Bi-State Habitat Restoration Project Monitoring

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Background

The purpose of this report is to present preliminary results from habitat restoration and monitoring projects within the Bi-State Greater Sage-grouse region. The Bi-State Action Plan for Conservation of the Greater Sage-grouse Bi-State Distinct Population Segment (2012; hereafter "Action Plan") identified pinyon and juniper (PJ) encroachment as a high threat across much of the Bi-State range. The greater sage-grouse (*Centrocercus urophasianus*) depend on sagebrush as its primary food source, cover from predators, habitat for lekking and nesting, and the support of annual and perennial forbs crucial for forage (Bates et al. 2017; Coates et al. 2017, 2016; Davies et al. 2011; Prochazka et al. 2017). Thus, the Bi-State local working group and technical advisory committee identified several PJ removal projects within historical sagebrush habitats being encroached upon by PJ.

Over the last century, pinyon-juniper woodlands have expanded into sagebrush communities for multiple reasons including wildfire suppression, increased grazing pressure, and climatic changes (Brockway et al. 2002; Chambers and Pellant, 2008; Miller and Tausch 2001). While PJ woodlands provide important habitat for native species including pinyon jays (*Gymnorhinus cyanocephalus*; Balda and Kamil 1998) and mule deer (*Odocoileus hemionus*; Watkins et al. 2007), expansion of PJ into sagebrush steppe can be detrimental to sagebrush-obligate species. PJ expansion can have both negative direct and indirect effects on Great Basin ecosystems. PJ expansion into sagebrush habitats can facilitate an increase in invasive, annual grasses like cheatgrass (*Bromus tectorum*) and medusahead (*Taeniatherum caput-medusae*;

Prevéy et al. 2010). Increases in PJ range and density can lead to greater tree crown connectivity, increasing fire susceptibility and intensity of fire regimes that in turn promote establishment and expansion of cheatgrass through its ability to germinate early and exploit available ground water before other native species can reestablish after a burn (Chambers et al. 2007).

Methods

In 2011 the Nevada Partners for Conservation and Development (NPCD) initiated a long-term habitat restoration and monitoring project across northern Nevada focused on quantifying the effects of conifer removal and fire restoration treatments on overall habitat health. A significant number of NPCD's plots are in the Bi-State sage-grouse Population Management Units (PMUs; Figure 1). NPCD's plots, including those within the Bi-State PMUs, are strictly related to restoration projects and are therefore not distributed evenly across all sage-grouse habitat types (i.e. wintering, lekking, breeding, and brood-rearing habitats). Most plots are in sage-grouse breeding and wintering habitats (sagebrush and PJ Phase I vegetation types) while very few plots are in late brood-rearing habitats (meadows or high elevation habitats).

At sites designated for restoration treatment (PJ removal), as well as at sites that have experienced episodes of wildfire, the NPCD establishes plots both within and outside of treatment and wildfire boundaries. Plots outside of treatment and wildfire boundaries serve as controls to determine treatment and fire restoration effectiveness. Sampling is conducted prior to treatment to establish baseline conditions and sites are revisited post treatment to monitor effectiveness of restoration treatments. The NPCD is implementing a statistically rigorous and ecologically meaningful monitoring protocol (Laycock 1987; Elzinga et al. 2000; Bestelmeyer et al. 2005; Forbis et al. 2007; Turner et al. 2010). The methods NPCD employs are consistent with the BLM's Assessment, Inventory and Monitoring (AIM; Taylor et al. 2014), the USGS Chronosequence (Knustson et al. 2009), the BLM's Emergency Stabilization and Rehabilitation (ES&R) and the USFS's Burn Area Emergency Response (BAER; Robichaud et al. 2000). The NPCD's methods are designed to be easily replicated and require little or no expensive equipment.

Plot selection is stratified random and the two primary strata are restoration project boundaries and various soil types found within the project site. The four main vegetation types are sagebrush, PJ Phase I, PJ Phase II and PJ Phase III (Figure 2) and are characterized using GIS, Google Earth and field visits. This characterization helps determine treatment type and whether a plot is to be treated or left as a non-treated control (Table 1).

Table 1. Plot type (Control, PJ Removal Treatment Status or Fire Restoration Treatment) by PMU.

	Plot Type				
Bi-state PMU	Control	Treatment Status		Fire	Grand Total
		Completed	Not Completed		
Pine Nut	10	19	0	45	74
Bodie/Mount Grant	127	44	57	28	256
Desert Creek/Fales	51	12	18	0	81
South Mono	14	18	9	2	43
White Mountains	12	0	0	0	12
Grand Total	**214**	**93**	**84**	**75**	**466**

At each plot, three 50 meter transects (oriented at 0, 120- and 240-degree compass bearings) are designated. Along each 50 meter transect, crews identify all plants to species and measure plant species foliar cover and percent bare ground via line point intercept (Canfield 1941). Additionally, at each transect, photographs are taken (Bonham 1989) along the transect, the height of shrubs and perennial grasses/forbs is measured, gaps in the perennial vegetation canopy are measured and shrub and tree density (grouped by species and size height classes) is measured using a 2 meter X 50 meter belt transect (Elzinga et al. 2000). These measurement techniques allow for a comprehensive depiction of the vegetation at each plot including species richness , (including noxious or other nonnative plants), percent cover of species, structure (height) of the shrubs and perennial understory and density by tree and shrub species (Daubenmire 1959; Elzinga et al. 2000; Bestelmeyer et al. 2005; Forbis et al. 2007).

A total of 409 plots have been sampled across the Bi-State in an initial sampling effort (Table 2) across the eight-year period of the study (2011 – 2018). The Bodie/Mt. Grant PMU contains the greatest number of plots (222) while the White Mountains PMU contains the least (12). Sites that experienced wildfire or unique sampling protocols (Spring Peak Fire, Bison Fire and Mount Grant plots) are not included here.

Table 2. NPCD plots sampled for the first time by year within each PMU and study site. There are additional plots that due to unique sampling methods are not included here.

	2011	2012	2013	2014	2015	2016	2017	2018	TOTAL
Pine Nuts									
Pine Nut Mountains	38	13		1					52
Desert Creek/Fales									
Bald Mountain			8		13				21
East Walker Unit E						15			15
East Walker Units D and O						14			14
Long Doctor	24		2						26
Long Doctor Wiley Ditch Lek				4					4
Bodie/Mount Grant									
Aurora								7	7
Big Flat							19		19
Bodie Hills - Bishop						11			11
Bodie Hills P-J					49	12	14	33	108
Bodie-Mt Grant PMU			15						15
Bridgeport					18				18
China Camp	20								20
East Walker Unit B					12	2			14
Green Creek							10		10
South Mono									
Long Valley					24		9		33
Parker Unit							10		10
White Mountains									
North White Mountains PMU			7						7
Southeast White Mountains PMU								5	5
TOTAL	82	13	32	5	116	54	62	45	409

Preliminary Results

Pre-treatment

This section presents results from data collected during the initial plot visits before restoration treatment. Mean species richness (native and nonnative species) varied from a low in the Pine Nut PMU in 2012 (15 species) to a high in Bodie/Mt. Grant (34) in 2016 (Figure 3). The Desert Creek/Fales PMU consistently contained a higher average species richness compared to other PMUs while the White Mountain PMU exhibited the lowest richness, possibly due to the small number of sampling plots in the White Mountain PMU.

Species richness across all plots sampled shows a higher average value than is seen in similar ecological sites across Nevada. For example, at the Patterson Pass project site in Lincoln County, average species richness was 26 in 2013 (Turner et al. 2018 Unpublished data). In the Desatoya Mountains in central Nevada, average species richness in 2011 was 27. Higher species richness values are shown to infer aspects of ecosystem health including resistance to non-native plant invasions and resilience or an ecosystem's ability to recover from disturbance such as fire and to provide higher quality sage grouse habitat (Clary and Jameson 1981, Pennington et al. 2016).

Following wet winters, many annual forbs germinate and flower as compared to years following dry winters. There is considerable variability within the Bi-State, however much of the area is considered relatively mesic (>35 cm average annual precipitation) compared to the extent of greater sage grouse habitat in the southern Great Basin (Coates et al. 2016) and higher precipitation can contribute to higher richness, resistance and resilience (McIver et al. 2014). Detection efforts at plots remain constant but it is possible that a small amount of interannual variation in species richness can be accounted for by more vigilant field workers. It is likely that species richness will show increases following conifer removal treatments and the wide-ranging post-treatment analyses will be completed once those treatments occur (Havrilla et al. 2017).

Average percent cover for cheatgrass (*Bromus tectorum*) and various functional groups (sage grouse preferred forbs, pinyon juniper, sagebrush and non-sagebrush shrubs) from plots during initial site visits before treatments across the PMUs is presented below (Figures 4 – 8; Turner et al. 2018 Unpublished data). Sage grouse preferred forb cover in the NPCD

Bi-State plots ranged from approximately 1% up to 11%. These values for sage-grouse preferred forb cover are consistent with studies across sage-grouse habitat in the Great Basin (Coates et al. 2016, Dahlgren et al. 2019).

Post Treatment

The oldest monitored conifer removal treatment in Nevada is at the Wellington Hills site in the Desert Creek Bi-State PMU. Conifer thinning, and removal treatments, were initially applied 34 years ago and NPCD crews sampled the treatments and controls in summer 2016. Sagebrush cover increased in certain treatments, and all shrub cover increased in all treatments compared to controls (Figure 9). Perennial grass cover increased in all treatments compared to controls. Perennial forb cover was low prior to treatments and remained low in controls and treatment plots. Cheatgrass cover was not significantly higher in any treatments but shows high variability. While rigorous monitoring on conifer thinning projects is widespread and common, there are few long-term (greater than 5-10 years) studies. The Wellington Hills study results are consistent with other long-term studies outside of the Bi-State PMUs (Bates et al 2005, Roundy et al. 2014, Bates et al. 2017a, Bates et al. 2017b,).

Preliminary results from conifer removal treatments at the China Camp site (Bodie/Mt. Grant PMUs) are comparable to the long-term Wellington Hills study (Figures 10 – 15). Sagebrush shows slightly increased cover in treatments and unchanging cover in controls. It is common for sagebrush and other woody plants to require more than 1-4 years following treatments to show large increases in cover (McIver et al. 2014, Summers and Roundy 2018). Non-sagebrush shrub cover has increased following treatments. Perennial grass cover is higher in treatments compared to controls while perennial forb cover increased slightly in 2016 and 2017 but in 2018 had returned to cover values equal to controls. Cheatgrass is highly variable with higher cover currently shown in treated plots. Species richness is higher in treatment plots compared to control plots across years. Further analysis is needed to determine which functional groups are driving this relationship.

The Bison Fire burned approximately 24,000 acres in the Pine Nut Mountains in 2013. Coincidentally, baseline vegetation data was collected in 2011 and 2012 at plots associated with a planned PJ removal project. The PJ removal effort was implemented in the fall of 2012, which then burned the following summer in the Bison Fire. During the winter of 2013-2014, much of the burned area was seeded by the Carson City BLM, Washoe Paiute Tribe, NDOW and NRCS. Vegetation response to the burn and seeding has been variable and is likely depending on factors not addressed in this analysis including burn temperature and intensity and on landscape factors such as slope, aspect and elevation. One confounding factor in the data analysis of the Bison Fire is the plots where PJ thinning occurred before the fire. It is possible that the trees removed during the effort could have changed the intensity of the fire and thus the seed bank in the soil. Before and after data for these plots is displayed separately and are termed 'Lop and Fire'. The number of unburned (control), burned non-seeded (fire control), burned seeded (fire seeded), and lop and fire plots sampled varied by year (Table 3).

Table 3. Number of Bison Fire plots sampled per year by plot type.

Plot Type	2011	2012	2014	2015	2016	2017
Control	6	2	8	8	8	7
Fire Control	9	1	18	15	10	21
Fire Seeded	4	0	10	12	4	13
Lop and Fire	4	1	4	3	4	1

Sagebrush cover has not increased in seeded plots (Fire Seeded) and remains low in unseeded plots (Fire Control) possibly due to the short time interval since treatments (Figure 16).

Non-sagebrush shrubs show a modest increase in cover post-fire in seeded plots and no change in unburned plots (Control; Figure 17). Perennial grass cover is higher in seeded plots as compared to burned unseeded plots (Figure 18). Perennial forb cover has increased in both seeded and unseeded plots which may indicate a trend toward higher quality sage grouse habitat (Figure 19). The largest increase in forb cover is shown in the 'Lop and Fire' plots possibly indicating the conifer removal allowed a release of forbs and the fire intensity did not reduce the overall forb cover in those plots although the estimates are imprecise due to the small number of plots in that category. Cheatgrass has shown a large response with increased cover in both seeded and unseeded plots (Figure 20). Average species richness across the Bison Fire is low compared to other Bi-State PMUs and project sites with an average richness around 30 (Figure 21). These responses have been measured 1, 2-, 3- and 4-years post fire and it is likely that the short-term transient responses will change through time. The vegetation sampling plots in the Bison Fire will be resampled in summer of 2020 and the analyses will be rerun including fire intensity and landscape covariates to determine the trajectory of the plant communities.

Cheatgrass

At treatment plots where conifer removal or wildfire has occurred there have been variable results with cheatgrass cover and abundance (Figures 13 & 20). Long- and short-term studies following conifer removal and wildfire recovery have shown that seasonal variation in cheatgrass cover is tied to the previous 1, 2- or 3-years precipitation (Holmgren 2006, Pilliod et al 2017). While cheatgrass is an annual grass, several wet years may allow for a seed bank to build up. Coates et al. (2016) suggest that habitats exhibiting annual grass cover exceeding 5.2 percent may be unsuitable for sage-grouse as they are generally avoided.

At the China Camp (Bodie/Mount Grant PMUs) conifer removal and Bison Fire (Pine Nut PMU) reseeding sites, cheatgrass shows variable cover since treatments (Figures 13 & 20). The largest increases are in the conifer removal treatments at China Camp and non-seeded plots on the Bison Fire and there is a clear correlation between cheatgrass cover and the previous year's precipitation at both sites. These short-term increases are likely transient responses and are shown to decrease over time at similar project sites (Tausch and Tueller 1977, Skousen et al. 1989, Havrilla et al.2017). However, if monitoring continues to show an elevated level of cheatgrass cover over time, then perhaps additional treatment techniques should be implemented to reduce its presence. If the previous years are dry, then cheatgrass can show decreases along with increases in native perennial grasses and forbs (Billings 1994). At the Wellington Hills site, cheatgrass shows no increased cover 34 years following treatment in any of the conifer removal plots as compared to non-treated plots (Ernst-Brock et al. 2019). The Wellington Hills study provides evidence that short-term increases in cheatgrass may not persist.

Restoration Treatment Status and Future Analysis

National Environmental Policy Act (NEPA) analyses have yet to be completed across many sites within the Bi-State for a variety of reasons including federal budget short falls and on-going litigation. Currently, approximately 20% of plots have been treated (Figure 22). It is unclear at this time when the Bodie Hills, Long Valley and other projects will be completed.

The NPCD continues to collect data at all plots that are scheduled to be treated once NEPA is completed and future analyses should provide strong evidence for the benefits to sage grouse and other wildlife. Cody Ernst-Brock has completed a Master's in the Leger lab at the University of Nevada, Reno and she is finalizing peer reviewed publications that focus on the

Wellington Hills long-term study and on a larger study of NPCD vegetation data. Her analyses will be expanded to include all Bi-State PMU data over the coming year.

Citations

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Figures

Figure 1. Distribution of NPCD plots across the Bi-State PMUs. VHA is the NPCD's vegetation and habitat assessment protocol.

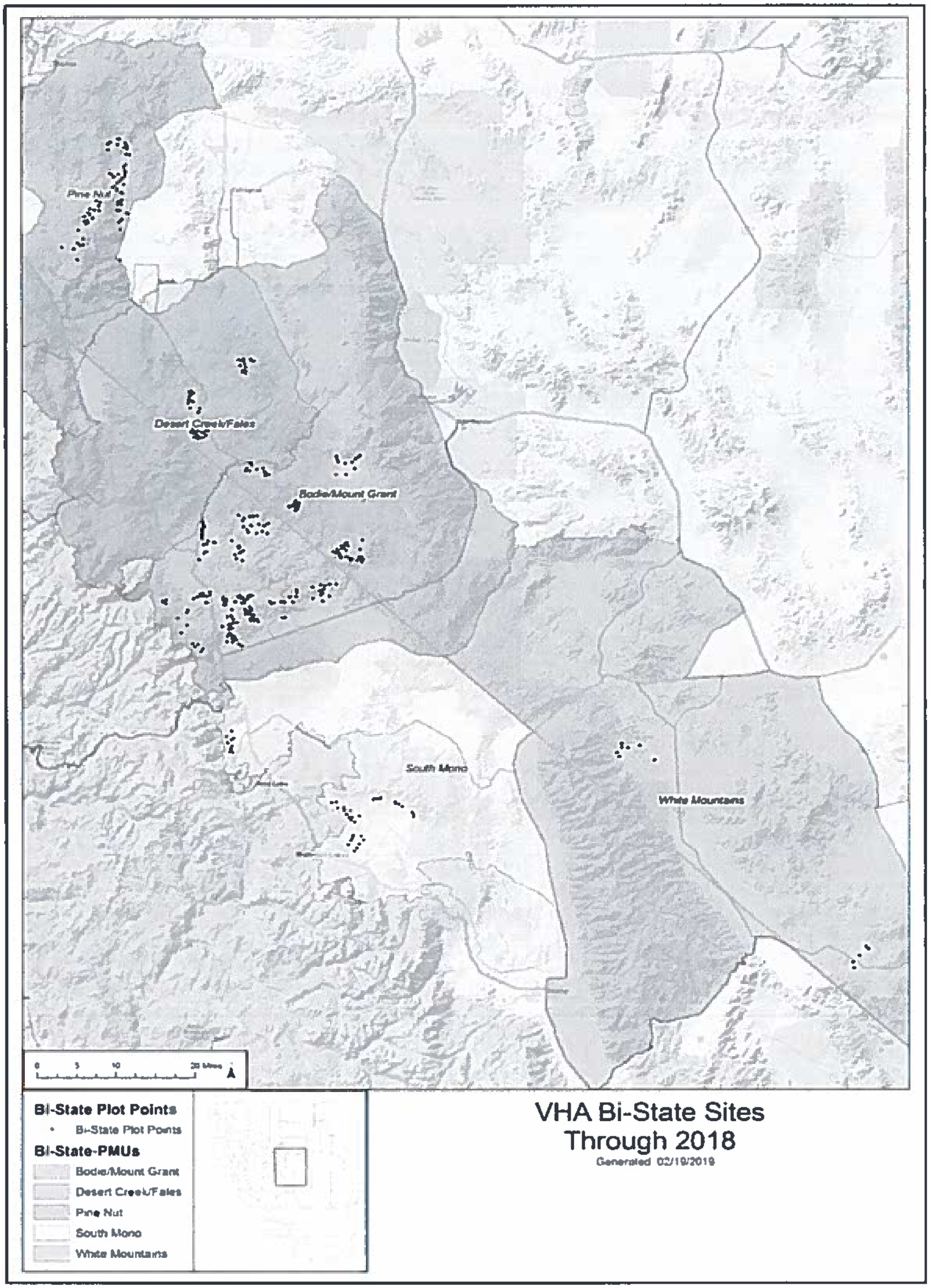
Pine Nut
Desert Creek/Fales
Bodie/Mount Grant
South Mono
White Mountains
Bi-State Plot Points
Bi-State Plot Points
Bi-State-PMUs
Bodie/Mount Grant
Desert Creek/Fales
Pine Nut
South Mono
White Mountains
VHA Bi-State Sites
Through 2018
Generated 02/19/2019

Figure 2. Number of plots in each Bi-State PMU by vegetation type designation.

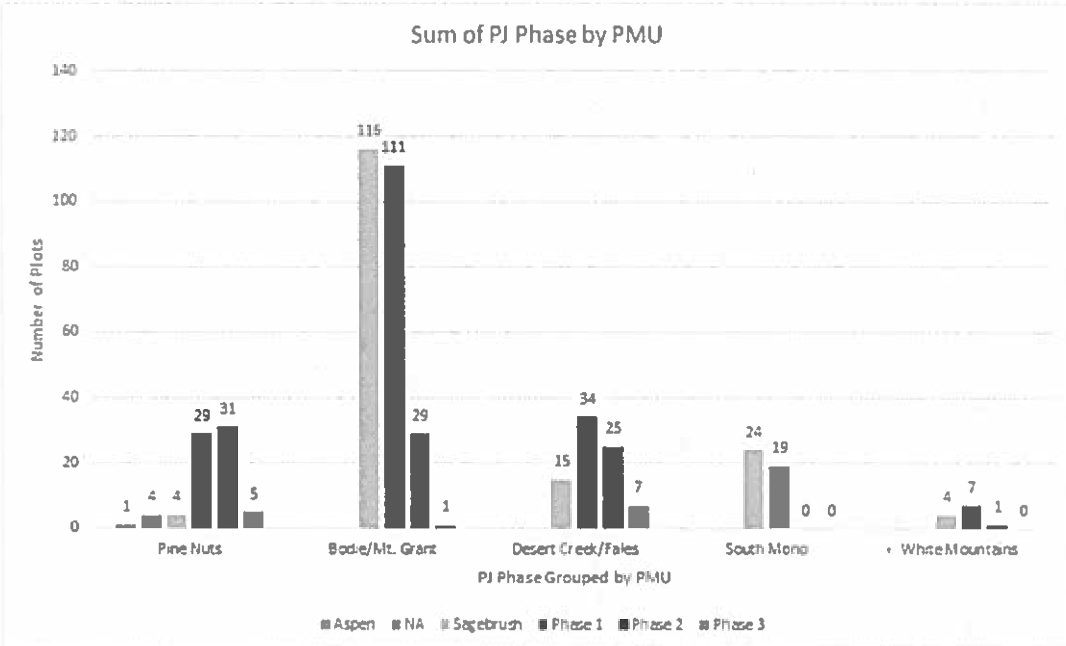

Figure 3. Species richness box plots from line point intercept plots across PMUs across years during initial pretreatment visits (2011 – 2018). Number of plots in parenthesis.

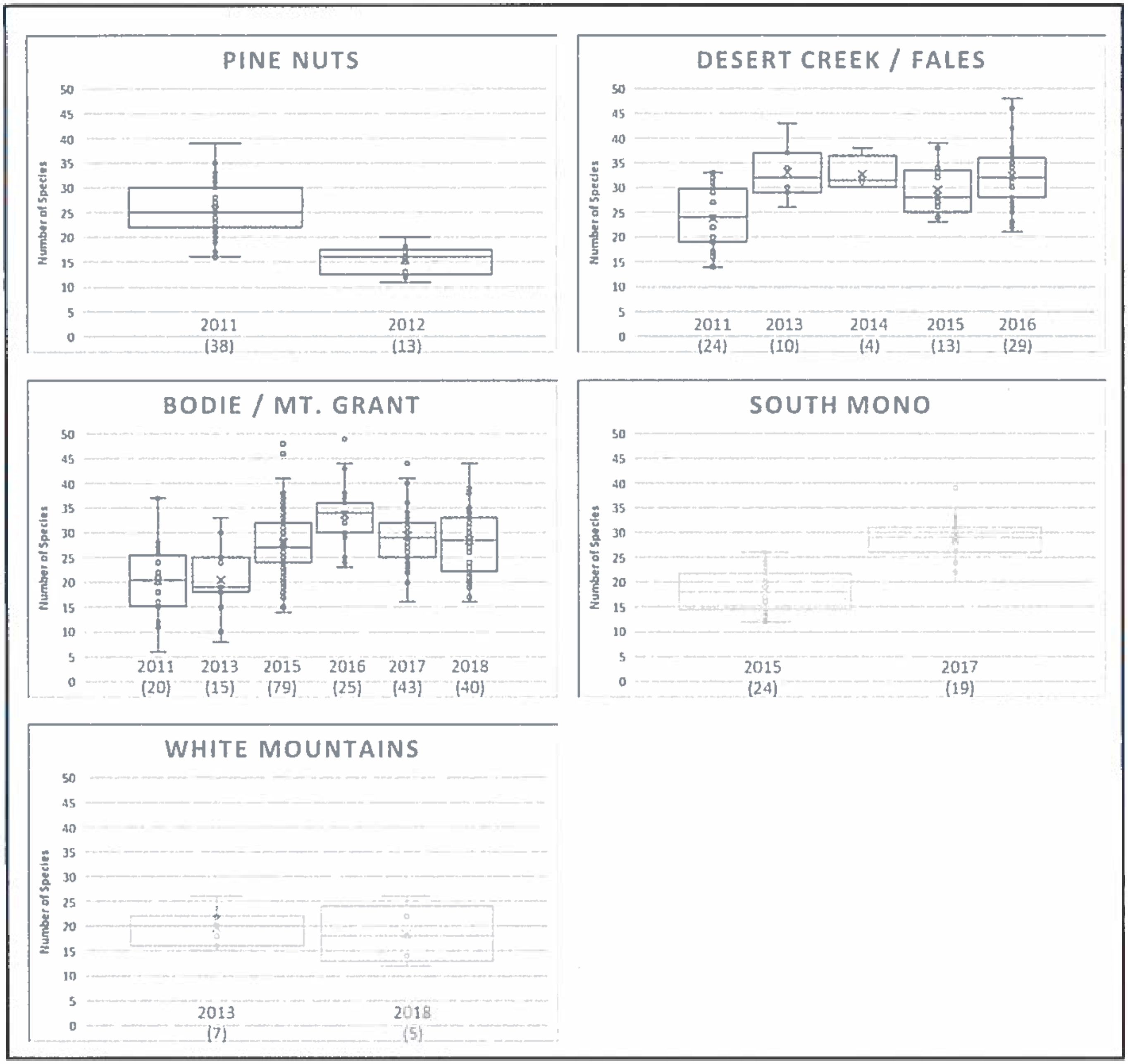

Figure 4. Canopy cover averages for cheatgrass (*bromus tectorum*) the Bi-State PMUs.

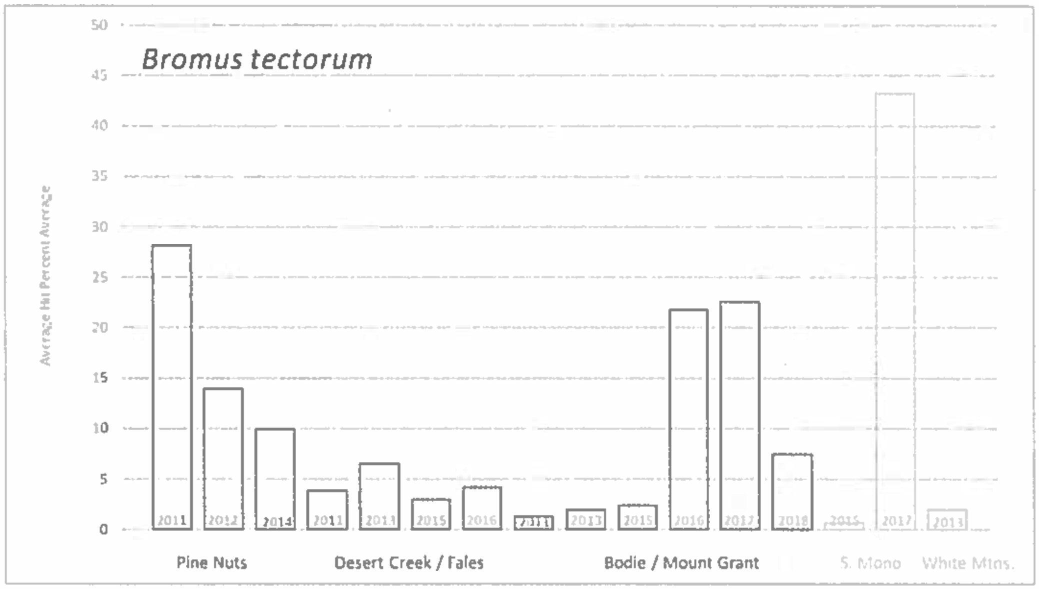

Figure 5. Canopy cover averages for sage-grouse preferred forbs across the Bi-State PMUs.

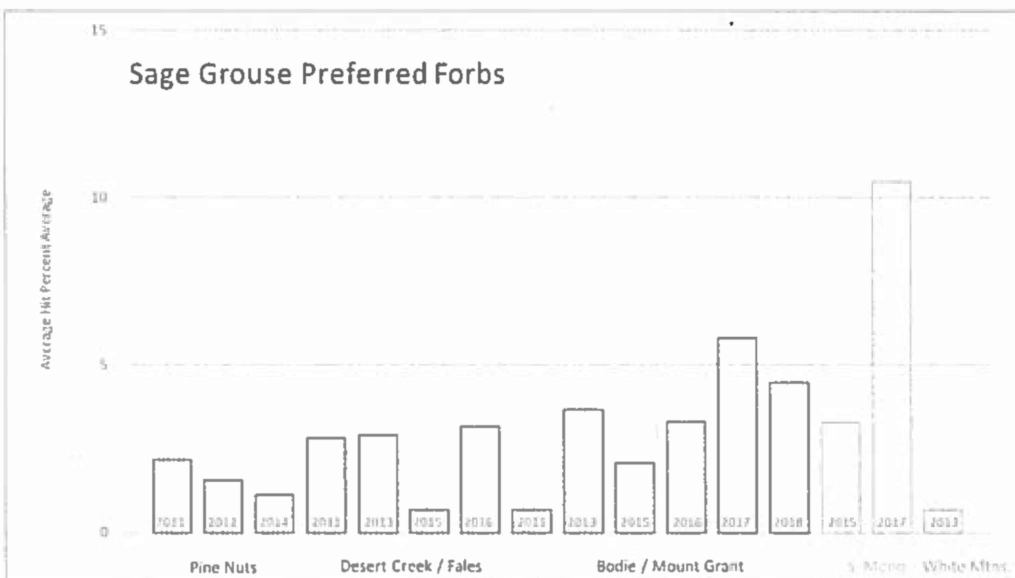

Figure 6. Canopy cover averages for Pinyon Juniper species across the Bi-State PMUs.

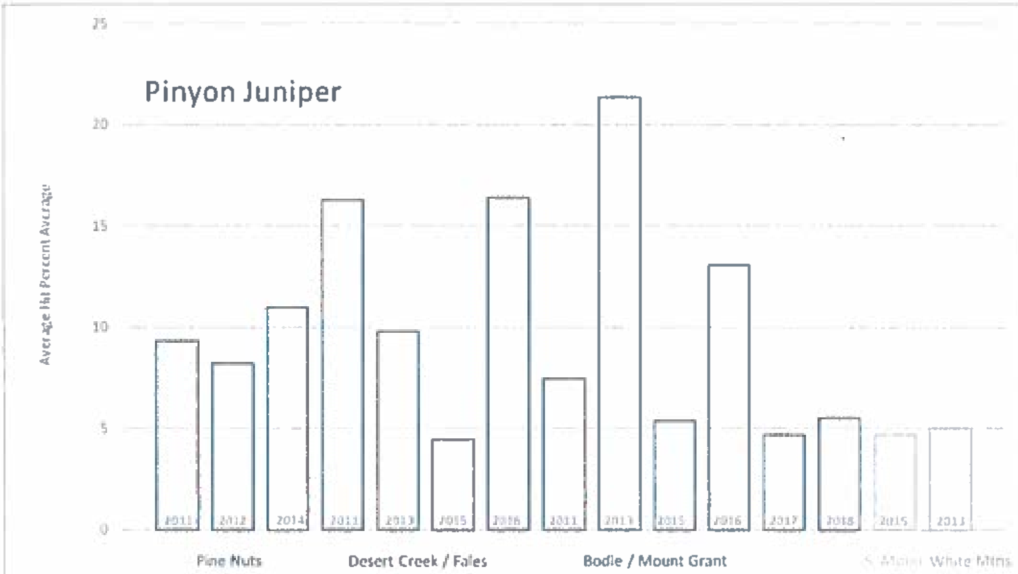

Figure 7. Canopy cover averages for sagebrush species across the Bi-State PMUs.

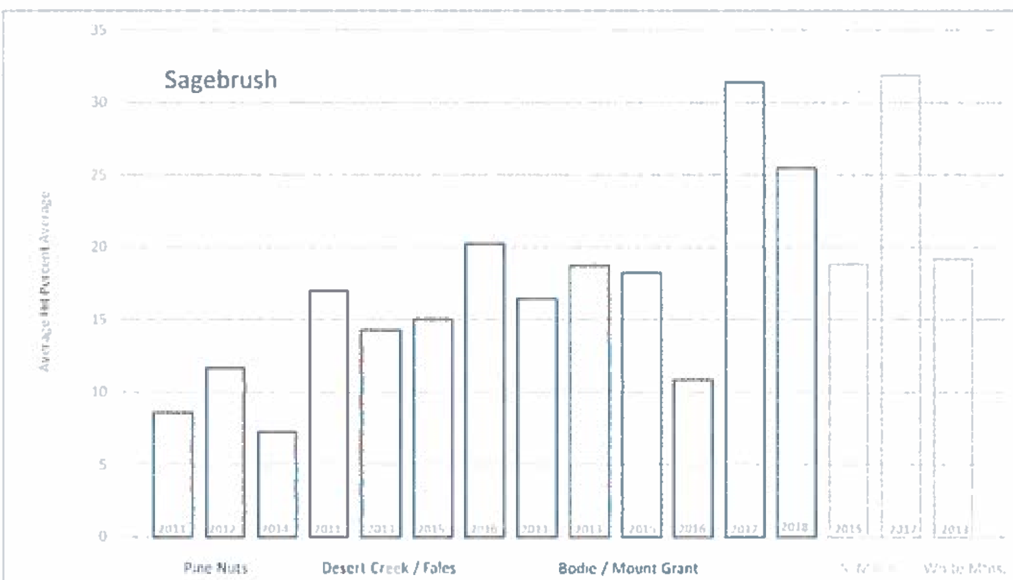

Figure 8. Canopy cover averages for non-sagebrush shrub species across the Bi-State PMUs.

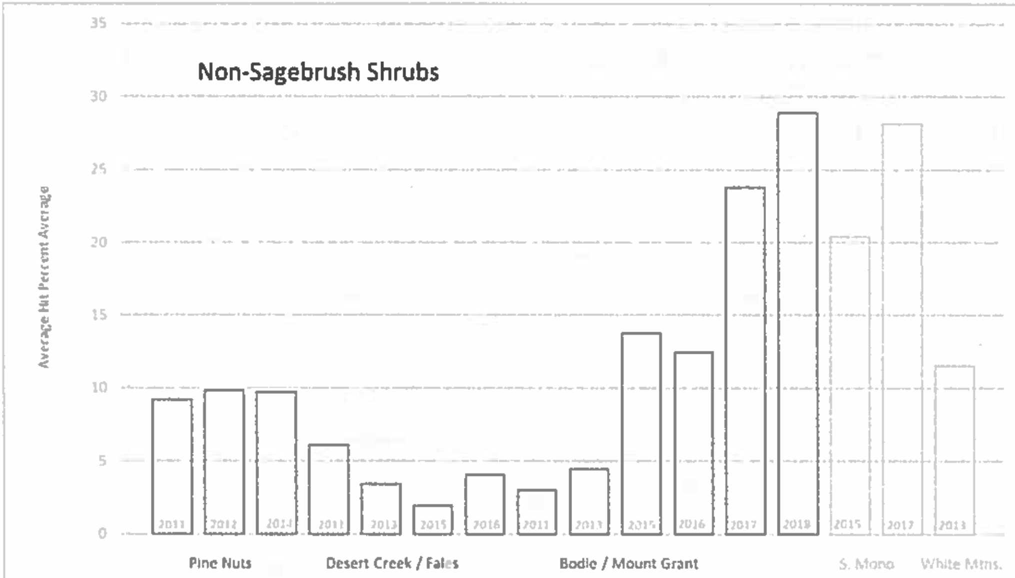

Figure 9. Foliar cover of target species and functional groups at the Wellington Hills field site in western Nevada, U.S. Significance of pairwise comparisons is indicated with lowercase letters,

and individual transect values are depicted as dots on boxplot figures, though transects were averaged within each block for analysis. 20 BAF treatment indicates a cut leaving a trunk cross-sectional area of 20 ft² per acre, 40 BAF treatment indicates a cut leaving a trunk cross-sectional area of 40 ft² per acre, and clear-cut treatment indicates the removal of all trees.

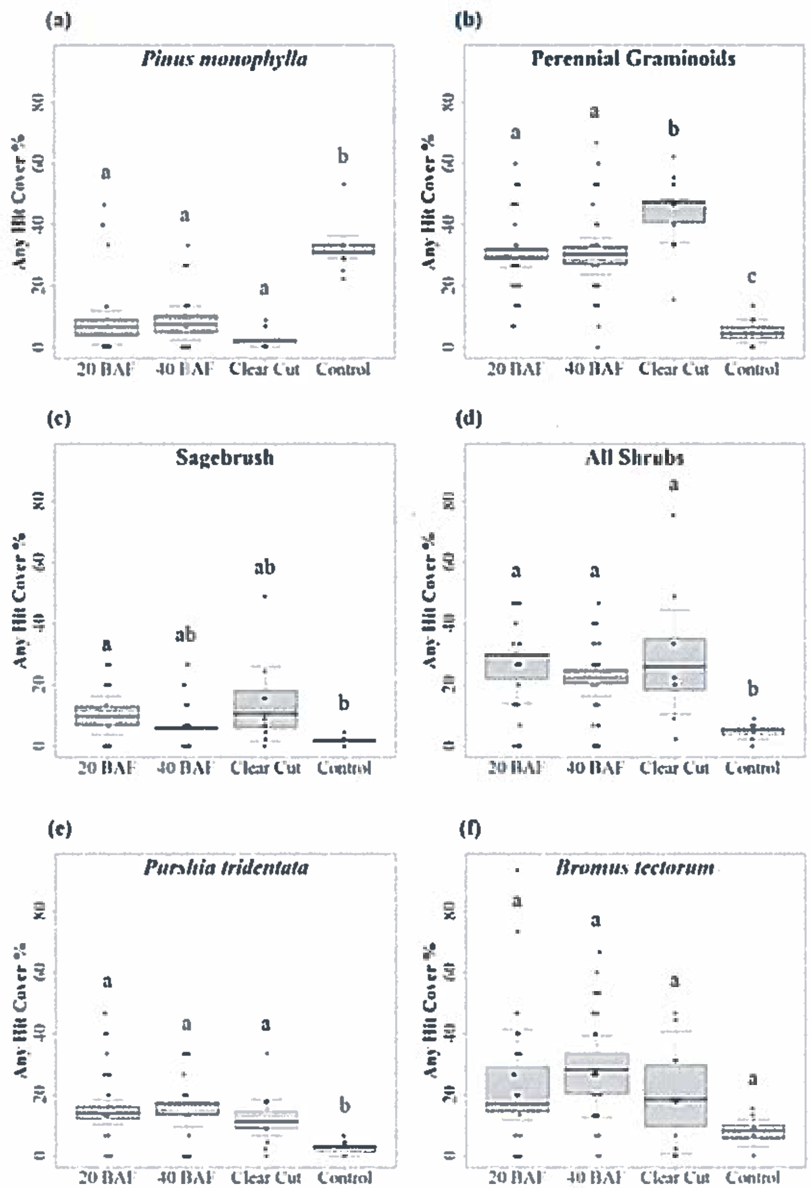

Figure 10. Preliminary percent non-sagebrush shrub cover from China Camp site P-J removal. Error bars represent 95% confidence intervals.

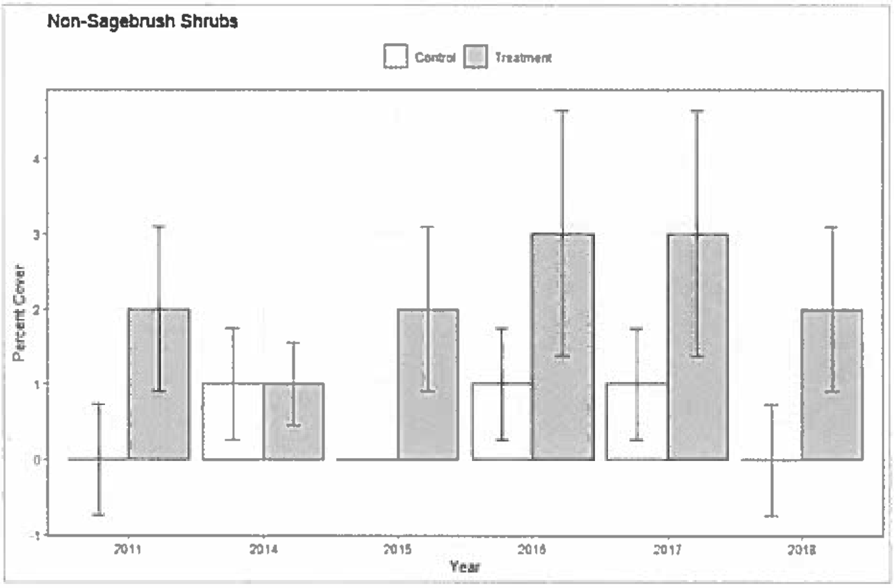

Figure 11. Preliminary percent perennial grass cover from China Camp site P-J removal. Error bars represent 95% confidence intervals.

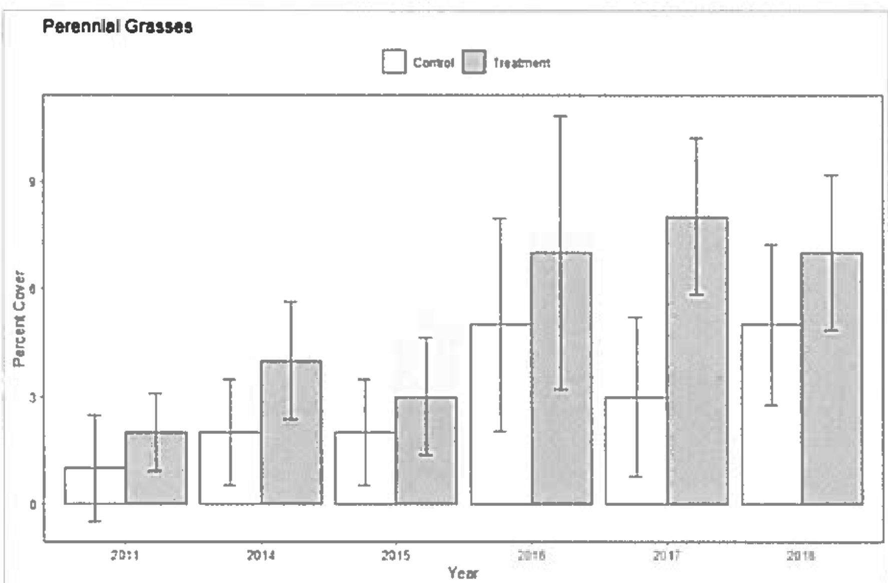

Figure 12. Preliminary perennial forbs percent cover from China Camp site P-J removal. Error bars represent 95% confidence intervals.

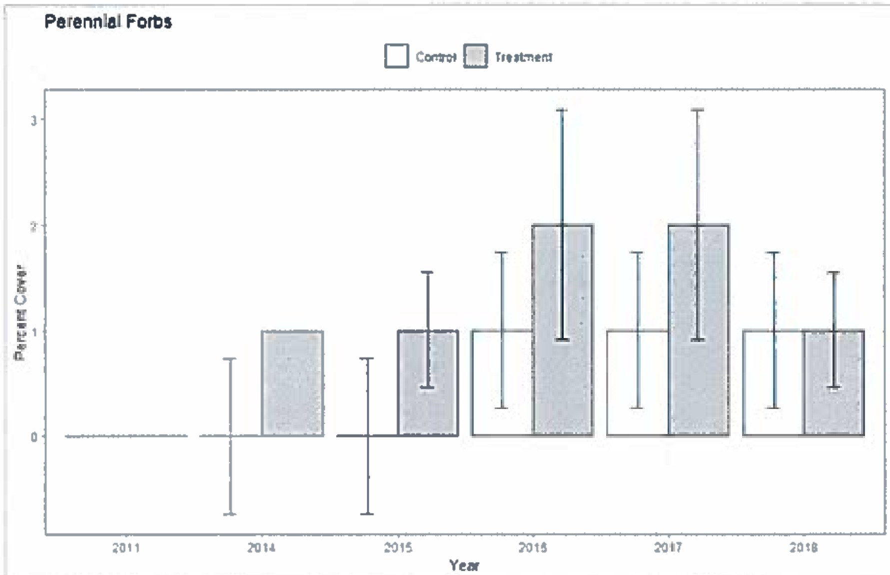

Figure 13. Preliminary cheatgrass percent cover by category from China Camp site P-J removal. Error bars represent 95% confidence intervals.

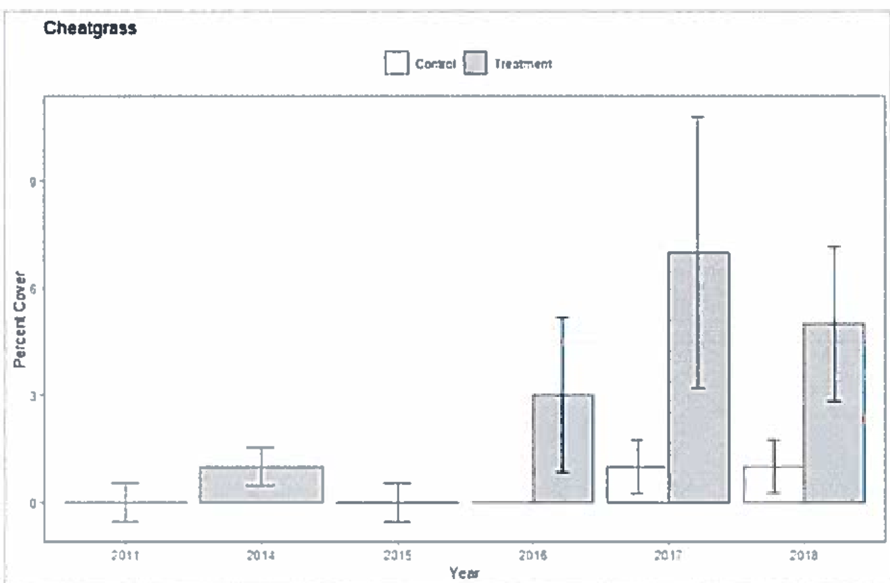

Figure 14. Preliminary sagebrush percent cover by category results from China Camp site P-J removal. Error bars represent 95% confidence intervals.

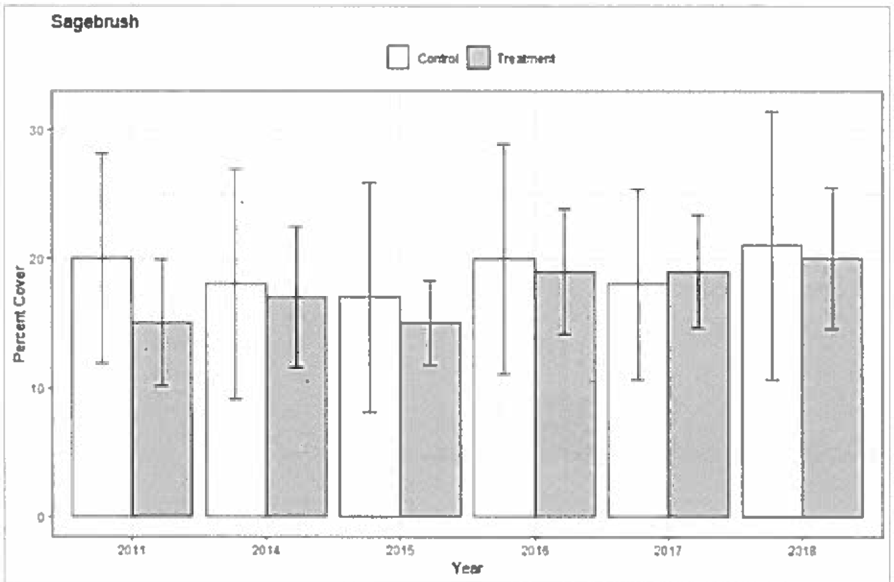

Figure 15. Preliminary total species richness results from China Camp site P-J removal. Error bars represent 95% confidence intervals.

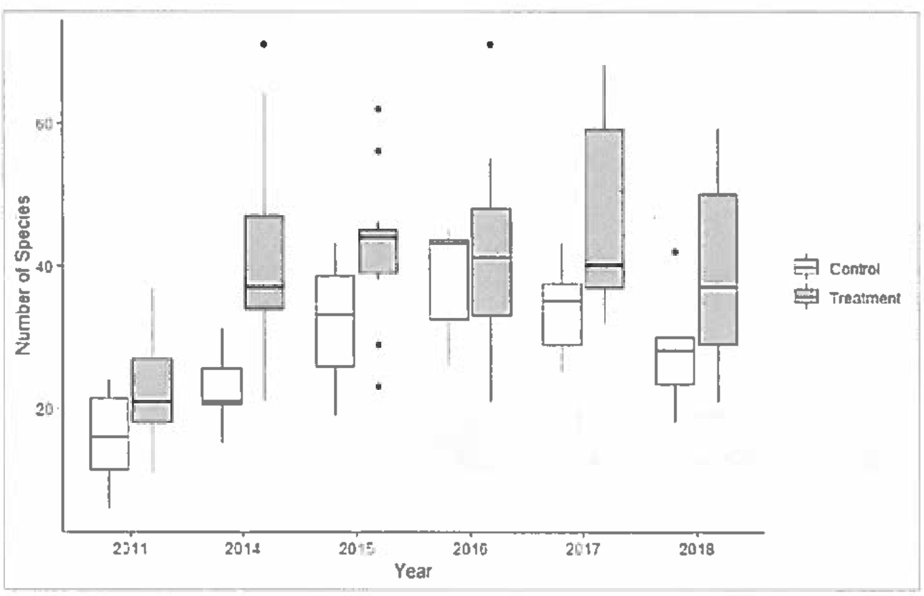

Figure 16. Preliminary sagebrush percent cover from Bison Fire reseeding restoration project. Error bars represent 95% confidence intervals.

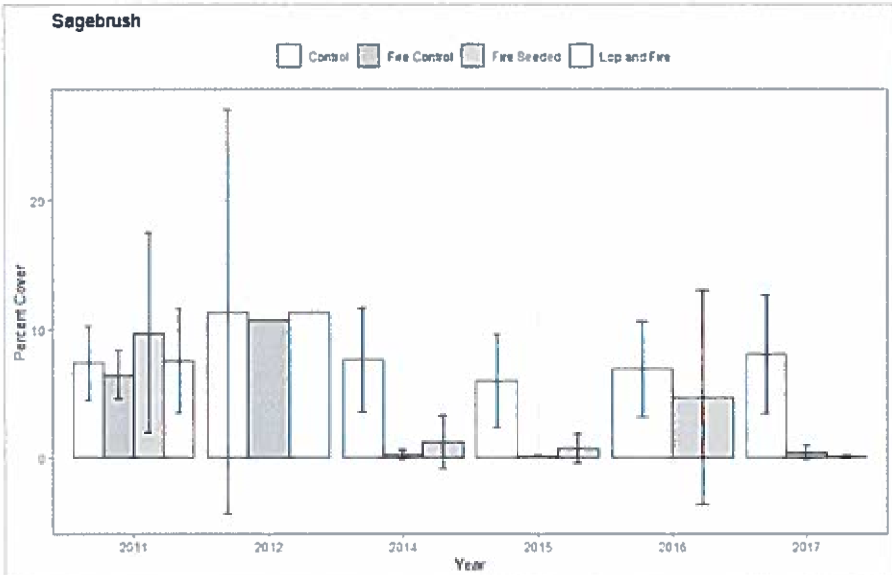

Figure 17. Preliminary non- sagebrush shrubs percent cover results from Bison Fire reseeding restoration project. Error bars represent 95% confidence intervals.

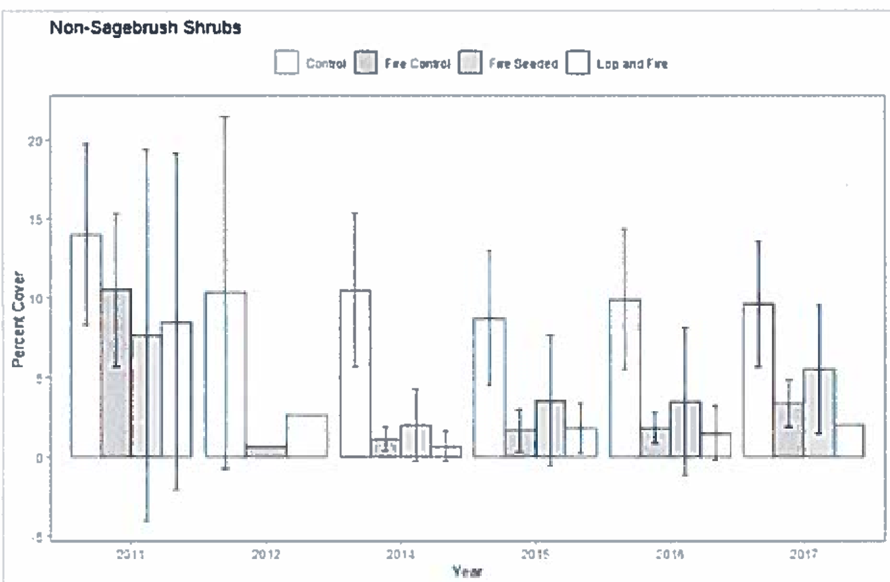

Figure 18. Preliminary perennial grasses percent cover results from Bison Fire reseeding restoration project. Error bars represent 95% confidence intervals.

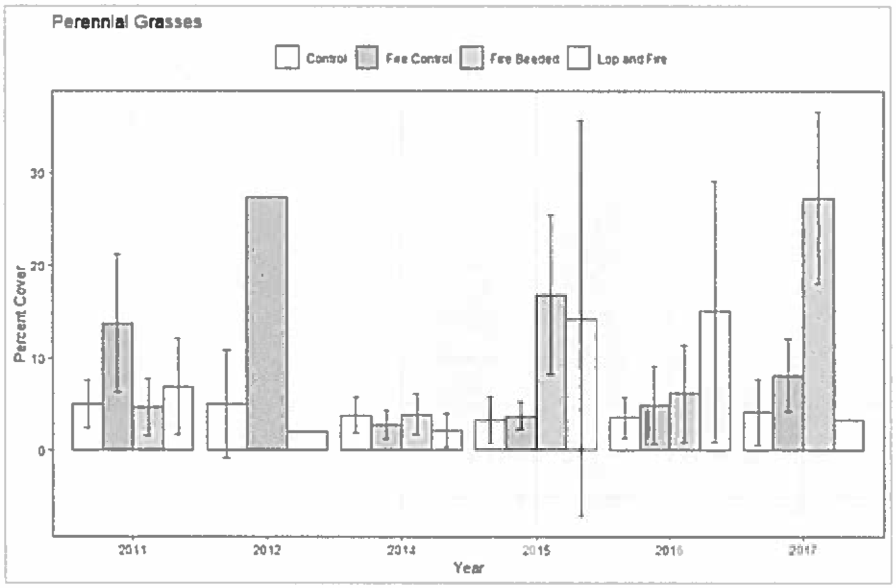

Figure 19. Preliminary perennial forbs percent cover results from Bison Fire reseeding restoration project. Error bars represent 95% confidence intervals.

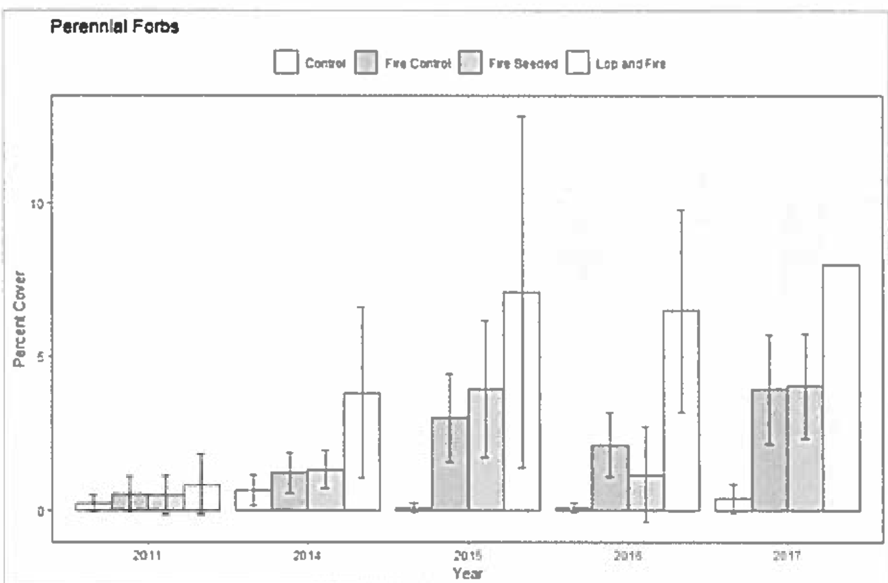

Figure 20. Preliminary perennial cheatgrass percent cover results from Bison Fire reseeding restoration project. Error bars represent 95% confidence intervals.

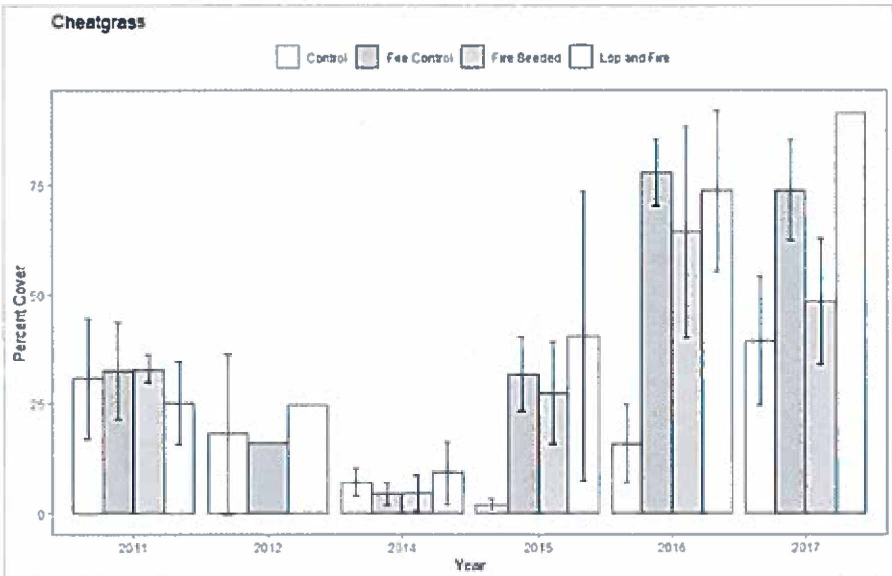

Figure 21. Preliminary species richness results from Bison Fire reseeding restoration project. Error bars represent 95% confidence intervals.

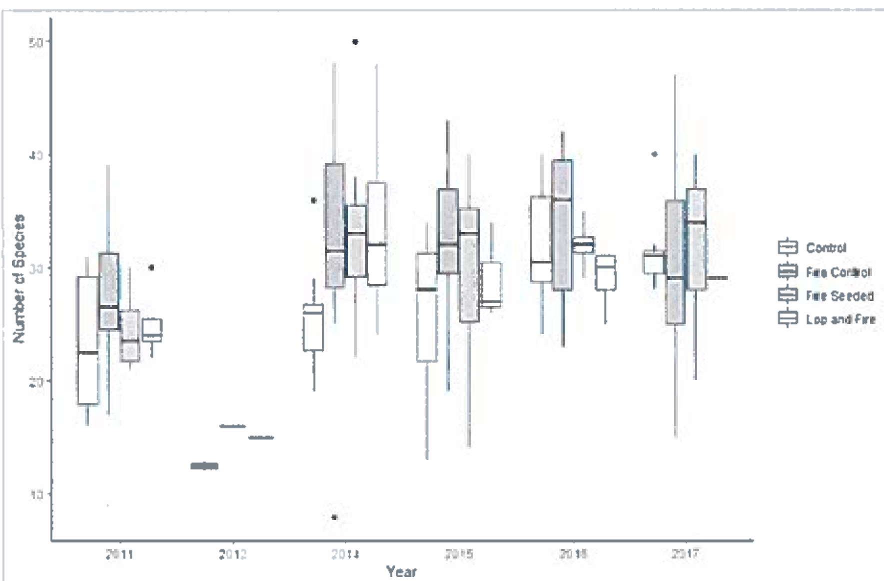

Figure 22. Treatment status of NPCD plots in the Bi-State PMUs.