to drop seed on snow. However, a recent study assessing the effectiveness of aerial seeding on over thirty fire-rehabilitation projects in burned sagebrush steppe plant communities of south-central and southwest Idaho indicates relatively low success (~33%) in terms of sagebrush reestablishment (Lysne and Pellant 2004).

A previous attempt to aerial seed big sagebrush on snow at the INL Site occurred in February 2001 on the Tin Cup Fire. Follow-up monitoring for presence of sagebrush seedlings in 2002 and 2003 included surveys of belt transects 35 m wide and 1000 m long. Fourteen of these transects were surveyed in the Tin Cup Burn. Only 12 seedlings were found in 2002 and only 5 seedlings were found in 2003 (Blew and Forman in press). The BLM plan acknowledges "…aerial sagebrush seeding over snow has previously been unsuccessful in the Big Desert and marginally successful in other portions of the field office…."

There are several potential causes for the limited success of aerial seeding, and seeding in general, of big sagebrush. Some researchers have suggested that using locally adapted seed is critically important to the success of sagebrush plantings (Meyer and Monsen 1991, Shaw et al. 2005). In a study to assess germination differences within and among big sagebrush subspecies, Meyer and Monsen (1992) found substantial variation in germination success of seeds, collected from several sites, under controlled greenhouse conditions. This study indicated that big sagebrush is adapted to its site of origin at the population level, creating ecotypes. If sagebrush seed is not adapted to the area being planted, it may germinate too early or too late, causing failure of the entire planting. In a study addressing the efficacy of aerial seeding in southern Idaho, Lysne and Pellant (2004) reported that much of the seed material used to aerially seed 35 burns wasn't the correct subspecies, much less the correct ecotype.

As opposed to seeding, planting sagebrush seedlings has been used successfully in many sagebrush restoration projects. Planting seedlings rather than seeds circumvents the critical establishment period during which many recently germinated seedlings die, and may thereby increase successful establishment. However, planting seedlings is expensive and, therefore, can be used to restore only relatively small areas at densities that would approximate the desired density and cover. This might be done by targeting areas of high priority for conservation. For example, for sage-grouse, this might include planting sagebrush near nesting habitat and brood-rearing habitat in the vicinity of leks. For pygmy rabbits, planting sagebrush may help develop corridors to reconnect fragmented habitats or habitat islands to a larger unburned area. The goal of this would be to ensure that the burn does not result in isolated populations of these leporids.

There is very little science demonstrating that accelerating sagebrush recovery at the large-scale necessary for fire rehabilitation is feasible. To accelerate sagebrush establishment on a much larger scale, but with a longer timeline for completion, Blew and Forman (in press) hypothesized that planting widely spaced individuals or small clusters would mimic natural patterns of recovery on the landscape. This approach utilizes the nucleation hypothesis of dispersion that provides for amelioration of microsites to be more favorable for germination and establishment, and also ensures wide distribution of seed from the planted seedlings during each year to take full advantage of those years when weather conditions are right to support establishment. Although this approach does not attempt to directly achieve landscape-scale sagebrush recovery on a short-time scale, it is an attempt to further ensure that seed availability on large burns is not limited by wind dispersal. Recovery to pre-burn conditions would still likely be on the order of decades.

Very little is known regarding threshold values for recovering sagebrush to provide habitat for sage-grouse or pygmy rabbits. It is likely that recovering sagebrush would provide substantial habitat prior to achieving pre-burn conditions.

Guidance from other INL Site Documents for Fire Recovery Planning

Wildland Fire Management Environmental Assessment

From the Wildland Fire Management Environmental Assessment, the goal of ecological resource management on the INL Site is to perpetuate and protect a large, unfragmented, native sagebrush steppe ecosystem, respond to existing executive orders, and federal, state, and DOE mandates for protecting biological resources, and support National Environmental Research Park objectives (DOE 2003).

The Wildland Fire Management Environmental Assessment (DOE 2003) lists nine objectives for ecological resources that should be considered in developing a recovery plan.

- Limit the size of unwanted wildland fires that put ecological resources at risk
- Maintain a natural fire cycle and landscape-scale ecosystem diversity
- Reduce the need for rehabilitation following fire suppression
- Protect sage-grouse and other sagebrush-obligate species and their habitat
- Prevent habitat loss and habitat fragmentation
- Maintain as much of the existing sagebrush steppe ecosystem as possible
- Maintain plant genetic diversity
- Protect unique ecological research opportunities
- Prevent invasion of non-native species, including noxious weeds.

Draft Candidate Conservation Agreement

The Conservation Management Plan (CMP) is intended, through management of biological resources on the INL Site including sensitive, threatened, and endangered species and associated habitat, to minimize disruption to routine site operations, cleanup, and research activities as well as improve the position of the INL Site as an attractive facility for new projects. The CMP and the draft Candidate Conservation Agreement (CCA) include direction defining threats and conservation measures associated with wildland fire.

The threat from wildland fire is high due to losses of sagebrush habitat. There is an increased risk of ignition due to increased level of activity in remote areas of the INL Site. The threat of wildland fire to habitat for sage-grouse and pygmy rabbit as manifested on the INL Site are addressed in the Draft CCA.

Although large portions of the INL Site have burned in the past 15 years, these areas have recovered primarily to native perennial grasses and re-sprouting shrubs (primarily green rabbitbrush). However, some areas are dominated or co-dominated by annual species including cheatgrass and mustards. There is no indication that an increase in non-native annual species has resulted in alteration of the fire regime on the INL Site; however, inventory and monitoring of these areas is needed to support a plan for reducing the risk of ignition in these areas. Furthermore, these areas represent specific locations where changes in land management have the potential to bring about improvement in the condition of the herbaceous component of these communities which would improve resistance and resilience.

The other threat noted in the draft CCA is the lack of timely rehabilitation of containment lines. Loss of perennial native species is a key risk factor for invasion by non-native annual species such as cheatgrass. Containment lines represent a potential invasion corridor into remote parts of the INL Site where there was previously little or no risk of invasion or domination by species that can alter the fire regime.

The draft CCA identifies conservation measures associated with fire recovery. After assessing the potential for natural recovery of re-sprouting native perennial species on the containment line, certain portions of the containment line may require artificial planting of native perennial species. The purpose for this is primarily to reduce the potential for invasive species to dominate these areas. Areas known to be dominated or have substantial presence of non-native annual plants (primarily cheatgrass) should be evaluated to determine restoration potential. These areas may be considered for changes in management or land use to alter plant communities to a more desirable condition. If the potential exists for simple changes in land management to bring about changes in plant community structure, then the area would be evaluated as a candidate for active rehabilitation and restoration to a native community. Large areas of the INL Site are now dominated by native perennial grasses and shrubs (primarily green rabbitbrush) and would be considered “restoration habitat.”

Idaho National Environmental Research Park

The National Environmental Research Park program was established in response to recommendations from citizens, scientists and members of Congress to set aside land for ecosystem preservation and study. This has been one of the few formal efforts to protect land on a national scale for research and education. In many cases, these protected lands became the last remaining refuges of what were once extensive natural ecosystems. Presently, there are Research Parks at seven DOE facilities around the country. There are five basic objectives guiding activities on the NERPs. They are to:

- Develop methods for assessing and documenting the environmental consequences of human actions related to energy development.
- Develop methods for predicting the environmental consequences of ongoing and proposed energy development.
- Explore methods for eliminating or minimizing predicted adverse effects from various energy development activities on the environment.
- Train people in ecological and environmental sciences.
- Use the NERPs for educating the public on environmental and ecological issues.

The INL Site was designated as a National Environmental Research Park in 1975. The Idaho Research Park provides a coordinating structure for ecological research and information exchange at the INL Site. The Idaho Research Park facilitates ecological research on the INL Site by attracting new researchers, providing background data to support new research project development, and providing logistical support for assisting researcher access to the INL Site. The Idaho Research Park provides infrastructure support to ecological researchers through the Experimental Field Station and museum reference collections. The Idaho Research Park tries to foster cooperation and research integration by encouraging researchers using the INL Site to collaborate, develop interdisciplinary teams to address more complex problems, and encourage data sharing, and by leveraging funding across projects to provide more efficient use of resources. The Idaho Research Park has begun to develop a centralized ecological database to provide an archive for ecological data and facilitate retrieval of data to support new research projects and land management decisions. The Idaho Research Park can also be a point of synthesis for research results that integrates results from many projects and disciplines and provides analysis of ecosystem-level responses. The Idaho Research Park also provides interpretation of research results to land and facility managers to support the National Environmental Policy Act (NEPA) process, natural resources management, radionuclide pathway analysis, and ecological risk assessment.

The basic objectives for the Idaho Research Park are as follows:

- Preserve the area as a representative example of a cool-temperate desert scrub biome
- Develop a regional reference data archive of the sagebrush steppe ecosystem

- Provide training and educational opportunities for environmental scientists and students
- Develop ecosystem models which can predict the effect of proposed activities in that ecosystem

The goals and objectives of the Idaho Research Park, including the unique opportunities it affords to researchers as a reference site, should also be considered when developing the proposed actions for recovery of the Jefferson Fire. Minimizing impacts to these goals, objectives and opportunities should be an important goal when considering fire recovery treatments to be implemented.

Time Horizons for Objectives

Rehabilitation objectives should address short-term and long-term issues separately. Short-term objectives are generally related to reducing the risk of further degradation of natural resources due to the fire or fire suppression activities. One short-term objective is to identify potential risks to the quick recovery of re-sprouting native perennial species. Another short-term objective is to identify potential risks for invasion by non-native species. Long-term recovery objectives ensure the affected communities remain in a diverse, stable, native condition. One objective is to ensure the prevailing land-use is consistent with the capabilities of the plant community occupying the area. It is very important that specific objectives be identified to guide the selection of stabilization and rehabilitation activities.

Recommendations Regarding Options Proposed by BLM

Ground Seeding

BLM plans to drill seed two native grass species and one wildflower species onto 1000 acres of land considered to be in low ecological condition. BLM reports that "residual seed concentrations in the soil may not be high enough to re-establish native species." BLM also plans to drill seed Wyoming big sagebrush, basin big sagebrush and winterfat (*Krascheninnikovia lanata*) onto 1000 acres of land.

Recommendation

It is unlikely that substantial areas within the Jefferson Fire on the INL Site are in sufficiently low ecological condition to warrant a similar action. Drill seeding on good condition sites would reduce the potential for quick recovery of the resprouting native, perennial species and would increase the risk of invasion by non-native species.

Greenstrips

BLM plans to create approximately 500 acres of greenstrips along 2 two-track roads on the BLM portion of the burn. Greenstrips are linear features planted with species that are less likely to burn and are created in an effort to reduce the size of fires. The species planted generally include crested wheatgrass (*Agropyron cristatum*) and Russian wildrye (*Psathyrostachys juncea*). Neither species is native to North America. Greenstrips have greatest potential for success in areas that have undergone a conversion to non-native annual grasses where the fire regime has been substantially altered and has a fire return interval of only 3 to 5 years.

Recommendation

The effectiveness of greenstrips has not been formally tested or published in the technical literature. However, crested wheatgrass is known to invade into otherwise good condition sagebrush steppe (Sheedy et al 2004). In the long-term, crested wheatgrass is known to alter soil properties and ecosystem function in a manner that likely precludes re-establishment by native species (Christian and Wilson 1999).

Although there have been a series of experiments around the Great Basin to investigate methods of eventually diversifying crested wheatgrass stands with native species, these attempts have thus far not been successful (Fansler and Mangold 2010, Hulet 2009, Hulet et al 2010).

The construction of these linear features results in habitat fragmentation for all but the most mobile wildlife species. Because crested wheatgrass is invasive, they also act as corridors providing for dispersion of this species into otherwise remote areas.

Our opinion is that greenstrips would be counterproductive to the goal of restoring habitat for sagebrush obligate wildlife on the INL Site.

Livestock Closure

BLM plans to close the burned portion of the Twin Buttes Allotment on the INL Site. Removal of livestock from the burned portion of the allotments is necessary to allow recovery of the herbaceous component of the native plant communities following fire. Permittees would be responsible for keeping livestock off of the closed portion of the allotment. BLM proposes to designate a corridor for trailing sheep from the south side of the fire to the north side.

The closure would remain in effect until "project-specific monitoring… shows that resource objectives have been met." Plant cover must be at least 70% of that found on nearby unburned islands and adjacent areas, and at least 80% of the herbaceous plants are producing seed.

Recommendation

Excluding grazing is appropriate and necessary to allow for natural recovery of the re-sprouting native, perennial species. We recommend cover measurements use methods compatible with those used for other vegetation data collection efforts on the INL Site.

We recommend the monitoring plan provide for statistical analysis to meet the cover and seed production objectives noted in the BLM plan. We recommend DOE request the corridor for trailing sheep from the south to north side of the burn be on the BLM portion where the distance across the burn is shorter. This would minimize the potential and extent of damage to recovering vegetation caused by trailing sheep on the recovering burn area.

Aerial Seeding

BLM plans to aerial seed 10,000 acres with Wyoming big sagebrush and basin big sagebrush. The goal of the planting is to speed return of big sagebrush cover to the burned area and restore sage-grouse habitat.

Recommendation

As noted earlier, aerial seeding has been shown to have only limited success due to limitations associated with weather conditions during the establishment period. We do not recommend aerial seeding as a cost effective option for accelerating the establishment of big sagebrush on the Jefferson Fire.

Seedling Planting

BLM plans to collect seed in fall 2010, which will be grown in a nursery as containerized stock to be planted in two areas of the Jefferson Fire. In 2010, BLM would plant 10,000 seedlings in two historic crested wheatgrass plantings in an attempt to re-establish sagebrush in crested wheatgrass plantings. In 2011, BLM would plant 30,000 seedlings near sage-grouse leks and in "high priority" areas. Seedlings would be planted in clumps of 100 per acre on 400 acres. Planting would be done with a mechanical planters pulled by tractors.

Recommendations

Using seedlings overcomes many of the environmental limitations on sagebrush establishment. There are several ways to use seedlings as part of a habitat restoration program. As noted earlier, seedlings are likely too expensive to use for large-scale restoration. Establishing the 500 plants per acre target would likely cost $1,500 to $2,500 per acre. Because of the need to disturb soil to plant the seedlings, cultural resource survey costs would need to be added as well.

Another approach is to concentrate this effort and cost in high priority areas like the areas surrounding leks. It would also be possible to use seedlings to re-establish connectivity in habitat that has been severely fragmented or isolated. This could be important for pygmy rabbit management given the limited mobility of this species and the extent of fragmentation on the INL Site due to the fires over the last 15 years. (See specific recommendations later in this document related to Habitat Connectivity.)

Establishing natives in crested wheatgrass has been shown to be limited by competition from crested wheatgrass as noted earlier. If the seedlings were to become established in the crested wheatgrass plantings they would still not provide suitable habitat for sage-grouse or pygmy rabbits. Although sagebrush is an important habitat component for these two species, it alone does not provide suitable habitat without a sufficient complement of native herbaceous species in the understory to provide cover and other necessary habitat characteristics. Crested wheatgrass does not provide suitable habitat characteristics for either sage-grouse or pygmy rabbit. We do not recommend actions related to diversifying crested wheatgrass plantings until the technical limitations described earlier have been addressed.

Weed Treatment

BLM Plans to conduct weed control on and in the vicinity of the burned area. They are aware of several noxious weed infestations that need to be targeted.

Recommendation
We recommend the burned area and area south of burn should be surveyed for noxious weeds, primarily musk thistle (*Carduus nutans*). It is likely biennial and perennial noxious weeds will bolt and produce seed in the burned area as well as in the area upwind of the burn. These species should be treated with herbicide immediately to prevent spread on the burned area. This would include inventory and spraying of weeds within about one-quarter mile of the upwind boundary of the burned area. This would likely need to be done using backpack sprayers. Estimated cost would be about $50,000.

Repair Damage to Minor Facilities

BLM Plans to repair some minor facilities like fences and wildlife water facilities (guzzlers).

Recommendation
We recommend that INL Site boundary signs destroyed in the fire along the east boundary be replaced as soon as possible. This will reduce the risk of trespass onto the INL Site by off road vehicles. Estimated cost would be about $5,000.

Additional Recommendations for the INL Site

Re-contour Containment Lines

Recommendation
We recommend that the soil berms be pulled back over the containment line. The topsoil in the rick contains the accumulated seed bank and using it to cover the containment line will replant those seeds on the damaged area. Although native seed requires rather shallow planting depth, it is likely that a substantial portion of the seeds will be at the right depth to geminate. This activity is currently underway on the Jefferson Fire containment lines.

Barricade Containment Lines

Recommendation
On the Twin Buttes Fire, we noted continued use of the containment line by vehicles more than one year after the fire. The areas receiving the most impact from vehicles on the Twin Buttes Fire in 2007 also had the highest frequency and density of invasive species including musk thistle and cheatgrass (Hafla et al. 2008). Preventing vehicle traffic on these areas is necessary for successful recovery of the containment lines. Barricades and/or signs should be placed on containment lines at intersections with roads or other potential access points. Estimated cost would be about $10,000.

INL Site Information Campaign

Recommendation

It has been some time since there was a coordinated campaign to inform INL Site employees about the risk of human caused fires on the INL Site. This should include both the safety aspects of a human caused fire, the potential for loss of utility of the INL Site to DOE and other customers because of lost sagebrush habitat, and the costs associated with fighting and rehabilitating burned areas. Our opinion is that an information and education campaign would be a cost effective way to improve the protection of remaining stands of sagebrush on the INL Site as well as provide information on the reasons protecting sagebrush habitat is important for sage-grouse and pygmy rabbit, as well as the link to protecting DOE mission activities. The campaign would include posters, articles and educational videos. Estimated cost would be about $50,000.

Satellite Imagery

Recommendation

Defining the boundaries of the burn and any unburned islands will be the important first step for developing a habitat recovery program. This information will be used to determine how much habitat was actually lost, how to best re-establish habitat connectivity and to develop costs associated with accomplishing habitat recovery.

Remote Sensing imagery can provide the spatial information needed to assess the post-fire conditions on vegetation by providing a snapshot measurement of the environment. Typically, remotely sensed data are collected from airborne or satellite platforms. Airborne sensors have the flexibility to fly on specific days and avoid cloud cover by postponing flights until the appropriate conditions occur. Airborne acquisitions are usually more costly, require advance notice for project/flight planning, and depending on weather conditions costs can increase substantially based on the number of standby days. Satellite sensors acquire imagery on a fixed return cycle of varying intervals. Since satellites are constrained to acquiring images at a specific time on a fixed cycle, poor imaging conditions (e.g., cloud cover) can negatively influence the quality of satellite image products. Most satellite data specifications will allow 10-20% cloud cover because it may take numerous acquisitions to ensure 100% cloud-free imagery.

There are several options for acquiring imagery suitable for the purposes of this effort. They include the following.

Moderate Resolution Satellite Imagery – The Landsat TM satellite archive has been opened to the public and imagery can be downloaded free of charge. Due to the moderate resolution of the imagery, the sensor would only capture unburned patches of sagebrush large enough to fill a pixel (900 m^2). Because we would like to be able to map all or most of the unburned patches, an image dataset capable of identifying smaller patches would be needed. At this resolution, the mapped unburned polygons would have less certainty and likely need widespread ground assessment which will require additional field survey costs. This imagery would not provide sufficient detail to support development of corridors for restoring habitat connectivity across the burn. Additional field surveys would be required to plan corridors

Higher Resolution Satellite Imagery – Higher resolution imagery has been used as a surrogate for ground validation data because of the image detail, and the most advanced satellite sensors in orbit today can collect imagery at resolutions previously only obtainable from airborne sensors. Areas mapped with high resolution imagery, would have greater certainty limiting the need for widespread ground validation which saves costs for field surveys.

The SPOT satellite sensor offers an intermediate data product with higher resolution than Landsat TM, but lower resolution than the most advanced satellite sensors. The most recently launched SPOT satellite has the capability to collect a higher resolution panchromatic band (5 m), while previous SPOT satellites were limited to 10 m. Depending on the data products (i.e., number of bands, and level of processing) imagery costs will vary. Image products are ordered by a scene (60 km x 60 km) or partial scenes. Further information would need to be requested to determine what image product would be required to cover the entire Jefferson Fire within the SPOT image footprint. Because the resolution is lower, there would be greater uncertainty with this data product than the options described below. This imagery may not provide the necessary information for designing habitat corridors.

There are three high-resolution commercial satellite sensors (IKONOS, Quickbird, GeoEye-1) that could provide the information required to map unburned sagebrush islands. All three have similar quality specifications and spatial resolutions. Each sensor collects a panchromatic band in addition to the color-infrared multispectral bands, thus capable of providing pan-sharpened imagery at 0.5 m or 1 m spatial resolution. Pricing ranges are similar among these sensors at roughly \$20-30/ km^2 depending on a number of factors, such as which spectral bands or data bundles ordered, the level of georeferencing accuracy and/or orthorectification (i.e., terrain correction) performed, and the whether or not data exists in the archive or needs to be newly tasked.

Any of the three highest resolution satellite sensors (IKONOS, Quickbird, GeoEye-1) would provide a tremendous amount of fine-scale information about post-fire vegetation conditions and would be adequate for the requirements of developing a restoration plan. The SPOT sensor would likely be adequate if funding was limited, but with larger pixel sizes the ability to confidently map small patches becomes questionable. Each of the imagery types would require some effort by a Remote Sensing/GIS analyst to process the data into a useful map for restoration planning.

With the high spatial resolution and data quality provided with the IKONOS, Quickbird, and GeoEye-1 datasets, the ability to identify and map small isolated unburned sagebrush islands would be greater and wouldn’t necessarily require extensive ground verification. We may also be able to identify regions where vegetation has only been partially burned, and areas where native re-sprouting since the fire has occurred, thus providing DOE-ID additional information that will assist with restoration and rehabilitation planning. We estimate this effort will cost about $30,000.

Habitat Connectivity

Recommendation

We recommend developing a plan for reconnecting habitat fragmented by the fire. The goal of this plan would be to limit impacts to sagebrush obligate wildlife species due to habitat fragmentation that could lead to isolated populations. We recommend two approaches to accomplish this.

First we recommend a focus on conservation of those species that are less mobile and likely unable to emigrate across large habitat gaps. This would initially provide corridors designed specifically to reconnect habitat for pygmy rabbits by planting sagebrush seedlings. The focus would make use of the satellite imagery to identify the most efficient locations for the corridors to be planted. We would use the imagery to locate remnant islands that did not burn. We would use imagery and existing topographic and surface hydrology layers to identify natural features to use as corridors. These might include drainages or areas of suitable soils associated with lava outcrops. The hope would be to design corridors that most efficiently fit the landscape as well as provide suitable habitat connectivity.

The second focus would be to reconnect sage-grouse leks with nesting and brood-rearing habitat. This would involve developing sage-grouse nesting and brood-rearing habitat in the vicinity of leks that have been isolated from these habitats by fire. We would use our recent inventories of active lek locations along with the satellite imagery to determine the best locations to efficiently and cost-effectively re-establish such habitat.

These plans would require collecting sagebrush seed this fall from the vicinity of the burn and subspecies and appropriate hybrids based on the new vegetation community map and community classifications. Seed collected would be sent to a grower to grow the seedlings and prepare them for planting. Contract planters would be used to plant the seedlings. The plan would also require that cultural resources surveys be completed in the areas to be planted. The estimated cost to plan and execute this effort would be in the range of $300,000 to $500,000.

Evaluating and Improving Low Condition Sites as Mitigation

Recommendation

One approach to mitigating for sagebrush dominated habitat lost in the Jefferson Fire would be to work toward improvement of habitat elsewhere on the INL Site. Identifying areas that still have suitable sagebrush cover but may have the herbaceous understory in declining condition would be the first step in this strategy. We recommend using the new vegetation community map to identify weedy areas and vegetation types that are particularly susceptible to increases in non-natives. The next step would be to prioritize for restoration or threat reduction those areas near habitat with high conservation values. These might include potential nesting and brood-rearing habitats near leks or habitats dominated by basin big sagebrush. Basin big sagebrush is likely one of the habitat types in lowest abundance on the INL Site, but is thought to be an important indicator of pygmy rabbit habitat.

Improving the condition of areas that already have sagebrush would likely provide more effective short-term conservation gains than attempting to re-establish big sagebrush onto the burn itself. This approach would provide additional benefits by increasing resistance and resilience of our remaining sagebrush habitat to future disturbance.

The estimated cost to identify low condition sites and develop a plan for execution would be about $50,000. Execution cost would be quite variable depending on the options identified in the plan development.

Monitoring Plan

Recommendation

We recommend that a monitoring plan for the burned area be developed. These monitoring activities would be used to determine the progress of recovery and the effectiveness or stabilization and rehabilitation actions. These data would also provide the necessary information to update the vegetation community map to reflect the changes caused by the fire. This monitoring plan would use existing long-term or recently inventoried plots as its foundation. The monitoring plan could include some of the follow approaches.

- We recommend re-sampling plots established prior to the fire including vegetation community map plots, Long-Term Vegetation plots, and plots surveyed for the CMP. These surveys would be used to evaluate post-fire recovery within the context of pre-burn condition and identify specific sites and plant communities that are at risk for increases in non-natives.
- We recommend using the vegetation community map and post-burn imagery to establish monitoring plots representing a range of pre-burn condition, vegetation type, and post-burn condition (e.g., unburned island, patchy burn, same season green-up, particularly high erosion – dunes, etc.). These data would be used to target sites for active restoration or changes in land use.
- We recommend establishing monitoring plots on sites where restoration activities are implemented, other changes in land use are recommended, and in high risk areas like excessive soil disturbance associated with containment lines, large weed patches, etc. These data would be used to guide adaptive management strategies.
- We recommend monitoring plots be established specifically to address the conditions necessary for return of livestock to the burned areas.

- We recommend that sample sizes should be adequate to represent the range of plant communities and conditions across the burn and to allow reasonably supported conclusions about recovery to be made.
- We recommend that plot sizes and sample protocols should be comparable to those used for vegetation research and monitoring elsewhere on the INL Site and should include at a minimum a thorough species list, absolute cover by species, and shrub density by species.

We estimate the cost of this monitoring program would be $100,000 each year until stabilization and rehabilitation goals and objectives have been achieved. Some of this cost could be offset by including some of the research projects described below.

Research Opportunities

The Jefferson Fire also presents some unique opportunities for research that would provide substantial amounts of information regarding fire recovery processes. This includes the opportunity to test certain hypotheses that have arisen from the results of previous research, but also could take advantage of the large amount of pre-fire data collected as part of the CMP process. Rarely has wildfire burned through such a heavily inventoried area before and the opportunities to learn about the relationship between pre-burn condition and recovery processes are rarer still. The knowledge gained from these research opportunities could provide valuable information for enhanced land management as well as conservation of sensitive species on the INL Site and sagebrush steppe in general. The following are brief proposal abstracts that could be quickly implemented.

Habitat Restoration Target

There are a number of concerns about the length of recovery of sagebrush following a fire. Our own research at the INL Site demonstrates that recovery to be equivalent to nearby unburned condition could take up to a century. However, recovery to a “pre-burn” condition may not be an appropriate target. It is likely that a threshold of sagebrush cover and height is reached before sage-grouse begin to use the recovering area as habitat. We are not aware of any previous research that addresses this. One consideration is to use the values at the bottom end of the range given in guidelines for managing habitat as that threshold (Connelly et al. 2000). Data in Connelly et al. (2000) Table 3 were not collected with a goal of finding the threshold, but represent a range of values for cover and height of sagebrush in areas that are used by grouse. We will be able to assess the use of recovering areas and minimum threshold values for sage-grouse habitat by looking for sage-grouse sign on the older burns, while simultaneously measuring sagebrush density and cover. The estimated cost for this would be $50,000 each year for three years.

General Reduction in Sagebrush Cover

The LTV data show a general decline in sagebrush cover over the past 30 years. This decline is independent of fires, and is likely a greater long-term problem for sagebrush-obligate species than fire. This reduction in sagebrush could be due to gap dynamics as in old-growth forests, self-thinning, or some other vector of decline. We suspect this reduction in sagebrush may be a characteristic of high-quality sagebrush steppe with a long history of no disturbance (as on the INL Site) and matches some early descriptions of sagebrush steppe. Scant information is available on this important topic, and we have a unique opportunity to address this question. Investigating spatial patterns of decline would allow us to determine if gap dynamics are at work. Estimated cost for this research would be $50,000 per year for three years.

Alternative Containment Line Methods

Containment lines bladed to bare ground bring the greatest risk of invasive species in remote areas of the INL Site. There is a need to investigate alternative methods for creating effective containment lines that do not require blading to bare soil or require a narrower bare soil line. There has been some information written on this subject, but no comprehensive review. We recommend preparing a review of the existing science on containment lines, methods used elsewhere, etc. to determine if there is a safe and effective alternative to three dozer-width lines. Estimated cost for this would be $50,000 per year for two years.

Responses of Mammals to Fire in the Development Zone of the Idaho National Laboratory Site

Small mammals, pygmy rabbits, bats, and ungulates have been studied intensively in the Development Zone since 2006 to provide information necessary for the CMP. The Jefferson Fire, however, burned approximately 200 square miles, much of which was in the Development Zone. Very little is known about relationships between mammals and fire in sagebrush-steppe ecosystems and as a result, the Jefferson Fire represents an unprecedented opportunity to monitor responses of mammals during post-fire recovery of sagebrush and other vegetation. We propose to establish long-term monitoring programs for small mammals, pygmy rabbits, bats, and ungulates to collect post-fire data that will be directly comparable with data collected for these species prior to the Jefferson Fire. Data on presence, abundance, and diversity of small mammals, and movements and habitat use of large mammals will provide land managers with critical information on ecological interactions between mammals and their environment, and would be useful for developing and implementing the CMP. Estimated cost for this would be $75,000 per year for three years.

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