Davis Canyon National Natural Landmark
Prescribed Burn Assessment and Monitoring

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Introduction

Davis Canyon National Natural Landmark (NNL), also recognized as a Washington State Natural Area Preserve (NAP), occupies 255 acres in Okanogan County, Washington, approximately 1 mile west of the Okanogan River and 10 miles southwest of the city of Okanogan. The site supports excellent examples of shrub-steppe plant communities, primarily antelope bitterbrush/Idaho fescue (*Purshia tridentata-Festuca idahoensis*), and a small amount of ponderosa pine (*Pinus ponderosa*) woodland at lower timberline. The historic fire regime in this area likely consisted of naturally-occurring fires every 10-30 years, with occasional longer intervals (Wilderman and Wonch 1998). Fire suppression in the area since the 1930's has prevented natural fires from occurring on the site and poses a threat to the plant communities for which the site was designated an NNL. In particular, the density and cover of antelope bitterbrush, a fire-sensitive shrub, have increased substantially in recent decades due to lack of fire. The need for prescribed fire on this site was identified in the Davis Canyon Fire Management Plan completed in 1998 (Wilderman and Wonch 1998). This plan called for initiation of prescribed burning beginning with a test area, or "pilot" unit, to assess the affects of burning on native vegetation as well as introduced plant species. The response of introduced species, in particular, needs to be assessed in order to determine whether to continue with prescribed burning in the future.

The trend toward high bitterbrush density and cover is a departure from historic natural conditions of the plant community. Natural conditions in the antelope bitterbrush/Idaho fescue community typically include bitterbrush cover of <20%, with native bunchgrasses and forbs providing most of the vegetative cover. Currently, nearly half of the Davis Canyon site has high (>30%) or very high (>40%) antelope bitterbrush cover (Wilderman and Wonch 1998) (see Figure 1). Under a natural fire regime, recurrent fires would generally maintain bitterbrush at lower levels. This reduces competition with bunchgrasses and forbs, allowing them to attain higher cover and diversity. In portions of the Davis Canyon NNL with high bitterbrush cover, the understory bunchgrasses and forbs are noticeably reduced. The litter accumulation beneath bitterbrush shrubs also provides enhanced habitat for cheatgrass and other invasive, non-native grasses to grow.

The increase in shrub cover has resulted in a loss of open grassland habitat on the site, creating a homogenous expanse of shrubland rather than a mosaic of shrub- and grass-dominated areas.

Many wildlife species in the area, e.g., western meadowlark, chipping sparrow, lark sparrow, and western kingbird, rely on or prefer a mixture of these habitats in close proximity and/or the edge habitat associated with the mosaic pattern (O'Neil et al. 2001). Sharp-tailed grouse, a State Threatened species known to occur on the site historically, but not currently, are known to preferentially forage in such edge habitat as well as open grassland with a diversity of broadleaf forbs (Hays et al. 1998) . Currently, only 20% of the site has ≤ 10% shrub cover and only a small proportion of this could be classified as grassland.

The high cover of bitterbrush on the NNL also presents a threat to the site if a wildfire burns in the area, which will inevitably occur. With high cover of shrubs such as antelope bitterbrush, which provide large amounts of fuel compared to grasses and forbs, a wildfire would burn at high intensity. This is particularly true during the hot, dry summer months when wildfires typically occur in this region. High-intensity wildfires in shrub-steppe vegetation often result in high mortality of native bunchgrasses, reductions in microbiotic soil crust, and increases in non-native plant species (e.g., Zlatnick 1999; Zouhar 2000; see Quigley and Arbelbide 1997). Such changes

Figure 1. Dense antelope bitterbrush at the south end of the prescribed burn unit.

are highly undesirable and would probably permanently degrade the composition and ecological function of the plant communities. Under natural conditions with lower fuel loading from shrubs, fires would typically burn at lower intensity.

For this project, a prescribed burn was conducted on approximately 15 acres, as identified in the Davis Canyon Fire Management Plan. Pre- and post-burn data were collected on shrub cover, herbaceous species frequency and cover, and ground cover variables. This report provides a description of the planning and execution of the prescribed burn, and analysis and summary of the pre- and post-burn data.

Goals and Objectives

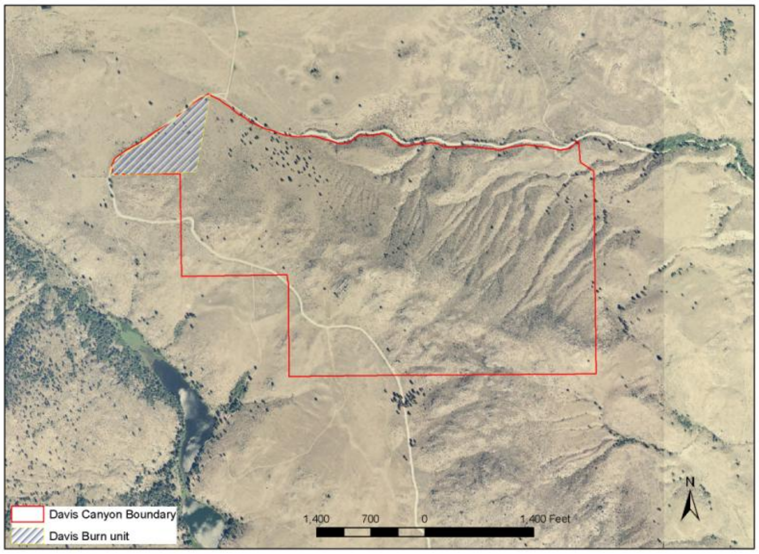
The overall goal of the project was to determine if prescribed burning can be successfully used at the site to reduce the amount of late-seral bitterbrush/bunchgrass without causing significant loss of desirable native vegetation or significant increases in non-native species. To accomplish this, we identified an area at the west end of the site (see Figure 2) to use as a “pilot” burn unit. The project called for this pilot unit to be burned according to a prescribed burn plan, and the vegetation response closely monitored.

Specific objectives for conducting the prescribed burn were to: 1) Reduce average shrub cover by at least 60%, 2) limit native bunchgrass mortality to approximately 10%, and 3) limit increases in non-native species to 10% or less 5 years after the burn.

Prescribed Burn Description

The burn unit was located at the extreme western end of the site (see Figure 2), and included approximately 15 acres. This area was proposed because it contained antelope bitterbrush/Idaho fescue with relatively high shrub cover (20-40%) and was logistically a relatively easy location to burn. Burning an area with high shrub cover would allow for assessment of fire effects in a vegetation type that is most likely to experience negative impacts (due to the higher fuel loading and higher temperatures that result). Thus, we would be able to monitor effects under a "worst-case" scenario in terms of potential loss of native species and invasion of non-natives. Davis Canyon Road borders the bottom of the unit, on the northwest, and provided an excellent fire break from which to anchor burning activities. The unit was bordered on the south by the site boundary (fenceline) and on the northeast by vegetation transition to much lower shrub cover.

Figure 2. Davis Canyon NNL/NAP Prescribed Burn Location

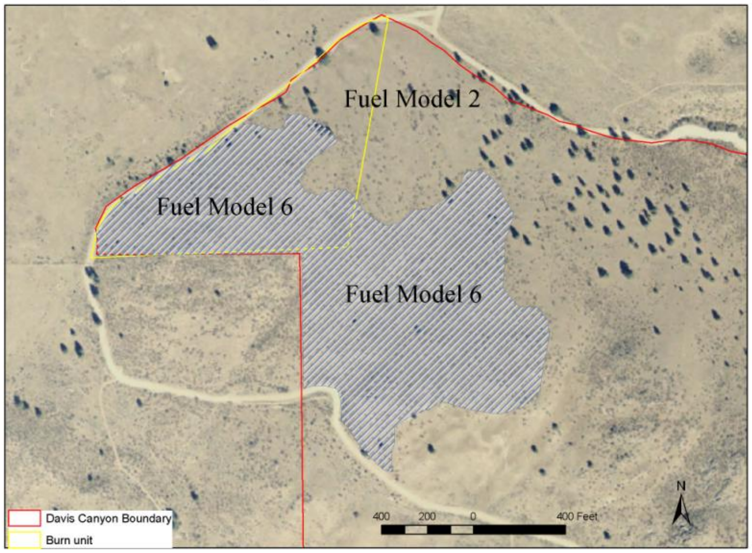


Following is a description of the Fuel Models (Anderson 1982) and topographic conditions of the 15-acre burn unit:

Vegetation Types	Fuel Models	% of Unit	% Slope	Aspect
Bitterbrush/Bunchgrass	6	75%	10-25%	W, NW, N
Mixed brush/Bunchgrass	2	20%	10%	N
Ponderosa Pine/Bunchgrass	2	5%	10%	NNW

The burn unit was located on primarily north and northwest aspects. Slopes were gentle throughout most of the unit, although the southwest portion of the unit had approximately 25% slopes facing west and northwest. Most of the vegetation was antelope bitterbrush/bunchgrass with relatively dense shrub cover (Fuel Model 6). In addition to antelope bitterbrush, shrubs included wax current, serviceberry, and small amounts of threetip sagebrush. The northeast portion of the unit had similar vegetation, but with much lighter shrub cover (Fuel Model 2). There were approximately 10 ponderosa pine trees within the unit, mostly within the areas of lighter shrub-cover (Fuel Model 2). Figure 3 shows the fuel pattern and distribution in the vicinity of the burn unit.

Figure 3. Davis Canyon NNL/NAP Prescribed Burn Unit Fuel Models



The prescribed burn was conducted according to the prescribed burn plan (Appendix A) on October 17, 2005. Burning began at approximately 1pm and ended at 4pm. Actual weather and fuel conditions were as follows:

- 1-hour fuel moisture 8%
- 10-hour fuel moisture 11%
- 100-hour fuel moisture 12-14%
- Relative humidity 59-63%
- Temperature 54-61°F

Ignition proceeded as outlined in the burn plan. Flame lengths ranged from approximately 2 feet in open grassland areas, to >10 feet in dense bitterbrush concentrations. According to the burn boss, the east, south and northeast portions of the unit carried fire the best, while the west flank and northwest corner did not burn as well due to insufficient amounts of fine fuels. For future burning in this area, or similar locations on the NAP, upslope winds from the north or northwest are recommended rather than the downslope winds that were prescribed. This would help to carry the fire upslope through the patches of minimal fine fuels.

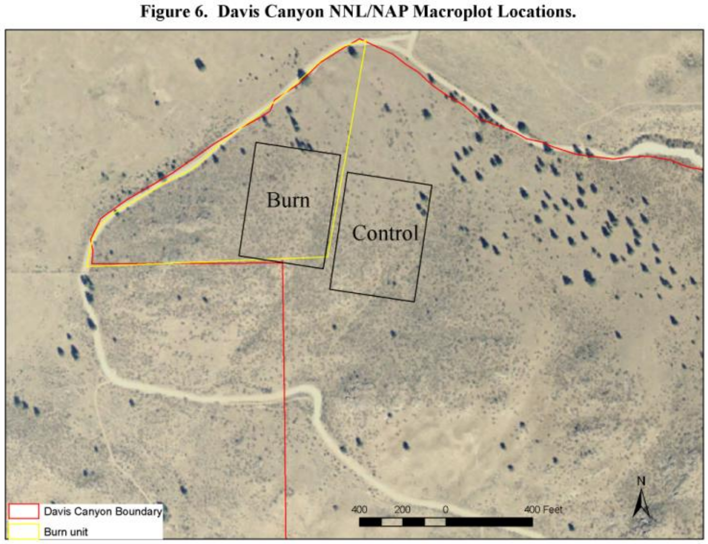
Figure 5. Establishing blackline along the east flank

Monitoring

<u>Methods</u>

Within the burn unit, a macroplot 125m x 200m (2.5ha/6.2 acres) in size was established (see Figure 6). A control macroplot of identical size and dimensions was established adjacent to the burn macroplot, with a 10m "buffer" between the two macroplots to allow room for fireline preparations and for edge effects within each of the macroplots. The vegetation and topography within the two macroplots appeared to be very similar, with the exception that the control

Figure 6. Davis Canyon NNL/NAP Macroplot Locations.



macroplot had an area of somewhat steeper hillside at its southern end compared to the burn macroplot. Vegetation in both macroplots was dominated by antelope bitterbrush, Idaho fescue, bluebunch wheatgrass, threadleaf sedge, and a variety of forbs. Introduced species were of low abundance in both macroplots.

Within each of the two macroplots, we measured frequency and cover of vegetation and ground cover variables. Ten transects 125m in length were used in each macroplot. These were located using an initial random starting point along the 200m side of the macroplots and then placing subsequent transects at a systematic distance from this point. The transects were then run into the macroplot, perpendicular to the 200m side. On each of the ten transects per macroplot, 20 point-intercept cover readings were taken, for a total of 200 points/macroplot and 10 nested frequency quadrats were read for a total of 100 quadrats /macroplot. Point intercept and nested frequency quadrat locations were chosen in the same manner as the transect locations, using an initial random starting point and then placing subsequent points and quadrats at a systematic distance from this point. Percent shrub cover was recorded for each transect using line-intercept measurements.

<u>Point-Intercept</u> At each of the 200 points, a point intercept tripod device was used to lower a pin vertically toward the ground from approximately 4 feet until it contacted vegetation other than shrubs, which were not recorded in this manner. The pin was then stopped and the species or plant group (see below) that the pin had contacted was recorded. We then continued lowering the pin and recording all new species or plant groups that it contacted. Finally, we lowered the pin to the ground and recorded the appropriate ground cover category. The percent of the 200 points/macroplot in which a species or plant group was contacted by the pin then represents the percent canopy cover of that species or group within the macroplot. The following were recorded in this manner:

- Graminoids, identified to species, or subspecies level where applicable
- Native Perennial Forbs, as a group
- Native Annual Forbs, as a group
- Introduced Forbs, identified to species, or subspecies level where applicable

- Ground cover recorded as one of the following: lichen/moss; bare ground; rock or litter.

Point-intercept data were converted to percent cover and analyzed using chi-square tests to assess the statistical significance of differences between pre- and post-treatment measurements within the burn and control macroplots.

Nested Frequency Each nested frequency quadrat consisted of three frame sizes -- 0.01m^2, 0.10 m^2, and 1m^2. Within each nested quadrat, all vascular plants rooted within the frames were recorded. Plants were identified to species or sub-species level whenever possible. Data were converted to percent frequencies and analyzed using chi-square tests to assess the statistical significance of differences between pre- and post-treatment measurements within the burn and control macroplots.

Line-intercept Cover of shrubs was measured along each of the ten transects per macroplot by recording the amount of the transect line intercepted by live shrub canopy. We recorded species separately, including any overlap of different species. The proportion of the 125m transect intercepted by a given species represented its percent canopy cover for that transect. Total shrub cover was calculated by summing the measurements for the separate species. Line intercept data were converted to percent cover and analyzed using Student's t-test to assess the statistical significance of differences between pre- and post-treatment measurements within the burn and control macroplots.

All pre-burn data were collected in late May and early June 2002, when vegetation was generally expected to be at or near its peak cover values. Pre-burn shrub cover data were not collected in the control macroplot due to time constraints, however any changes in shrub cover over the few years of the project were expected to be negligible. Post-burn data were collected in late May and early June 2006, the first growing season after the burn. Pre-burn data were collected in 2002 because the prescribed burn was originally scheduled for 2002; however, funding and weather constraints delayed the burn until 2005. While changes in variables between 2002 and 2006 may be related to the elapsed time period in addition to fire effects, any such changes would presumably occur in both the control and burn macroplots, so that any *differences* in the degree of changes between the two macroplots are presumably due to fire effects (or some other unaccounted for phenomenon) rather than the elapsed time period.

Plant nomenclature follows Hitchcock and Cronquist (1973).

Photopoints were established at eight locations within and around the burn unit. Pre- and post-burn photos from some of the photopoints are included at the end of the report (Figures 7-15).

Results

The prescribed burn appears to have accomplished the goals and objectives of the project quite well in the short-term. Following are results as they relate to the three primary objectives of the prescribed burn:

1) **Reduce average shrub cover by at least 60%**

   Shrub cover in the burn macroplot was reduced from 36.6% pre-burn to 7.2% post-burn, a reduction of 80% from the pre-burn level (see Table 5). This reduction was statistically significant ($p<.001$). Shrub cover in the control macroplot was not measured pre-burn but was 19.2% in post-burn measurements, indicating that the control macroplot was somewhat more open than the burn macroplot prior to the burn.

2) **Kill 10% or less of the native bunchgrass**

   As a group, Native Perennial Grass frequency declined a small amount in the burn macroplot, from 68% to 63%, but this change was not significant ($p=0.46$) (see Table 1). The group increased a small amount, from 50%-59%, in the control macroplot, also a non-significant change. Native Perennial Grass cover increased substantially in both macroplots. While neither frequency nor cover are a direct measurement of grass mortality, the results (especially frequency measures) indicate very low levels of mortality due to the fire.

3) **Limit increases in non-native species to 10% or less 5 years after the burn**

   Non-native annual grass frequency increased significantly in both the burn and control macroplots, with the increase somewhat greater in the control macroplot (30% to 57%)

than the burn macroplot (16% to 36%) (see Table 4). The cause of this increase in both macroplots is unclear, however the fact that the level of increase was similar in both macroplots indicates that the burn was not responsible for the increase in non-natives. Cover of non-native annual grasses increased only a minor amount in the burn macroplot (0% to 3%), while increasing substantially in the control macroplot (0% to 10%). Non-native forb frequency was very low in both macroplots and showed minor, insignificant increases in both. Continued monitoring will be necessary to fully evaluate the effect of the fire on non-native species.

In addition to results related to the three specific prescribed burn objectives, overall responses of vegetation groups and individual species were analyzed to provide a more thorough assessment of vegetation effects. This analysis is presented below, grouped by the six plant species guilds and variable groupings that were used: Native Perennial Graminoids, Native Perennial Forbs, Native Annual Forbs, Non-native Species, Native Shrubs and Sub-shrubs, and Ground Cover Variables. These sections provide an assessment of the responses of the guilds/variable groupings as a whole and highlight those species or variables that changed most dramatically over time. For a full list of species or variables in each group and their pre- and post-burn frequency levels, see Tables 7-11 at the end of the report.

Native Perennial Graminoids (NPG): As indicated above, frequency of NPG as a group declined a small amount in the burn macroplot and increased a small amount in the control macroplot (see Table 1). NPG cover increased substantially in both macroplots. Among individual species, *Festuca idahoensis* and *Carex filifolia* appear to have been reduced by the burn. *Festuca idahoensis* decreased in frequency moderately (78% to 67%) in the burn macroplot, while remaining essentially unchanged in the control (58% to 56%). *Carex filifolia* frequency decreased in the burn (66% to 60%) while increasing in the control (48% to 57%). The two other major graminoids on the site, *Agropyron spicatum* and *Poa secunda*, increased substantially in both macroplots. Cover values increased for all NPG species in both macroplots.

Table 1. Native Perennial Graminoids						
			Frequency		Cover	
	Quadrat	Macroplot	Pre-burn	Post-burn	Pre-burn	Post-burn
Bluebunch wheatgrass (*Agropyron spicatum*)	$1.0m^2$	Burn	**68%	86%	**3%	15%
	$1.0m^2$	Control	**50%	81%	*5%	13%
Threadleaf sedge (*Carex fillifolia*)	$1.0m^2$	Burn	66%	60%	4%	8%
	$1.0m^2$	Control	48%	57%	4%	8%
Idaho fescue (*Festuca idahoensis*)	$0.1\ m^2$	Burn	*78%	67%	**11%	27%
	$0.1\ m^2$	Control	58%	56%	*14%	25%
Prairie junegrass (*Koeleria pyramidata*)	$1.0m^2$	Burn	9%	18%		
	$1.0m^2$	Control	7%	14%		
Native Perennial Graminoids	$.01m^2$	Burn	68%	63%	**18%	57%
	$.01m^2$	Control	50%	59%	**25%	53%
Sandberg's bluegrass (*Poa secunda*)	$1.0m^2$	Burn	**10%	49%		
	$1.0m^2$	Control	**26%	67%		

Colored cells in adjacent columns indicate a statistically significant increase or decrease of the species following burning, in the respective measurement (frequency or cover). Adjacent green cells indicate an increase; red cells indicate a decrease. * $p \leq .1$; ** $p \leq .05$.

Native Perennial Forbs (NPF): As a group, NPF decreased in frequency in the control (46% to 34%) but remained essentially unchanged in the burn (58% to 61%) (see Table 2). Individual species with significant trends included *Microseris troximoides* which was reduced in the burn, *Lomatium triternatum* which increased slightly in the burn, and *Lithophragma parviflora*, *Erigeron corymbosus*, and *Dodecatheon conjugens* which increased substantially in the burn. Other species were essentially unchanged in the burn macroplot or showed similar changes to the control macroplot over the time period. Cover of NPF as a group increased slightly in the burn and decreased slightly in the control.

Table 2. Native Perennial Forbs						
			Frequency		Cover	
	Quadrat	Macroplot	Pre-burn	Post-burn	Pre-burn	Post-burn
yarrow (*Achillea millefolium*)	1.0m^2	Burn	27%	35%		
	1.0m^2	Control	24%	24%		
littleleaf pussytoes (*Antennaria microphylla*)	1.0m^2	Burn	54%	51%		
	1.0m^2	Control	35%	33%		
arrowleaf balsamroot (*Balsamorhiza sagitatta*)	1.0m^2	Burn	25%	33%		
	1.0m^2	Control	37%	35%		
Douglas' brodiaea (*Brodiaea douglasii*)	0.1 m^2	Burn	**63%	43%		
	0.1 m^2	Control	**45%	27%		
Lyall's mariposa lily (*Calochortus lyallii*)	1.0m^2	Burn	45%	52%		
	1.0m^2	Control	*22%	34%		
slender hawkweed (*Crepis atrabarba*)	1.0m^2	Burn	**7%	49%		
	1.0m^2	Control	**8%	35%		
Bonneville shootingstar (*Dodecatheon conjugens*)	1.0m^2	Burn	43%	50%		
	1.0m^2	Control	40%	34%		
longleaf fleabane (*Erigeron corymbosus*)	1.0m^2	Burn	**35%	52%		
	1.0m^2	Control	34%	39%		
whitestem frasera (*Frasera albicaulis*)	1.0m^2	Burn	21%	26%		
	1.0m^2	Control	12%	19%		
smallflower woodland-star (*Lithophragma parviflorum*)	1.0m^2	Burn	**4%	20%		
	1.0m^2	Control	4%	7%		
Wyeth biscuitroot (*Lomatium ambiguum*)	1.0m^2	Burn	*15%	24%		
	1.0m^2	Control	26%	29%		
silky lupine (*Lupinus sericeus*)	1.0m^2	Burn	6%	12%		
	1.0m^2	Control	11%	6%		
weevil prairie-dandelion (*Microseris troximoides*)	1.0m^2	Burn	**29%	12%		
	1.0m^2	Control	7%	4%		
Native Perennial Forbs	.01m^2	Burn	58%	61%	13%	17%
	.01m^2	Control	*46%	34%	18%	16%
Alberta saxifrage (*Saxifraga occidentalis*)	1.0m^2	Burn	**17%	30%		
	1.0m^2	Control	5%	11%		
meadow deathcamas (*Zigadenus venenosus*)	1.0m^2	Burn	37%	36%		
	1.0m^2	Control	22%	27%		

Colored cells in adjacent columns indicate a statistically significant increase or decrease of the species following burning, in the respective measurement (frequency or cover). Adjacent green cells indicate an increase; red cells indicate a decrease. * $p \leq .1$; **$p \leq .05$.

Native Annual Forbs (NAF): As a group, NAF frequency increased dramatically in both macroplots (see Table 3). The only two species that exhibited different trends in the two macroplots were *Collinsia parviflora*, which increased substantially in the burn, and *Plantago* *patagonica*, which increased in the control but not in the burn. All other species increased, substantially in most cases, in both macroplots. Cover of NAF as a group increased in both macroplots, but the increase was significant only in the burn.

Table 3. Native Annual Forbs						
			Frequency		Cover	
	Quadrat	Macroplot	Pre-burn	Post-burn	Pre-burn	Post-burn
tiny trumpet *(Collomia linearis)*	1.0m^2	Burn	**21%	70%		
	1.0m^2	Control	**12%	85%		
blue-eyed Mary *(Collinsia parviflora)*	1.0m^2	Burn	**35%	54%		
	1.0m^2	Control	47%	50%		
basin cryptantha *(Cryptantha ambigua)*	1.0m^2	Burn	**23%	36%		
	1.0m^2	Control	9%	14%		
spreading groundsmoke *(Gayophytum diffusum)*	1.0m^2	Burn	**19%	42%		
	1.0m^2	Control	**0%	31%		
small tarweed *(Madia exigua)*	1.0m^2	Burn	*14%	24%		
	1.0m^2	Control	**0%	31%		
slender phlox *(Microsteris gracilis var. humilor)*	1.0m^2	Burn	**0%	23%		
	1.0m^2	Control	**9%	20%		
Native Annual Forbs	0.1m^2	Burn	**34%	70%	**1%	9%
	0.1m^2	Control	**26%	66%	1%	3%
wooly plantain *(Plantago patagonica)*	1.0m^2	Burn	10%	10%		
	1.0m^2	Control	**5%	39%		

Colored cells in adjacent columns indicate a statistically significant increase or decrease of the species following burning, in the respective measurement (frequency or cover). Adjacent green cells indicate an increase; red cells indicate a decrease. * $p \leq .1$; **$p \leq .05$.

Non-Native Species: Non-native annual grasses on the site include *Bromus japonicus* and *Bromus tectorum*, with *B. japonicus* the more abundant of the two. As described earlier, non-native annual grass frequency increased significantly as a group in both the burn and control macroplots (see Table 4). However, cover of these grasses increased more in the control (1% to 10%) than in the burn (0% to 3%). *Poa bulbosa*, a non-native perennial grass, increased substantially in frequency in the control (12% to 22%) while only increasing a small amount in the burn (2% to 6%). Non-native forbs in the macroplots included common dandelion and salsify. All three were present at very low levels (3% or less frequency in 1.0m2 quadrat) and showed no significant trends.

Table 4. Non-native Species						
			Frequency		Cover	
	Quadrat	Macroplot	Pre-burn	Post-burn	Pre-burn	Post-burn
Japanese brome *(Bromus japonicus)*	$1.0m^2$	Burn	**13%	34%	0%	2%
	$1.0m^2$	Control	**17%	49%	**0%	7%
cheatgrass *(Bromus tectorum)*	$1.0m^2$	Burn	4%	7%	0%	1%
	$1.0m^2$	Control	18%	24%	1%	3%
Non-native Annual Grasses	$1.0m^2$	Burn	**16%	36%	0%	3%
	$1.0m^2$	Control	**30%	57%	**1%	10%
bulbous bluegrass *(Poa bulbosa)*	$1.0m^2$	Burn	2%	6%		
	$1.0m^2$	Control	*12%	22%		
common dandelion *(Taraxacum officinale)*	$1.0m^2$	Burn	0%	0%		
	$1.0m^2$	Control	2%	0%		
yellow salsify *(Tragopogon dubius)*	$1.0m^2$	Burn	0%	1%		
	$1.0m^2$	Control	0%	3%		

Colored cells in adjacent columns indicate a statistically significant increase or decrease of the species following burning, in the respective measurement (frequency or cover). Adjacent green cells indicate an increase; red cells indicate a decrease. * $p \leq .1$; ** $p \leq .05$.

Native Shrubs and Sub-shrubs: As described above, shrub cover was substantially reduced in the burn macroplot as expected. Shrub frequency remained essentially unchanged in both macroplots (see Table 5). *Ribes cereum* was the only shrub to show a different trend in the burn, where it increased significantly while remaining unchanged in the control. Sub-shrubs, consisting of ***Eriogonum*** *heracleoides*, *Eriogonum niveum*, and *Phlox longifolia*, remained essentially the same in both macroplots.

Table 5. Native Shrubs and Sub-shrubs						
			Frequency		Cover	
	Quadrat	Macroplot	Pre-burn	Post-burn	Pre-burn	Post-burn
threetip sagebrush *(Artemisia tripartita)*	$1.0m^2$	Burn	21%	18%		
	$1.0m^2$	Control	17%	15%		
parsnip-flowered buckwheat *(Eriogonum heracleoides)*	$1.0m^2$	Burn	21%	24%		
	$1.0m^2$	Control	19%	27%		
antelope bitterbrush *(Purshia tridentata)*	$1.0m^2$	Burn	21%	22%		
	$1.0m^2$	Control	17%	26%		
wax currant *(Ribes cereum)*	$1.0m^2$	Burn	**5%	16%		
	$1.0m^2$	Control	4%	4%		
Total Shrub		Burn			**37%	7%
		Control				19%

Colored cells in adjacent columns indicate a statistically significant increase or decrease of the species following burning, in the respective measurement (frequency or cover). Adjacent green cells indicate an increase; red cells indicate a decrease. * $p \leq .1$; ** $p \leq .05$.

Ground Cover Variables: Ground cover variables included lichen/moss cover, litter cover, bare ground cover, and rock cover. Of these, rock and bare ground remained essentially the same in both macroplots over the time period (see Table 6). Lichen/moss cover increased slightly in the burn while decreasing in the control, although neither was statistically significant. Litter increased in both macroplots, but the increase was significant only in the control.

Table 6. Ground Cover Variables

		Cover	
	Macroplot	Pre-burn	Post-burn
Lichen/Moss	Burn	8%	10%
	Control	*9%	3%
Litter	Burn	67%	70%
	Control	**71%	84%

Colored cells in adjacent columns indicate a statistically significant increase or decrease of the species following burning. Adjacent green cells indicate an increase; red cells indicate a decrease. * $p \leq .1$; ** $p \leq .05$.

Conclusions and Discussion

The prescribed burn accomplished the overall goal of substantially reducing shrub cover within the burn unit and moving the plant community toward an earlier successional stage. Data on herbaceous vegetation in the first post-fire year indicate that most native species were present at similar levels after the fire as before, or showed similar changes to the control plot. Native herbaceous species that are typically most fire-sensitive, such as Idaho fescue, were reduced only slightly or moderately compared to the unburned plot. Non-native species also did not show any marked trend in the burn plot vs. the control plot, indicating there has been no immediate invasion or expansion of non-natives due to the fire. They did, however, increase substantially in both of the macroplots. Continued monitoring will be important in assessing longer-term vegetation trends, especially the non-natives, since vegetation responses often occur over several years. DNR plans to continue tracking trends in the non-native species, at a minimum, in the near-future.

This prescribed fire, conducted in mid-October, occurred under relatively cool and humid conditions. Relative humidity was around 60%, nearly twice the desired level of 30-40%. Temperatures were in the 50s to low 60s, rather than mid-60s to 70s that were expected. Fuel moisture conditions were at the upper end of the desired range. These overall conditions appear to have resulted in a quite low-intensity burn throughout the burn unit, and a portion (20%) of the unit burned in a very patchy manner. Although the unit could have been burned more completely, and shrub cover reduced more, with a higher-intensity burn, this type of cool, low-intensity burn is probably ideal for the site in order to minimize mortality of native species (Idaho fescue in particular) and to reduce the potential for invasion or expansion of non-native plant species. If vegetation responses over the next few years remain similar to what has occurred in the first post-fire growing season, prescribed burning will be an effective tool to use on other portions of the site. Monitoring over the next two to three years will provide a more complete assessment of this prescribed burn and will help determine future prescribed burn planning.

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Tables 7-11. Frequency data for all species by plant group.

Table 7. Native Perennial Forb Frequency					
		Burn		Control	
	Quadrat	Pre-burn	Post-burn	Pre-burn	Post-burn
Achillea millefolium	$1.0m^2$	27%	35%	24%	24%
Agoseris grandiflora	$1.0m^2$	0%	0%	1%	0%
Antennaria microphylla	$1.0m^2$	54%	51%	35%	33%
Arabis holboelii	$1.0m^2$	0%	2%	1%	3%
Arenaria congesta	$1.0m^2$	0%	20%	0%	31%
Artemisia dracunculus var. drac.	$1.0m^2$	0%	5%	1%	10%
Balsamorhiza sagitatta	$1.0m^2$	25%	33%	37%	35%
Brodiaea dougalsii	$.01m^2$	63%	43%	45%	27%
Calochortus lyallii	$1.0m^2$	45%	52%	22%	34%
Castilleja thompsonii	$1.0m^2$	8%	2%	4%	2%
Commandra umbellata	$1.0m^2$	3%	7%	1%	4%
Crepis atrabarba	$1.0m^2$	7%	49%	8%	35%
Delphinium nuttallianum var. nutt.	$1.0m^2$	0%	0%	0%	2%
Dodecatheon conjugens var. con.	$1.0m^2$	43%	50%	40%	34%
Epilobium angustifolium	$1.0m^2$	0%	0%	0%	2%
Erigeron corymbosus	$1.0m^2$	35%	52%	34%	39%
Erigeron pumilis	$1.0m^2$	0%	1%	0%	2%
Frasera albicaulis	$1.0m^2$	21%	26%	12%	19%
Gaillardia aristata	$1.0m^2$	1%	0%	0%	3%
Geum triflorum	$1.0m^2$	3%	3%	0%	0%
Gnaphalium microcephalum	$1.0m^2$	0%	0%	0%	1%
Heuchera cylindrica	$1.0m^2$	1%	0%	0%	0%
Hieracium scouleri	$1.0m^2$	3%	6%	6%	0%
Lithophragma parviflorum	$1.0m^2$	4%	20%	4%	7%
Lithospermum ruderale	$1.0m^2$	3%	6%	3%	3%
Lomatium ambiguum	$1.0m^2$	15%	24%	26%	29%
Lomatium macrocarpum	$1.0m^2$	1%	0%	2%	3%
Lomatium triternatum	$1.0m^2$	0%	7%	3%	8%
Lupinus sericeus	$1.0m^2$	6%	12%	11%	6%
Microseris troximoides	$1.0m^2$	29%	12%	7%	4%
Penstemon attenuatus	$1.0m^2$	1%	0%	7%	0%
Penstemon confertus	$1.0m^2$	0%	0%	0%	3%
Perideridia gairdneri ssp. borealis	$1.0m^2$	7%	0%	0%	1%
Polygonum douglasii	$1.0m^2$	1%	11%	0%	10%
Potentilla arguta	$1.0m^2$	3%	5%	5%	3%
Potentilla gracilis var. flabelliformis	$1.0m^2$	0%	1%	0%	0%
Saxifraga occidentalis	$1.0m^2$	17%	30%	5%	11%
Senecio integerrimus var. exaltatus	$1.0m^2$	7%	17%	0%	2%
Silene douglasii var. douglasii	$1.0m^2$	0%	0%	0%	1%
Zigadenus venenosus	$1.0m^2$	37%	36%	22%	27%

Table 8. Native Perennial Graminoid Frequency					
		Burn		Control	
	Quadrat	Pre-burn	Post-burn	Pre-burn	Post-burn
Agropyron spicatum	1.0m^2	68%	86%	50%	81%
Carex fillifolia	1.0m^2	66%	60%	48%	57%
Festuca idahoensis	.01m^2	78%	67%	58%	56%
Juncus balticus	1.0m^2	0%	0%	0%	1%
Koeleria cristata	1.0m^2	9%	18%	7%	14%
Poa secunda	1.0m^2	10%	49%	26%	67%
Stipa comata	1.0m^2	0%	0%	4%	0%
Stipa occidentalis	1.0m^2	0%	0%	1%	8%

Table 9. Native Annual Forb & Graminoid Frequency					
		Burn		Control	
	Quadrat	Pre-burn	Post-burn	Pre-burn	Post-burn
Agoseris heterophylla	1.0m^2	0%	18%	1%	21%
Collinsia parviflora	1.0m^2	35%	54%	47%	50%
Collomia grandiflora	1.0m^2	0%	0%	2%	0%
Collomia linearis	1.0m^2	21%	70%	12%	85%
Cryptantha ambigua	1.0m^2	23%	36%	9%	14%
Draba verna	1.0m^2	0%	12%	0%	6%
Epilobium minutum	1.0m^2	0%	1%	0%	3%
Gayophytum diffusum	1.0m^2	19%	42%	0%	31%
Linanthus harknessii	1.0m^2	1%	1%	1%	0%
Madia exigua	1.0m^2	14%	24%	0%	31%
Microsteris gracilis var. humilor	1.0m^2	0%	23%	9%	20%
Montia perfoliata	1.0m^2	1%	6%	0%	4%
Plantago patagonica	1.0m^2	10%	10%	5%	39%
Vulpia microstachys	1.0m^2	0%	10%	2%	14%
Vulpia octoflora	1.0m^2	17%	42%	16%	41%

Table 10. Non-native Species Frequency					
		Burn		Control	
	Quadrat	Pre-burn	Post-burn	Pre-burn	Post-burn
Bromus japonicus	1.0m^2	13%	34%	17%	49%
Bromus tectorum	1.0m^2	4%	7%	18%	24%
Agropyron cristatum	1.0m^2	0%	0%	0%	6%
Poa bulbosa	1.0m^2	2%	6%	12%	22%
Camelina microcarpa	1.0m^2	0%	0%	0%	0%
Taraxacum officinale	1.0m^2	0%	0%	2%	0%
Tragopogon dubius	1.0m^2	0%	1%	0%	3%

Table 11. Native Shrub & Sub-shrub Frequency					
		Burn		**Control**	
	Quadrat	**Pre-burn**	**Post-burn**	**Pre-burn**	**Post-burn**
Amelanchier alnifolia	$1.0m^2$	2%	1%	0%	1%
Artemisia tripartita	$1.0m^2$	21%	18%	17%	15%
Eriogonum heracleoides	$1.0m^2$	21%	24%	19%	27%
Eriogonum niveum	$1.0m^2$	0%	0%	1%	3%
Phlox longifolia	$1.0m^2$	9%	9%	10%	6%
Purshia tridentata	$1.0m^2$	21%	22%	17%	26%
Ribes cereum	$1.0m^2$	5%	16%	4%	4%
Rosa woodsii	$1.0m^2$	3%	2%	2%	2%
Symphorcarpos albus	$1.0m^2$	0%	0%	1%	0%

Figure 7. Photopoint 2a before (top, September 2005) and after (bottom, May 2006) prescribed burning.

Figure 8. Photopoint 2b before (top, September 2005) and after (bottom, May 2006) prescribed burning.

Figure 9. Photopoint 5 before (top, September 2005) and after (bottom, May 2006) prescribed burning.

Figure 10. Photopoint 1 before (top, September 2005) and after (bottom, May 2006) prescribed burning.

Figure 11. Photopoint 3 before (top, September 2005) and after (bottom, May 2006) prescribed burning.

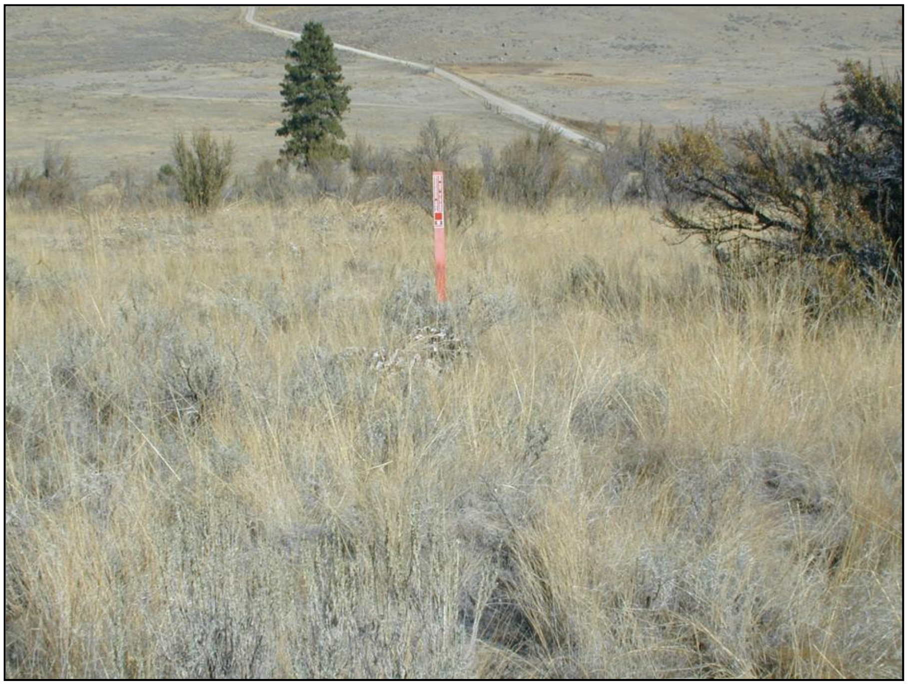

Figure 12. Photopoint 5 before (top, September 2005) and after (bottom, May 2006) prescribed burning.

Figure 13. North end of burn unit in May 2006 after prescribed burning. Note small ponderosa pine seedlings/saplings (light brown) killed in the mid-ground.

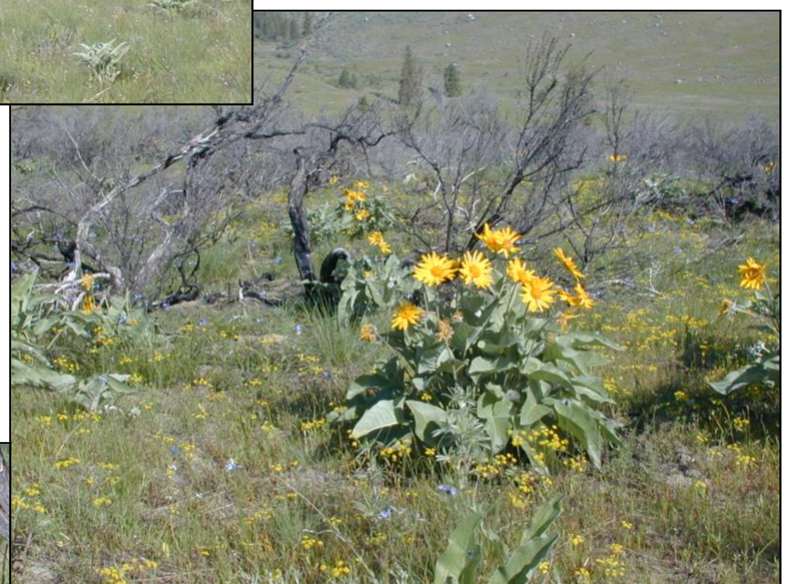

Figure 14. Arrowleaf balsamroot (*Balsamorhiza sagittata*) and Wyeth biscuitroot (*Lomatium ambiguum*) in May 2006 after prescribed burning.

Figure 15. Bluebunch wheatgrass (*Agropyron spicatum*) resprouting next to a burned antelope bitterbrush (*Purshia tridentata*) in May 2006 after prescribed burning.

APPENDIX A

Prescribed Burn Plan