



Sagebrush Steppe Vegetation Monitoring in City of Rocks National Reserve

2012 Annual Report

Natural Resource Data Series NPS/UCBN/NRDS—2012/407



ON THE COVER

Estimating canopy cover of sagebrush steppe plants in the Bath Rock area of City of Rocks National Reserve, 2012.
Photograph by: Tom Rodhouse

Sagebrush Steppe Vegetation Monitoring in City of Rocks National Reserve

2012 Annual Report

Natural Resource Data Series NPS/UCBN/NRDS—2012/407

Devin S. Stucki

National Park Service
Upper Columbia Basin Network
Craters of the Moon National Monument and Preserve
Arco, Idaho 83213

Thomas J. Rodhouse

National Park Service
Upper Columbia Basin Network
63095 Deschutes Market Rd
Bend, OR 97701

November 2012

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from the Upper Columbia Basin Network website (<http://science.nature.nps.gov/im/units/ucbn/>) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>).

Please cite this publication as:

Stucki, D. S. and T. J. Rodhouse. 2012. Sagebrush steppe vegetation monitoring in City of Rocks National Reserve: 2012 Annual Report. Natural Resource Data Series NPS/UCBN/NRDS—2012/407. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	iv
Tables.....	v
Executive Summary.....	vii
Acknowledgments.....	viii
Introduction.....	1
Methods.....	2
Weather.....	4
Results and Discussion	5
Literature Cited	10
Appendix A: List of plant species mentioned in the report with common and scientific names.	11
Appendix B: Climate diagrams for the City of Rocks and Oakley weather station, near City of Rocks National Reserve.....	14
Appendix C. 2012 sage monitoring results for CIRO: Percentage of plots within each cover class for exposed bare ground and principal plant species organized by species guilds.....	16

Figures

Page

Figure 1. Map of City of Rocks National Reserve and Castle Rocks State Park, showing sampling frames and plot locations for the 2012 monitoring survey. 2

Figure A-1. This figure compares long term averages of monthly temperatures (red line) and monthly precipitation (blue line) from 7/1/1893 to 8/31/2012 from the Oakley, Idaho (106542) weather station. The period when the temperature line exceeds the precipitation line defines the arid period for plant growth. 14

Figure A-2. This figure compares long term averages of monthly temperatures (red line) and monthly precipitation (blue line) during 2011 from the City of Rocks Idaho weather station. The period when the temperature line exceeds the precipitation line defines the arid period for plant growth. 14

Figure A-3. This figure compares long term averages of monthly temperatures (red line) and monthly precipitation (blue line) during 2012 from the City of Rocks Idaho weather station. The period when the temperature line exceeds the precipitation line defines the arid period for plant growth. 15

Tables

	Page
Table 1. Sample sizes obtained from 10 sampling frames within CIRO during 2012 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.	3
Table 2. Daubenmire's cover classes used for visually estimating vegetation cover in 1 m ² square quadrats.	4
Table 3. 2012 cheatgrass infestation summary statistics for the 10 sampling frames in CIRO.	7
Table A-1. Plant common, species, and updated species names.	11
Table A-2. 2012 Bath Rock sampling frame, CIRO: percentage of plots (n=55 1 m ² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.	16
Table A-3. 2012 Circle Creek North sampling frame, CIRO: percentage of plots (n=65 1 m ² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.	17
Table A-4. 2012 Circle Creek South sampling frame, CIRO: percentage of plots (n=55 1 m ² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.	18
Table A-5. 2012 Emery Canyon sampling frame, CIRO: percentage of plots (n=73 1 m ² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.	20
Table A-6. 2012 Kempton sampling frame, CIRO: percentage of plots (n=60 1 m ² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.	22
Table A-7. 2012 Tracy Lane sampling frame, CIRO: percentage of plots (n=55 1 m ² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.	23
Table A-8. 2012 Trail Canyon sampling frame, CIRO: percentage of plots (n=66 1 m ² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.	25
Table A-9. 2012 Castle Rocks North sampling frame, CRSP: percentage of plots (n=65 1 m ² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.	26

Tables (continued)

Page

Table A-10. 2012 Castle Rocks South sampling frame, CRSP: percentage of plots (n=60 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds..... 28

Table A-11. 2012 Castle Rocks West sampling frame, CRSP: percentage of plots (n=55 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds..... 29

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 2012 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 plot-based surveys occurred within 10 sampling frames that are positioned to overlap grazing allotments. Canopy cover of exposed soil and of principal native and non-native plants or genera were estimated in 599 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 2012 field season.

Big sagebrush was the most abundant shrub, occurring in all sampling frames, followed by green rabbitbrush and antelope bitterbrush. Western wheatgrass was the most widespread and abundant native perennial grass encountered. The proportion of plots with western wheatgrass cover ranged among frames from 10 to 70%. Bluebunch wheatgrass, another important native perennial grass, ranged in frequency from 2-64%. The proportion of plots with steppe bluegrass, a small stature and highly resilient native perennial grass ranged from 51-98%. Idaho fescue, indian ricegrass, needlegrass, and squirreltail were less abundant native perennial grasses encountered in many plots. Balsamroot, lupine, and yarrow 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 2-95%. Salsify was the most common non-native invasive weed, followed by tumble mustard and tansymustard. We did not encounter any noxious weeds within plots. We noted distinct differences among frames in the patterns of cheatgrass and native perennial grass abundance. Trail Canyon, Emery Canyon, Bath Rock, and Circle Creek South had distinct 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 also noted in previous annual reports from 2008 and 2010 surveys, suggesting an emerging pattern of trend. Management decisions associated with grazing, fire, and other issues in the uplands of the Reserve may benefit from considering this information.

Acknowledgments

We thank Superintendent Wallace Keck and the park resource staff for hosting us and providing logistical and safety support during the field season.

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 2012 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

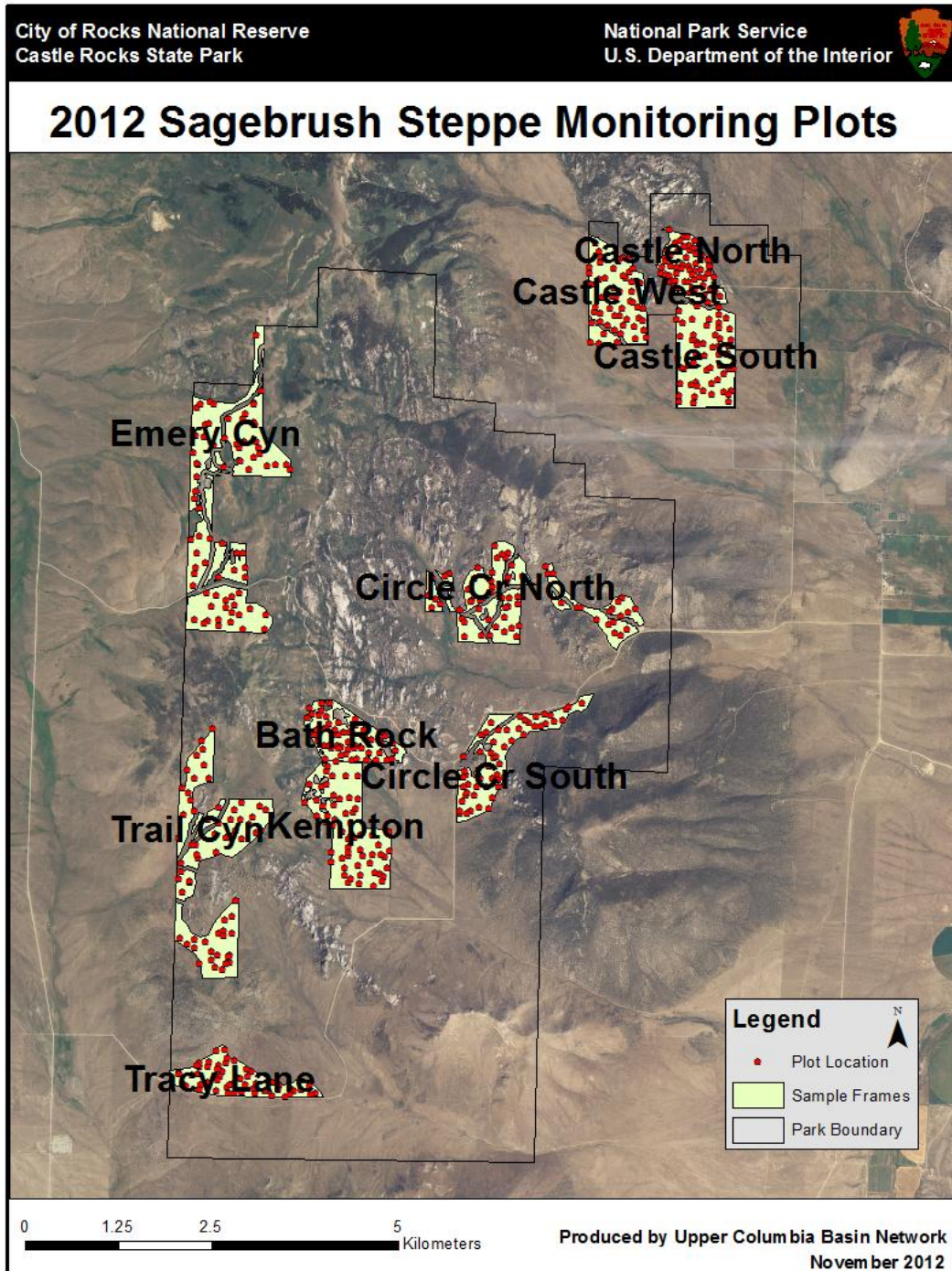


Figure 1. Map of City of Rocks National Reserve and Castle Rocks State Park, showing sampling frames and plot locations for the 2012 monitoring survey.

Sample sizes within each frame were selected to be proportional to the area of each frame (Table 1; Figure 1; Yeo et al. 2009). Two plots (synonymously, quadrats) were dropped in Emery Canyon due to mapping errors associated with allotment fence lines and boundaries. These errors will be addressed in a revised sampling frame for Emery Canyon for the future. One additional oversample plot was surveyed in Trail Canyon. 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). 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 2012 are listed in Appendix A.

Table 1. Sample sizes obtained from 10 sampling frames within CIRO during 2012 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	55
CIRO	Circle Creek North	65
CIRO	Circle Creek South	55
CIRO	Emery Canyon	73
CIRO	Kempton	60
CIRO	Tracy Lane	55
CIRO	Trail Canyon	66
CRSP	Castle Rocks North	55
CRSP	Castle Rocks South	60
CRSP	Castle Rocks West	55
Total		599

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 8/31/2012. A fairly new RAWS weather station has been established in CIRO with monthly averages dating back to December 2010. Precipitation in January 2012 was twice the long-term average amount of precipitation for that month, followed by lower than average monthly precipitation through July. Temperatures in 2012 were very similar to long term averages. Weather records for 2011 and 2012 from City of Rocks, along with long term averages from Oakley, are presented as figures in Appendix B.

Results and Discussion

The UCBN sagebrush steppe monitoring program completed a second season of monitoring in CIRO in 2012 following approval of the Yeo et al. (2009) protocol. Sample sizes ranged from 55 to 76 per sampling frame, and were spatially extensive 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 2012 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 17% to 63% among frames (Appendix C). Highest estimates were in the Tracy Lane sampling frame, followed by the Kempton and Circle Creek North frames. The Tracy Lane and Circle Creek North frames each had bare ground cover estimates >25% in more than 15% of plots.

Big sagebrush dominates the overstory in all sampling frames (Appendix C). Tracy Lane and Castle Rocks West had the lowest cover estimates for big sagebrush with the proportion of plots having cover estimates >5% being 11% and 16%, respectively. Tracy Lane experienced wildfire in 2000, and sagebrush cover has not yet recovered. 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 91% of plots estimated at having >5% cover and 37% of plots estimated at having >50% cover. Big sagebrush was the most abundant shrub, followed by green rabbitbrush and bitterbrush. Bluebunch wheatgrass cover was low in the Bath Rock, Circle Creek North, and Kempton frames with cover estimates >5% ranging from 0-2%. Castle Rocks West and Emery Canyon had the highest cover estimates of bluebunch wheatgrass, with cover >5% in 53% and 27% of plots, respectively. In many frames in CIRO other important large-stature native perennial grasses were more abundant than bluebunch wheatgrass. Western wheatgrass was the most abundant and widespread native perennial grass species in CIRO, ranging in cover >5% from 5% to 36% of frames. 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, needlegrass, and squirreltail (Appendix C). Where several of these species are abundant in concert with 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, reflected in the summaries tables of Appendix C. Steppe bluegrass is a low stature native perennial bunchgrass that is highly resilient to grazing and other disturbances. It ranged in cover >5% from 15-67%. 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 the non-native annual grass cheatgrass is also 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 arrowleaf balsamroot, yarrow, and lupines 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 18%-44%, and the proportion of plots with cover >25% ranging from 4 to 7% (Appendix C). Lupines are ecologically important nitrogen-fixing forbs and were found in all frames except for the Castle Rocks South. Tracy Lane frame had only one occurrence of lupines in a plot. Emery Canyon had the highest frequency of lupines (45%) followed by the Bath Rock frame (36%).

No noxious weeds were encountered in plots during 2012 sampling. The invasive annual cheatgrass is the most widespread and threatening non-native species in the park. Results from monitoring in 2012 point to a significant increase in cheatgrass abundance within several sampling frames over estimates in 2010 (Rodhouse 2011). This may be the result of the spike in winter moisture during the month of January (Appendix B), as cheatgrass is capable of exploiting late fall and winter precipitation. It may also be a more sustained long-term trend of increasing abundance in the area. Remarkably, in 2012, the Circle Creek South frame had only one plot with cheatgrass cover and subsequently had the lowest cheatgrass abundance of the 10 frames, followed by the Emery Canyon frame (Table 3; Appendix C). Frames with high cheatgrass abundance include the Castle Rocks North and Tracy Lane frames (Table 3; Appendix C). We also noted substantial increases in cheatgrass abundance over 2010 in the Castle Rocks West and Castle Rocks South frames. Other non-native grasses that occur across the park in moderate abundance are crested wheatgrass and bulbous bluegrass (Appendix C). These species occur throughout all 10 sampling frames and 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 North, Circle Creek South, and Tracy Lane frames (Appendix C). The Castle Rock North, South, and West frames, along with the Emery Canyon and Kempton frames, had very low abundance of crested wheatgrass (Appendix C). Bulbous bluegrass was found most often in the Castle Rocks West and Trail Canyon frames. Despite relatively high abundance of cheatgrass and crested wheatgrass, the Tracy Lane frame had the lowest abundance of bulbous bluegrass. Non-native invasive forbs were found infrequently in most frames. Salsify had the highest frequency and cover of non-native invasive forbs being found in 7 of the frames. The Tracy Lane frame had the highest proportion of plots with salsify cover (Appendix C). Other widespread non-native invasive forbs encountered in 2012 included tumble mustard and tansymustard.

The overall patterns reflected in the data collected in 2012 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 Trail Canyon, Emery Canyon, and Bath Rock. Circle Creek South is also noteworthy of its surprisingly low infestation by cheatgrass. 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. 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 (33 species; Appendix C), while the Castle Rocks North frame had the lowest diversity with 11 native

perennial 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. 2012 cheatgrass infestation summary statistics for the 10 sampling frames in CIRO.

Bath Rock Cheatgrass Infestation 2012	
Total acreage sampled	155.16
Total with no cheatgrass	98.74
Proportion of total strata area with no cheatgrass	0.64
Total with at least some cheatgrass	56.42
Proportion of total strata area with cheatgrass	0.36
Heavily infested acreage (>25% cover)	2.82
Proportion of heavily infested	0.02
Circle Creek North Cheatgrass Infestation 2012	
Total acreage sampled	314.18
Total with no cheatgrass	149.84
Proportion of total strata area with no cheatgrass	0.48
Total with at least some cheatgrass	164.34
Proportion of total strata area with cheatgrass	0.52
Heavily infested acreage (>25% cover)	48.34
Proportion of heavily infested	0.15
Circle Creek South Cheatgrass Infestation 2012	
Total acreage sampled	200.73
Total with no cheatgrass	197.08
Proportion of total strata area with no cheatgrass	0.98
Total with at least some cheatgrass	3.65
Proportion of total strata area with cheatgrass	0.02
Heavily infested acreage (>25% cover)	3.65
Proportion of heavily infested	0.02
Emery Canyon Cheatgrass Infestation 2012	
Total acreage sampled	525.73
Total with no cheatgrass	453.71
Proportion of total strata area with no cheatgrass	0.86
Total with at least some cheatgrass	72.02
Proportion of total strata area with cheatgrass	0.14
Heavily infested acreage (>25% cover)	0.00
Proportion of heavily infested	0.00

Table 3 (continued). 2012 cheatgrass infestation summary statistics for the 10 sampling frames in CIRO.

Kempton Cheatgrass Infestation 2012	
Total acreage sampled	289.70
Total with no cheatgrass	115.88
Proportion of total strata area with no cheatgrass	0.40
Total with at least some cheatgrass	173.82
Proportion of total strata area with cheatgrass	0.60
Heavily infested acreage (>25% cover)	9.66
Proportion of heavily infested	0.03
Tracy Lane Cheatgrass Infestation 2012	
Total acreage sampled	163.89
Total with no cheatgrass	59.60
Proportion of total strata area with no cheatgrass	0.36
Total with at least some cheatgrass	104.29
Proportion of total strata area with cheatgrass	0.64
Heavily infested acreage (>25% cover)	53.64
Proportion of heavily infested	0.33
Trail Canyon Cheatgrass Infestation 2012	
Total acreage sampled	388.41
Total with no cheatgrass	270.71
Proportion of total strata area with no cheatgrass	0.70
Total with at least some cheatgrass	117.70
Proportion of total strata area with cheatgrass	0.30
Heavily infested acreage (>25% cover)	17.65
Proportion of heavily infested	0.05
Castle Rocks North Cheatgrass Infestation 2012	
Total acreage sampled	112.86
Total with no cheatgrass	6.16
Proportion of total strata area with no cheatgrass	0.05
Total with at least some cheatgrass	106.70
Proportion of total strata area with cheatgrass	0.95
Heavily infested acreage (>25% cover)	30.78
Proportion of heavily infested	0.27

Table 3 (continued). 2012 cheatgrass infestation summary statistics for the 10 sampling frames in CIRO.

Castle Rocks South Cheatgrass Infestation 2012	
Total acreage sampled	277.37
Total with no cheatgrass	36.98
Proportion of total strata area with no cheatgrass	0.13
Total with at least some cheatgrass	240.39
Proportion of total strata area with cheatgrass	0.87
Heavily infested acreage (>25% cover)	55.47
Proportion of heavily infested	0.20
Castle Rocks West Cheatgrass Infestation 2012	
Total acreage sampled	218.32
Total with no cheatgrass	35.73
Proportion of total strata area with no cheatgrass	0.16
Total with at least some cheatgrass	182.60
Proportion of total strata area with cheatgrass	0.84
Heavily infested acreage (>25% cover)	39.69
Proportion of heavily infested	0.18

Literature Cited

- Daubenmire, R.F. 1959. A canopy-coverage method. *Northwest Science* 33:43-64.
- Garrett, L. K., T. J. Rodhouse, G. H. Dicus, C. C. Caudill, and M. R. Shardlow. 2007. Upper Columbia Basin Network vital signs monitoring plan. Natural Resource Report NPS/UCBN/NRR-2007/002. National Park Service, Fort Collins, CO.
- Prevey, J. S., M. J. Germino, N. J. Huntly, and R. S. Inouye. 2010. Exotic plants increase and native plants decrease with loss of foundation species in sagebrush steppe. *Plant Ecology* 207:39-51.
- Rodhouse, T. J. 2011. Sagebrush steppe vegetation monitoring in Craters of the Moon National Monument and Preserve and City of Rocks National Reserve: 2010 annual report. Natural Resource Technical Report NPS/UCBN/NRTR—2011/462. National Park Service, Fort Collins, Colorado.
- Stevens, D. L., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. *Journal of the American Statistical Association* 99:262-278.
- Stevens, D. L., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. *Journal of the American Statistical Association* 99:262-278.
- Yeo, J. J., T. J. Rodhouse, G. H. Dicus, K. M. Irvine, and L. K. Garrett. 2009. Upper Columbia Basin Network sagebrush steppe vegetation monitoring protocol: Narrative version 1.0. Natural Resource Report NPS/UCBN/NRR—2009/142. National Park Service, Fort Collins, Colorado.

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.

Common Name	Species Name	Updated Species Name
Sagebrush		
Low sagebrush	<i>Artemisia arbuscula</i>	
Big sagebrush	<i>Artemisia tridentata</i>	
Other Shrubs		
Serviceberry	<i>Amerlanchier spp</i>	
Green rabbitbrush	<i>Chrysothamnus viscidiflorus</i>	
Rubber rabbitbrush	<i>Ericameria nauseosa</i>	
Winterfat	<i>Eurotia lanata</i>	
Broom snakeweed	<i>Gutierrezia sarothrae</i>	
Rock spirea	<i>Holodiscus dumosus</i>	
Prickly phlox	<i>Leptodactylon pungens</i>	<i>Linanthus pungens</i>
Barberry	<i>Mahonia spp</i>	
Single-leaf pinyon pine	<i>Pinus monophylla</i>	
Chokecherry	<i>Prunus virginiana</i>	
Bitterbrush	<i>Purshia tridentata</i>	
Wood's rose	<i>Rosa woodsii</i>	
Mountain snowberry	<i>Symphoricarpos oreophilus</i>	
Spineless horsebrush	<i>Tetradymia canescens</i>	
Native Grasses		
Western wheatgrass	<i>Agropyron smithii</i>	<i>Pascopyrum smithii</i>
Mountain brome	<i>Bromus carinatus</i>	
Sedges	<i>Carex spp</i>	
One-spike oatgrass	<i>Danthonia unispicatum</i>	
Saltgrass	<i>Distichlis spicata</i>	
Great Basin wildrye	<i>Elymus cinereus</i>	<i>Leymus cinereus</i>
Idaho fescue	<i>Festuca idahoensis</i>	
Prairie junegrass	<i>Koeleria macrantha</i>	
Rushes	<i>Juncus spp</i>	
Oniongrass	<i>Melica bulbosa</i>	
Muhly	<i>Muhlenbergia spp</i>	
Indian ricegrass	<i>Oryzopsis hymenoides</i>	<i>Achnatherum hymenoides</i>
Steppe bluegrass	<i>Poa secunda</i>	
(Other) Native bluegrass	<i>Poa spp</i>	
Bluebunch wheatgrass	<i>Pseudoroegneria spicata</i>	

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

Common Name	Species Name	Updated Species Name
Native Grasses		
Squirreltail	<i>Sitanion hystrix</i>	<i>Elymus elymoides</i>
Needlegrass	<i>Stipa spp</i>	<i>Achnatherum, Hesperostipa</i>
Persistent Native Forbs		
Yarrow	<i>Achillea millefolium</i>	
Pussytoes	<i>Antennaria spp</i>	
Rockcress	<i>Arabis spp</i>	
Sandwort	<i>Arennaria spp</i>	
White sagebrush	<i>Artemisia ludoviciana</i>	
Lava aster	<i>Aster scopulorum</i>	<i>Ionactis alpina</i>
Locoweed	<i>Astragalus spp</i>	
Balsamroot	<i>Balsamorhiza spp</i>	
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>	
Desert buckwheat	<i>Eriogonum spp</i>	
Common wooly sunflower	<i>Eriophyllum lanatum</i>	
Sticky purple geranium	<i>Geranium viscosissimum</i>	
Stemless mock goldenweed	<i>Haplopappus acaulis</i>	<i>Stenotus acaulis</i>
Western stoneseed	<i>Lithospermum ruderales</i>	
Biscuitroot	<i>Lomatium spp</i>	
Lupine	<i>Lupinus spp</i>	
Bluebells	<i>Mertensia spp</i>	
Prickly pear	<i>Opuntia polyacantha</i>	
Hedgehog cactus	<i>Pediocactus simpsonii</i>	
Penstemon (beardtongue)	<i>Penstemon spp</i>	
Phlox	<i>Phlox spp</i>	
Ragwort	<i>Senecio spp</i>	
False hellebore	<i>Viratrum viride</i>	
Other Native Forbs		
Mountain dandelion	<i>Agoseris spp</i>	
Wild onion	<i>Allium spp</i>	
Trumpet	<i>Collomia spp</i>	
Mariposa lily	<i>Calochortus spp</i>	
Larkspur	<i>Delphinium spp</i>	
Gilia	<i>Gilia spp</i>	
Curlycup gumweed	<i>Grindelia squarrosa</i>	

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

Common Name	Species Name	Updated Species Name
Other Native Forbs		
Stickseed	<i>Hackelia spp</i>	
Waterleaf	<i>Hydrophyllum spp</i>	
Iris	<i>Iris spp</i>	
Blue flax	<i>Linum lewisii</i>	
Broomrape	<i>Orobanche spp</i>	
Spearleaf stonecrop	<i>Sedum lanceolatum</i>	
Death camas	<i>Zigadenus spp</i>	
Invasive Forbs		
Tansymustard	<i>Descurainia spp</i>	
Clasping pepperweed	<i>Lepidium perfoliatum</i>	
Tumble mustard	<i>Sisymbrium altissimum</i>	
Common dandelion	<i>Taraxicum officinale</i>	
Salsify	<i>Tragopogon dubius</i>	
Invasive Grasses		
Crested wheatgrass	<i>Agropyron cristatum</i>	
Cheatgrass	<i>Bromus tectorum</i>	
Bulbous bluegrass	<i>Poa bulbosa</i>	
Kentucky bluegrass	<i>Poa pratensis</i>	

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

Figure A-1. This figure compares long term averages of monthly temperatures (red line) and monthly precipitation (blue line) from 7/1/1893 to 8/31/2012 from the Oakley, Idaho (106542) weather station. The period when the temperature line exceeds the precipitation line defines the arid period for plant growth.

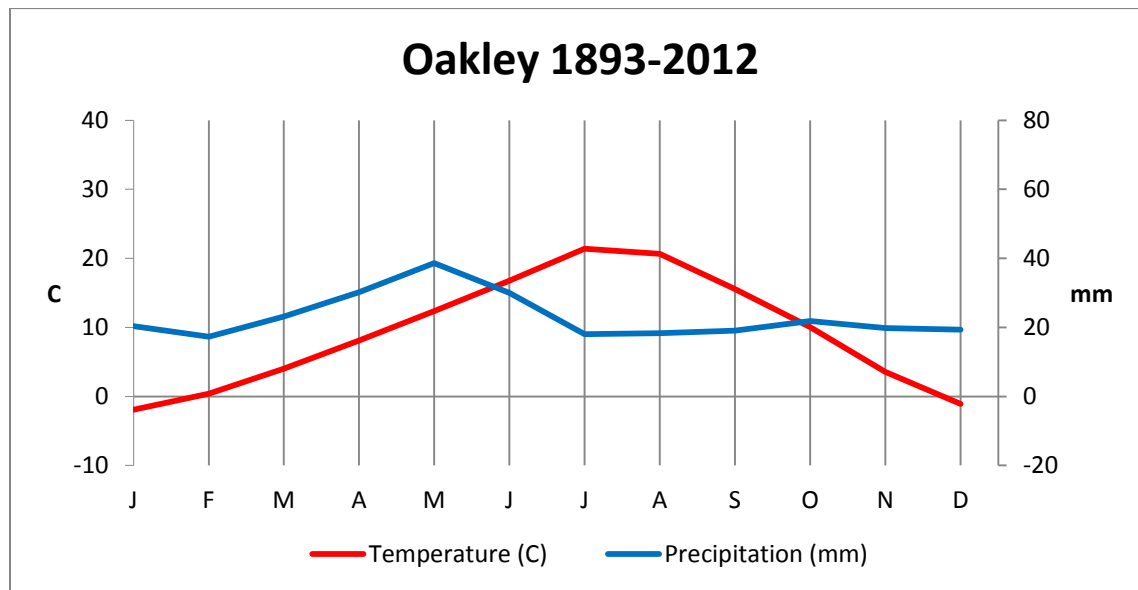


Figure A-2. This figure compares long term averages of monthly temperatures (red line) and monthly precipitation (blue line) during 2011 from the City of Rocks Idaho weather station. The period when the temperature line exceeds the precipitation line defines the arid period for plant growth.

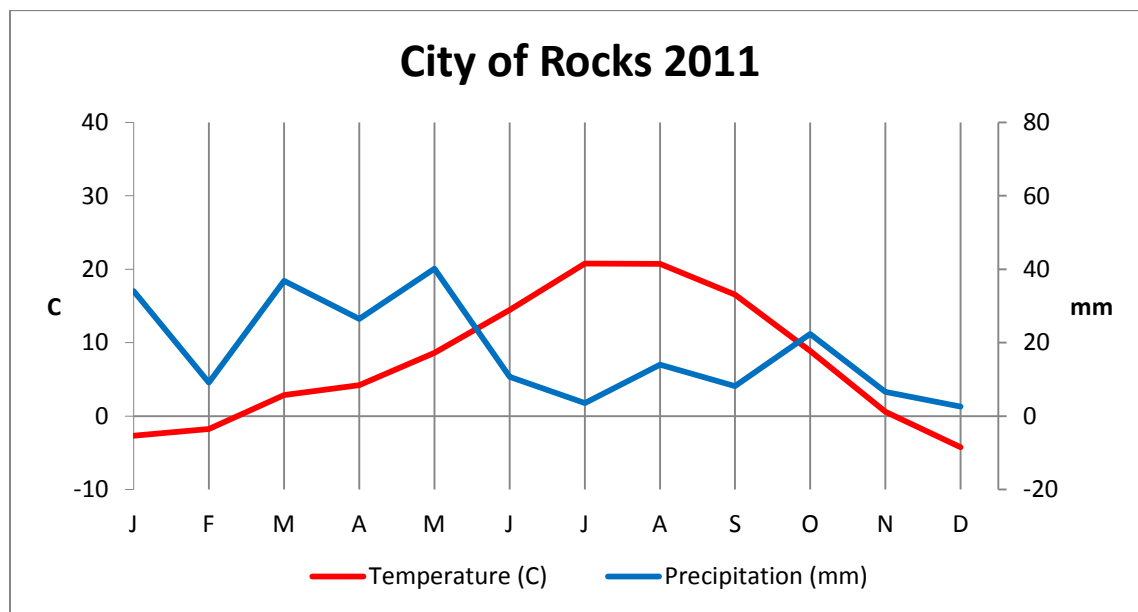
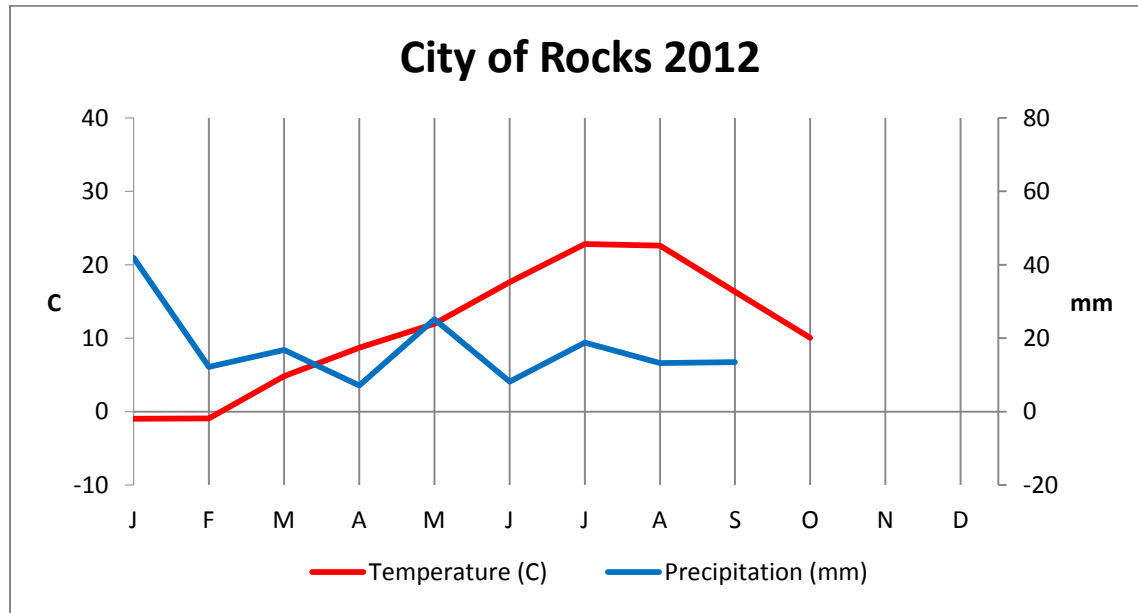


Figure A-3. This figure compares long term averages of monthly temperatures (red line) and monthly precipitation (blue line) during 2012 from the City of Rocks Idaho weather station. The period when the temperature line exceeds the precipitation line defines the arid period for plant growth.



Appendix C. 2012 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. 2012 Bath Rock sampling frame, CIRO: percentage of plots (n=55 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0%	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	13	55	25	4	4	0	0
Sagebrush							
<i>Artemisia arbuscula</i>	98	0	0	2	0	0	0
<i>Artemisia tridentata</i>	15	16	22	20	16	11	0
Shrubs							
<i>Chrysothamnus viscidiflorus</i>	49	29	15	7	0	0	0
<i>Mahonia</i> spp	91	2	7	0	0	0	0
<i>Purshia tridentata</i>	73	7	11	9	0	0	0
<i>Rosa woodsii</i>	98	0	2	0	0	0	0
<i>Symphoricarpos oreophilus</i>	62	11	9	9	7	2	0
Native Perennial Grasses							
<i>Agropyron smithii</i>	31	38	18	13	0	0	0
<i>Danthonia unispicatum</i>	98	2	0	0	0	0	0
<i>Elymus cinereus</i>	96	0	2	2	0	0	0
<i>Festuca idahoensis</i>	98	2	0	0	0	0	0
<i>Juncus</i> spp	98	2	0	0	0	0	0
<i>Poa secunda</i>	33	42	24	0	2	0	0
<i>Poa</i> spp	71	7	20	2	0	0	0
<i>Pseudoroegneria spicata</i>	96	4	0	0	0	0	0
<i>Stipa</i> spp	87	9	2	0	2	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>Arabis</i> spp	96	4	0	0	0	0	0
<i>Artemisia ludoviciana</i>	96	4	0	0	0	0	0
<i>Astragalus</i> spp	87	11	2	0	0	0	0
<i>Balsamorhiza</i> spp	82	11	4	4	0	0	0
<i>Cirsium</i> spp	95	5	0	0	0	0	0
<i>Comandra umbellata</i>	80	16	4	0	0	0	0
<i>Crepis acuminata</i>	98	2	0	0	0	0	0
<i>Erigeron</i> spp	98	2	0	0	0	0	0
<i>Eriogonum</i> spp	76	13	9	0	0	2	0
<i>Geranium viscosissimum</i>	98	0	2	0	0	0	0
<i>Iris</i> spp	95	4	2	0	0	0	0

Table A-2 (continued). 2012 Bath Rock sampling frame, CIRO: percentage of plots (n=55 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0%	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
<i>Lithospermum ruderae</i>	98	2	0	0	0	0	0
<i>Lomatium</i> spp	98	2	0	0	0	0	0
<i>Lupinus</i> spp	64	36	0	0	0	0	0
<i>Mertensia</i> spp	85	15	0	0	0	0	0
<i>Opuntia polyacantha</i>	95	4	2	0	0	0	0
<i>Phlox</i> spp	62	38	0	0	0	0	0
<i>Senecio</i> spp	96	4	0	0	0	0	0
<i>Zigadenus</i> spp	98	2	0	0	0	0	0
Native Other Forbs							
<i>Agoseris</i> spp	93	7	0	0	0	0	0
<i>Allium</i> spp	71	29	0	0	0	0	0
<i>Collomia</i> spp	58	38	4	0	0	0	0
Non-native Invasive Forbs							
<i>Descurainia</i> spp	98	2	0	0	0	0	0
<i>Tragopogon dubius</i>	96	4	0	0	0	0	0
<i>Taraxicum officinale</i>	91	9	0	0	0	0	0
Non-native Invasive Grasses							
<i>Agropyron cristatum</i>	55	25	13	5	2	0	0
<i>Bromus tectorum</i>	64	22	13	2	0	0	0
<i>Poa bulbosa</i>	76	22	2	0	0	0	0
<i>Poa pratensis</i>	98	0	0	0	0	2	0

Table A-3. 2012 Circle Creek North 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.

	0%	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	9	40	35	15	0	0	0
Sagebrush							
<i>Artemisia arbuscula</i>	97	0	2	2	0	0	0
<i>Artemisia tridentata</i>	6	3	23	31	29	8	0
Shrubs							
<i>Chrysothamnus viscidiflorus</i>	80	8	8	3	2	0	0
<i>Ericameria nauseosa</i>	94	2	2	3	0	0	0
<i>Prunus virginiana</i>	98	0	0	2	0	0	0
<i>Purshia tridentata</i>	80	6	5	8	2	0	0
<i>Rosa woodsii</i>	98	0	2	0	0	0	0
Native Perennial Grasses							
<i>Agropyron smithii</i>	75	17	8	0	0	0	0
<i>Poa secunda</i>	38	23	35	3	0	0	0
<i>Poa</i> spp	98	2	0	0	0	0	0

Table A-3 (continued). 2012 Circle Creek North 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.

	0%	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
<i>Pseudoroegneria spicata</i>	98	0	2	0	0	0	0
<i>Stipa</i> spp	94	3	3	0	0	0	0
Native Persistent Forbs							
<i>Achillea millefolium</i>	95	3	2	0	0	0	0
<i>Antennaria</i> spp	98	2	0	0	0	0	0
<i>Arabis</i> spp	94	6	0	0	0	0	0
<i>Aster scopulorum</i>	98	2	0	0	0	0	0
<i>Astragalus</i> spp	97	3	0	0	0	0	0
<i>Balsamorhiza</i> spp	98	0	2	0	0	0	0
<i>Crepis acuminata</i>	98	0	2	0	0	0	0
<i>Eriogonum</i> spp	97	0	3	0	0	0	0
<i>Geranium viscosissimum</i>	98	0	2	0	0	0	0
<i>Lomatium</i> spp	98	2	0	0	0	0	0
<i>Lupinus</i> spp	66	23	11	0	0	0	0
<i>Opuntia polyacantha</i>	94	3	3	0	0	0	0
<i>Phlox</i> spp	91	8	2	0	0	0	0
<i>Zigadenus</i> spp	97	3	0	0	0	0	0
Native Other Forbs							
<i>Agoseris</i> spp	95	5	0	0	0	0	0
<i>Allium</i> spp	97	3	0	0	0	0	0
<i>Collomia</i> spp	94	6	0	0	0	0	0
Non-native Invasive Forbs							
none							
Non-native Invasive Grasses							
<i>Agropyron cristatum</i>	26	5	38	29	2	0	0
<i>Bromus tectorum</i>	48	23	14	8	6	2	0
<i>Poa bulbosa</i>	97	3	0	0	0	0	0
<i>Poa pratensis</i>	92	2	6	0	0	0	0

Table A-4. 2012 Circle Creek South sampling frame, CIRO: percentage of plots (n=55 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0%	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	7	53	29	11	0	0	0
Sagebrush							
<i>Artemisia tridentata</i>	13	7	27	35	15	4	0
Shrubs							
<i>Amelanchier</i> spp	96	2	0	0	2	0	0

Table A-4 (continued). 2012 Circle Creek South sampling frame, CIRO: percentage of plots (n=55 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0%	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Shrubs							
<i>Chrysothamnus viscidiflorus</i>	62	29	7	2	0	0	0
<i>Ericameria nauseosa</i>	89	11	0	0	0	0	0
<i>Gutierrezia sarothrae</i>	96	4	0	0	0	0	0
<i>Pinus monophylla</i>	96	2	0	2	0	0	0
<i>Purshia tridentata</i>	82	2	7	4	2	4	0
<i>Symphoricarpos oreophilus</i>	91	4	4	2	0	0	0
Native Perennial Grasses							
<i>Agropyron smithii</i>	78	15	5	2	0	0	0
<i>Danthonia unispicatum</i>	98	2	0	0	0	0	0
<i>Festuca idahoensis</i>	91	5	2	2	0	0	0
<i>Koeleria macrantha</i>	98	2	0	0	0	0	0
<i>Poa secunda</i>	2	35	49	15	0	0	0
<i>Poa</i> spp	98	0	2	0	0	0	0
<i>Pseudoroegneria spicata</i>	82	7	11	0	0	0	0
<i>Stipa</i> spp	93	2	5	0	0	0	0
Native Persistent Forbs							
<i>Antennaria</i> spp	95	4	2	0	0	0	0
<i>Astragalus</i> spp	91	9	0	0	0	0	0
<i>Balsamorhiza</i> spp	98	2	0	0	0	0	0
<i>Castilleja</i> spp	98	2	0	0	0	0	0
<i>Cirsium</i> spp	98	2	0	0	0	0	0
<i>Comandra umbellata</i>	89	11	0	0	0	0	0
<i>Crepis acuminata</i>	98	2	0	0	0	0	0
<i>Erigeron</i> spp	96	4	0	0	0	0	0
<i>Eriogonum</i> spp	87	11	2	0	0	0	0
<i>Haplopappus acaulis</i>	98	2	0	0	0	0	0
<i>Lithospermum ruderale</i>	98	0	2	0	0	0	0
<i>Lupinus</i> spp	82	18	0	0	0	0	0
<i>Opuntia polyacantha</i>	89	5	5	0	0	0	0
<i>Phacelia hastata</i>	98	2	0	0	0	0	0
<i>Phlox</i> spp	71	27	2	0	0	0	0
<i>Senecio</i> spp	98	2	0	0	0	0	0
<i>Zigadenus</i> spp	98	2	0	0	0	0	0
Native Other Forbs							
<i>Agoseris</i> spp	93	7	0	0	0	0	0
<i>Allium</i> spp	95	5	0	0	0	0	0

Table A-4 (continued). 2012 Circle Creek South sampling frame, CIRO: percentage of plots (n=55 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0%	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Non-native Invasive Forbs							
<i>Taraxicum officinale</i>	96	4	0	0	0	0	0
Non-native Invasive Grasses							
<i>Agropyron cristatum</i>	36	20	16	20	2	4	2
<i>Bromus tectorum</i>	98	0	0	2	0	0	0
<i>Poa bulbosa</i>	91	4	4	2	0	0	0

Table A-5. 2012 Emery 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.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	16	64	16	1	0	1	0
Sagebrush							
<i>Artemisia arbuscula</i>	67	12	14	7	0	0	0
<i>Artemisia tridentata</i>	55	11	12	10	10	3	0
Shrubs							
<i>Amelanchier</i> spp	99	1	0	0	0	0	0
<i>Cercocarpus ledifolius</i>	99	1	0	0	0	0	0
<i>Chrysothamnus viscidiflorus</i>	55	21	21	4	0	0	0
<i>Eurotia lanata</i>	99	1	0	0	0	0	0
<i>Leptodactylon pungens</i>	86	11	1	1	0	0	0
<i>Mahonia</i> spp	79	15	5	0	0	0	0
<i>Prunus virginiana</i>	96	3	0	1	0	0	0
<i>Purshia tridentata</i>	97	1	0	1	0	0	0
<i>Symphoricarpos oreophilus</i>	68	7	8	11	1	4	0
<i>Tetradymia canescens</i>	96	4	0	0	0	0	0
Native Perennial Grasses							
<i>Agropyron smithii</i>	62	21	15	3	0	0	0
<i>Bromus carinatus</i>	89	7	4	0	0	0	0
<i>Elymus cinereus</i>	90	1	4	3	1	0	0
<i>Festuca idahoensis</i>	64	10	14	11	1	0	0
<i>Juncus</i> spp	99	0	1	0	0	0	0
<i>Koeleria macrantha</i>	81	5	12	1	0	0	0
<i>Melica bulbosa</i>	96	1	3	0	0	0	0
<i>Poa secunda</i>	49	19	19	11	0	0	1
<i>Poa</i> spp	89	7	1	3	0	0	0
<i>Pseudoroegneria spicata</i>	53	19	19	8	0	0	0
<i>Stipa</i> spp	89	5	5	0	0	0	0

Table A-5 (continued). 2012 Emery 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.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Persistent Forbs							
<i>Achillea millefolium</i>	97	1	1	0	0	0	0
<i>Antennaria</i> spp	79	7	7	7	0	0	0
<i>Arabis</i> spp	88	12	0	0	0	0	0
<i>Arennaria</i> spp	97	3	0	0	0	0	0
<i>Artemisia ludoviciana</i>	97	0	1	0	1	0	0
<i>Astragalus</i> spp	96	3	1	0	0	0	0
<i>Balsamorhiza</i> spp	73	12	8	5	1	0	0
<i>Castilleja</i> spp	70	29	1	0	0	0	0
<i>Chaenactis douglasii</i>	99	1	0	0	0	0	0
<i>Comandra umbellata</i>	74	22	4	0	0	0	0
<i>Crepis acuminata</i>	85	12	3	0	0	0	0
<i>Erigeron</i> spp	97	3	0	0	0	0	0
<i>Eriogonum</i> spp	70	18	10	3	0	0	0
<i>Eriophyllum lanatum</i>	99	1	0	0	0	0	0
<i>Geranium viscosissimum</i>	95	4	1	0	0	0	0
<i>Haplopappus acaulis</i>	95	4	1	0	0	0	0
<i>Iris</i> spp	97	0	1	1	0	0	0
<i>Lithospermum ruderales</i>	95	4	1	0	0	0	0
<i>Lomatium</i> spp	99	0	1	0	0	0	0
<i>Lupinus</i> spp	55	27	16	1	0	0	0
<i>Mertensia</i> spp	88	10	3	0	0	0	0
<i>Opuntia polyacantha</i>	93	7	0	0	0	0	0
<i>Pediocactus simpsonii</i>	95	5	0	0	0	0	0
<i>Penstemon</i> spp	97	3	0	0	0	0	0
<i>Phacelia hastata</i>	93	5	1	0	0	0	0
<i>Phlox</i> spp	74	21	5	0	0	0	0
<i>Sedum lanceolatum</i>	71	27	1	0	0	0	0
<i>Senecio</i> spp	85	14	1	0	0	0	0
<i>Viratrum viridae</i>	97	1	1	0	0	0	0
<i>Zigadenus</i> spp	99	1	0	0	0	0	0
Native Other Forbs							
<i>Agoseris</i> spp	89	11	0	0	0	0	0
<i>Collomia</i> spp	85	15	0	0	0	0	0
<i>Delphinium</i> spp	99	1	0	0	0	0	0
<i>Gilia</i> spp	99	1	0	0	0	0	0
<i>Hackelia</i> spp	96	1	3	0	0	0	0

Table A-5 (continued). 2012 Emery 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.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Non-native Invasive Forbs							
<i>Descurainia</i> spp	92	7	1	0	0	0	0
<i>Taraxicum officinale</i>	96	3	1	0	0	0	0
<i>Tragopogon dubius</i>	95	5	0	0	0	0	0
Non-native Invasive Grasses							
<i>Agropyron cristatum</i>	99	1	0	0	0	0	0
<i>Bromus tectorum</i>	86	11	3	0	0	0	0
<i>Poa bulbosa</i>	75	7	14	3	1	0	0
<i>Poa pratensis</i>	97	0	0	0	3	0	0

Table A-6. 2012 Kempton sampling frame, CIRO: percentage of plots (n=60 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	7	40	42	8	3	0	0
Sagebrush							
<i>Artemisia tridentata</i>	20	12	13	27	23	5	0
Shrubs							
<i>Chrysothamnus viscidiflorus</i>	53	28	17	2	0	0	0
<i>Ericameria nauseosa</i>	97	3	0	0	0	0	0
<i>Mahonia</i> spp	98	0	2	0	0	0	0
<i>Purshia tridentata</i>	75	12	7	3	2	0	2
<i>Symphoricarpos oreophilus</i>	70	12	8	8	0	2	0
Native Perennial Grasses							
<i>Agropyron smithii</i>	30	65	5	0	0	0	0
<i>Carex</i> spp	87	8	5	0	0	0	0
<i>Distichlis spicata</i>	97	3	0	0	0	0	0
<i>Elymus cinereus</i>	98	0	2	0	0	0	0
<i>Muhlenbergia</i> spp	97	0	0	2	0	2	0
<i>Poa secunda</i>	13	45	38	3	0	0	0
<i>Poa</i> spp	82	17	2	0	0	0	0
<i>Pseudoroegneria spicata</i>	93	7	0	0	0	0	0
<i>Stipa</i> spp	95	5	0	0	0	0	0
Native Persistent Forbs							
<i>Achillea millefolium</i>	87	13	0	0	0	0	0
<i>Antennaria</i> spp	95	5	0	0	0	0	0
<i>Arabis</i> spp	93	7	0	0	0	0	0
<i>Astragalus</i> spp	90	8	2	0	0	0	0
<i>Balsamorhiza</i> spp	95	3	2	0	0	0	0
<i>Chaenactis douglasii</i>	97	3	0	0	0	0	0

Table A-6 (continued). 2012 Kempton sampling frame, CIRO: percentage of plots (n=60 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
<i>Cirsium</i> spp	95	3	2	0	0	0	0
<i>Comandra umbellata</i>	72	28	0	0	0	0	0
<i>Crepis acuminata</i>	97	3	0	0	0	0	0
<i>Erigeron</i> spp	95	5	0	0	0	0	0
<i>Eriogonum</i> spp	82	15	2	2	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	70	27	3	0	0	0	0
<i>Mertensia</i> spp	98	2	0	0	0	0	0
<i>Opuntia polyacantha</i>	88	5	5	2	0	0	0
<i>Phlox</i> spp	68	30	2	0	0	0	0
Native Other Forbs							
<i>Allium</i> spp	72	28	0	0	0	0	0
<i>Collomia</i> spp	87	13	0	0	0	0	0
<i>Delphinium</i> spp	98	2	0	0	0	0	0
<i>Linum lewisii</i>	98	2	0	0	0	0	0
Non-native Invasive Forbs							
<i>Descurainia</i> spp	98	2	0	0	0	0	0
<i>Taraxicum officinale</i>	95	5	0	0	0	0	0
Non-native Invasive Grasses							
<i>Agropyron cristatum</i>	97	3	0	0	0	0	0
<i>Bromus tectorum</i>	40	32	25	3	0	0	0
<i>Poa bulbosa</i>	93	5	0	2	0	0	0

Table A-7. 2012 Tracy Lane sampling frame, CIRO: percentage of plots (n=55 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	9	27	38	18	7	0	0
Sagebrush							
<i>Artemisia arbuscula</i>	91	4	4	2	0	0	0
<i>Artemisia tridentata</i>	80	9	9	2	0	0	0
Shrubs							
<i>Chrysothamnus viscidiflorus</i>	44	27	18	9	2	0	0
<i>Ericameria nauseosa</i>	85	11	2	2	0	0	0
<i>Purshia tridentata</i>	93	0	7	0	0	0	0
<i>Symphoricarpos oreophilus</i>	98	0	2	0	0	0	0
<i>Tetradymia canescens</i>	98	2	0	0	0	0	0

Table A-7 (continued). 2012 Tracy Lane sampling frame, CIRO: percentage of plots (n=55 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Perennial Grasses							
<i>Agropyron smithii</i>	44	20	20	13	4	0	0
<i>Oryzopsis hymenoides</i>	91	7	2	0	0	0	0
<i>Poa secunda</i>	9	24	45	22	0	0	0
<i>Poa</i> spp	98	0	2	0	0	0	0
<i>Pseudoroegneria spicata</i>	82	7	7	4	0	0	0
<i>Sitanion hystrix</i>	96	2	2	0	0	0	0
<i>Stipa</i> spp	98	2	0	0	0	0	0
Native Persistent Forbs							
<i>Arabis</i> spp	96	4	0	0	0	0	0
<i>Aster scopulorum</i>	98	2	0	0	0	0	0
<i>Astragalus</i> spp	85	15	0	0	0	0	0
<i>Balsamorhiza</i> spp	96	4	0	0	0	0	0
<i>Chaenactis douglasii</i>	91	9	0	0	0	0	0
<i>Cirsium</i> spp	95	5	0	0	0	0	0
<i>Comandra umbellata</i>	98	0	2	0	0	0	0
<i>Erigeron</i> spp	95	5	0	0	0	0	0
<i>Eriogonum</i> spp	93	5	2	0	0	0	0
<i>Eriophyllum lanatum</i>	98	2	0	0	0	0	0
<i>Lithospermum ruderales</i>	98	2	0	0	0	0	0
<i>Lupinus</i> spp	98	2	0	0	0	0	0
<i>Opuntia polyacantha</i>	93	4	4	0	0	0	0
<i>Penstemon</i> spp	96	4	0	0	0	0	0
<i>Phlox</i> spp	84	16	0	0	0	0	0
<i>Zigadenus</i> spp	98	2	0	0	0	0	0
Native Other Forbs							
<i>Agoseris</i> spp	93	7	0	0	0	0	0
<i>Allium</i> spp	95	5	0	0	0	0	0
<i>Linum lewisii</i>	98	0	2	0	0	0	0
Non-native Invasive Forbs							
<i>Sisymbrium altissimum</i>	95	5	0	0	0	0	0
<i>Tragopogon dubius</i>	71	27	2	0	0	0	0
Non-native Invasive Grasses							
<i>Agropyron cristatum</i>	45	13	33	9	0	0	0
<i>Bromus tectorum</i>	36	18	13	13	7	9	4
<i>Poa bulbosa</i>	98	2	0	0	0	0	0

Table A-8. 2012 Trail Canyon sampling frame, CIRO: percentage of plots (n=66 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	9	74	15	2	0	0	0
Sagebrush							
<i>Artemisia arbuscula</i>	70	8	18	5	0	0	0
<i>Artemisia tridentata</i>	30	17	18	23	5	8	0
Shrubs							
<i>Amelanchier</i> spp	94	0	2	2	2	0	2
<i>Chrysothamnus viscidiflorus</i>	55	24	14	8	0	0	0
<i>Ericameria nauseosa</i>	97	3	0	0	0	0	0
<i>Eurotia lanata</i>	98	2	0	0	0	0	0
<i>Gutierrezia sarothrae</i>	98	2	0	0	0	0	0
<i>Holodiscus dumosus</i>	98	0	0	2	0	0	0
<i>Mahonia</i> spp	92	6	2	0	0	0	0
<i>Pinus monophylla</i>	97	0	3	0	0	0	0
<i>Purshia tridentata</i>	86	6	2	3	3	0	0
<i>Rosa woodsii</i>	98	2	0	0	0	0	0
<i>Symphoricarpos oreophilus</i>	58	18	9	8	5	3	0
<i>Tetradymia canescens</i>	97	2	2	0	0	0	0
Native Perennial Grasses							
<i>Agropyron smithii</i>	68	26	6	0	0	0	0
<i>Carex</i> spp	97	0	3	0	0	0	0
<i>Danthonia unispicatum</i>	95	2	3	0	0	0	0
<i>Elymus cinereus</i>	98	0	0	2	0	0	0
<i>Festuca idahoensis</i>	80	9	9	2	0	0	0
<i>Koeleria macrantha</i>	76	20	5	0	0	0	0
<i>Oryzopsis hymenoides</i>	98	2	0	0	0	0	0
<i>Poa secunda</i>	23	62	14	2	0	0	0
<i>Poa</i> spp	86	9	5	0	0	0	0
<i>Pseudoroegneria spicata</i>	71	18	11	0	0	0	0
<i>Sitanion hystrix</i>	97	3	0	0	0	0	0
<i>Stipa</i> spp	76	20	2	3	0	0	0
Native Persistent Forbs							
<i>Achillea millefolium</i>	89	9	2	0	0	0	0
<i>Antennaria</i> spp	85	3	9	3	0	0	0
<i>Astragalus</i> spp	91	8	2	0	0	0	0
<i>Balsamorhiza</i> spp	56	24	14	6	0	0	0
<i>Castilleja</i> spp	89	11	0	0	0	0	0
<i>Chaenactis douglasii</i>	95	5	0	0	0	0	0
<i>Cirsium</i> spp	97	3	0	0	0	0	0
<i>Comandra umbellata</i>	83	17	0	0	0	0	0
<i>Crepis acuminata</i>	92	8	0	0	0	0	0

Table A-8 (continued). 2012 Trail Canyon sampling frame, CIRO: percentage of plots (n=66 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
<i>Erigeron</i> spp	94	6	0	0	0	0	0
<i>Eriogonum</i> spp	64	29	6	2	0	0	0
<i>Lithospermum ruderales</i>	97	3	0	0	0	0	0
<i>Lomatium</i> spp	94	6	0	0	0	0	0
<i>Lupinus</i> spp	70	24	6	0	0	0	0
<i>Mertensia</i> spp	98	2	0	0	0	0	0
<i>Opuntia polyacantha</i>	86	9	3	2	0	0	0
<i>Pediocactus simpsonii</i>	98	2	0	0	0	0	0
<i>Penstemon</i> spp	98	2	0	0	0	0	0
<i>Phlox</i> spp	70	26	5	0	0	0	0
<i>Sedum lanceolatum</i>	95	5	0	0	0	0	0
<i>Senecio</i> spp	92	6	2	0	0	0	0
<i>Zigadenus</i> spp	97	3	0	0	0	0	0
Native Other Forbs							
<i>Agoseris</i> spp	95	5	0	0	0	0	0
<i>Arabis</i> spp	97	3	0	0	0	0	0
<i>Calochortus</i> spp	98	2	0	0	0	0	0
<i>Collomia</i> spp	89	11	0	0	0	0	0
Non-native Invasive Forbs							
<i>Cirsium arvense</i>	98	2	0	0	0	0	0
<i>Taraxicum officinale</i>	97	3	0	0	0	0	0
<i>Tragopogon dubius</i>	98	2	0	0	0	0	0
Non-native Invasive Grasses							
<i>Agropyron cristatum</i>	88	5	8	0	0	0	0
<i>Bromus tectorum</i>	70	17	9	3	2	0	0
<i>Poa bulbosa</i>	56	24	14	5	2	0	0

Table A-9. 2012 Castle Rocks North sampling frame, CRSP: percentage of plots (n=65 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	9	40	35	15	0	0	0
Sagebrush							
<i>Artemisia arbuscula</i>	97	0	2	2	0	0	0
<i>Artemisia tridentata</i>	6	3	23	31	29	8	0

Table A-9 (continued). 2012 Castle Rocks North sampling frame, CRSP: percentage of plots (n=65 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Shrubs							
<i>Chrysothamnus viscidiflorus</i>	80	8	8	3	2	0	0
<i>Ericameria nauseosa</i>	94	2	2	3	0	0	0
<i>Prunus virginiana</i>	98	0	0	2	0	0	0
<i>Purshia tridentata</i>	80	6	5	8	2	0	0
<i>Rosa woodsii</i>	98	0	2	0	0	0	0
Native Perennial Grasses							
<i>Agropyron smithii</i>	75	17	8	0	0	0	0
<i>Poa secunda</i>	38	23	35	3	0	0	0
<i>Poa</i> spp	98	2	0	0	0	0	0
<i>Pseudoroegneria spicata</i>	98	0	2	0	0	0	0
<i>Stipa</i> spp	94	3	3	0	0	0	0
Native Persistent Forbs							
<i>Achillea millefolium</i>	95	3	2	0	0	0	0
<i>Antennaria</i> spp	98	2	0	0	0	0	0
<i>Arabis</i> spp	94	6	0	0	0	0	0
<i>Aster scopulorum</i>	98	2	0	0	0	0	0
<i>Astragalus</i> spp	97	3	0	0	0	0	0
<i>Balsamorhiza</i> spp	98	0	2	0	0	0	0
<i>Crepis acuminata</i>	98	0	2	0	0	0	0
<i>Eriogonum</i> spp	97	0	3	0	0	0	0
<i>Geranium viscosissimum</i>	98	0	2	0	0	0	0
<i>Lomatium</i> spp	98	2	0	0	0	0	0
<i>Lupinus</i> spp	66	23	11	0	0	0	0
<i>Opuntia polyacantha</i>	94	3	3	0	0	0	0
<i>Phlox</i> spp	91	8	2	0	0	0	0
<i>Zigadenus</i> spp	97	3	0	0	0	0	0
Native Other Forbs							
<i>Agoseris</i> spp	95	5	0	0	0	0	0
<i>Allium</i> spp	97	3	0	0	0	0	0
<i>Collomia</i> spp	94	6	0	0	0	0	0
Non-native Invasive Forbs							
none							
Non-native Invasive Grasses							
<i>Agropyron cristatum</i>	26	5	38	29	2	0	0
<i>Bromus tectorum</i>	48	23	14	8	6	2	0
<i>Poa bulbosa</i>	97	3	0	0	0	0	0
<i>Poa pratensis</i>	92	2	6	0	0	0	0

Table A-10. 2012 Castle Rocks South sampling frame, CRSP: percentage of plots (n=60 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	5	63	23	7	2	0	0
Sagebrush							
<i>Artemisia arbuscula</i>	88	2	7	3	0	0	0
<i>Artemisia tridentata</i>	35	8	13	22	17	5	0
Shrubs							
<i>Amelanchier</i> spp	88	0	7	2	2	2	0
<i>Chrysothamnus viscidiflorus</i>	87	8	5	0	0	0	0
<i>Ericameria nauseosa</i>	98	0	2	0	0	0	0
<i>Gutierrezia sarothrae</i>	77	17	7	0	0	0	0
<i>Purshia tridentata</i>	83	3	3	10	0	0	0
<i>Rosa woodsii</i>	93	0	3	3	0	0	0
<i>Tetradymia canescens</i>	98	0	2	0	0	0	0
Native Perennial Grasses							
<i>Agropyron smithii</i>	47	30	17	2	5	0	0
<i>Carex</i> spp	90	5	2	3	0	0	0
<i>Danthonia unispicatum</i>	98	0	0	2	0	0	0
<i>Festuca idahoensis</i>	98	2	0	0	0	0	0
<i>Juncus</i> spp	95	2	3	0	0	0	0
<i>Koeleria macrantha</i>	95	5	0	0	0	0	0
<i>Poa secunda</i>	10	45	37	8	0	0	0
<i>Pseudoroegneria spicata</i>	75	10	10	5	0	0	0
<i>Sitanion hystrix</i>	87	8	5	0	0	0	0
<i>Stipa</i> spp	95	5	0	0	0	0	0
Native Persistent Forbs							
<i>Achillea millefolium</i>	90	8	2	0	0	0	0
<i>Antennaria</i> spp	98	2	0	0	0	0	0
<i>Arabis</i> spp	95	5	0	0	0	0	0
<i>Artemisia ludoviciana</i>	98	0	2	0	0	0	0
<i>Aster scopulorum</i>	97	3	0	0	0	0	0
<i>Astragalus</i> spp	82	18	0	0	0	0	0
<i>Castilleja</i> spp	98	2	0	0	0	0	0
<i>Chaenactis douglasii</i>	98	2	0	0	0	0	0
<i>Cirsium</i> spp	98	2	0	0	0	0	0
<i>Comandra umbellata</i>	77	18	5	0	0	0	0
<i>Erigeron</i> spp	98	2	0	0	0	0	0
<i>Eriogonum</i> spp	90	8	2	0	0	0	0
<i>Eriophyllum lanatum</i>	98	2	0	0	0	0	0
<i>Haplopappus acaulis</i>	98	0	2	0	0	0	0
<i>Lithospermum ruderale</i>	95	0	5	0	0	0	0

Table A-10 (continued). 2012 Castle Rocks South sampling frame, CRSP: percentage of plots (n=60 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Persistent Forbs							
<i>Lomatium</i> spp	93	7	0	0	0	0	0
<i>Opuntia polyacantha</i>	93	5	2	0	0	0	0
<i>Phlox</i> spp	73	25	2	0	0	0	0
<i>Zigadenus</i> spp	93	7	0	0	0	0	0
Native Other Forbs							
<i>Agoseris</i> spp	95	5	0	0	0	0	0
<i>Allium</i> spp	85	15	0	0	0	0	0
<i>Grindelia squarrosa</i>	87	12	2	0	0	0	0
<i>Linum lewisii</i>	97	3	0	0	0	0	0
Non-native Invasive Forbs							
<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>Agropyron cristatum</i>	97	3	0	0	0	0	0
<i>Bromus tectorum</i>	13	42	25	13	5	2	0
<i>Poa bulbosa</i>	77	7	5	8	3	0	0
<i>Poa pratensis</i>	98	0	0	0	2	0	0

Table A-11. 2012 Castle Rocks West sampling frame, CRSP: percentage of plots (n=55 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	4	75	22	0	0	0	0
Sagebrush							
<i>Artemisia arbuscula</i>	44	15	29	9	4	0	0
<i>Artemisia tridentata</i>	80	4	9	5	2	0	0
Shrubs							
<i>Amelanchier</i> spp	95	4	0	0	0	2	0
<i>Chrysothamnus viscidiflorus</i>	87	4	7	2	0	0	0
<i>Ericameria nauseosa</i>	96	4	0	0	0	0	0
<i>Gutierrezia sarothrae</i>	93	4	4	0	0	0	0
<i>Purshia tridentata</i>	56	9	13	15	5	2	0
<i>Symphoricarpos oreophilus</i>	98	0	0	2	0	0	0

Table A-11 (continued). 2012 Castle Rocks West sampling frame, CRSP: percentage of plots (n=55 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Native Perennial Grasses							
<i>Agropyron smithii</i>	91	2	2	5	0	0	0
<i>Carex</i> spp	98	2	0	0	0	0	0
<i>Danthonia unispicatum</i>	84	11	5	0	0	0	0
<i>Koeleria macrantha</i>	64	24	13	0	0	0	0
<i>Melica bulbosa</i>	98	0	2	0	0	0	0
<i>Poa secunda</i>	5	38	47	9	0	0	0
<i>Pseudoroegneria spicata</i>	36	11	40	13	0	0	0
<i>Sitanion hystrix</i>	67	20	13	0	0	0	0
<i>Stipa</i> spp	96	4	0	0	0	0	0
Native Persistent Forbs							
<i>Achillea millefolium</i>	87	11	2	0	0	0	0
<i>Antennaria</i> spp	98	2	0	0	0	0	0
<i>Arabis</i> spp	96	4	0	0	0	0	0
<i>Artemisia ludoviciana</i>	96	2	2	0	0	0	0
<i>Aster scopulorum</i>	96	4	0	0	0	0	0
<i>Astragalus</i> spp	98	2	0	0	0	0	0
<i>Cirsium</i> spp	98	2	0	0	0	0	0
<i>Comandra umbellata</i>	84	13	4	0	0	0	0
<i>Erigeron</i> spp	95	5	0	0	0	0	0
<i>Eriogonum</i> spp	89	2	9	0	0	0	0
<i>Eriophyllum lanatum</i>	91	7	2	0	0	0	0
<i>Lithospermum ruderales</i>	95	4	2	0	0	0	0
<i>Lomatium</i> spp	75	25	0	0	0	0	0
<i>Lupinus</i> spp	91	5	4	0	0	0	0
<i>Opuntia polyacantha</i>	98	2	0	0	0	0	0
<i>Penstemon</i> spp	96	4	0	0	0	0	0
<i>Phlox</i> spp	91	9	0	0	0	0	0
<i>Senecio</i> spp	93	7	0	0	0	0	0
<i>Zigadenus</i> spp	91	5	4	0	0	0	0
Native Other Forbs							
<i>Agoseris</i> spp	82	18	0	0	0	0	0
<i>Allium</i> spp	96	4	0	0	0	0	0
<i>Collomia</i> spp	98	2	0	0	0	0	0
<i>Grindelia squarrosa</i>	98	2	0	0	0	0	0
<i>Hydrophyllum</i> spp	98	2	0	0	0	0	0
<i>Orobancha</i> spp	98	2	0	0	0	0	0

Table A-11 (continued). 2012 Castle Rocks West sampling frame, CRSP: percentage of plots (n=55 1 m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Non-native Invasive Forbs							
<i>Tragopogon dubius</i>	91	7	2	0	0	0	0
Non-native Invasive Grasses							
<i>Agropyron cristatum</i>	98	2	0	0	0	0	0
<i>Bromus tectorum</i>	16	40	25	9	9	0	0
<i>Poa bulbosa</i>	38	18	20	18	5	0	0
<i>Poa pratensis</i>	85	4	7	4	0	0	0