



Sagebrush Steppe Vegetation Monitoring in City of Rocks National Reserve

2018 Annual Report

Natural Resource Report NPS/UCBN/NRR—2019/1869



ON THE COVER

Crew posing among sagebrush steppe environment above City of Rocks National Reserve, closest to the Emery Canyon sampling frame, 2018.

Photograph by: Devin Stucki

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Executive Summary

As part of the Upper Columbia Basin Network sagebrush steppe vital signs monitoring program, a survey of sagebrush steppe ecological condition was conducted in June and July 2018 in City of Rocks National Reserve and adjacent Castle Rocks State Park (together referred to by acronym as CIRO) following methods outlined in the Upper Columbia Basin Network monitoring protocol (Yeo et al. 2009). The plots were surveyed on two separate weeks, approximately one month apart. The lower elevation plots were surveyed in June and the higher elevation plots in July. The plot-based surveys occurred within 10 sampling frames that are positioned to overlap grazing allotments (Figure 1). Canopy cover of exposed soil and of principal native and non- native plants or genera were estimated in six-hundred ninety-four 1 m² quadrats randomly placed throughout the sampling frames. Quadrat locations were drawn using a spatially-balanced random sampling design, the Generalized Random Tessellation Stratified (GRTS) design, which ensures a good representative random sample with good dispersion and scope of inference within each sampling frame. Sagebrush steppe is one of the most threatened ecosystems in the intermountain west, and land use practices both within and adjacent to UCBN park steppe communities have resulted in fragmented and altered park ecosystems. Predicted climate change for the region may exacerbate these changes. This brief annual report summarizes some of the key findings from the 2018 field season.

Big sagebrush was the most abundant shrub, occurring in all sampling frames, followed by green rabbitbrush, antelope bitterbrush, and snowberry. Sandberg's bluegrass, a small stature and highly resilient native perennial grass, was the most widespread and abundant native perennial grass encountered. The percentage of plots with Sandberg's bluegrass cover ranged among frames from 39% to 85%. Western wheatgrass, another important native perennial grass, ranged in frequency from 24-78.5%. Bluebunch wheatgrass, a hardy grass with drought resistant root systems, varied in frequency from 3% to 49%. Idaho fescue, indian ricegrass, needle and thread grass, sand dropseed and squirreltail were less abundant native perennial grasses encountered in many plots. Lupine, buckwheat, and phlox were the most abundant native perennial forbs. All frames in CIRO had some presence of cheatgrass with the proportion of plots containing cheatgrass cover ranging among frames from 18-92%. Yellow salsify was the most common non-native invasive weed, followed by common dandelion and tumble mustard. Noxious weeds were encountered that included dalmatian toadflax, white top, and Canada thistle. The frequencies of these noxious plants were relatively low, with only 2-3% cover being documented in frames where they occurred. We noted varying combinations among frames in the patterns of cheatgrass and native perennial grass abundance. As one might expect, frames with high cheatgrass abundance showed lower native grass abundance, and vice versa. Trail Canyon, Emery Canyon, and Circle Creek South had expected combinations of low cheatgrass and high diversity and abundance of native grasses and other native steppe species. Tracy Lane, which experienced a wildfire in 2000, as well as Circle Creek North, Kempton, and the Castle Rocks frames had much higher amounts of cheatgrass and lower amounts and diversity of native species. These kinds of patterns will vary over time in relation to winter precipitation and so should be interpreted cautiously. However, they provide preliminary insights into the relative health or ecological integrity of allotments. Similar patterns were noted in previous annual reports from 2012 and 2015 surveys, suggesting a of range natural resources management problems in those four

frames. In general, upland vegetation management will benefit from increased understanding about the interactions between grazing, fire, and annual grass invasion, informed in part from this monitoring program.

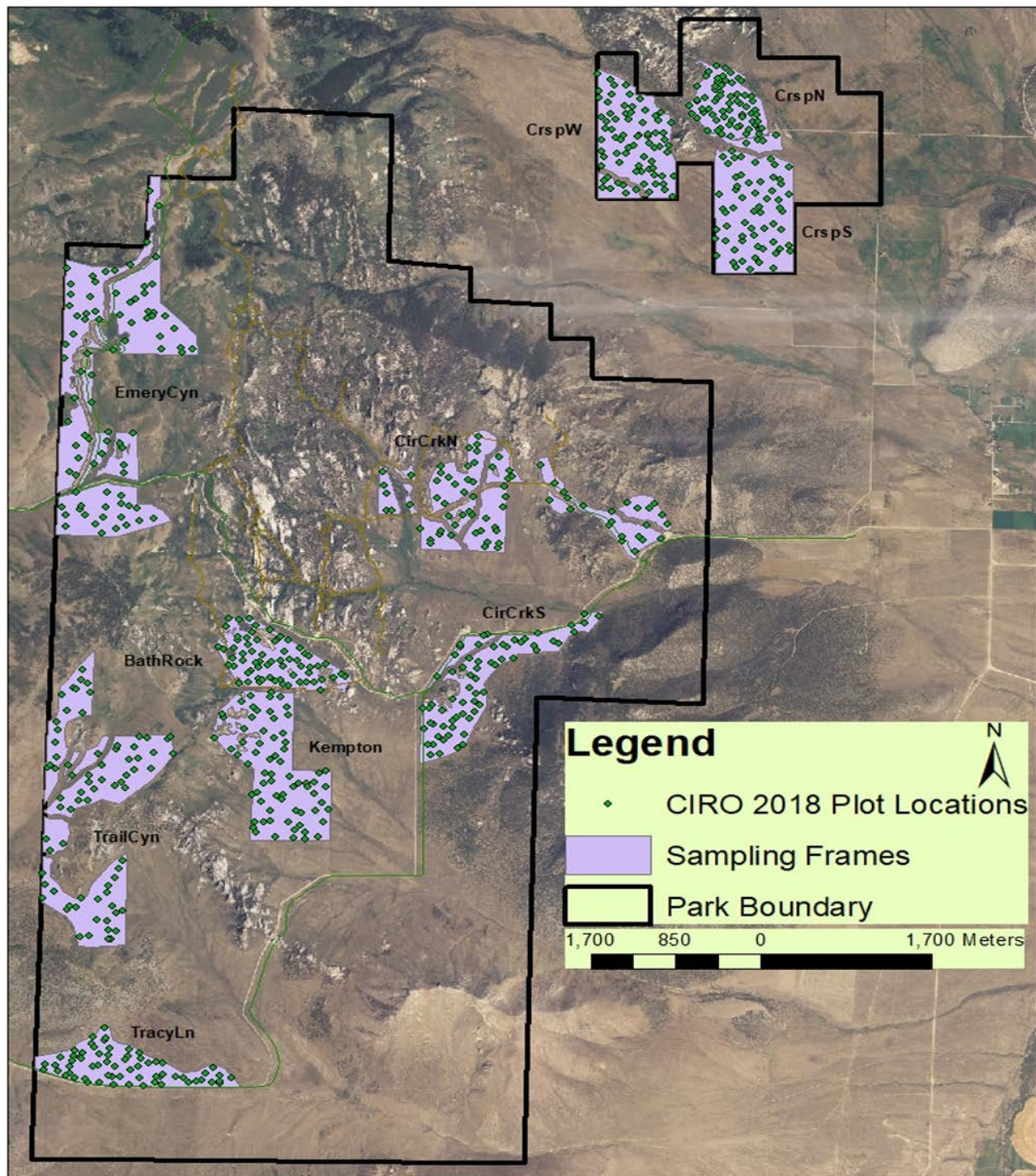


Figure 1. Map of City of Rocks National Reserve and Castle Rocks State Park, showing sampling frames and plot locations for the 2018 monitoring survey.

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Introduction

Prior to Euro-American settlement, sagebrush steppe ecosystems in the Upper Columbia Basin extended across the eastern half of Washington and Oregon, and across the northern Great Basin of southern Idaho. Currently much of that ecosystem has been lost to development and agriculture or substantially degraded as a result of livestock grazing, fire, non-native invasive plants, and recreational use. The Upper Columbia Basin Network (UCBN) has identified the ecological condition of sagebrush steppe vegetation as a high priority vital sign and monitoring of its condition is central to its monitoring program (Garrett et al. 2007). A long-term monitoring program that provides for regular evaluation of the status of the health of sagebrush steppe communities, and for identification of trends of ecosystem condition over time within and among parks within the network was implemented in 2008 (Yeo et al. 2009). The foundation of the sagebrush steppe monitoring protocol is a perspective that ecological health or integrity of these steppe systems is sustained by plant communities dominated by a diverse suite of native plants. Divergence of sagebrush steppe communities from these natural states (e.g., invasion by non- native plants, increased fire frequencies, long-term trends of increasing cover of exposed soil, declines in cover of principal native plants) signifies a loss of health, and monitoring provides park managers with feedback necessary for developing effective adaptive management strategies. Simple monitoring objectives follow directly from this view:

- Determine the status (current condition) and trends (change in condition over time) in the composition and abundance (cover) of principal native plant species in UCBN sagebrush steppe communities.
- Determine the status and trends in composition and abundance (cover) of principal invasive plant species, including exotic annual grasses, in UCBN sagebrush steppe communities.
- Determine the status and trend in the amount of exposed soil (cover), a fundamental indicator of soil stability.

This report summarizes the data collected in 2018 for City of Rocks National Reserve and Castle Rocks State Park. Both units are co-managed by the National Park Service and Idaho State Parks and Recreation. Throughout the rest of the report we refer to both units together as the Reserve and by acronym as CIRO.

Methods

Sample sizes within each frame were selected to be proportional to the area of each frame (Table 1; Figure 1; Yeo et al. 2009). Four plots (synonymously, quadrats) were dropped in the Bathrock frame due to incorrect vegetation type or plot falling precisely on a granite slab. Three plots were dropped in Trail Canyon, Circle Creek North, and Castle Rock SP South due to mapping errors associated with allotment fence lines and boundaries. These errors will be addressed in a revised sampling frame for the future. Four additional plots were dropped due to falling on the incorrect habitat type. Oversample plots were surveyed in each sampling frame to maintain a large enough sample size, despite having instances where plots were dropped. Sampling procedures followed Yeo et al. (2009). Within each frame, 1-m² plots were located using the generalized random tessellation stratified (GRTS) spatially-balanced sampling design (Stevens and Olsen 2004; Figure 1). The GRTS approach provides for randomly located plots and good spatial dispersion across each site.

Within each 1-m² plot, we estimated canopy cover of exposed bare ground and principal native plants and non-native invasive plants. Cover estimates were categorized into the following cover classes: 0, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, and 95-100% (Daubenmire 1959; Table 2). Plant canopy cover was defined as the natural spread of current year's growth outlined using a minimum convex polygon with small gaps included in the cover estimate. Exposed bare ground was defined as soil surface not overlain by plant cover, litter, and rock >1/4 in size. A list of the common names and scientific names of principal plant species encountered in plots during 2018 are listed in Appendix A.

Table 1. Sample sizes obtained from 10 sampling frames within CIRO during 2018 sagebrush steppe monitoring. Details of frame development and target sample sizes are provided in Yeo et al. (2009). Frame names are drawn from the associated grazing allotment.

Park	Sampling Frame	Sample Size
CIRO	Bath Rock	61
CIRO	Circle Creek North	74
CIRO	Circle Creek South	65
CIRO	Emery Canyon	84
CIRO	Kempton	70
CIRO	Tracy Lane	65
CIRO	Trail Canyon	73
CRSP	Castle Rocks North	64
CRSP	Castle Rocks South	63
CRSP	Castle Rocks West	75
Total	–	694

Table 2. Daubenmire's cover classes used for visually estimating vegetation cover in 1 m² square quadrats.

Cover Class	Range	Midpoint
0	0%	0%
1	1-5%	2.50%
2	>5-25%	15%
3	>25-50%	37.50%
4	>50-75%	62.50%
5	>75-95%	85%
6	>95%	97.50%

Weather

Historic weather information was compiled from data obtained from the Oakley, Idaho Co-Op weather station outside of Oakley, Idaho approximately 15-25 km from CIRO (station # 106542). This station is the closest to the Reserve with accessible long term climate data though it is about 300 m lower in elevation than the park. Data from this site range from 7/1/1893 to present. Precipitation was twice the 30 year average in early fall of 2017 (November) followed by a below average winter snowfall. The spring of 2018 saw above average precipitation in March and May, followed by below average summer rain. Temperatures in 2018 were very similar to long term averages, with a slightly warmer spring. Weather records from Oakley for 2008 to 2018 compared with long term averages are presented as figures in Appendix B.

Results and Discussion

The UCBN sagebrush steppe monitoring program completed a fourth season (following surveys in 2010, 2012, and 2015) of monitoring in CIRO in 2018 following approval of the Yeo et al. (2009) protocol. Sample sizes ranged from 61 to 84 per sampling frame, and were spatially extensive and random so that inferences can be drawn about the condition of sagebrush steppe condition for each frame (Figure 1). Of particular importance for park management is the overlap of each frame with individual grazing allotments. Monitoring of these areas over time will provide the park with invaluable information about the condition of allotments and the effectiveness of their grazing management program. Appendix C provides complete tables of bare ground and principal species cover estimates from the 2018 survey for each frame.

The amount of exposed bare soil – bare ground cover – is a fundamental measure of ecological condition in grazed rangeland. Too much bare ground indicates a loss of soil stability and hydrologic function, and also creates opportunities for weed invasion and loss of biological integrity. The proportion of plots where bare ground cover was estimated to be >5% ranged from 2% to 34% among frames (Appendix C). Highest estimates were in the Tracy Lane sampling frame, followed by Circle Creek South and Castle Rock State Park South frames. The Circle Creek South frame had bare ground cover estimates >25% in approximately 8% of plots. The Tracy Lane frame had bare ground cover >25% in 5% of plots and Circle Creek North frame had >25% bare ground cover in 4% of plots.

The majority of the sampling frames in CIRO contained trees in the overstory. The most abundant tree species was single-leaf pinyon pine. It was found with the most abundance in the Trail Canyon and Castle Rocks North frames with 5% of the plots having >5% cover. Big sagebrush dominates the overstory in all sampling frames (Appendix C). The Castle Rocks State Park West frame and Tracy Lane frame had the lowest cover estimates for big sagebrush with the proportion of plots having cover estimates >0% being 17% and 25%, respectively. Tracy Lane experienced wildfire in 2000, and sagebrush cover has not yet fully recovered. However, numbers are up by 14% compared to 6 years ago when Tracy Lane was surveyed in 2012. Castle Rocks West has a substantial overstory of low sagebrush, which accounts for the lower estimate of big sagebrush cover in that frame. The Circle Creek North frame had the highest big sagebrush cover with 81% of plots estimated at having >5% cover and 12% of plots estimated at having >50% cover. Big sagebrush was the most abundant shrub, followed by green rabbitbrush and bitterbrush. Bluebunch wheatgrass cover was lowest in the Castle Rocks North and Kempton frames with no plots having cover estimates >5%. Castle Rocks West and Emery Canyon had the highest cover estimates of bluebunch wheatgrass, with cover >5% ranging from 25% and 10% of plots. In most frames in CIRO other important large-stature native perennial grasses were more abundant than bluebunch wheatgrass. Western wheatgrass was the second most abundant and widespread native perennial grass species in CIRO, ranging in cover >5% from 2% to 20%. Bunchgrass species that are less widely distributed and abundant but nonetheless important components of the sagebrush steppe communities in CIRO include Idaho fescue, junegrass, indian ricegrass, needle and thread grass, sand dropseed and squirreltail (Appendix C). Where several of these species are abundant in concert with Sandberg's bluegrass, western

wheatgrass and bluebunch wheatgrass, it suggests good ecological condition. The upper slopes of the Emery Canyon and Trail Canyon frames are particularly notable for high perennial grass diversity and abundance, as well as Castle Rocks West, reflected in the summaries tables of Appendix C. Sandberg's bluegrass was the most abundant perennial native bunchgrass, with the highest covers in the Kempton frame with 27% of the plots having >5% cover. It was lowest in the Castle Rocks North and South frames with only 3% of plots having >5% cover. While an important and beneficial component of the native plant communities of CIRO, when dominant and in association with very high sagebrush cover and very low diversity and abundance of other native perennial grasses, it suggests poor ecological condition. This pattern is of particular concern when combined with the non-native annual grass, cheatgrass, being present in abundance. Circle Creek North and Kempton are two frames where these kinds of patterns are apparent, as well as Tracy Lane which has low sagebrush cover due to the recent wildfire (Appendix C). A wide variety of native perennial forbs were encountered during monitoring, with lupine, buckwheat, phlox, and balsamroot being most abundant. Balsamroot and lupine, important deep-rooted perennial forbs, were particularly widespread in Bath Rock, Emery Canyon, and Trail Canyon, with the frequency of occurrence ranging from 21%-47%, and the proportion of plots with cover >25% ranging from 1 to 2% (Appendix C). Lupines are ecologically important nitrogen-fixing forbs and were found in all frames at CIRO. Tracy Lane frame had only one occurrence of lupines in a plot. The Circle Creek North frame had the highest frequency of lupines (62%) followed by the Emery Canyon frame (58%). Phlox and buckwheat were found in every sampling frame at CIRO with the highest abundance of phlox occurring in the Kempton frame at 34% and buckwheat in the Trail Canyon frame at 37%.

Three noxious weed species were documented during the 2018 monitoring. These species were whitetop, Canada thistle, and dalmatian toadflax. The noxious weeds were found in low abundance (<4%) in three of the sampling frames including Bathrock, Castle Rocks North and South. The invasive annual cheatgrass is the most widespread and threatening non-native species in the park. Results from monitoring in 2018 point to an increase in cheatgrass abundance within several sampling frames cover estimates compared to 2012 monitoring (Stucki 2012). This may be the result of the spike in spring moisture during the month of November 2017 (Appendix B), as cheatgrass is capable of taking advantage of late fall and winter precipitation. It may also be a more sustained long-term trend of increasing abundance in the area. As a park wide trend, there was an increase in overall cheatgrass cover in CIRO from 2012 to 2018 (Figure A-7 in Appendix D). The sampling frame with the lowest cheatgrass abundance in 2018 was Emery Canyon, with 18% cover (Table 3; Appendix C). Remarkably, in 2012, the Circle Creek South frame had only one plot with cheatgrass cover (1%) and subsequently had the lowest cheatgrass abundance of the 10 frames; now 6 years later in 2018, the frame still has relatively low cheatgrass abundance at 23% and the second lowest abundance of the 10 frames, but nonetheless a worrisome increase. Frames with the highest cheatgrass abundance include the Castle Rocks North, Castle Rocks West and Kempton frames (Table 3; Appendix C). The Trail Canyon frame saw the biggest decrease in cheatgrass cover, going from 52% in 2015 to 37% in 2018. It is yet apparent whether this is a sustained improvement nor what might be causing this. The Bathrock frame had relatively low cheatgrass cover in 2012 and has since increased by 28% to having an overall cover of 64% in 2018. Other non-native grasses that

occur across the park in moderate abundance are crested wheatgrass, bulbous bluegrass, and Kentucky bluegrass (Appendix C).

These species occur throughout most sampling frames, with exception to crested wheatgrass, which was not found in Castle Rocks State Park or Emery Canyon during 2018 surveying. These species are abundant in some areas, although less invasive and worrisome than the patterns of cheatgrass abundance. The frames with the highest frequencies for crested wheatgrass were the Circle Creek South, Circle Creek North, and Tracy Lane frames (Appendix C). Kentucky bluegrass was found in all sampling frames except Tracy Lane (Appendix C). Bulbous bluegrass was found most often in the Trail Canyon and Castle Rocks West. Castle Rocks North frame had the lowest abundance of bulbous bluegrass at 2% cover. Non-native invasive forbs were found infrequently in most frames. Yellow salsify had the highest frequency and cover of non- native invasive forbs being found in 8 of the 10 sampling frames. The Tracy Lane and Castle Rocks West frames had the highest proportion of plots with yellow salsify cover at 20% (Appendix C). Other widespread non-native invasive forbs encountered in 2018 included tumble mustard and common dandelion.

The overall patterns reflected in the data collected in 2018 suggest that much of the sagebrush steppe vegetation within CIRO and CRSP remains in good ecological condition. Particularly noteworthy is the combination of high diversity and abundance of native perennial grasses and forbs and moderate abundances of big sagebrush and steppe bluegrass in the high-elevation Trail Canyon and Emery Canyon frames. Circle Creek South is also noteworthy of its surprisingly low infestation by cheatgrass, with only a slight increase over the past 2 monitoring cycles. Frames where indicators of poor condition were consistently observed include Tracy Lane, Circle Creek North, and Kempton. There are some worrying signs in the Castle Rocks frames, particularly because of the heavy and apparently increasing infestation of cheatgrass. Noxious weeds were noted in 3 sampling frames that had never been recorded before. Deep-rooted native perennial forbs were found within all sampling frames in varying amounts with the Emery Canyon sampling frame having the most varied diversity (37 species; Appendix C), while the Tracy Lane frame had the lowest diversity with 15 native forb species encountered. Native perennial forb cover has been attributed to ecological resistance and resilience in western sagebrush rangelands, generally (Prevey et al. 2010).

Maintaining this component of CIRO sagebrush steppe ecosystems along with a diverse and abundant native perennial grass component will facilitate the persistence of healthy intact native sagebrush steppe in CIRO. Monitoring these communities will provide a good indication of ecological condition over time.

Table 3. 2018 cheatgrass infestation summary statistics for the 10 sampling frames in CIRO.

Sampling Frame	Metric	Result
Bath Rock	Total acreage sampled	148.55
	Total with no cheatgrass	53.58
	Proportion of total frame area with no cheatgrass	0.36
	Total with at least some cheatgrass	94.97
	Proportion of total surveyed area with cheatgrass	0.64
	Heavily infested acreage (>25% cover)	14.61
	Proportion of heavily infested	0.10
Circle Creek North	Total acreage sampled	314.55
	Total with no cheatgrass	51.01
	Proportion of total frame area with no cheatgrass	0.16
	Total with at least some cheatgrass	263.54
	Proportion of total surveyed area with cheatgrass	0.84
	Heavily infested acreage (>25% cover)	42.51
	Proportion of heavily infested	0.14
Circle Creek South	Total acreage sampled	200.73
	Total with no cheatgrass	154.41
	Proportion of total frame area with no cheatgrass	0.77
	Total with at least some cheatgrass	46.32
	Proportion of total surveyed area with cheatgrass	0.23
	Heavily infested acreage (>25% cover)	6.18
	Proportion of heavily infested	0.03
Emery Canyon	Total acreage sampled	512.79
	Total with no cheatgrass	421.22
	Proportion of total frame area with no cheatgrass	0.82
	Total with at least some cheatgrass	91.57
	Proportion of total surveyed area with cheatgrass	0.18
	Heavily infested acreage (>25% cover)	12.21
	Proportion of heavily infested	0.02

Table 3 (continued). 2018 cheatgrass infestation summary statistics for the 10 sampling frames in CIRO.

Sampling Frame	Metric	Result
Kempton	Total acreage sampled	289.70
	Total with no cheatgrass	33.11
	Proportion of total frame area with no cheatgrass	0.11
	Total with at least some cheatgrass	256.59
	Proportion of total surveyed area with cheatgrass	0.89
	Heavily infested acreage (>25% cover)	45.52
	Proportion of heavily infested	0.16
Tracy Lane	Total acreage sampled	163.89
	Total with no cheatgrass	68.08
	Proportion of total frame area with no cheatgrass	0.42
	Total with at least some cheatgrass	95.81
	Proportion of total surveyed area with cheatgrass	0.58
	Heavily infested acreage (>25% cover)	25.21
	Proportion of heavily infested	0.15
Trail Canyon	Total acreage sampled	388.41
	Total with no cheatgrass	244.75
	Proportion of total frame area with no cheatgrass	0.63
	Total with at least some cheatgrass	143.66
	Proportion of total surveyed area with cheatgrass	0.37
	Heavily infested acreage (>25% cover)	10.64
	Proportion of heavily infested	0.03
Castle Rocks SP North	Total acreage sampled	112.86
	Total with no cheatgrass	1.76
	Proportion of total frame area with no cheatgrass	0.02
	Total with at least some cheatgrass	111.10
	Proportion of total surveyed area with cheatgrass	0.98
	Heavily infested acreage (>25% cover)	52.90
	Proportion of heavily infested	0.47

Table 3 (continued). 2018 cheatgrass infestation summary statistics for the 10 sampling frames in CIRO.

Sampling Frame	Metric	Result
Castle Rocks SP South	Total acreage sampled	277.74
	Total with no cheatgrass	35.27
	Proportion of total frame area with no cheatgrass	0.13
	Total with at least some cheatgrass	242.47
	Proportion of total surveyed area with cheatgrass	0.87
	Heavily infested acreage (>25% cover)	22.04
	Proportion of heavily infested	0.08
Castle Rocks SP West	Total acreage sampled	218.32
	Total with no cheatgrass	17.47
	Proportion of total frame area with no cheatgrass	0.08
	Total with at least some cheatgrass	200.85
	Proportion of total surveyed area with cheatgrass	0.92
	Heavily infested acreage (>25% cover)	52.40
	Proportion of heavily infested	0.24

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Appendix A

List of plant species mentioned in the report with common and scientific names.

Table A-1. Plant common, species, and updated species names.

Plant Category	Common names	Species name	Updated Species Name
Trees	Rocky mountain juniper	<i>Juniperus scopulorum</i>	–
	Single-leaf pinyon pine	<i>Pinus monophylla</i>	–
	Quaking aspen	<i>Populus tremuloides</i>	–
Sagebrush	Low Sagebrush	<i>Artemisia arbuscula</i>	–
	Big Sagebrush	<i>Artemisia tridentata</i>	–
Other Shrubs	Serviceberry	<i>Amerlanchier spp</i>	–
	Mountain mahogany	<i>Cercocarpus ledifolius</i>	–
	Green rabbitbrush	<i>Chrysothamnus viscidiflorus</i>	–
	Rubber rabbitbrush	<i>Ericameria nauseosa</i>	–
	Broom snakeweed	<i>Gutierrezia sarothrae</i>	–
	Prickly phlox	<i>Leptodactylon pungens</i>	<i>Linanthus pungens</i>
	Barberry	<i>Mahonia spp</i>	–
	Chokecherry	<i>Prunus virginiana</i>	–
	Bitterbrush	<i>Purshia tridentata</i>	–
	Currant	<i>Ribes spp.</i>	–
	Wood's rose	<i>Rosa woodsii</i>	–
	Snowberry	<i>Symphoricarpos spp.</i>	–
	Spineless horsebrush	<i>Tetradymia canescens</i>	–

Table A-1 (continued). Plant common, species, and updated species names.

Plant Category	Common names	Species name	Updated Species Name
Native Grasses	Needlegrass	<i>Achnatherum spp</i>	–
	Mountain brome	<i>Bromus carinatus</i>	–
	Sedges	<i>Carex spp</i>	–
	One-spike oatgrass	<i>Danthonia unispicatum</i>	–
	Great Basin wildrye	<i>Elymus cinereus</i>	<i>Leymus cinereus</i>
	Squirreltail	<i>Elymus elymoides</i>	–
	Idaho fescue	<i>Festuca idahoensis</i>	–
	Needle and thread grass	<i>Hesperostipa comata</i>	–
	Rushes	<i>Juncus spp</i>	–
	Prairie junegrass	<i>Koeleria macrantha</i>	–
	Oniongrass	<i>Melica bulbosa</i>	–
	Indian ricegrass	<i>Oryzopsis hymenoides</i>	<i>Achnatherum hymenoides</i>
	Western wheatgrass	<i>Pascopyrum smithii</i>	–
	Sandberg's steppe bluegrass	<i>Poa secunda</i>	–
	Bluegrass spp	<i>Poa spp</i>	–
	Bluebunch wheatgrass	<i>Pseudoroegneria spicata</i>	–
Persistent Native Forbs	Yarrow	<i>Achillea millefolium</i>	–
	Pussytoes	<i>Antennaria spp</i>	–
	Sandwort	<i>Arennaria spp</i>	–
	Western mugwort	<i>Artemisia ludoviciana</i>	–
	Aster	<i>Aster spp.</i>	–
	Astragalus, Milkvetch	<i>Astragalus spp</i>	–
	Arrowleaf balsamroot	<i>Balsamorhiza sagittata</i>	–

Table A-1 (continued). Plant common, species, and updated species names.

Plant Category	Common names	Species name	Updated Species Name
Persistent Native Forbs (continued)	Indian paintbrush	<i>Castilleja spp</i>	–
	(Native) Thistle	<i>Cirsium spp</i>	–
	Douglas' chaenactis	<i>Chaenactis douglasii</i>	–
	Bastard toadflax	<i>Comandra umbellata</i>	–
	Tapertip hawksbeard	<i>Crepis acuminata</i>	–
	Daisy	<i>Erigeron spp</i>	–
	Buckwheat	<i>Eriogonum spp</i>	–
	Common wooly sunflower	<i>Eriophyllum lanatum</i>	–
	Sticky purple geranium	<i>Geranium viscosissimum</i>	–
	Stemless mock goldenweed	<i>Haplopappus spp.</i>	–
	Iris	<i>Iris spp.</i>	–
	Western stoneseed	<i>Lithospermum ruderae</i>	–
	Biscuitroot	<i>Lomatium spp</i>	–
	Lupine	<i>Lupinus spp</i>	–
	Prickly pear	<i>Opuntia polyacantha</i>	–
	Hedgehog cactus	<i>Pediocactus simpsonii</i>	–
	Beardtongues	<i>Penstemon spp.</i>	–
	Silverleaf scoriprionweed	<i>Phacelia hastata</i>	–
	Phlox	<i>Phlox spp</i>	–
	Cinquefoil	<i>Potentilla spp.</i>	–
	Ragwort	<i>Senecio spp</i>	–
	False hellebore	<i>Viratrum viride</i>	–
	Mule's ears	<i>Wyethia spp</i>	–

Table A-1 (continued). Plant common, species, and updated species names.

Plant Category	Common names	Species name	Updated Species Name
Other Native Forbs	Mountain dandelion	<i>Agoseris spp</i>	–
	Wild onion	<i>Allium spp</i>	–
	Rockcress	<i>Arabis spp</i>	–
	Trumpet	<i>Collomia spp</i>	–
	Mariposa lily	<i>Calochortus spp</i>	–
	Cat's eye	<i>Cryptantha spp.</i>	–
	Larkspur	<i>Delphinium spp</i>	–
	Yellowbells	<i>Fritillaria pudica</i>	–
	Stickseed	<i>Hackelia spp</i>	–
	Blue flax	<i>Linum lewisii</i>	–
	Woodland stars	<i>Lithophragma spp</i>	–
	Spearleaf stonecrop	<i>Sedum lanceolatum</i>	–
	Violets	<i>Viola spp.</i>	–
	Death camas	<i>Zigadenus spp</i>	–
Invasive Grasses	Crested wheatgrass	<i>Agropyron cristatum</i>	–
	Bromes	<i>Bromus spp.</i>	–
	Cheatgrass	<i>Bromus tectorum</i>	–
	Bulbous bluegrass	<i>Poa bulbosa</i>	–
	Kentucky bluegrass	<i>Poa pratensis</i>	–

Table A-1 (continued). Plant common, species, and updated species names.

Plant Category	Common names	Species name	Updated Species Name
Invasive Forbs	Whitetop	<i>Cardaria draba</i>	<i>Lepidium draba</i>
	Canada thistle	<i>Cirsium arvense</i>	–
	Tansymustard	<i>Descurainia spp</i>	–
	Stork's bill	<i>Erodium cicutarium</i>	–
	Curlycup gumweed	<i>Grindelia squarrosa</i>	–
	Clasping pepperweed	<i>Lepidium perfoliatum</i>	–
	Dalmatian toadflax	<i>Linaria dalmatica</i>	–
	Tumble mustard	<i>Sisymbrium altissimum</i>	–
	Common dandelion	<i>Taraxicum officinale</i>	–
	Salsify	<i>Tragopogon dubius</i>	–

Appendix B

Climate diagrams for the City of Rocks and Oakley weather station, near City of Rocks National Reserve.

Oakley Idaho (USC00106542) 2017-2018: Departure from 1981 - 2010 Avgs.

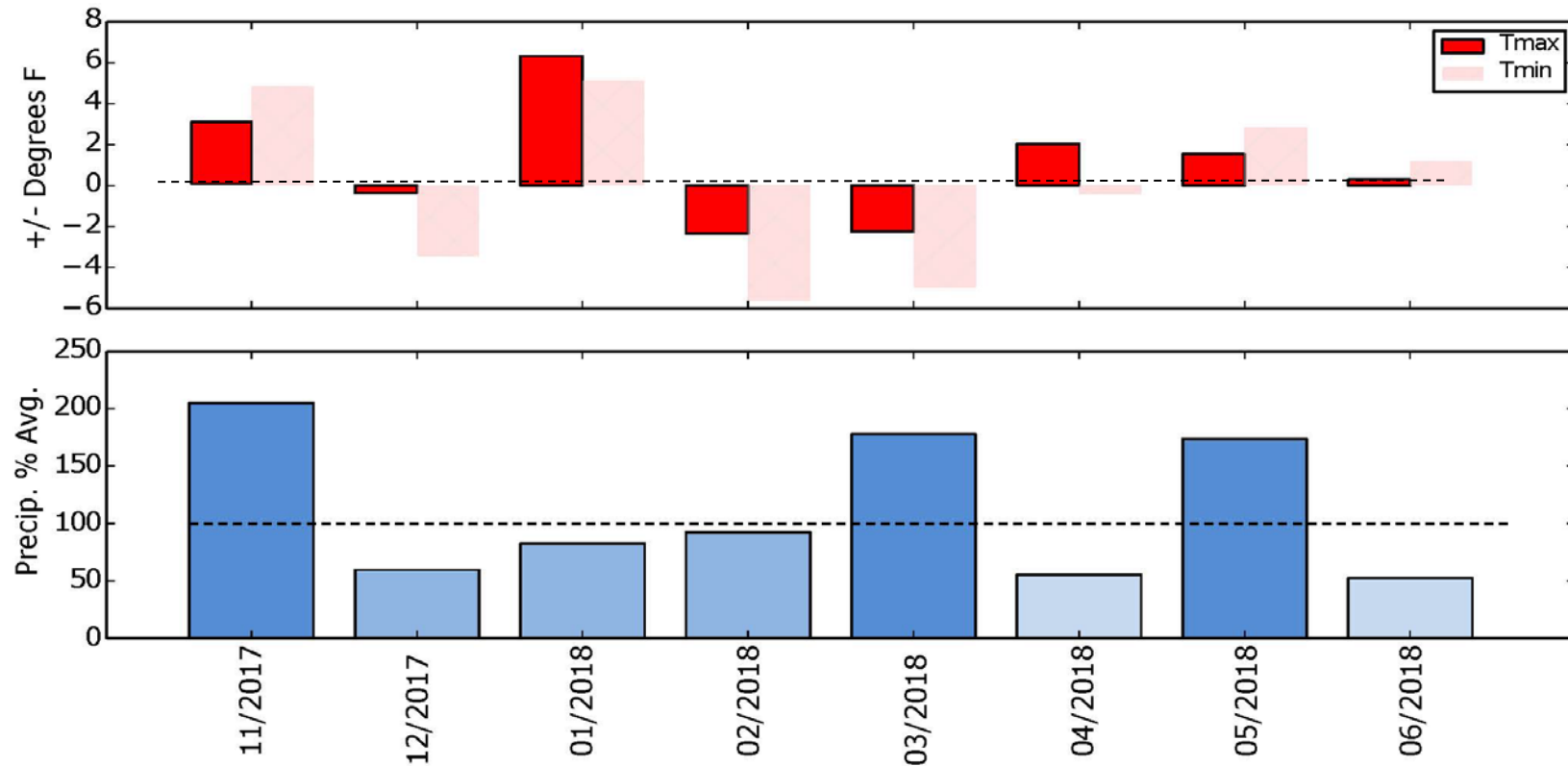


Figure A-1. This figure compares 2018 data to the long-term (30 year) averages of monthly temperatures (red boxes) and monthly precipitation (blue boxes). The dotted black line in the both graphs represents the 30 year average for temperature and precipitation.

Oakley Idaho (USC00106542) 2016-2017: Departure from 1981 - 2010 Avgs.

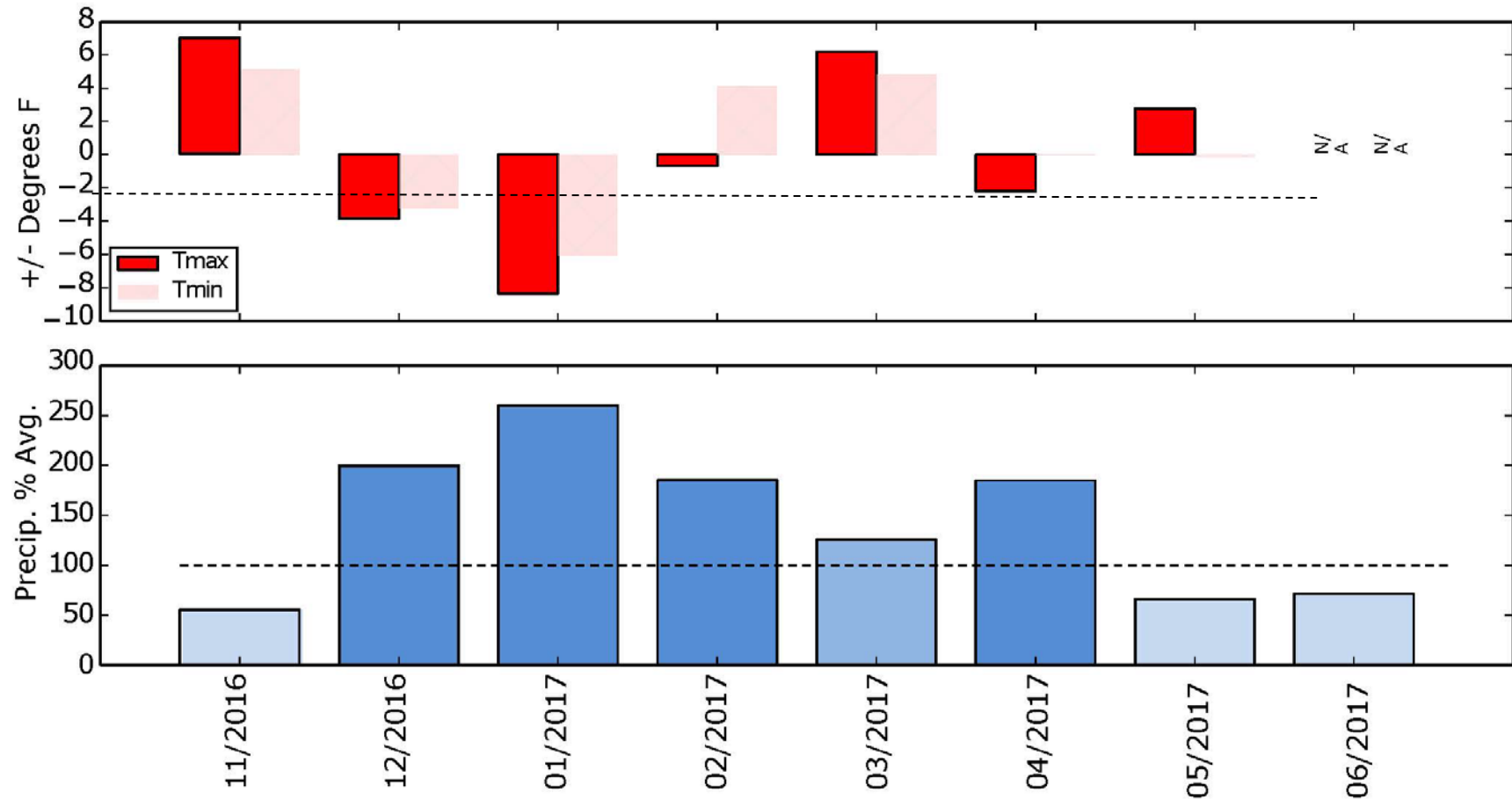


Figure A-2. This figure compares 2017 data to the long-term (30 year) averages of monthly temperatures (red boxes) and monthly precipitation (blue boxes). The dotted black line in the both graphs represents the 30 year average for temperature and precipitation.

Oakley Idaho (USC00106542) 2015-2016: Departure from 1981 - 2010 Avgs.

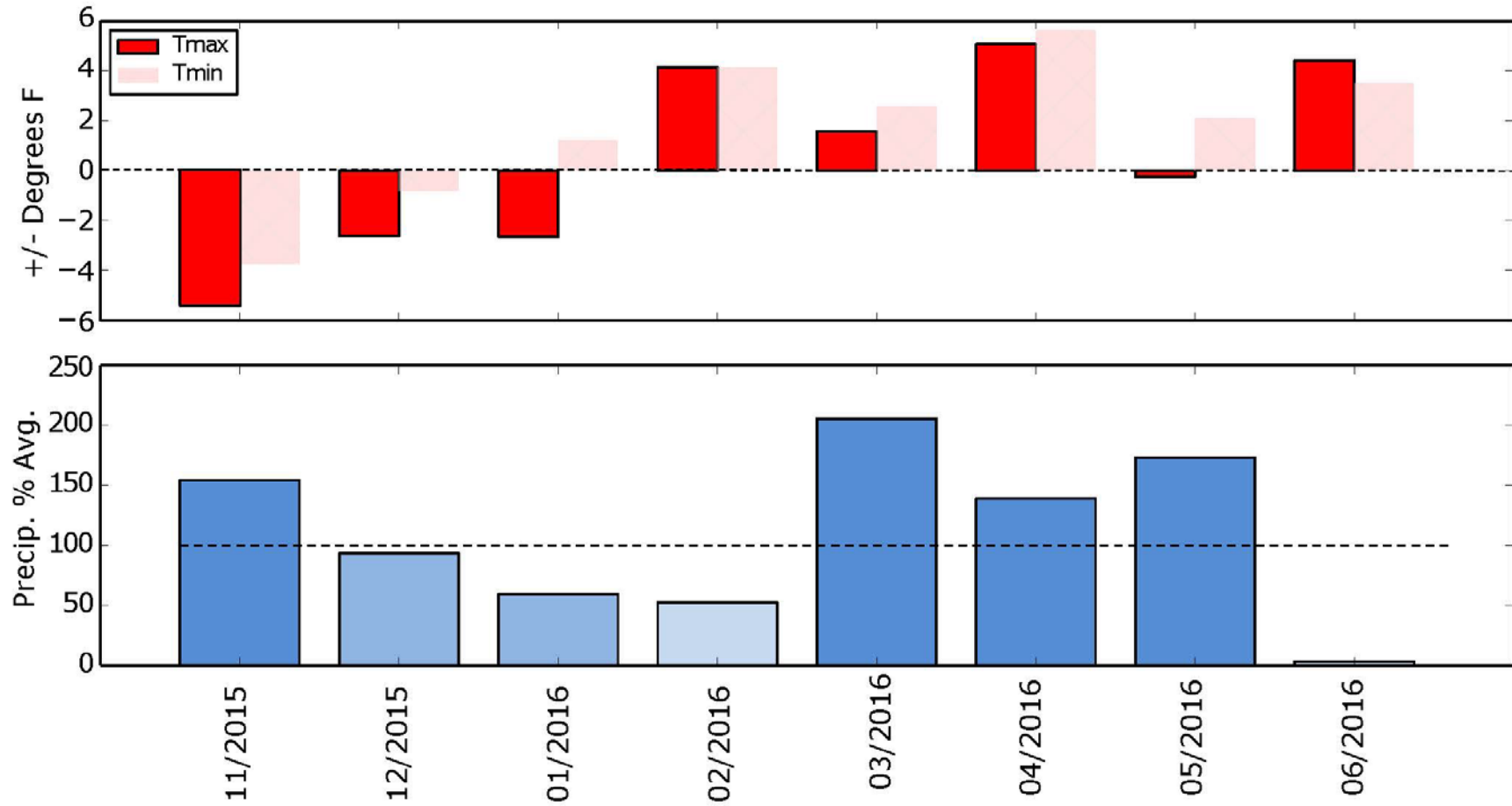


Figure A-3. This figure compares 2016 data to the long-term (30 year) averages of monthly temperatures (red boxes) and monthly precipitation (blue boxes). The dotted black line in the both graphs represents the 30 year average for temperature and precipitation.

Oakley Idaho (USC00106542) 2014-2015: Departure from 1981 - 2010 Avgs.

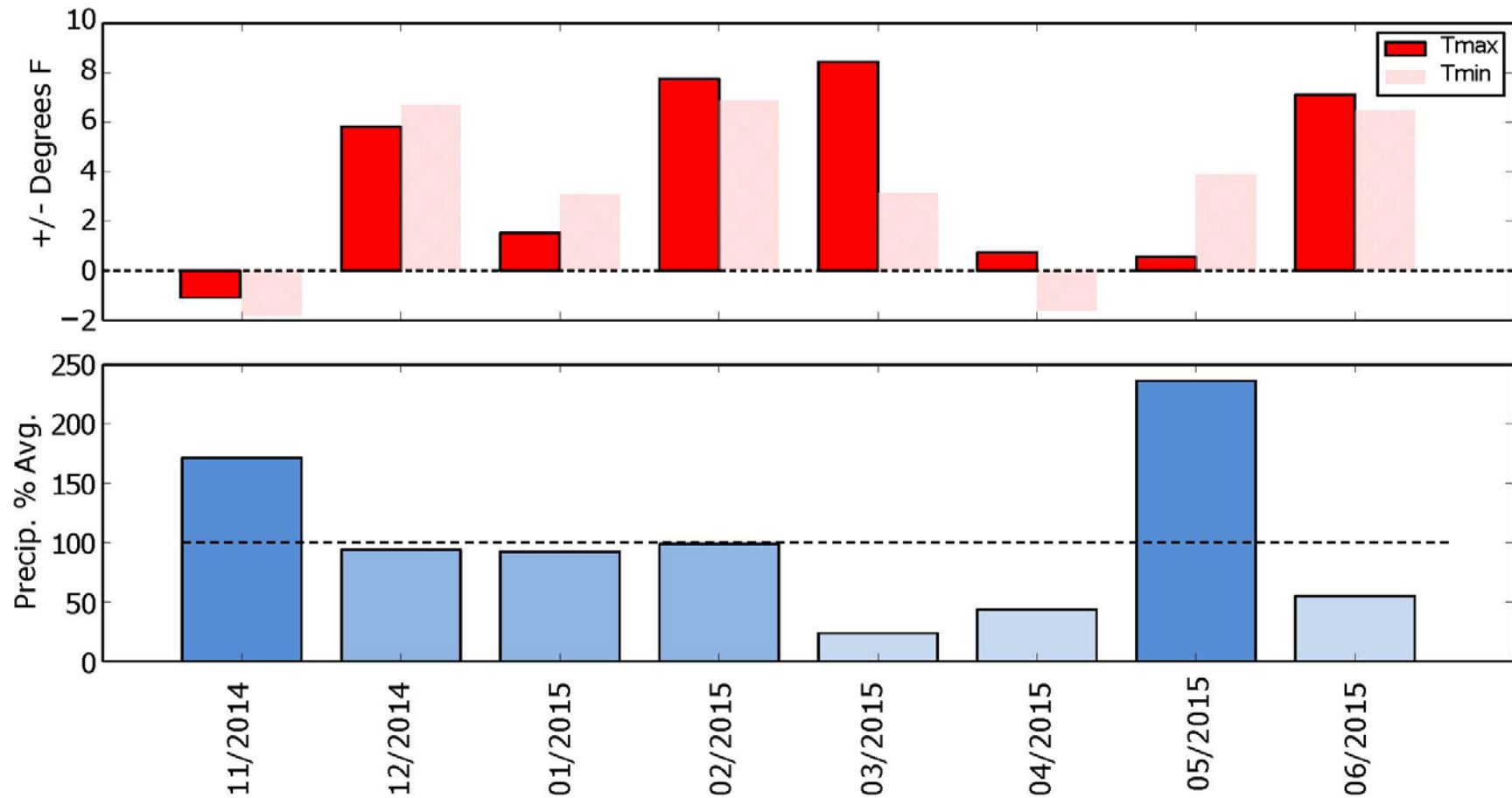


Figure A-4. This figure compares 2015 data to the long-term (30 year) averages of monthly temperatures (red boxes) and monthly precipitation (blue boxes). The dotted black line in the both graphs represents the 30 year average for temperature and precipitation.

Oakley Idaho (USC00106542) 2008-2014: Departure from 1981 - 2010 Avgs.

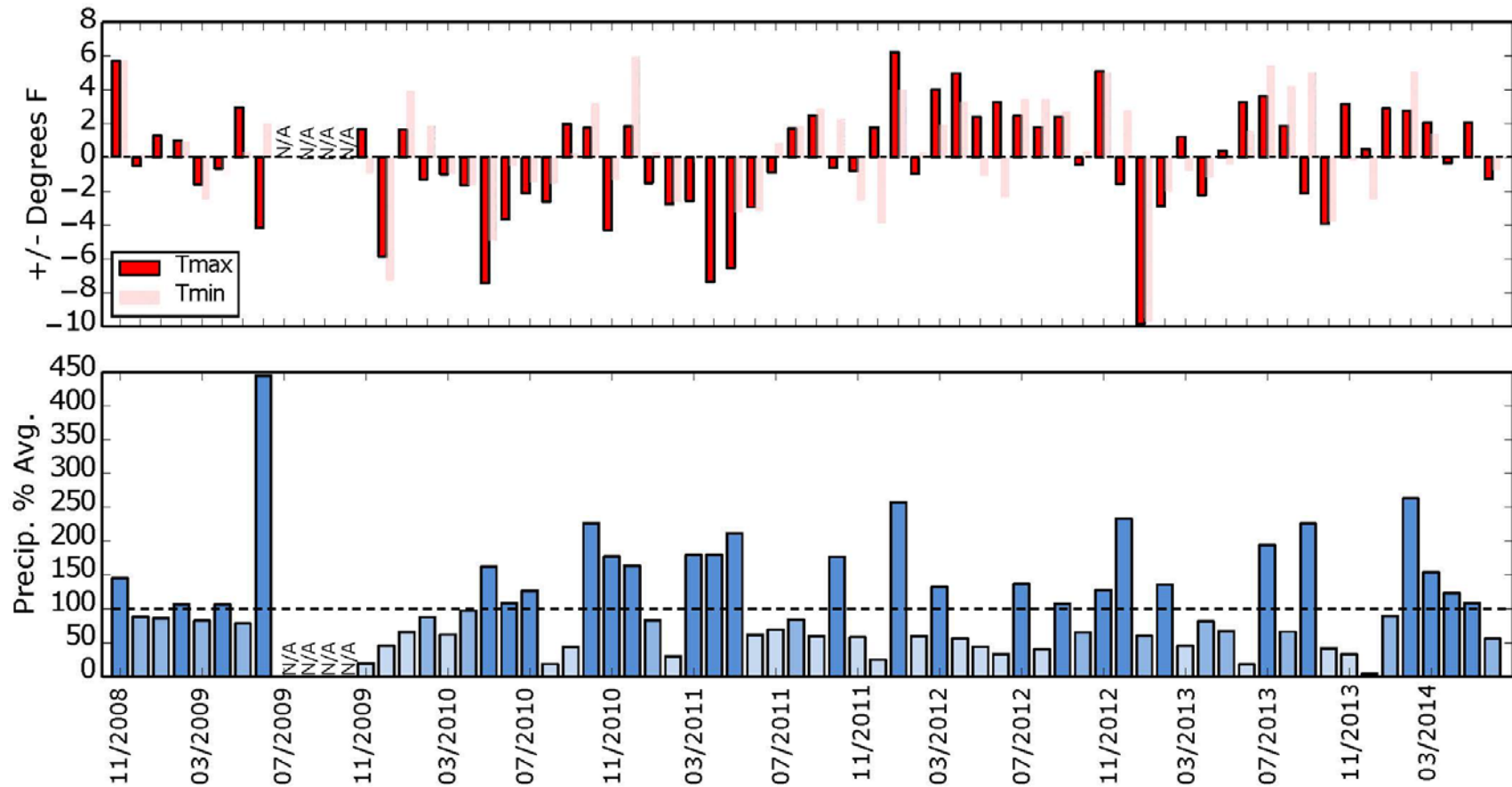


Figure A-5. This figure compares data from 2008 to 2014 against the long-term (30 year) averages of monthly temperatures (red boxes) and monthly precipitation (blue boxes). The dotted black line in the both graphs represents the 30 year average for temperature and precipitation.

Appendix C

2018 sage monitoring results for CIRO: Percentage of plots within each cover class for exposed bare ground and principal plant species organized by species guilds.

Table A-2. 2018 Bath Rock sampling frame, CIRO: percentage of plots (n=61 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	—	21	66	13	0	0	0	0
Trees	<i>Pinus monophylla</i>	98	2	0	0	0	0	0
	<i>Populus tremuloides</i>	98	0	2	0	0	0	0
Sagebrush	<i>Artemisia arbuscula</i>	95	5	0	0	0	0	0
	<i>Artemisia tridentata</i>	28	26	21	18	7	0	0
Shrubs	<i>Amelanchier</i> spp	98	2	0	0	0	0	0
	<i>Cercocarpus ledifolius</i>	97	1.5	1.5	0	0	0	0
	<i>Chrysothamnus viscidiflorus</i>	47.5	38	14.5	0	0	0	0
	<i>Ericameria nauseosa</i>	92	5	3	0	0	0	0
	<i>Mahonia</i> spp	97	3	0	0	0	0	0
	<i>Purshia tridentata</i>	62	17	8	8	3	2	0
	<i>Ribes</i> spp	98	0	0	0	0	2	0
	<i>Rosa woodsii</i>	95	3	2	0	0	0	0
	<i>Symphoricarpos</i> spp.	60.5	28	3	6.5	2	0	0
Native Perennial Grasses	<i>Achnatherum</i> spp	92	6.5	1.5	0	0	0	0
	<i>Carex</i> spp.	95	5	0	0	0	0	0
	<i>Elymus cinereus</i>	98	2	0	0	0	0	0
	<i>Elymus elymoides</i>	98	2	0	0	0	0	0

Table A-2 (continued). 2018 Bath Rock sampling frame, CIRO: percentage of plots (n=61 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Perennial Grasses (continued)	<i>Festuca idahoensis</i>	94	3	3	0	0	0	0
	<i>Juncus</i> spp	98	0	2	0	0	0	0
	<i>Koeleria macrantha</i>	98	2	0	0	0	0	0
	<i>Pascopyrum smithii</i>	49	43	8	0	0	0	0
	<i>Poa secunda</i>	30	63.5	6.5	0	0	0	0
	<i>Pseudoroegneria spicata</i>	92	6.5	1.5	0	0	0	0
Native Persistent Forbs	<i>Achillea millefolium</i>	85	15	0	0	0	0	0
	<i>Antennaria</i> spp	95	5	0	0	0	0	0
	<i>Artemisia ludoviciana</i>	93	7	0	0	0	0	0
	<i>Astragalus</i> spp	98	2	0	0	0	0	0
	<i>Balsamorhiza sagittata</i>	64	24.5	10	1.5	0	0	0
	<i>Comandra umbellata</i>	95	5	0	0	0	0	0
	<i>Crepis acuminata</i>	90	10	0	0	0	0	0
	<i>Eriogonum</i> spp	69	21	7	3	0	0	0
	<i>Geranium viscosissimum</i>	98	2	0	0	0	0	0
	<i>Iris</i> spp	98	2	0	0	0	0	0
	<i>Lithospermum ruderae</i>	97	3	0	0	0	0	0
	<i>Lomatium</i> spp	98	2	0	0	0	0	0
	<i>Lupinus</i> spp	59	34	7	0	0	0	0
	<i>Opuntia polyacantha</i>	80	15	5	0	0	0	0
	<i>Phlox</i> spp	87	13	0	0	0	0	0

Table A-2 (continued). 2018 Bath Rock sampling frame, CIRO: percentage of plots (n=61 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Other Forbs	<i>Agoseris</i> spp	95	5	0	0	0	0	0
	<i>Allium</i> spp	88	12	0	0	0	0	0
	<i>Arabis</i> spp.	98	2	0	0	0	0	0
	<i>Calochortus</i> spp.	98	2	0	0	0	0	0
	<i>Collomia</i> spp	79	21	0	0	0	0	0
	<i>Cryptantha</i> spp.	90	10	0	0	0	0	0
	<i>Hackelia</i> spp.	93	7	0	0	0	0	0
	<i>Linum lewisii</i>	98	2	0	0	0	0	0
	<i>Lithophragma</i> spp.	98	2	0	0	0	0	0
	<i>Viola</i> spp.	97	3	0	0	0	0	0
	<i>Zigadenus</i> spp.	98	2	0	0	0	0	0
Non-native Invasive Forbs	<i>Linaria dalmatica</i>	97	3	0	0	0	0	0
	<i>Taraxicum officinale</i>	98	2	0	0	0	0	0
	<i>Tragopogon dubius</i>	95	5	0	0	0	0	0
Non-native Invasive Grasses	<i>Agropyron cristatum</i>	48	26	24.5	1.5	0	0	0
	<i>Bromus</i> spp.	98	2	0	0	0	0	0
	<i>Bromus tectorum</i>	36	44	10	10	0	0	0
	<i>Poa bulbosa</i>	56	34	8	2	0	0	0
	<i>Poa pratensis</i>	72	13	10	5	0	0	0

Table A-3. 2018 Circle Creek North sampling frame, CIRO: percentage of plots (n=74 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	–	12	73	11	4	0	0	0
Trees	<i>Juniperus scopulorum</i>	97	1.5	0	0	0	0	1.5
	<i>Pinus monophylla</i>	99	1	0	0	0	0	0
Sagebrush	<i>Artemisia tridentata</i>	7	12	45	23	12	1	0
Shrubs	<i>Chrysothamnus viscidiflorus</i>	85	8	5.5	1.5	0	0	0
	<i>Ericameria nauseosa</i>	94.5	5.5	0	0	0	0	0
	<i>Purshia tridentata</i>	73	11	10	4	1	1	0
	<i>Rosa woodsii</i>	99	1	0	0	0	0	0
Native Perennial Grasses	<i>Achnatherum</i> spp.	99	1	0	0	0	0	0
	<i>Carex</i> spp.	93	7	0	0	0	0	0
	<i>Hesperostipa comata</i>	95	5	0	0	0	0	0
	<i>Koeleria macrantha</i>	99	1	0	0	0	0	0
	<i>Pascopyrum smithii</i>	71.5	21.5	4	0	3	0	0
	<i>Poa secunda</i>	38	55	7	0	0	0	0
	<i>Pseudoroegneria spicata</i>	97	1.5	1.5	0	0	0	0
Native Persistent Forbs	<i>Astragalus</i> spp	92	8	0	0	0	0	0
	<i>Balsamorhiza sagittata</i>	96	1	3	0	0	0	0
	<i>Chaenactis douglasii</i>	97	3	0	0	0	0	0
	<i>Cirsium</i> spp.	99	1	0	0	0	0	0
	<i>Comandra umbellata</i>	99	1	0	0	0	0	0
	<i>Crepis acuminata</i>	99	1	0	0	0	0	0
	<i>Erigeron</i> spp	99	1	0	0	0	0	0

Table A-3 (continued). 2018 Circle Creek North sampling frame, CIRO: percentage of plots (n=74 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Persistent Forbs (continued)	<i>Eriogonum</i> spp	93	6	1	0	0	0	0
	<i>Lithospermum ruderales</i>	97	0	3	0	0	0	0
	<i>Lupinus</i> spp	38	55	7	0	0	0	0
	<i>Opuntia polyacantha</i>	93	7	0	0	0	0	0
	<i>Phacelia hastata</i>	99	1	0	0	0	0	0
	<i>Phlox</i> spp	88	12	0	0	0	0	0
Native Other Forbs	<i>Agoseris</i> spp	96	4	0	0	0	0	0
	<i>Arabis</i> spp.	96	4	0	0	0	0	0
	<i>Collomia</i> spp	85	15	0	0	0	0	0
	<i>Cryptantha</i> spp.	74	26	0	0	0	0	0
	<i>Viola</i> spp.	96	4	0	0	0	0	0
	<i>Zigadenus</i> spp.	99	1	0	0	0	0	0
Non-native Invasive Forbs	<i>Descurainia</i> spp	97	3	0	0	0	0	0
	<i>Erodium cicutarium</i>	99	1	0	0	0	0	0
	<i>Taraxicum officinale</i>	97	3	0	0	0	0	0
Non-native Invasive Grasses	<i>Agropyron cristatum</i>	20	32.5	32.5	15	0	0	0
	<i>Bromus</i> spp.	78	19	3	0	0	0	0
	<i>Bromus tectorum</i>	16	55	15	8	6	0	0
	<i>Poa bulbosa</i>	93	7	0	0	0	0	0
	<i>Poa pratensis</i>	97	3	0	0	0	0	0

Table A-4. 2018 Circle Creek South sampling frame, CIRO: percentage of plots (n=65 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	–	11	66	15	5	1.5	1.5	0
Trees	None	–	–	–	–	–	–	–
Sagebrush	<i>Artemisia tridentata</i>	9	31	34	21.5	4.5	0	0
Shrubs	<i>Chrysothamnus viscidiflorus</i>	68	23	9	0	0	0	0
	<i>Ericameria nauseosa</i>	92	6	2	0	0	0	0
	<i>Purshia tridentata</i>	70	9	9	6	3	3	0
	<i>Ribes</i> spp.	98.5	1.5	0	0	0	0	0
	<i>Symphoricarpos</i> spp	92	4	3	1	0	0	0
Native Perennial Grasses	<i>Achnatherum</i> spp.	98.5	1.5	0	0	0	0	0
	<i>Carex</i> spp.	98.5	1.5	0	0	0	0	0
	<i>Elymus cinereus</i>	98.5	0	0	1.5	0	0	0
	<i>Hesperostipa comata</i>	98.5	1.5	0	0	0	0	0
	<i>Koeleria macrantha</i>	98.5	1.5	0	0	0	0	0
	<i>Oryzopsis hymenoides</i>	98.5	1.5	0	0	0	0	0
	<i>Pascopyrum smithii</i>	52	40	8	0	0	0	0
	<i>Poa secunda</i>	20	63	17	0	0	0	0
	<i>Pseudoroegneria spicata</i>	97	1.5	1.5	0	0	0	0

Table A-4 (continued). 2018 Circle Creek South sampling frame, CIRO: percentage of plots (n=65 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Persistent Forbs	<i>Achillea millefolium</i>	95	5	0	0	0	0	0
	<i>Antennaria</i> spp	94	4.5	1.5	0	0	0	0
	<i>Astragalus</i> spp	77	23	0	0	0	0	0
	<i>Chaenactis douglasii</i>	98.5	1.5	0	0	0	0	0
	<i>Cirsium</i> spp.	97	3	0	0	0	0	0
	<i>Crepis acuminata</i>	97	3	0	0	0	0	0
	<i>Erigeron</i> spp	86	14	0	0	0	0	0
	<i>Eriogonum</i> spp	85	12	3	0	0	0	0
	<i>Eriophyllum lanatum</i>	98.5	1.5	0	0	0	0	0
	<i>Lithospermum ruderae</i>	97	1.5	1.5	0	0	0	0
	<i>Lomatium</i> spp	91	9	0	0	0	0	0
	<i>Lupinus</i> spp	63	35.5	1.5	0	0	0	0
	<i>Opuntia polyacantha</i>	88	9	3	0	0	0	0
	<i>Penstemon</i> spp	98.5	1.5	0	0	0	0	0
	<i>Phacelia hastata</i>	98.5	1.5	0	0	0	0	0
	<i>Phlox</i> spp	80	20	0	0	0	0	0
Native Other Forbs	<i>Agoseris</i> spp	97	3	0	0	0	0	0
	<i>Allium</i> spp.	89	11	0	0	0	0	0
	<i>Calochortus</i> spp	98.5	1.5	0	0	0	0	0
	<i>Collomia</i> spp	94	6	0	0	0	0	0
	<i>Cryptantha</i> spp.	69	31	0	0	0	0	0
	<i>Hackelia</i> spp	98.5	1.5	0	0	0	0	0

Table A-4 (continued). 2018 Circle Creek South sampling frame, CIRO: percentage of plots (n=65 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Non-native Invasive Forbs	<i>Descurainia</i> spp	98.5	1.5	0	0	0	0	0
	<i>Taraxicum officinale</i>	98.5	1.5	0	0	0	0	0
Non-native Invasive Grasses	<i>Agropyron cristatum</i>	17	29	41.5	11	0	1.5	0
	<i>Bromus</i> spp.	95	5	0	0	0	0	0
	<i>Bromus tectorum</i>	77	18.5	1.5	1.5	0	1.5	0
	<i>Poa bulbosa</i>	88	9	3	0	0	0	0
	<i>Poa pratensis</i>	98.5	1.5	0	0	0	0	0

Table A-5. 2018 Emery Canyon sampling frame, CIRO: percentage of plots (n=84 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	–	17	81	2	0	0	0	0
Trees	<i>Populus tremuloides</i>	98	1	0	0	1	0	0
Sagebrush	<i>Artemisia arbuscula</i>	70	17	12	1	0	0	0
	<i>Artemisia tridentata</i>	45	27	11	13	4	0	0
Shrubs	<i>Amelanchier</i> spp	96.5	2.5	1	0	0	0	0
	<i>Cercocarpus ledifolius</i>	99	0	0	0	1	0	0
	<i>Chrysothamnus viscidiflorus</i>	48	37	14	1	0	0	0
	<i>Leptodactylon viscidiflorus</i>	92	8	0	0	0	0	0
	<i>Mahonia</i> spp	77.5	21.5	1	0	0	0	0
	<i>Prunus virginiana</i>	99	0	0	1	0	0	0
	<i>Purshia tridentata</i>	98	0	2	0	0	0	0
	<i>Ribes</i> spp	98	1	1	0	0	0	0
	<i>Rosa woodsii</i>	99	1	0	0	0	0	0
	<i>Symphoricarpos</i> spp.	57	29	11	2	0	1	0
	<i>Tetradymia canescens</i>	98	1	1	0	0	0	0
Native Perennial Grasses	<i>Achnatherum</i> spp	95	5	0	0	0	0	0
	<i>Bromus carinatus</i>	90	10	0	0	0	0	0
	<i>Carex</i> spp.	97	2	0	1	0	0	0
	<i>Elymus cinereus</i>	90.5	6	3.5	0	0	0	0
	<i>Elymus elymoides</i>	99	1	0	0	0	0	0

Table A-5 (continued). 2018 Emery Canyon sampling frame, CIRO: percentage of plots (n=84 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Perennial Grasses (continued)	<i>Juncus</i> spp	99	0	0	0	1	0	0
	<i>Koeleria macrantha</i>	80	18	2	0	0	0	0
	<i>Melica bulbosa</i>	99	1	0	0	0	0	0
	<i>Pascopyrum smithii</i>	52.5	45.5	2	0	0	0	0
	<i>Poa secunda</i>	39	54	7	0	0	0	0
	<i>Poa</i> spp.	99	1	0	0	0	0	0
	<i>Pseudoroegneria spicata</i>	63	27	10	0	0	0	0
Native Persistent Forbs	<i>Achillea millefolium</i>	93	7	0	0	0	0	0
	<i>Antennaria</i> spp	81	9.5	6	3.5	0	0	0
	<i>Aster</i> spp.	99	1	0	0	0	0	0
	<i>Astragalus</i> spp	98	2	0	0	0	0	0
	<i>Balsamorhiza sagittata</i>	79	8	11	2	0	0	0
	<i>Castilleja</i> spp	67	33	0	0	0	0	0
	<i>Chaenactis douglasii</i>	99	1	0	0	0	0	0
	<i>Comandra umbellata</i>	73	27	0	0	0	0	0
	<i>Crepis acuminata</i>	80	20	0	0	0	0	0
	<i>Erigeron</i> spp.	98	2	0	0	0	0	0
	<i>Eriogonum</i> spp	71.5	26	2.5	0	0	0	0
	<i>Eriophyllum lanatum</i>	95	4	1	0	0	0	0
	<i>Geranium viscosissimum</i>	96	4	0	0	0	0	0

Table A-5 (continued). 2018 Emery Canyon sampling frame, CIRO: percentage of plots (n=84 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Persistent Forbs (continued)	<i>Haplopappus</i> spp	90.5	7	2.5	0	0	0	0
	<i>Iris</i> spp.	98	2	0	0	0	0	0
	<i>Lithospermum ruderales</i>	87	9.5	3.5	0	0	0	0
	<i>Lomatium</i> spp	96	4	0	0	0	0	0
	<i>Lupinus</i> spp	42	45	12	1	0	0	0
	<i>Opuntia polyacantha</i>	92	0	0	0	0	0	0
	<i>Pediocactus simpsonii</i>	98	2	0	0	0	0	0
	<i>Penstemon</i> spp	94	6	0	0	0	0	0
	<i>Phacelia hastata</i>	98	2	0	0	0	0	0
	<i>Phlox</i> spp	76	24	0	0	0	0	0
	<i>Potentilla</i> spp.	99	1	0	0	0	0	0
	<i>Senecio</i> spp.	88	11	1	0	0	0	0
	<i>Viratrum viridae</i>	99	1	0	0	0	0	0
	<i>Wyethia</i> spp.	99	0	1	0	0	0	0
Native Other Forbs	<i>Agoseris</i> spp	83	17	0	0	0	0	0
	<i>Allium</i> spp	96	4	0	0	0	0	0
	<i>Arabis</i> spp.	99	1	0	0	0	0	0
	<i>Calochortus</i> spp.	98	2	0	0	0	0	0
	<i>Collomia</i> spp	84.5	15.5	0	0	0	0	0
	<i>Cryptantha</i> spp.	98	2	0	0	0	0	0

Table A-5 (continued). 2018 Emery Canyon sampling frame, CIRO: percentage of plots (n=84 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
	<i>Delphinium</i> spp.	98	1	1	0	0	0	0
	<i>Hackelia</i> spp.	92	8	0	0	0	0	0
	<i>Sedum lanceolatum</i>	75	25	0	0	0	0	0
	<i>Zigadenus</i> spp.	98	2	0	0	0	0	0
Non-native Invasive Forbs	<i>Descurainia</i> spp	98	2	0	0	0	0	0
	<i>Sisymbrium altissimum</i>	99	1	0	0	0	0	0
	<i>Tragopogon dubius</i>	89	11	0	0	0	0	0
Non-native Invasive Grasses	<i>Bromus tectorum</i>	82	11	5	2	0	0	0
	<i>Poa bulbosa</i>	70	16	12	2	0	0	0
	<i>Poa pratensis</i>	80	14	5	1	0	0	0

Table A-6. 2018 Kempton sampling frame, CIRO: percentage of plots (n=70 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	–	19	66	14	1	0	0	0
Trees	None	–	–	–	–	–	–	–
Sagebrush	<i>Artemisia tridentata</i>	13	23	44	13	6	1	0
Shrubs	<i>Chrysothamnus viscidiflorus</i>	50	37	11.5	1.5	0	0	0
	<i>Ericameria nauseosa</i>	96	1	3	0	0	0	0
	<i>Gutierrezia sarothrae</i>	99	0	1	0	0	0	0
	<i>Mahonia</i> spp	94	6	0	0	0	0	0
	<i>Purshia tridentata</i>	71.5	8.5	7	7	6	0	0
	<i>Rosa woodsii</i>	99	1	0	0	0	0	0
	<i>Symphoricarpos</i> spp	78.5	10	8.5	3	0	0	0
Native Perennial Grasses	<i>Achnatherum</i> spp.	97	3	0	0	0	0	0
	<i>Carex</i> spp.	81	19	0	0	0	0	0
	<i>Elymus elymoides</i>	99	1	0	0	0	0	0
	<i>Hesperostipa comata</i>	97	3	0	0	0	0	0
	<i>Juncus</i> spp.	99	1	0	0	0	0	0
	<i>Melica bulbosa</i>	99	1	0	0	0	0	0
	<i>Pascopyrum smithii</i>	21.5	57	20	1.5	0	0	0
	<i>Poa secunda</i>	17	51.5	27	4.5	0	0	0
	<i>Pseudoroegneria spicata</i>	96	4	0	0	0	0	0

Table A-6 (continued). 2018 Kempton sampling frame, CIRO: percentage of plots (n=70 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Persistent Forbs	<i>Achillea millefolium</i>	91	9	0	0	0	0	0
	<i>Artemisia ludoviciana</i>	99	2	1	0	0	0	0
	<i>Aster</i> spp.	97	3	0	0	0	0	0
	<i>Astragalus</i> spp.	87	13	0	0	0	0	0
	<i>Balsamorhiza sagittata</i>	99	0	1	0	0	0	0
	<i>Chaenactis douglasii</i>	97	3	0	0	0	0	0
	<i>Cirsium</i> spp.	94	6	0	0	0	0	0
	<i>Comandra umbellata</i>	89	11	0	0	0	0	0
	<i>Crepis acuminata</i>	96	4	0	0	0	0	0
	<i>Erigeron</i> spp	91	9	0	0	0	0	0
	<i>Eriogonum</i> spp	84	7.5	7.5	1	0	0	0
	<i>Eriophyllum lanatum</i>	99	1	0	0	0	0	0
	<i>Geranium viscosissimum</i>	99	0	1	0	0	0	0
	<i>Haplopappus</i> spp	97	3	0	0	0	0	0
	<i>Iris</i> spp.	97	3	0	0	0	0	0
	<i>Lithospermum ruderae</i>	80	20	0	0	0	0	0
	<i>Lomatium</i> spp	97	3	0	0	0	0	0
	<i>Lupinus</i> spp	54	39	7	0	0	0	0
	<i>Opuntia polyacantha</i>	82	14	4	0	0	0	0
	<i>Penstemon</i> spp	99	1	0	0	0	0	0
	<i>Phlox</i> spp	66	34	0	0	0	0	0

Table A-6 (continued). 2018 Kempton sampling frame, CIRO: percentage of plots (n=70 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Other Forbs	<i>Agoseris</i> spp	99	1	0	0	0	0	0
	<i>Allium</i> spp.	89	11	0	0	0	0	0
	<i>Arabis</i> spp.	94	6	0	0	0	0	0
	<i>Collomia</i> spp	83	17	0	0	0	0	0
	<i>Cryptantha</i> spp.	87	13	0	0	0	0	0
	<i>Fritillaria pudica</i>	99	1	0	0	0	0	0
	<i>Hackelia</i> spp	94	6	0	0	0	0	0
	<i>Viola</i> spp.	93	7	0	0	0	0	0
	<i>Zigadenus</i> spp	90	10	0	0	0	0	0
Non-native Invasive Forbs	<i>Taraxacum officinale</i>	97	3	0	0	0	0	0
	<i>Tragopogon dubius</i>	99	1	0	0	0	0	0
Non-native Invasive Grasses	<i>Agropyron cristatum</i>	94	6	0	0	0	0	0
	<i>Bromus</i> spp.	91	9	0	0	0	0	0
	<i>Bromus tectorum</i>	11	44	29	10	6	0	0
	<i>Poa bulbosa</i>	83	16	1	0	0	0	0
	<i>Poa pratensis</i>	86	10	4	0	0	0	0

Table A-7. 2018 Tracy Lane sampling frame, CIRO: percentage of plots (n=65 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	–	11	55	29	5	0	0	0
Trees	<i>Juniperus scopulorum</i>	95	3	0	2	0	0	0
Sagebrush	<i>Artemisia tridentata</i>	75	9	8	6	2	0	0
Shrubs	<i>Chrysothamnus viscidiflorus</i>	55.5	35.5	9	0	0	0	0
	<i>Ericameria nauseosa</i>	91	3	6	0	0	0	0
	<i>Purshia tridentata</i>	92	5	0	0	0	3	0
	<i>Symphoricarpos</i> spp	98.5	0	0	1.5	0	0	0
	<i>Tetradymia canescens</i>	98.5	1.5	0	0	0	0	0
Native Perennial Grasses	<i>Elymus elymoides</i>	98.5	1.5	0	0	0	0	0
	<i>Hesperostipa comata</i>	94	3	3	0	0	0	0
	<i>Oryzopsis hymenoides</i>	94	6	0	0	0	0	0
	<i>Pascopyrum smithii</i>	49	45	6	0	0	0	0
	<i>Poa secunda</i>	15	80	5	0	0	0	0
	<i>Pseudoroegneria spicata</i>	91	6	3	0	0	0	0
Native Persistent Forbs	<i>Astragalus</i> spp.	86	14	0	0	0	0	0
	<i>Chaenactis douglasii</i>	97	3	0	0	0	0	0
	<i>Cirsium</i> spp.	86	12	2	0	0	0	0
	<i>Comandra umbellata</i>	95	5	0	0	0	0	0
	<i>Crepis acuminata</i>	98.5	1.5	0	0	0	0	0
	<i>Erigeron</i> spp	92	6	2	0	0	0	0

Table A-7 (continued). 2018 Tracy Lane sampling frame, CIRO: percentage of plots (n=65 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Persistent Forbs (continued)	<i>Eriogonum</i> spp	89	11	0	0	0	0	0
	<i>Lithospermum ruderale</i>	98.5	1.5	0	0	0	0	0
	<i>Lupinus</i> spp	98.5	1.5	0	0	0	0	0
	<i>Opuntia polyacantha</i>	97	1.5	1.5	0	0	0	0
	<i>Phlox</i> spp	97	3	0	0	0	0	0
Native Other Forbs	<i>Allium</i> spp.	95	5	0	0	0	0	0
	<i>Arabis</i> spp.	98.5	1.5	0	0	0	0	0
	<i>Cryptantha</i> spp.	98.5	1.5	0	0	0	0	0
	<i>Linum lewisii</i>	97	3	0	0	0	0	0
Non-native Invasive Forbs	<i>Grindelia squarrosa</i>	98.5	1.5	0	0	0	0	0
	<i>Sisymbrium altissimum</i>	94	6	0	0	0	0	0
	<i>Tragopogon dubius</i>	80	20	0	0	0	0	0
Non-native Invasive Grasses	<i>Agropyron cristatum</i>	43	42	15	0	0	0	0
	<i>Bromus tectorum</i>	41.5	21.5	21.5	8	4.5	3	0
	<i>Poa bulbosa</i>	92	6	2	0	0	0	0

Table A-8. 2018 Trail Canyon sampling frame, CIRO: percentage of plots (n=73 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	–	5.5	86	5.5	3	0	0	0
Trees	<i>Pinus monophylla</i>	95	0	4	1	0	0	0
Sagebrush	<i>Artemisia arbuscula</i>	74	16	7	3	0	0	0
	<i>Artemisia tridentata</i>	40	30	20.5	5.5	4	0	0
Shrubs	<i>Amelanchier</i> spp	97	0	3	0	0	0	0
	<i>Chrysothamnus viscidiflorus</i>	38	58	4	0	0	0	0
	<i>Ericameria nauseosa</i>	97	3	0	0	0	0	0
	<i>Mahonia</i> spp	95	5	0	0	0	0	0
	<i>Purshia tridentata</i>	86	6	6	1	0	1	0
	<i>Symphoricarpos</i> spp.	57.5	31.5	7	3	1	0	0
	<i>Tetradymia canescens</i>	99	1	0	0	0	0	0
Native Perennial Grasses	<i>Achnatherum</i> spp	96	4	0	0	0	0	0
	<i>Carex</i> spp.	97	3	0	0	0	0	0
	<i>Elymus elymoides</i>	96	4	0	0	0	0	0
	<i>Festuca idahoensis</i>	97	3	0	0	0	0	0
	<i>Koeleria macrantha</i>	85	12	3	0	0	0	0
	<i>Pascopyrum smithii</i>	59	38	3	0	0	0	0
	<i>Poa secunda</i>	38.5	53.5	8	0	0	0	0
	<i>Poa</i> spp.	99	0	1	0	0	0	0
	<i>Pseudoroegneria spicata</i>	57.5	35.5	7	0	0	0	0

Table A-8 (continued). 2018 Trail Canyon sampling frame, CIRO: percentage of plots (n=73 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Persistent Forbs	<i>Achillea millefolium</i>	99	1	0	0	0	0	0
	<i>Antennaria</i> spp	84	4	8	4	0	0	0
	<i>Arenaria</i> spp	99	1	0	0	0	0	0
	<i>Aster</i> spp	90	10	0	0	0	0	0
	<i>Astragalus</i> spp	96	4	0	0	0	0	0
	<i>Balsamorhiza sagittata</i>	63	31.5	5.5	0	0	0	0
	<i>Balsamorhiza serrata</i>	91	8	1	0	0	0	0
	<i>Castilleja</i> spp	82	18	0	0	0	0	0
	<i>Chaenactis douglasii</i>	96	4	0	0	0	0	0
	<i>Cirsium</i> spp.	97	3	0	0	0	0	0
	<i>Comandra umbellata</i>	77	23	0	0	0	0	0
	<i>Crepis acuminata</i>	82	18	0	0	0	0	0
	<i>Erigeron</i> spp	99	1	0	0	0	0	0
	<i>Eriogonum</i> spp	63	34	3	0	0	0	0
	<i>Eriophyllum lanatum</i>	99	1	0	0	0	0	0
	<i>Lithospermum ruderales</i>	93	7	0	0	0	0	0
	<i>Lomatium</i> spp	97	3	0	0	0	0	0
	<i>Lupinus</i> spp	57.5	42.5	0	0	0	0	0
	<i>Opuntia polyacantha</i>	93	6	0	1	0	0	0
	<i>Phacelia hastata</i>	93	7	0	0	0	0	0
	<i>Phlox</i> spp	73	27	0	0	0	0	0
	<i>Senecio</i> spp	96	4	0	0	0	0	0

Table A-8 (continued). 2018 Trail Canyon sampling frame, CIRO: percentage of plots (n=73 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Other Forbs	<i>Agoseris</i> spp	99	1	0	0	0	0	0
	<i>Allium</i> spp	99	1	0	0	0	0	0
	<i>Arabis</i> spp.	99	1	0	0	0	0	0
	<i>Calochortus</i> spp.	96	4	0	0	0	0	0
	<i>Collomia</i> spp	99	1	0	0	0	0	0
Non-native Invasive Forbs	<i>Descurainia</i> spp	99	1	0	0	0	0	0
Non-native Invasive Grasses	<i>Agropyron cristatum</i>	89	10	0	1	0	0	0
	<i>Bromus tectorum</i>	63	27	7	3	0	0	0
	<i>Poa bulbosa</i>	47	41	11	1	0	0	0
	<i>Poa pratensis</i>	85	12	3	0	0	0	0

Table A-9. 2018 Castle Rock State Park North sampling frame, CIRO: percentage of plots (n=64 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	–	34	50	14	2	0	0	0
Trees	<i>Pinus monophylla</i>	92	3	2	0	0	0	3
Sagebrush	<i>Artemisia tridentata</i>	11	19	29.5	22	11	7.5	0
Shrubs	<i>Chrysothamnus viscidiflorus</i>	48	27	25	0	0	0	0
	<i>Ericameria nauseosa</i>	97	3	0	0	0	0	0
	<i>Mahonia</i> spp	94	3	3	0	0	0	0
	<i>Purshia tridentata</i>	58	9	13	6	5	9	0
	<i>Ribes</i> spp	98	2	0	0	0	0	0
	<i>Rosa woodsii</i>	92	5	1.5	1.5	0	0	0
	<i>Symphoricarpos</i> spp	98	0	2	0	0	0	0
Native Perennial Grasses	<i>Achnatherum</i> spp	98	2	0	0	0	0	0
	<i>Carex</i> spp.	97	3	0	0	0	0	0
	<i>Elymus elymoides</i>	97	3	0	0	0	0	0
	<i>Hesperostipa comata</i>	94	4.5	0	1.5	0	0	0
	<i>Pascopyrum smithii</i>	55	40.5	5.5	0	0	0	0
	<i>Poa secunda</i>	61	36	3	0	0	0	0
	<i>Pseudoroegneria spicata</i>	91	9	0	0	0	0	0
Native Persistent Forbs	<i>Achillea millefolium</i>	98	2	0	0	0	0	0
	<i>Aster</i> spp	98	2	0	0	0	0	0
	<i>Astragalus</i> spp	98	2	0	0	0	0	0
	<i>Balsamorhiza sagittata</i>	90.5	8	0	1.5	0	0	0
	<i>Cirsium</i> spp.	98	2	0	0	0	0	0

Table A-9 (continued). 2018 Castle Rock State Park North sampling frame, CIRO: percentage of plots (n=64 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Persistent Forbs (continued)	<i>Comandra umbellata</i>	95	5	0	0	0	0	0
	<i>Crepis acuminata</i>	94	6	0	0	0	0	0
	<i>Eriogonum</i> spp	91	9	0	0	0	0	0
	<i>Lithospermum ruderales</i>	81	13	4.5	1.5	0	0	0
	<i>Lupinus</i> spp	53	36	11	0	0	0	0
	<i>Opuntia polyacantha</i>	88	6	6	0	0	0	0
	<i>Phlox</i> spp	83	17	0	0	0	0	0
Native Other Forbs	<i>Allium</i> spp.	97	3	0	0	0	0	0
	<i>Calochortus</i> spp	98	2	0	0	0	0	0
	<i>Collomia</i> spp	83	17	0	0	0	0	0
	<i>Cryptantha</i> spp.	81	19	0	0	0	0	0
	<i>Zigadenus</i> spp	94	6	0	0	0	0	0
Non-native Invasive Forbs	<i>Cirsium arvense</i>	98	2	0	0	0	0	0
	<i>Erodium cicutarium</i>	98	2	0	0	0	0	0
	<i>Lepidium perfoliatum</i>	98	2	0	0	0	0	0
	<i>Tragopogon dubius</i>	98	2	0	0	0	0	0
Non-native Invasive Grasses	<i>Bromus</i> spp.	89	11	0	0	0	0	0
	<i>Bromus tectorum</i>	1	30	22	27	19	1	0
	<i>Poa bulbosa</i>	98	2	0	0	0	0	0
	<i>Poa pratensis</i>	67	20	8	3	2	0	0

Table A-10. 2018 Castle Rock State Park South sampling frame, CIRO: percentage of plots (n=63 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	–	17.5	62	17.5	1.5	0	1.5	0
Trees	None	–	–	–	–	–	–	–
Sagebrush	<i>Artemisia arbuscula</i>	89	0	9.5	1.5	0	0	0
	<i>Artemisia tridentata</i>	27	14	37	11	8	3	0
Shrubs	<i>Amelanchier</i> spp	90.5	1.5	3	2	3	0	0
	<i>Chrysothamnus viscidiflorus</i>	86	8	6	0	0	0	0
	<i>Ericameria nauseosa</i>	95	3	2	0	0	0	0
	<i>Gutierrezia sarothrae</i>	63	32	5	0	0	0	0
	<i>Mahonia</i> spp	98	2	0	0	0	0	0
	<i>Purshia tridentata</i>	75	10	10	3	1	1	0
	<i>Rosa woodsii</i>	98	0	2	0	0	0	0
Native Perennial Grasses	<i>Carex</i> spp.	94	6	0	0	0	0	0
	<i>Danthonia unispicata</i>	95	5	0	0	0	0	0
	<i>Elymus elymoides</i>	76	21	1.5	1.5	0	0	0
	<i>Juncus</i> spp.	95	3	2	0	0	0	0
	<i>Koeleria macrantha</i>	90.5	8	1.5	0	0	0	0
	<i>Pascopyrum smithii</i>	52	32	10	3	1.5	1.5	0
	<i>Poa secunda</i>	43	54	3	0	0	0	0
	<i>Pseudoroegneria spicata</i>	87	5	8	0	0	0	0

Table A-10 (continued). 2018 Castle Rock State Park South sampling frame, CIRO: percentage of plots (n=63 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Persistent Forbs	<i>Achillea millefolium</i>	94	6	0	0	0	0	0
	<i>Artemisia ludoviciana</i>	98	2	0	0	0	0	0
	<i>Astragalus</i> spp.	87	13	0	0	0	0	0
	<i>Castilleja</i> spp	98	2	0	0	0	0	0
	<i>Cirsium</i> spp.	97	3	0	0	0	0	0
	<i>Crepis acuminata</i>	97	3	0	0	0	0	0
	<i>Erigeron</i> spp	98	0	2	0	0	0	0
	<i>Eriogonum</i> spp	90	10	0	0	0	0	0
	<i>Haplopappus</i> spp	98	2	0	0	0	0	0
	<i>Lithospermum ruderales</i>	89	8	1.5	1.5	0	0	0
	<i>Lomatium</i> spp	97	3	0	0	0	0	0
	<i>Lupinus</i> spp	95	3	2	0	0	0	0
	<i>Opuntia polyacantha</i>	92	5	1.5	1.5	0	0	0
	<i>Penstemon</i> spp	98	2	0	0	0	0	0
	<i>Phlox</i> spp	84	16	0	0	0	0	0
Native Other Forbs	<i>Allium</i> spp.	97	3	0	0	0	0	0
	<i>Arabis</i> spp.	98	2	0	0	0	0	0
	<i>Cryptantha</i> spp.	78	22	0	0	0	0	0
	<i>Linum lewisii</i>	95	5	0	0	0	0	0
	<i>Zigadenus</i> spp	97	3	0	0	0	0	0

Table A-10 (continued). 2018 Castle Rock State Park South sampling frame, CIRO: percentage of plots (n=63 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Non-native Invasive Forbs	<i>Cardaria draba</i>	98	2	0	0	0	0	0
	<i>Grindelia squarrosa</i>	97	3	0	0	0	0	0
	<i>Tragopogon dubius</i>	95	5	0	0	0	0	0
Non-native Invasive Grasses	<i>Bromus</i> spp.	43	43	11	3	0	0	0
	<i>Bromus tectorum</i>	13	56	24	6	0	1	0
	<i>Poa bulbosa</i>	78	17.5	3	1.5	0	0	0
	<i>Poa pratensis</i>	81	16	3	0	0	0	0

Table A-11. 2018 Castle Rock State Park West sampling frame, CIRO: percentage of plots (n=75 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	–	41	57	2	0	0	0	0
Trees	<i>Juniperus scopulorum</i>	99	0	0	0	0	0	1
	<i>Pinus monophylla</i>	98	1	1	0	0	0	0
Sagebrush	<i>Artemisia arbuscula</i>	69	16	12	3	0	0	0
	<i>Artemisia tridentata</i>	83	5	7	2.5	2.5	0	0
Shrubs	<i>Amelanchier</i> spp	96	1.5	1.5	1	0	0	0
	<i>Chrysothamnus viscidiflorus</i>	88	8	4	0	0	0	0
	<i>Ericameria nauseosa</i>	95	1	4	0	0	0	0
	<i>Gutierrezia sarothrae</i>	85	11	4	0	0	0	0
	<i>Prunus virginiana</i>	99	1	0	0	0	0	0
	<i>Purshia tridentata</i>	49	13	19	5.5	5.5	8	0
	<i>Symphoricarpos</i> spp	96	0	4	0	0	0	0
	<i>Tetradymia canescens</i>	99	0	1	0	0	0	0
Native Perennial Grasses	<i>Achnatherum</i> spp	81	19	0	0	0	0	0
	<i>Danthonia unispicata</i>	91	5	4	0	0	0	0
	<i>Elymus elymoides</i>	64	33	3	0	0	0	0
	<i>Koeleria macrantha</i>	72	27	1	0	0	0	0
	<i>Melica bulbosa</i>	96	4	0	0	0	0	0
	<i>Pascopyrum smithii</i>	76	16	7	1	0	0	0
	<i>Poa secunda</i>	40	49	11	0	0	0	0
	<i>Poa</i> spp.	98	1	1	0	0	0	0
	<i>Pseudoroegneria spicata</i>	51	21	25	3	0	0	0

Table A-11 (continued). 2018 Castle Rock State Park West sampling frame, CIRO: percentage of plots (n=75 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Persistent Forbs	<i>Achillea millefolium</i>	77	19	4	0	0	0	0
	<i>Antennaria</i> spp	97	3	0	0	0	0	0
	<i>Artemisia ludoviciana</i>	99	1	0	0	0	0	0
	<i>Aster</i> spp	99	1	0	0	0	0	0
	<i>Astragalus</i> spp.	96	4	0	0	0	0	0
	<i>Chaenactis douglasii</i>	99	1	0	0	0	0	0
	<i>Cirsium</i> spp.	95	5	0	0	0	0	0
	<i>Comandra umbellata</i>	92	7	1	0	0	0	0
	<i>Erigeron</i> spp	99	1	0	0	0	0	0
	<i>Eriogonum</i> spp	84	8	7	1	0	0	0
	<i>Lithospermum ruderales</i>	93	7	0	0	0	0	0
	<i>Lomatium</i> spp	92	8	0	0	0	0	0
	<i>Lupinus</i> spp	88	11	1	0	0	0	0
	<i>Opuntia polyacantha</i>	95	5	0	0	0	0	0
	<i>Phlox</i> spp	96	4	0	0	0	0	0
	<i>Wyethia</i> spp	99	1	0	0	0	0	0
Native Other Forbs	<i>Agoseris</i> spp	99	1	0	0	0	0	0
	<i>Allium</i> spp	97	3	0	0	0	0	0
	<i>Arabis</i> spp.	99	1	0	0	0	0	0
	<i>Collomia</i> spp	91	9	0	0	0	0	0
	<i>Cryptantha</i> spp.	88	12	0	0	0	0	0

Table A-11 (continued). 2018 Castle Rock State Park West sampling frame, CIRO: percentage of plots (n=75 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

Cover Type	Species	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Other Forbs (continued)	<i>Linum lewisii</i>	96	4	0	0	0	0	0
	<i>Zigadenus</i> spp.	87	13	0	0	0	0	0
Non-native Invasive Forbs	<i>Erodium cicutarium</i>	97	3	0	0	0	0	0
	<i>Grindelia squarrosa</i>	96	3	1	0	0	0	0
	<i>Sisymbrium altissimum</i>	99	1	0	0	0	0	0
	<i>Taraxacum officinale</i>	96	4	0	0	0	0	0
	<i>Tragopogon dubius</i>	80	19	1	0	0	0	0
Non-native Invasive Grasses	<i>Bromus</i> spp.	24	28	21	17	7	3	0
	<i>Bromus tectorum</i>	8	43	25	17	7	0	0
	<i>Poa bulbosa</i>	49	32	15	4	0	0	0
	<i>Poa pratensis</i>	84	9	4	0	3	0	0

Appendix D

Bar graphs comparing 2012, 2015 and 2018 cheatgrass cover estimates in City of Rocks National Reserve

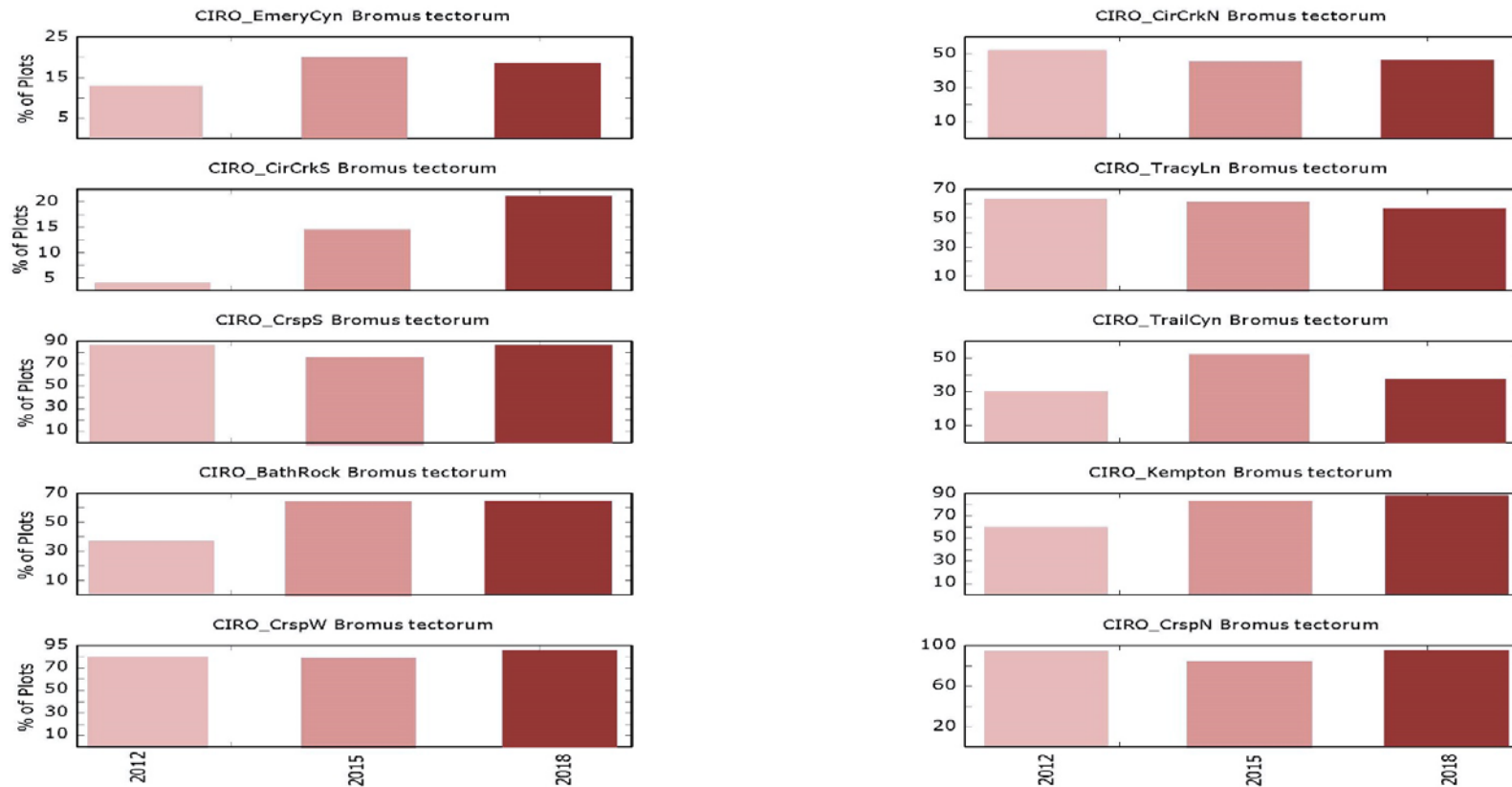


Figure A-6. Estimated percentage of cheatgrass cover (>0%) in each sampling frame at CIRO through the last three years of surveying 2012, 2015, and 2018.

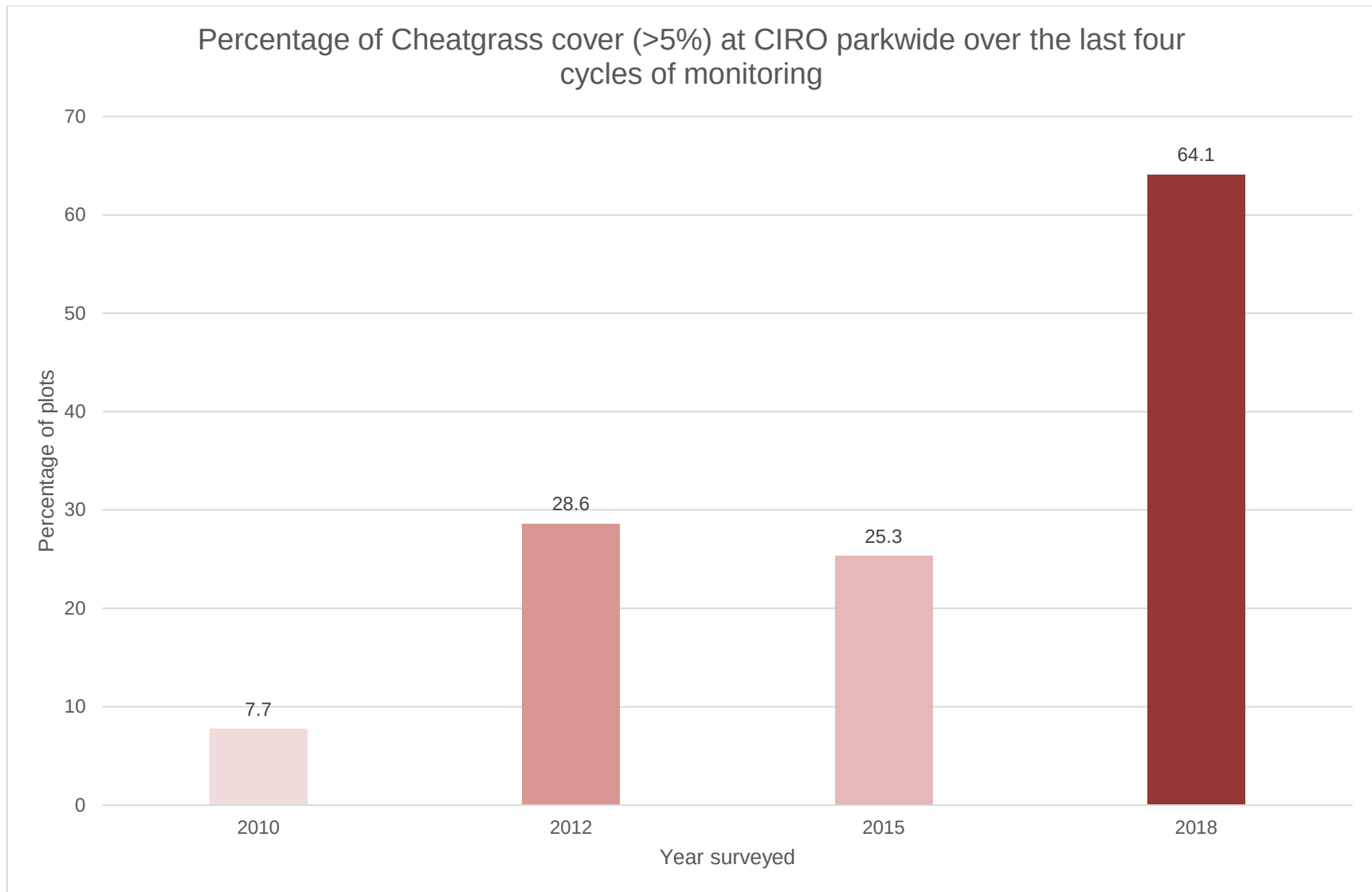


Figure A-7. Estimated percentage of cheatgrass cover (>5%) parkwide at CIRO through the last four years of surveying 2010, 2012, 2015, and 2018.

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