



Sagebrush Steppe Vegetation Monitoring in Craters of the Moon National Monument and Preserve

2013 Annual Report

Natural Resource Data Series NPS/UCBN/NRTR—2014/911



ON THE COVER

Sagebrush steppe vegetation represents 90% of vegetation in Craters of the Moon National Monument and Preserve.
Photograph by Devin Stucki, NPS.

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Abstract

As part of the Upper Columbia Basin Network's (UCBN) vital signs monitoring in 2013, estimates of areal cover, in Daubenmire classes, of principal native and nonnative sagebrush steppe plant species and exposed bare soil were collected from 1252 one m² plots in Craters of the Moon National Monument and Preserve (CRMO). Cover estimates for these species are key indicators of sagebrush steppe vegetation biotic integrity, soil stability, and hydrologic function and inform park management about trends in these attributes. 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. These changes may be exacerbated by climate change, particularly under predicted scenarios for the region that include reduced snowpack and increased drought. This annual report summarizes cover estimates from key species of particular interest, including big sagebrush (*Artemisia tridentata*), bluebunch wheatgrass (*Pseudoegneria spicata*), and cheatgrass (*Bromus tectorum*). Methods follow a protocol that was peer-reviewed and approved following the 2009 pilot field season (Yeo et al. 2009). In 2013, data were collected across the park in 25 discrete sampling "frames" which capture a wide range of environmental conditions and site histories.

This report summarizes patterns in selected sagebrush steppe plant and bare ground cover indicators measured during 2013 sampling in CRMO. A wide range of conditions was encountered among sampling frames. The proportion of plots containing cheatgrass ranged from 0% in several frames, to over 90% in several other frames. Bluebunch wheatgrass, a fundamental native perennial bunchgrass, was encountered with >5% cover in 0%-38% of plots, although in some frames, other important native bunchgrass species such as Idaho fescue (*Festuca idahoensis*) replace wheatgrass, depending on ecological site type. This is the case in Brass Cap Kipuka (frame 25), a low sage (*Artemisia arbuscula*) –dominated frame in good condition with very few non-native species present. However, several frames in CRMO are dominated instead by the native perennial steppe bluegrass (*Poa secunda*) and cheatgrass, together taken as a sign of degradation. The proportion of plots containing >5% cover of big sagebrush ranged from 2% to 78% in CRMO. Rush skeletonweed (*Chondrilla juncea*) was encountered in one CRMO plot. Several areas within CRMO appear to be in exceptionally good ecological condition, most notably Brass Cap Kipuka and the Sunset Cone area on the north end of CRMO. Other areas such as the frames on the Wapi Flow are degraded, as indicated by the abundance of non-native invasive species.

This report represents an important contribution to the park's effort to engage in science-based adaptive management. By identifying not only the overall condition of park rangelands but also *where* areas of good and poor condition exist, the park will be better able to prioritize and target effective management strategies.

Acknowledgments

Special thanks to the CRMO park staff for providing UCBN employees with housing and additional resources needed to complete the 2013 monitoring efforts.

Introduction

Prior to European colonization, sagebrush steppe covered approximately 44 million hectares of the Intermountain West, the vast areas of land between the Rocky Mountains and the Cascades and Sierra Nevada mountain ranges (West and Young 2000). Since then the sagebrush steppe ecosystem has experienced extensive changes (USDA Forest Service 1996, West and Young 2000, Bureau of Land Management 2002, Reid et al. 2002). Substantial portions of the region have been converted to agriculture and development (West and Young 2000, Bunting et al. 2002). Much of the remaining sagebrush steppe has been degraded through overgrazing by livestock, altered fire regimes, and invasion of non-native plants (Reid et al. 2002). These changes have had significant impacts on the ecological condition of the sagebrush steppe, including a decline in native flora and fauna, decreased soil stability, and reduced hydrologic function (Mack and D'Antonio 1998, Wisdom et al. 2000, Keane et al. 2002, Knick et al. 2003, Dobkin and Sauder 2004). Sagebrush steppe today is one of the most threatened ecosystems in the Intermountain West (Noss et al. 1995). Biological invasions, altered fire regimes, and other stressors continue to cause major, possibly irreversible, changes to steppe ecosystem structure and function, including a loss of foundational species and dominance by non-native weedy annual grasses (e.g., Knick et al. 2003, Brooks et al. 2004, Dobkin and Sauder 2004).

The degradation of sagebrush steppe that has occurred throughout the Intermountain West has occurred within UCBN parks as well. Sagebrush steppe is the most extensive ecosystem type in the Upper Columbia Basin Network (UCBN), occupying over 50% of land cover in City of Rocks National Reserve (CIRO), Hagerman Fossil Beds National Monument (HAFO), and the John Day Fossil Beds National Monument (JODA). At Craters of the Moon National Monument and Preserve (CRMO), where bare lava rock comprises 81% of the total land cover, sagebrush steppe represents over 90% of the vegetation cover. At Lake Roosevelt National Recreation Area (LARO), sagebrush steppe is present and extensive in the southern half of the recreation area. Historic and current land use practices such as grazing and farming both within and adjacent to UCBN park units, continue to fragment and alter steppe ecosystems (e.g., Knick and Rotenberry 1997, Hanser and Huntly 2006). This degradation of sagebrush steppe will likely be exacerbated by predicted climate change scenarios for the region with potential outcomes including reduced snowpack and increased frequency of drought and wildfire, increased ability of non-native species to invade sagebrush steppe, and altered plant phenology (Smith et al. 2000, Wagner et al. 2003, Karl et al. 2009). Long-term vegetation trends at the Idaho National Laboratory (INL) near CRMO provide substantial evidence of the importance of climate patterns on sagebrush steppe vegetation dynamics (Anderson and Inouye 2001). A half-century of monitoring at INL has shown a multi-decadal plant community response to prolonged drought during the mid-20th century that has important implications for management within the context of varying and changing climate conditions.

The UCBN has identified the ecological condition of sagebrush steppe vegetation as a high priority vital sign and monitoring of sagebrush steppe condition will be a central element to the UCBN monitoring program (Garrett et al. 2007). Community response to fire and drought, vulnerability to invasion, and the potential for restoration and recovery can differ significantly among sagebrush

steppe communities (Reid et al. 2002, Bureau of Land Management 2002). The heterogeneity of sagebrush community types (e.g., alliances and associations defined by *Artemisia* subtaxa) in the UCBN, the complexity of ecological threats to sagebrush steppe ecosystems, and the substantial variability of vegetation change that has been reported among years and decades emphasize the uncertainty that managers face. Understanding the complexity of change at the park level is critical for effective management strategies to be developed. These challenges underscore the need for a long-term monitoring program that provides for routine evaluation of the status of UCBN sagebrush steppe communities, and for identification of trends over time within parks and across the network. This information will provide the feedback required for effective adaptive management.

This report presents the results of the 2013 monitoring in CRMO. In 2010 a final peer reviewed and approved protocol (Yeo et al. 2009) was implemented in UCBN parks, following two years of pilot work (Rodhouse 2009, 2010). Following methods outlined by Yeo et al. (2009), information on the cover and frequency of occurrence of principal rangeland health indicator species, including both native and non-native species, as well as the cover of exposed bare soil, were obtained. These data represent a continued effort to quantify species composition and abundance within sagebrush steppe vegetation in UCBN parks.

Objectives

The monitoring objectives for this vital sign monitoring program are:

- 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 vegetation communities.
- Determine the status and trends in composition and abundance (cover) of principal invasive plant species, including 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 describes fundamental baseline conditions for the following key indicators: cover of exposed bare soil, steppe bluegrass (*Poa secunda*), bluebunch wheatgrass (*Pseudoroegneria spicata*), cheatgrass (*Bromus tectorum*), big sagebrush (*Artemisia tridentata*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and several forb species. Cover estimates for a total of 104 species from the 2013 sampling period are available upon request from the UCBN. In order to focus attention on the most immediately apparent and meaningful patterns, only 1 cover class threshold (typically >5% cover) was used per indicator. Although arbitrary, these thresholds are useful to distinguish meaningfully among sites relative to the range of cover values observed. In many cases choosing another threshold would mask real differences among plots and frames because too few plots would be represented in one category. As more information is collected from the monitoring program and a greater understanding is achieved about the range of cover values expected in UCBN sagebrush steppe landscapes, these cover class reporting decisions can be revised. Importantly, these decisions should be made within the context of park management goals and desired future conditions. The

presentation of results in this report is primarily graphical, providing snapshots of condition within the park sampling frames.

Methods

The UCBN used a generalized random tessellation stratified (GRTS) spatially-balanced sampling design (Stevens and Olsen 2004) within each of 25 park sampling frames in CRMO in 2013 following methods outlined by Yeo et al. (2009). The GRTS design ensures that each frame is sampled with statistical representativeness and optimal spatial dispersion (Stevens and Olsen 2004). The randomly located points provide the location for subsequent plot-based estimation of cover (described in the next paragraph). The total number of randomly located sampling points was 1252, distributed across frames following sample size determination described by Yeo et al. (2009). A minimum of 50 points were sampled in any one frame and adjusted upward proportional to the area of each frame. Sample frames in CRMO were labeled by an arbitrary frame number, from 1-35. More intuitive names for some of these frames have been appended based on geographic location or nearby topographic features. Frames 19, 20, 25, 26, 27, 28, and 35 are located in kipukas. Kipukas are areas of land within the CRMO lava fields that are completely surrounded by younger lava flows. Often kipukas have well developed soils and late-successional vegetation. In CRMO, kipukas are ecologically important because many have been isolated from livestock grazing, and, in a few cases, still support quasi-pristine plant communities and are therefore of special interest to CRMO park staff. Table 1 shows the kipuka identification numbers for these 7 frames from the CRMO kipuka geodatabase and also the official or tentative descriptive names for these kipukas.

Table 1. The names and identification numbers of seven CRMO sampling frames that encompass or fall within kipukas, which are unique areas of park management interest.

Kipuka name	Sample Frame ID	Kipuka Geodatabase ID
Schodde Well	19	469
Baker Cave	20	591
Brass Cap	25	89
Carey	26	410
Bear Park	27	382
County Line	28	55
Sand	35	536

Sampling methods followed those detailed by Yeo et al. (2009). The approach utilized 1 m² quadrats, anchored at each GRTS sample point on the lower right-hand corner of the quadrat. Cover was visually estimated within each quadrat following Daubenmire's (1959) 6- point cover class system (7 classes when "0" is included; Table 2). Cover was estimated separately for principal native and non-native plant species as well as for exposed bare soil. For this report, bar graphs are used to present mean cover class estimates for each sampling frame, and include 90% confidence intervals obtained by calculating the more efficient "local" variance estimator developed for GRTS samples by Stevens and Olsen (2003). The height of each bar represents the proportion of plots >5% cover. These estimates are also a population estimate of the proportion of sample frame area with cover >5% for each species. Ninety percent confidence intervals provide a measure of uncertainty for each of these point estimates. Environmental attributes such as the age of lava and subsequent soil development in

CRMO are unique to each frame. These unique frame attributes influence patterns of bare ground and other indicators, and relative change over time within frames will be more meaningful than comparisons among frames in many cases.

Table 2. Daubenmire's cover classes used for visually estimating vegetation cover in 1 m² square plots (quadrats) placed at spatially-balanced locations in each sampling frame.

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%

Results

Bare Ground

The proportion of plots where bare ground cover was estimated to be >5% ranged widely from 2% to 88% among frames (Figure A1) compared with 0%- 77% reported in 2010. Highest estimates were in frames 25 (Brass Cap Kipuka) and 11, respectively. Frame 11 also had 30% of plots with cover estimates >25% (not shown). Greater than 50% of plots in frames 2, 8, 11, 25, 26, and 32 had bare ground estimates >5%. The proportion of plots in the remaining frames with bare ground estimated to be >5% ranged from 2%-46%. Note that in some frames (e.g., frame 25), high cover of bare ground is not indicative of degradation but rather reflects characteristics of the ecological site.

Principal Native Species

Table 3 presents summaries of the proportion of plots where selected native species cover was estimated to be >5%. Figures A2-A9 provide a graphical summary of the same information. Figures B1-B3 provide maps of the locations of plots, color-coded by cover class estimates for bluebunch wheatgrass and big sagebrush, providing a spatial representation of these patterns. There is tremendous variability among the frames for all species due to differences in site disturbance history (e.g., frame 32 is within the Golden Chariot Fire perimeter that burned in 2000) and other factors. Proportion of plots with >5% cover of bluebunch wheatgrass ranged from 0 to 36%.

In 2013 frame 1, north of Sunset Cone, was noted as having the highest amount of bluebunch wheatgrass, and 10% of plots in this frame had bluebunch wheatgrass cover estimates >25%. Frame 1 also contained the largest proportion (54%) of plots with an estimated cover >5% for bluebunch wheatgrass. Frame 25, Brass Cap Kipuka, is noteworthy because of the dominance of Idaho fescue (*Festuca idahoensis*), with 50% of plots having >5% cover of that species. Bluebunch wheatgrass was not encountered in any of the plots in this frame. Frame 26, Carey Kipuka, is notable as the only other frame where Idaho fescue was observed as well as having the second highest proportion of bluebunch wheatgrass within the sample. In this frame, 16% of the plots were estimated to contain >5% cover of Idaho fescue and 38% of the plots were estimated to contain >5% cover of bluebunch wheatgrass. Steppe bluegrass was nearly ubiquitous across the sample with most frames having >20% of plots with an estimated cover of >5%. Big sagebrush cover varied among the frames with 17 out of 25 frames having >40% of plots with an estimated cover of >5%. Frame 25, Brass Cap Kipuka, was dominated by another similar species, low sagebrush (*Artemisia arbuscula*). Sixty-six percent of the plots in that frame had cover >5% for low sagebrush. Frame 32, which burned in 2000, had the second lowest cover of big sagebrush with 10% of plots estimated at >5% cover (Table 3 and Figure A2).

Principal Non-native Species

The noxious forb rush skeletonweed (*Chondrilla juncea*) was encountered in one plot in frame 22 on the west side of the Preserve during 2010 and 2013 sampling. Yellow salsify (*Tragopogon dubius*) occurrence was sparse but widespread, and was found in the greatest number (40%) of frames for invasive forbs. Tumblemustard (*Sisymbrium altissimum*) was only found in the three Wapi frames (19, 20, & 35), occurring scattered or occasionally in dense patches. The invasive annual grass

cheatgrass is the most widespread and threatening non-native species in the park. Table 3 presents the summaries of the proportion of plots where cheatgrass cover was estimated to be >5%. Figure A9 provides a graphical summary of the same information. Figure B3 provides maps of the locations of plots, color-coded by cover class estimates for cheatgrass, providing a spatial representation of these patterns. The absence of any plots with cheatgrass >5% cover in frames 1 (Sunset Cone) and 25 (Brass Cap Kipuka), and the low proportion in several other frames is noteworthy. However, even Sunset Cone and Brass Cap Kipuka frames are completely free of cheatgrass. In 2010, one plot in frame Brass Cap Kipuka was found with cheatgrass estimated at 1-5% cover. Cheatgrass was not observed in any plots in frame Brass Cap Kipuka during the 2013 season, however it was observed while walking through the Kipuka as a small patch approximately 1 m wide. Conversely, several frames are noteworthy for the high abundance of cheatgrass. Frames on the Wapi flow (19, 20, & 35) range from proportions of 73% to 90% of their plots with cheatgrass >5% cover.

Table 3. The proportion of plots (%) in CRMO sampling frames estimated to have >5% cover for selected principal native species and for the non-native annual grass cheatgrass.

Frame ID	Big Sagebrush	Arrowleaf Balsamroot	Green Rabbitbrush	Lupine Species	Steppe Bluegrass	Bluebunch Wheatgrass	Cheatgrass
1	70	0	2	0	28	54	0
2	66	18	0	18	2	0	2
3	70	0	0	0	44	0	4
4	78	0	0	0	46	0	0
6	40	0	0	0	28	0	12
7	55	0	0	0	25	0	24
8	68	0	8	0	4	0	2
9	64	0	0	0	54	0	24
10	34	0	0	0	30	0	4
11	32	0	2	0	0	0	0
12	50	0	0	0	42	6	8
13	62	0	0	0	50	0	18
16	64	0	0	0	30	0	10
17	32	0	0	0	50	10	12
19	38	0	4	0	79	0	73
20	50	10	4	22	52	0	90
22	48	0	0	0	36	0	8
24	47	0	0	0	27	14	4
25	2	0	0	0	22	0	0
26	44	2	18	0	34	38	28
29	24	0	4	0	26	8	30
30	50	0	6	0	48	16	14
31	72	0	0	0	38	0	12
32	10	0	18	0	46	2	10
35	18	20	22	10	32	0	82

Discussion

Patterns of cover observed in CRMO frames in 2013 tended to co-occur in ways that suggest areas of high ecological condition (e.g., Brass Cap Kipuka) and low ecological condition (e.g., Sand Kipuka on the Wapi Flow). Native perennial forb and bunchgrass wheatgrass cover has been generally associated with ecological resistance and resilience in western sagebrush rangelands (Germino et al. 2004, Prevey et al. 2010). The Golden Chariot Fire frame, frame 32, which burned in 2000, also has notably high cover of cheatgrass. The Golden Chariot Fire illustrates the changes that can occur in response to fire. Of particular interest for the Golden Chariot Fire frame are the large numbers of sage grouse that use the area for lekking and brood rearing (M. Munts, CRMO, personal communication). Monitoring data that provides a measure of change over time in that frame will be important for park management.

Based on cheatgrass cover observations as well as on the low cover observations for native perennial species, it appears that low elevation, southern portions of the park are less likely to exhibit resilience, particularly if climate change predictions for the region, which include increased aridity, creating more favorable conditions for cheatgrass, are realized (Chambers et al. 2007, Karl et al. 2009). The three frames on the Wapi Flow (frames 19, 20, and 35), which are in kipukas in the lowest portion of CRMO, as well as Carey Kipuka (frame 26) located approximately in the middle of the elevational gradient, were observed with high amounts of cheatgrass cover. These observations underscore that even areas physically isolated from past grazing are vulnerable to degradation, particularly if burned. In 2013, frame 6, located south of Laidlaw Park in a remote portion of the Preserve, showed signs of being recently burned and approximately one third of the frame appeared to have been affected by recent wildfire. Cheatgrass cover >5% was found in approximately 12% of plots in frame 6 and is likely to increase with the recent fire disturbance. Finally, it is worth mentioning that frame 2 (Little Cottonwood Creek frame), which had relatively high cheatgrass cover observed in 2010 was observed as having widespread cover but low abundance of this species during the 2013 season. Site disturbance history may explain the localized cheatgrass invasion. Sheep grazing and mining activities have occurred in the drainage in the past (J. Apel, CRMO, personal communication). Trends in cheatgrass cover in this frame should be watched carefully. Little Cottonwood Creek frame is in an area proposed for National Natural Landmark designation, along with Brass Cap Kipuka, and is located near Sunset Cone.

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Appendix A

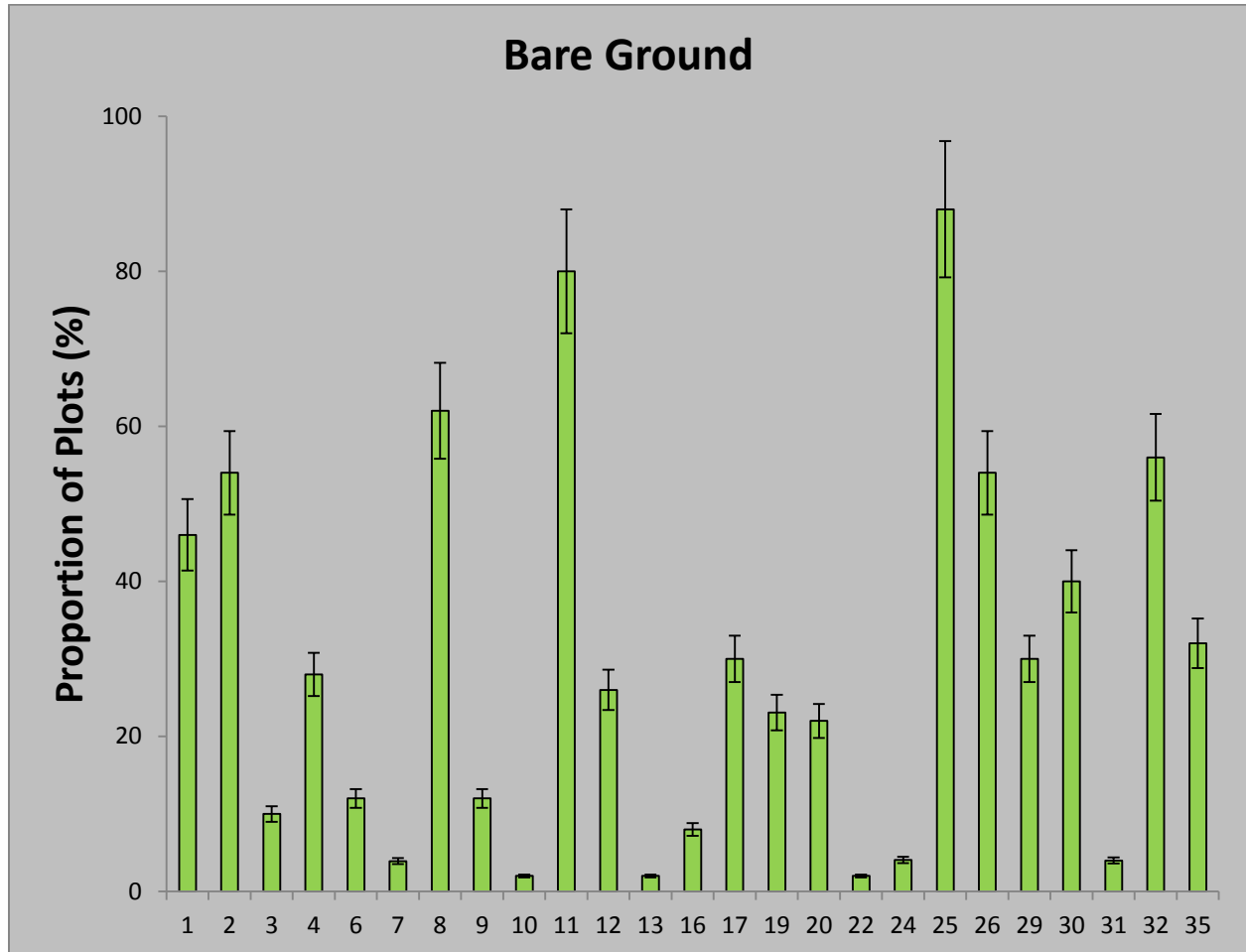


Figure A-1. Proportion of plots expressed in percent, in which bare ground cover was estimated to occur with >5% cover for each of 25 CRMO sampling frames in 2013. 90% confidence intervals are presented as black vertical bars.

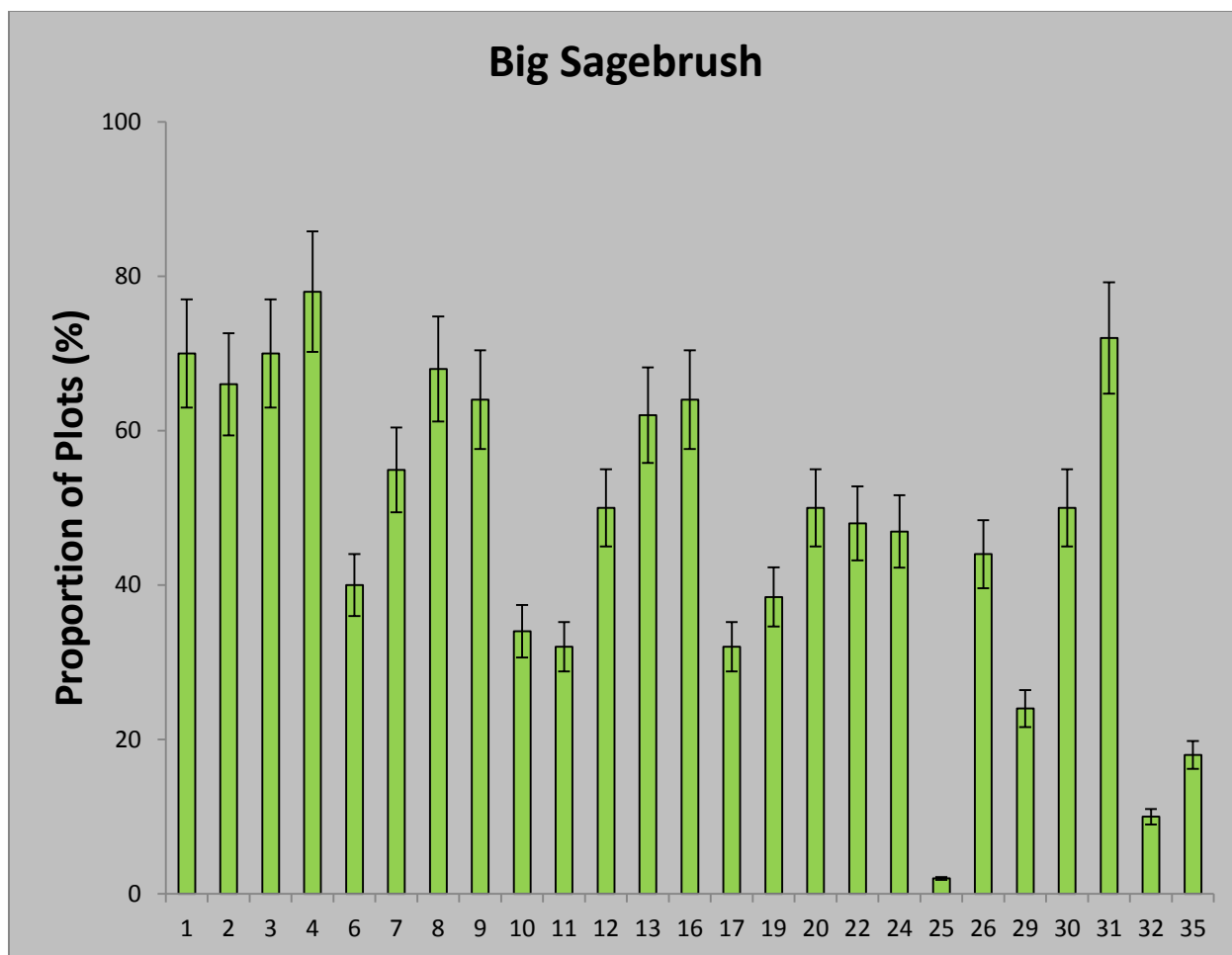


Figure A-2. Proportion of plots expressed in percent, in which big sagebrush was estimated to occur with >5% cover for each of 25 CRMO sampling frames in 2013. 90% confidence intervals are presented as black vertical bars.

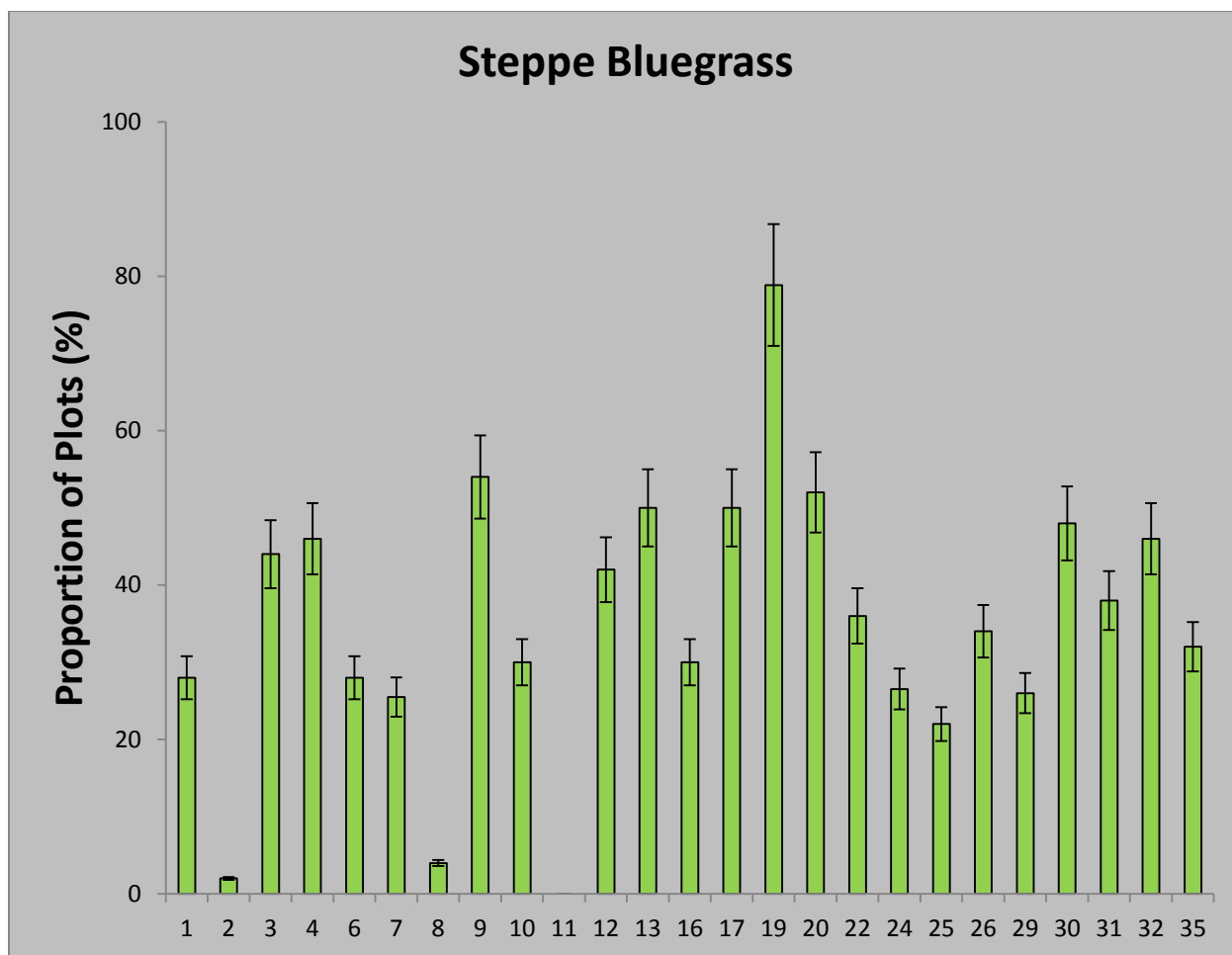


Figure A-3. Proportion of plots expressed in percent, in which steppe bluegrass was estimated to occur with >5% cover for each of 25 CRMO sampling frames in 2013. 90% confidence intervals are presented as black vertical bars.

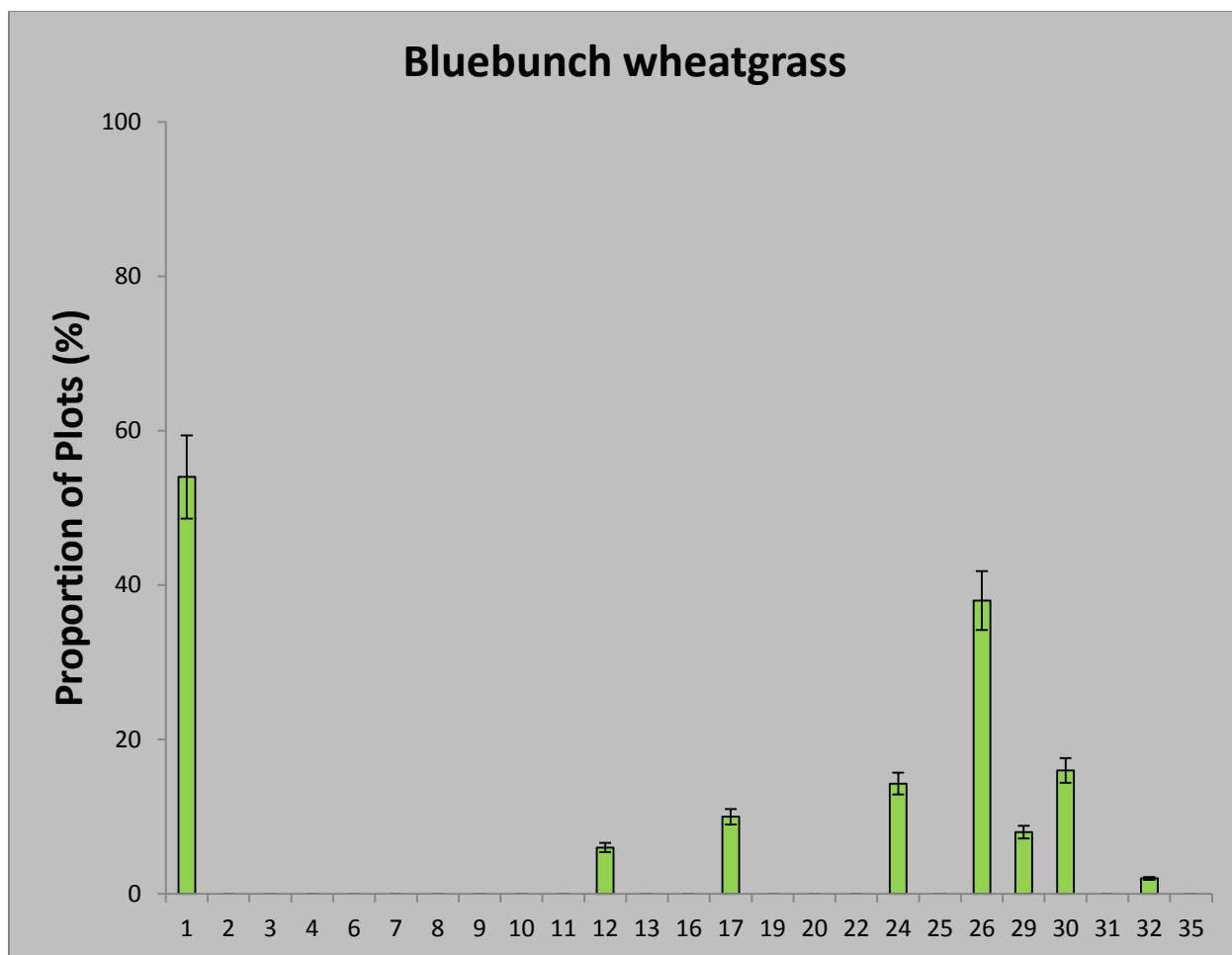


Figure A-4. Proportion of plots expressed in percent, in which bluebunch wheatgrass was estimated to occur with >5% cover for each of 25 CRMO sampling frames in 2013. 90% confidence intervals are presented as black vertical bars.

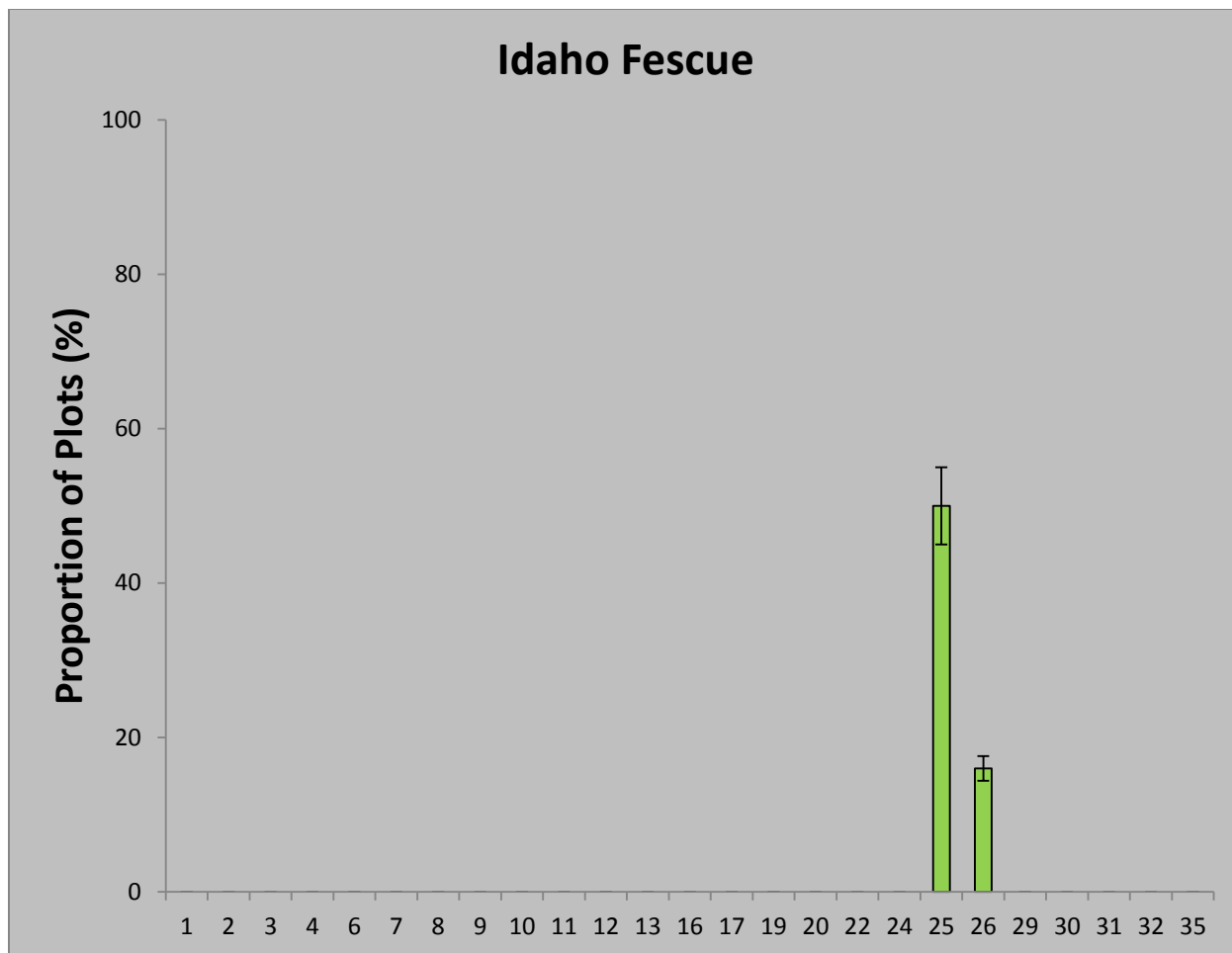


Figure A-5. Proportion of plots expressed in percent, in which Idaho fescue was estimated to occur with >5% cover for each of 25 CRMO sampling frames in 2013. 90% confidence intervals are presented as black vertical bars.

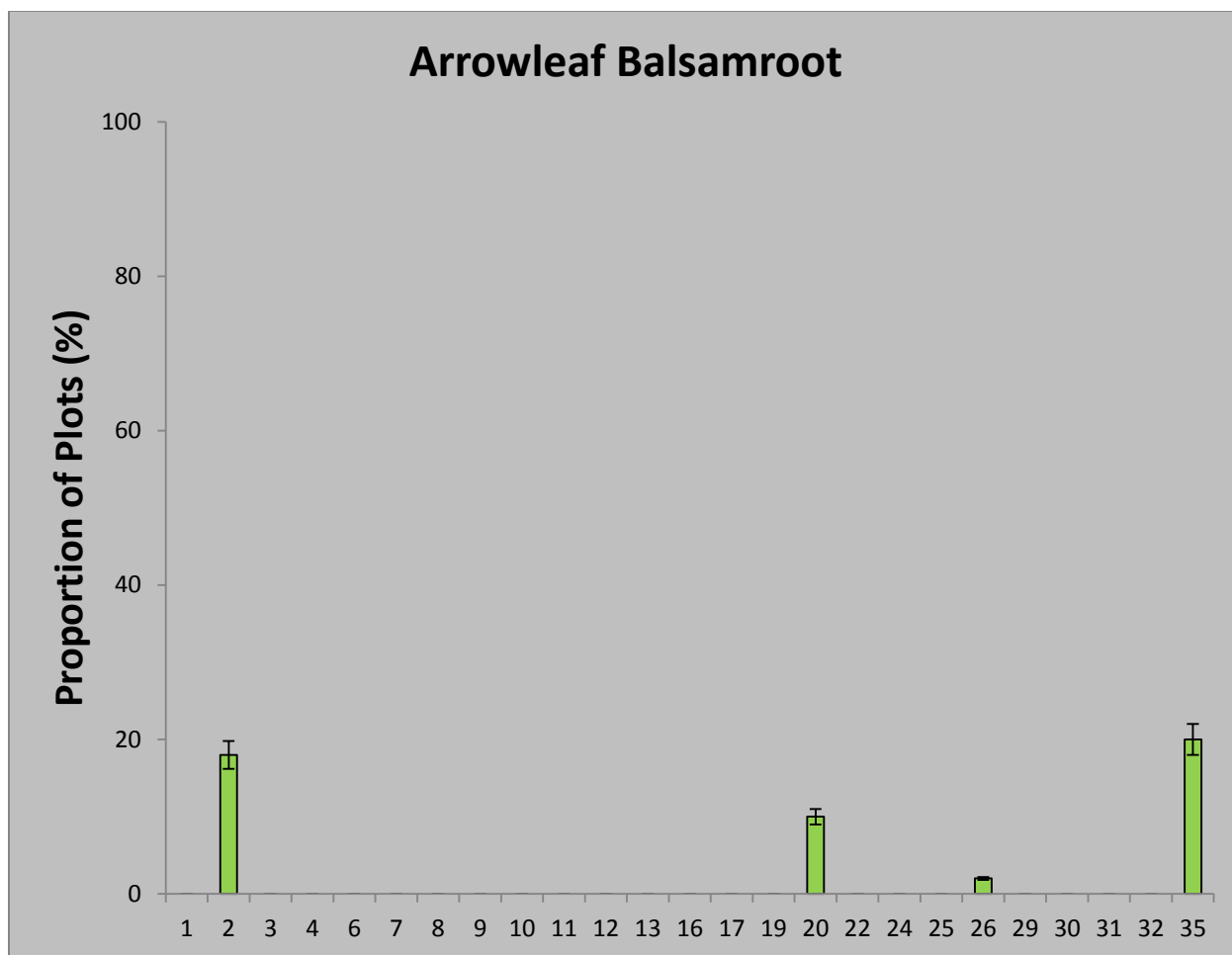


Figure A-6. Proportion of plots expressed in percent, in which arrowleaf balsamroot was estimated to occur with >5% cover for each of 25 CRMO sampling frames in 2013. 90% confidence intervals are presented as black vertical bars.

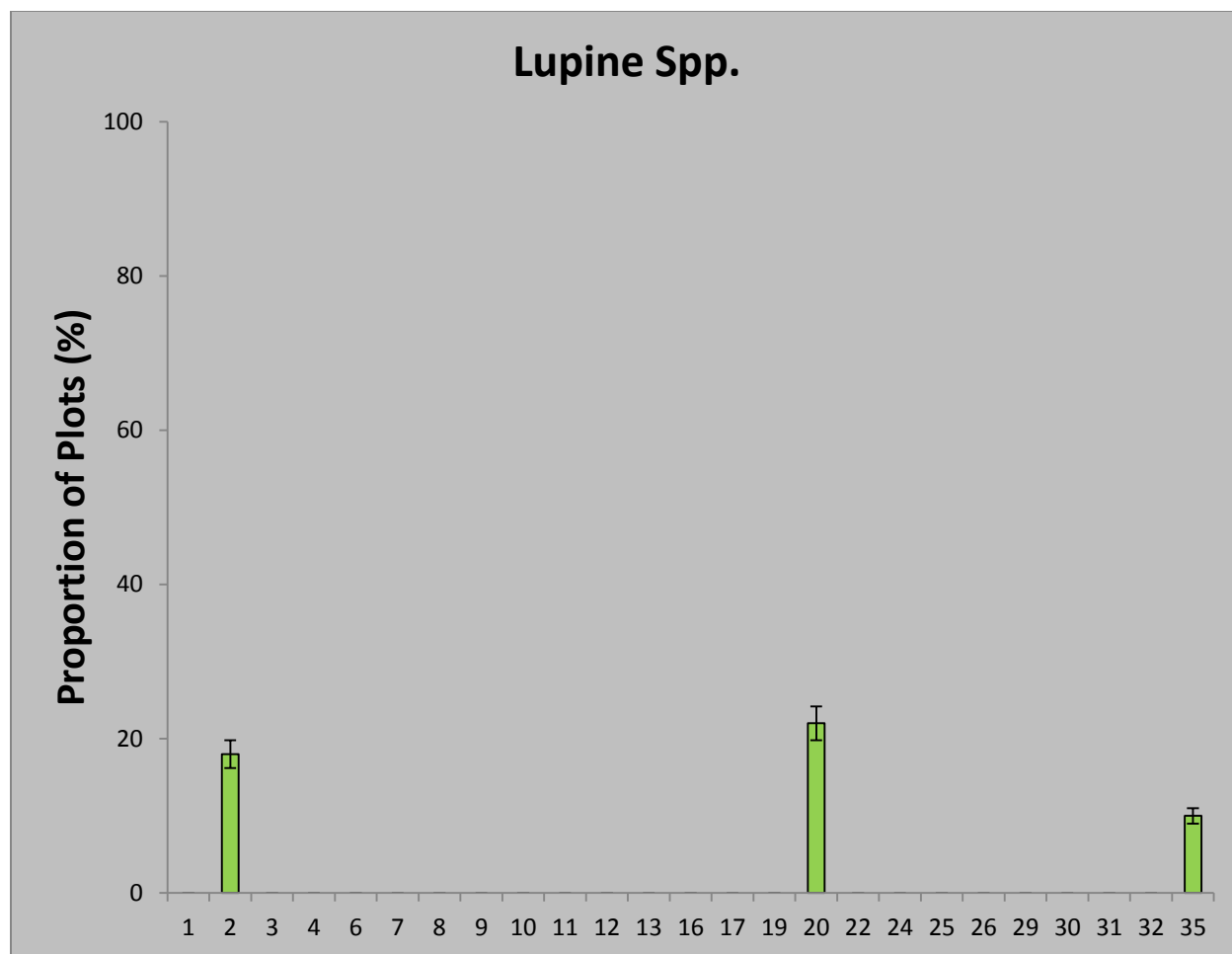


Figure A-7. Proportion of plots expressed in percent, in which lupine species were estimated to occur with >5% cover for each of 25 CRMO sampling frames in 2013. 90% confidence intervals are presented as black vertical bars.

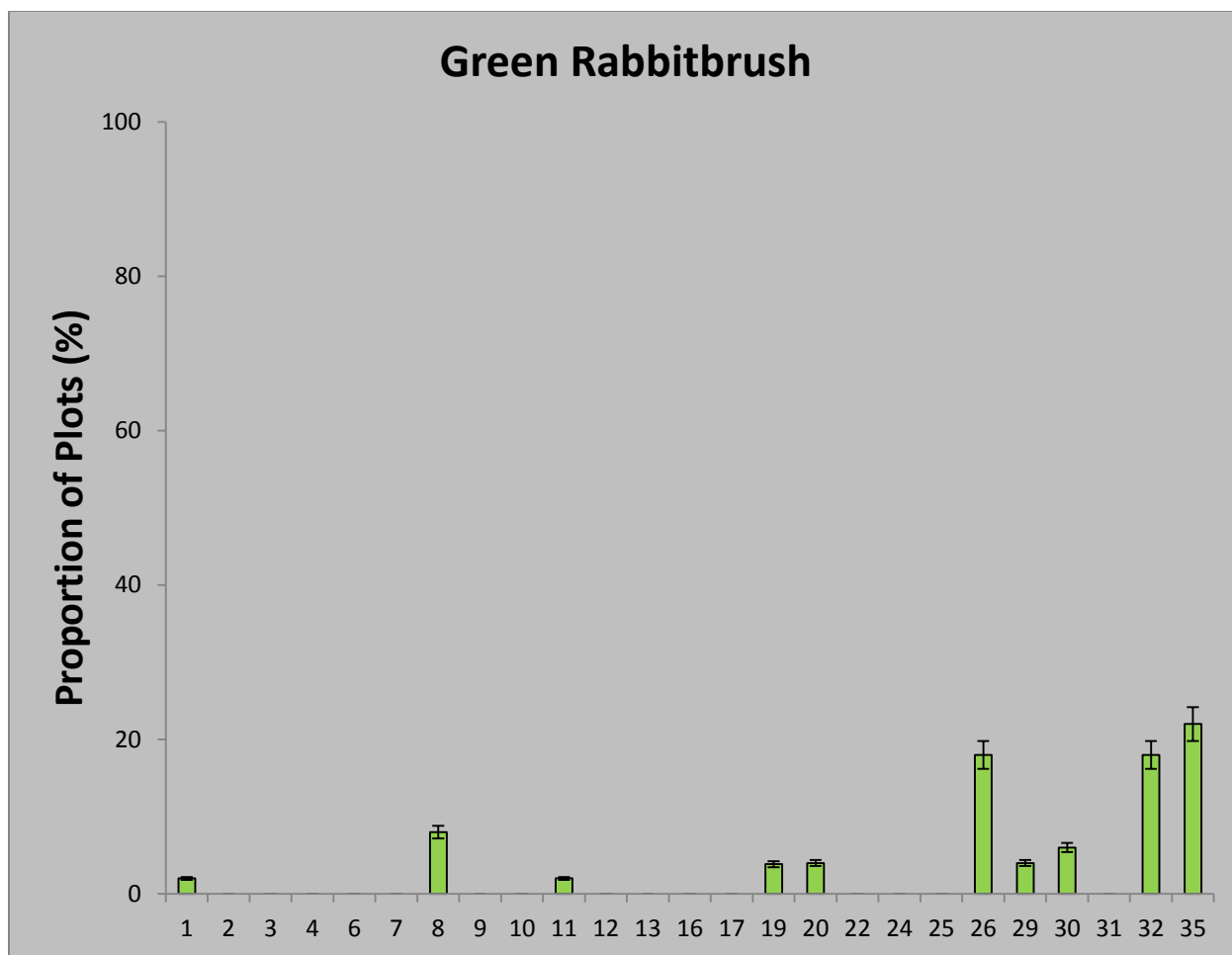


Figure A-8. Proportion of plots expressed in percent, in which green rabbitbrush was estimated to occur with >5% cover for each of 25 CRMO sampling frames in 2013. 90% confidence intervals are presented as black vertical bars.

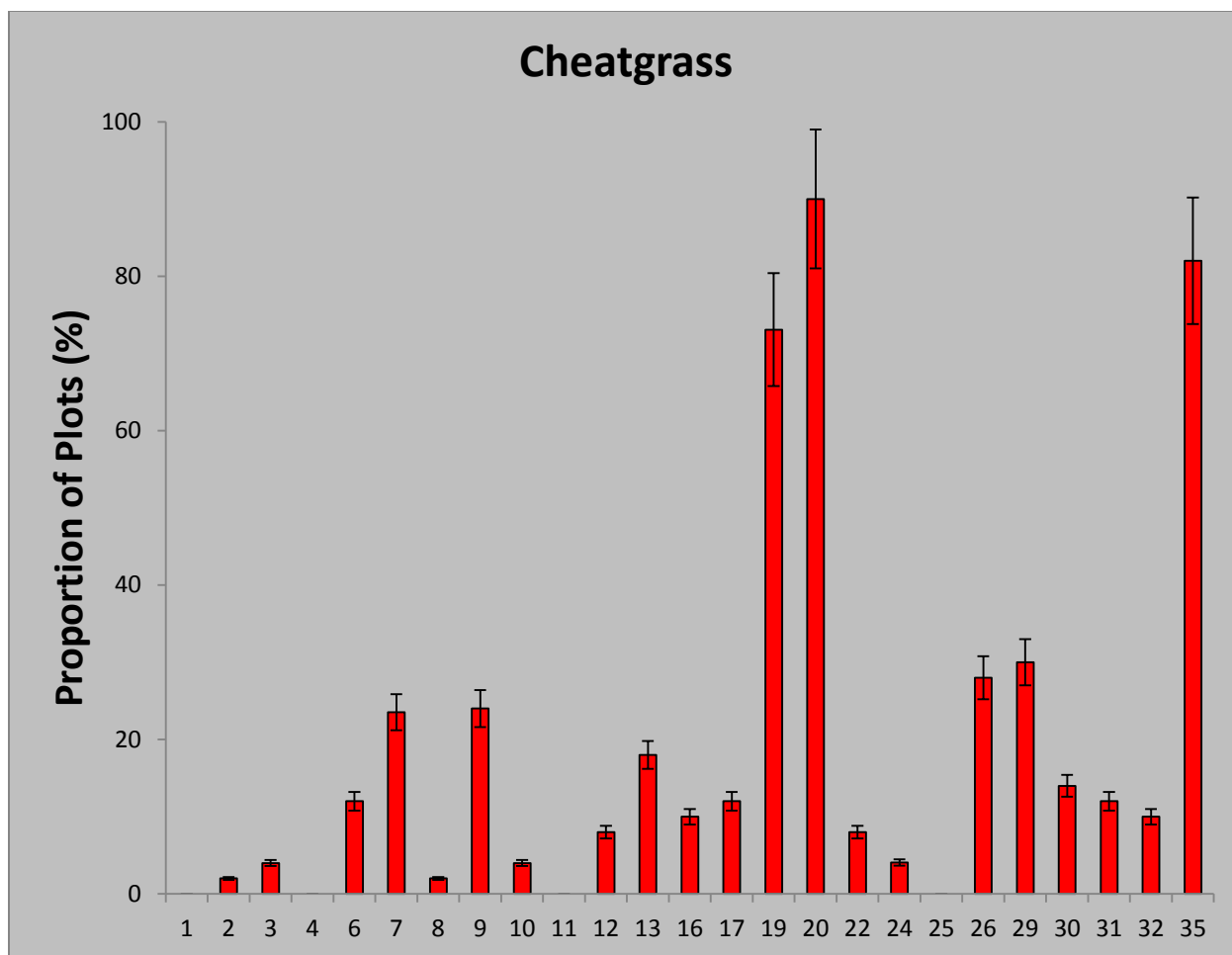


Figure A-9. Proportion of plots expressed in percent, in which cheatgrass was estimated to occur with >5% cover for each of 25 CRMO sampling frames in 2013. 90% confidence intervals are presented as black vertical bars.

Appendix B

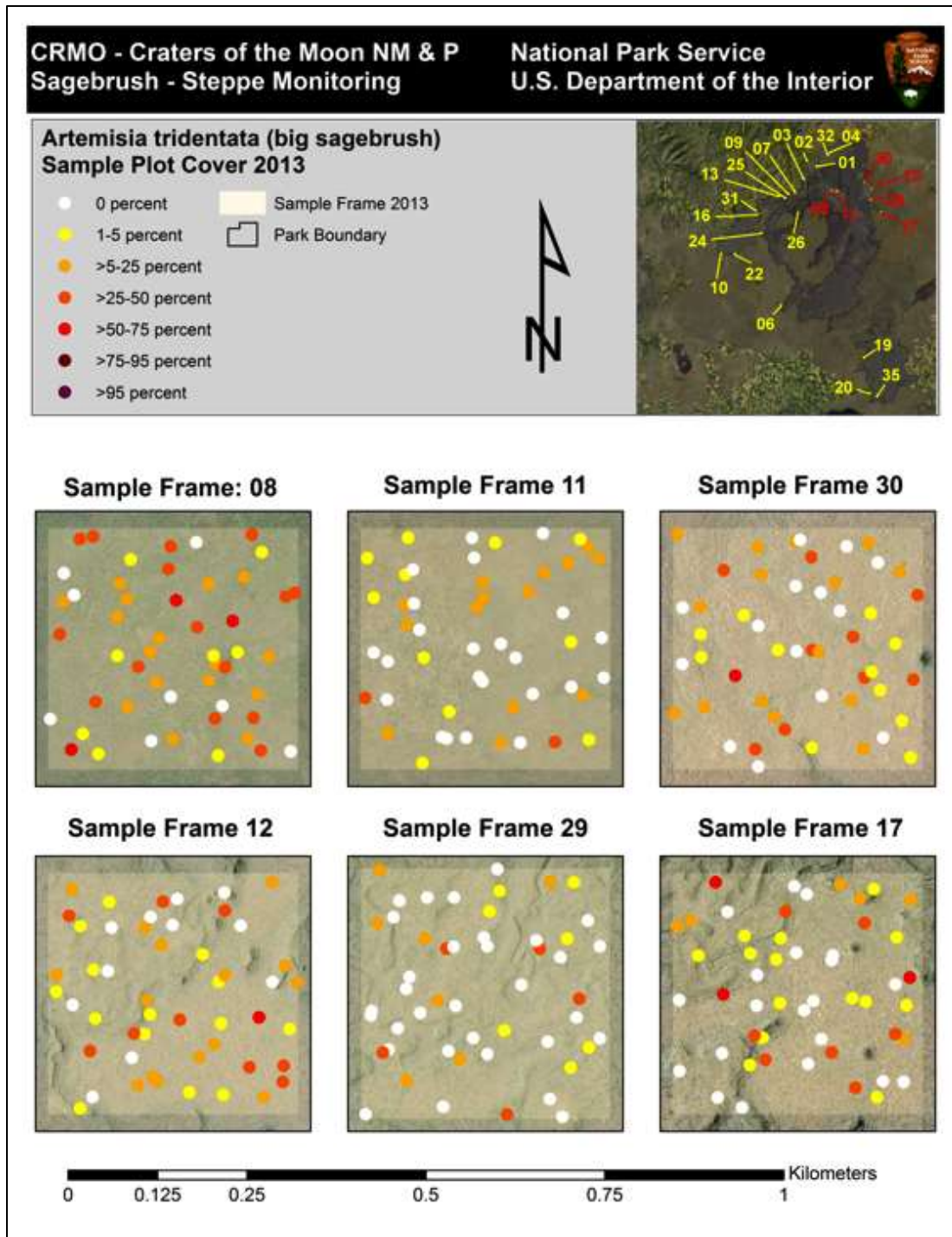


Figure B-1. The location of 2013 plots in CRMO containing big sagebrush, color coded by Daubenmire cover class. Frame numbers correspond to the iterative order of identification and development during protocol development (Yeo et al. 2009), and are grouped for illustration here by geographic proximity.

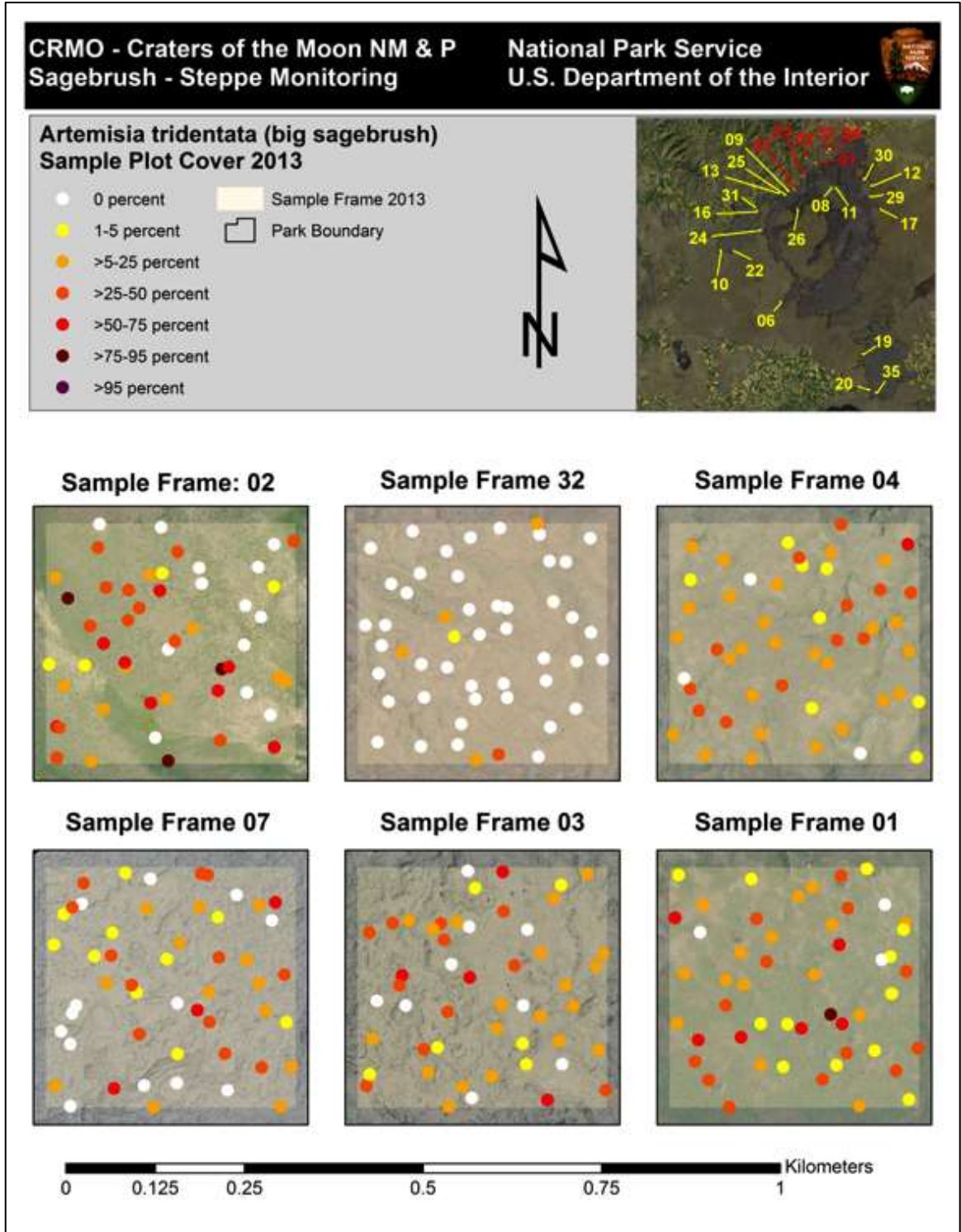
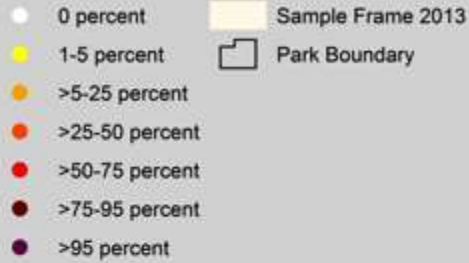


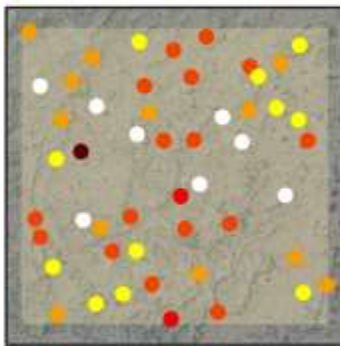
Figure B-1. The location of 2013 plots in CRMO containing big sagebrush, color coded by Daubenmire cover class (continued).



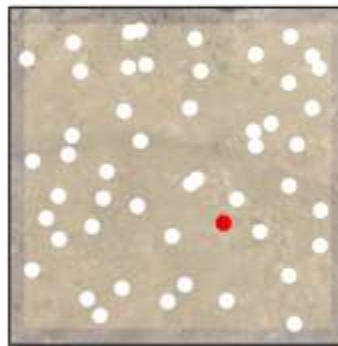
**Artemisia tridentata (big sagebrush)
Sample Plot Cover 2013**



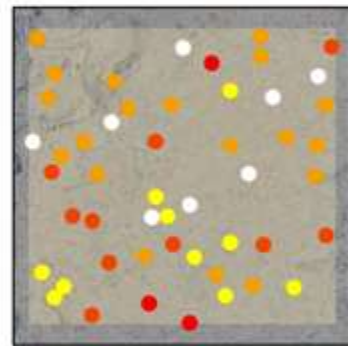
Sample Frame: 13



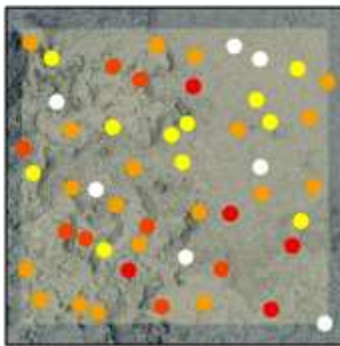
Sample Frame 25



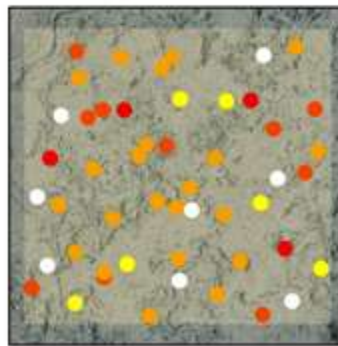
Sample Frame 09



Sample Frame 16



Sample Frame 31



Sample Frame 26

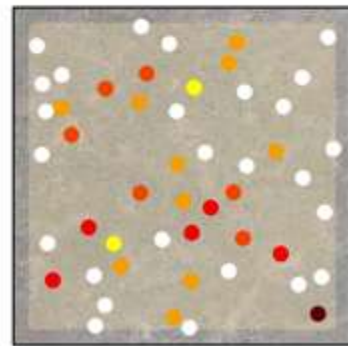
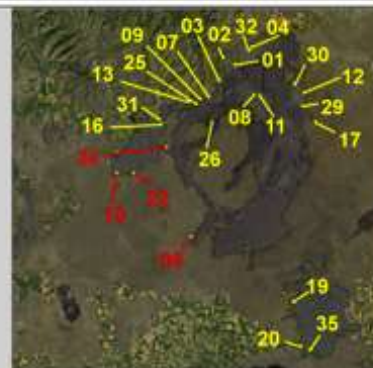
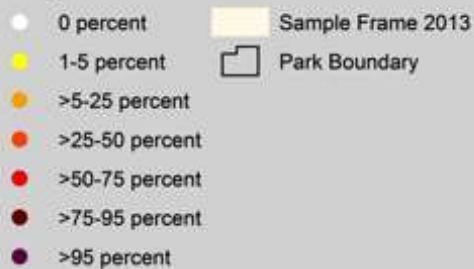


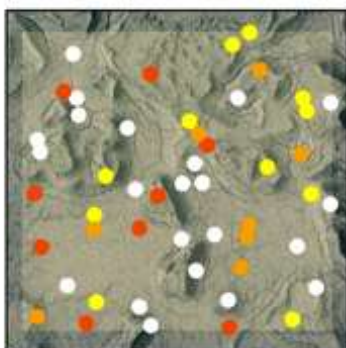
Figure B-1. The location of 2013 plots in CRMO containing big sagebrush, color coded by Daubenmire cover class (continued).



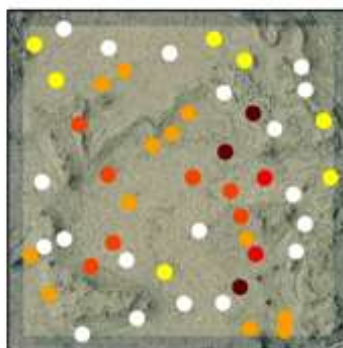
**Artemisia tridentata (big sagebrush)
Sample Plot Cover 2013**



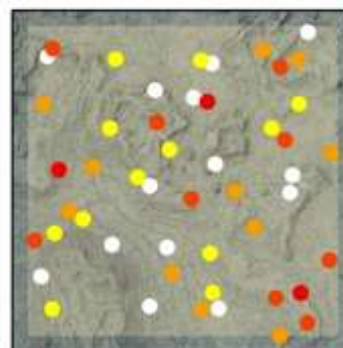
Sample Frame: 10



Sample Frame 22



Sample Frame 24



Sample Frame 06

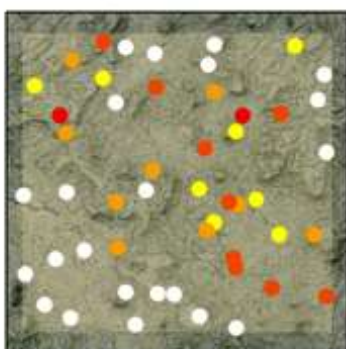
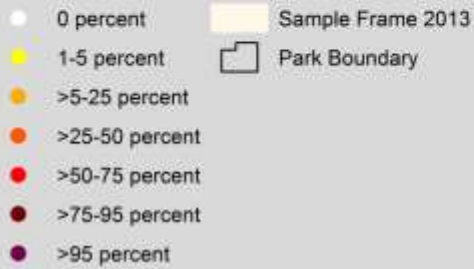


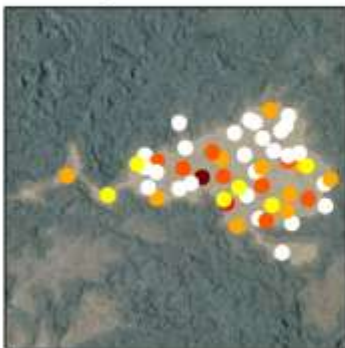
Figure B-1. The location of 2013 plots in CRMO containing big sagebrush, color coded by Daubenmire cover class (continued).



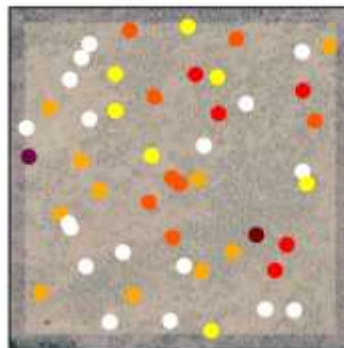
**Artemisia tridentata (big sagebrush)
Sample Plot Cover 2013**



Sample Frame: 19



Sample Frame 20



Sample Frame 35

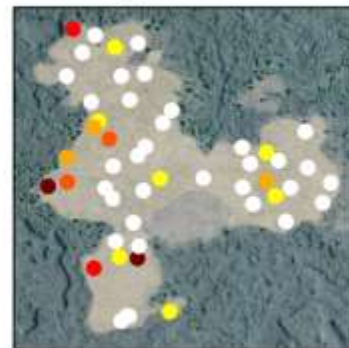


Figure B-1. The location of 2013 plots in CRMO containing big sagebrush, color coded by Daubenmire cover class (continued).

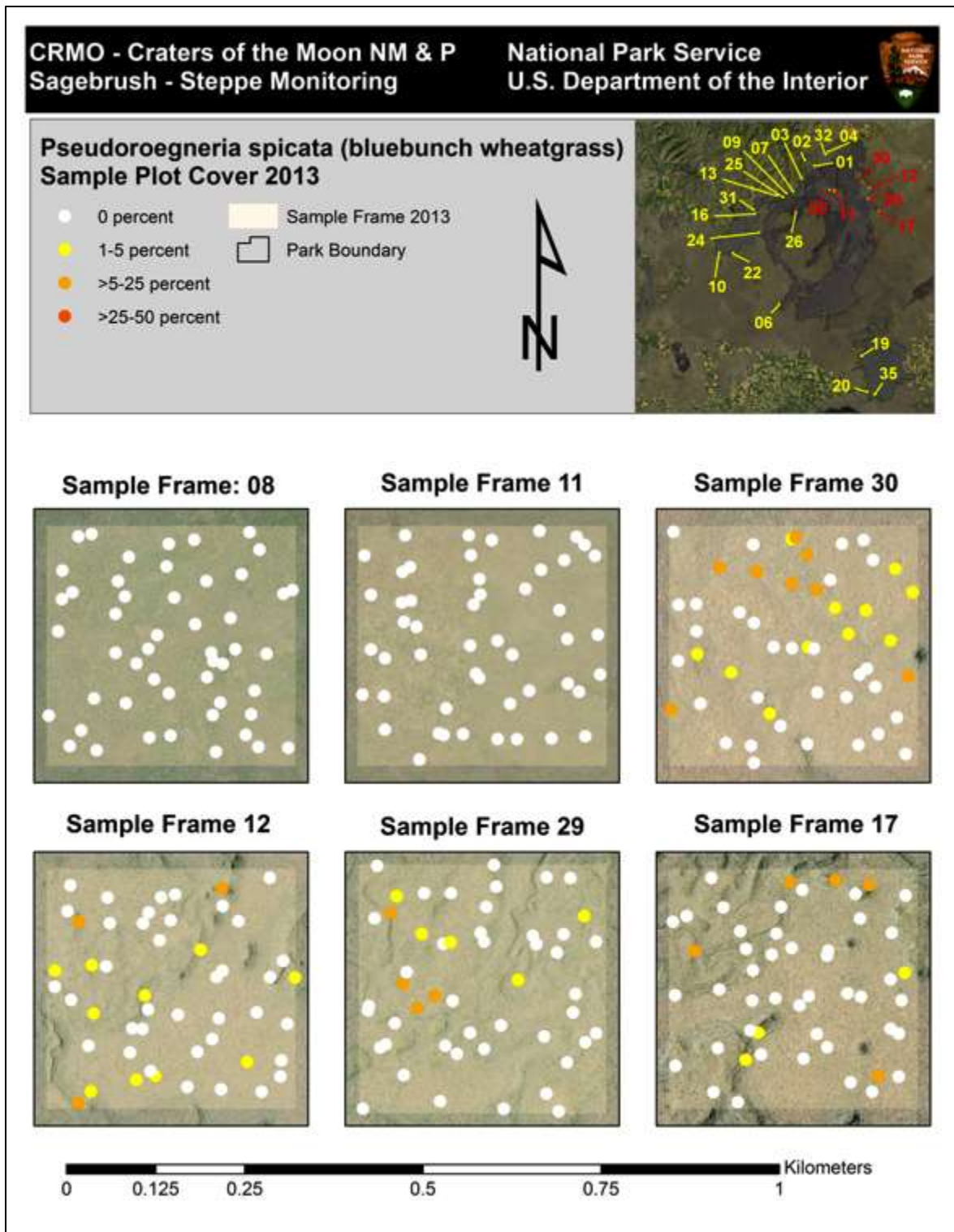
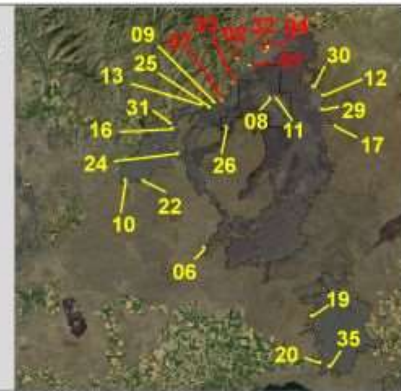


Figure B-2. The location of 2013 plots in CRMO containing bluebunch wheatgrass, color coded by Daubenmire cover class. Frame numbers correspond to the iterative order of identification and development during protocol development (Yeo et al. 2009), and are grouped for illustration here by geographic proximity.



***Pseudoroegneria spicata* (bluebunch wheatgrass)
Sample Plot Cover 2013**

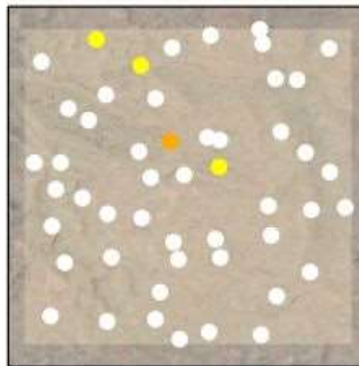
- 0 percent
- 1-5 percent
- >5-25 percent
- >25-50 percent
- Sample Frame 2013
- Park Boundary



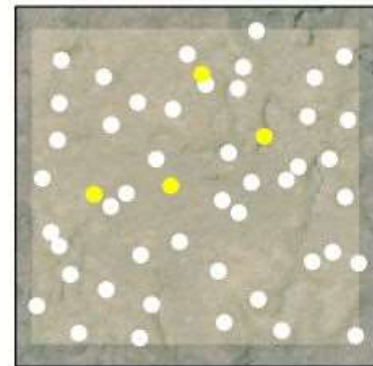
Sample Frame: 02



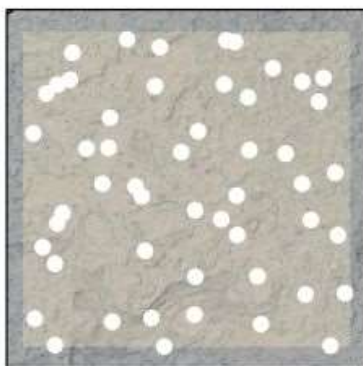
Sample Frame 32



Sample Frame 04



Sample Frame 07



Sample Frame 03



Sample Frame 01

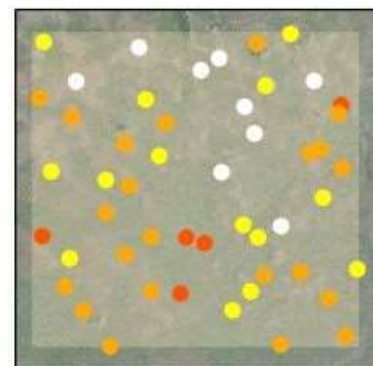


Figure B-2. The location of 2013 plots in CRMO containing bluebunch wheatgrass, color coded by Daubenmire cover class (continued).



***Pseudoroegneria spicata* (bluebunch wheatgrass)
Sample Plot Cover 2013**

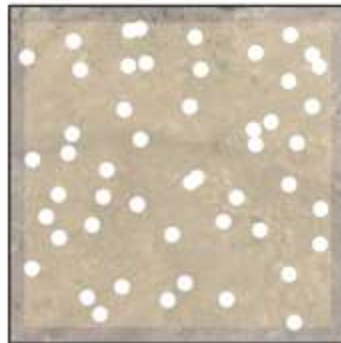
- 0 percent
- 1-5 percent
- >5-25 percent
- >25-50 percent
- Sample Frame 2013
- Park Boundary



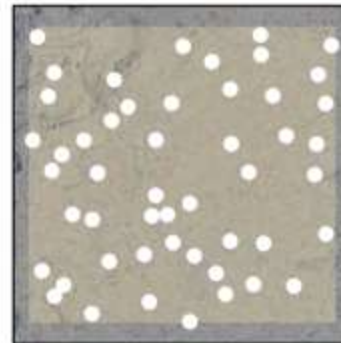
Sample Frame: 13



Sample Frame 25



Sample Frame 09



Sample Frame 16



Sample Frame 31



Sample Frame 26

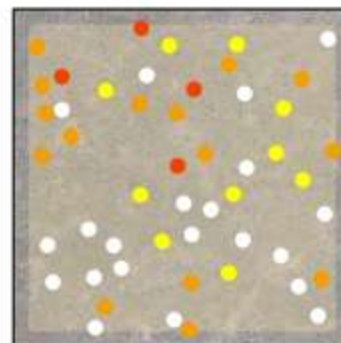


Figure B-2. The location of 2013 plots in CRMO containing bluebunch wheatgrass, color coded by Daubenmire cover class (continued).



***Pseudoroegneria spicata* (bluebunch wheatgrass)
Sample Plot Cover 2013**

- 0 percent
- 1-5 percent
- >5-25 percent
- >25-50 percent
- Sample Frame 2013
- Park Boundary



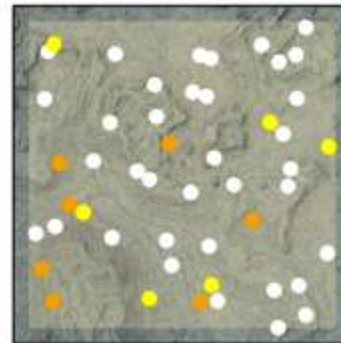
Sample Frame: 10



Sample Frame 22



Sample Frame 24



Sample Frame 06



Figure B-2. The location of 2013 plots in CRMO containing bluebunch wheatgrass, color coded by Daubenmire cover class (continued).

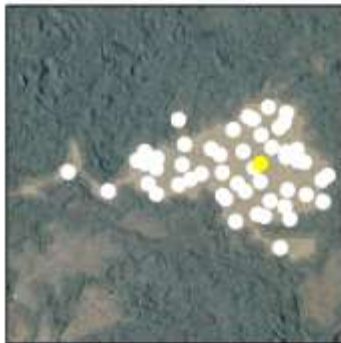


***Pseudoroegneria spicata* (bluebunch wheatgrass)
Sample Plot Cover 2013**

- 0 percent
- 1-5 percent
- >5-25 percent
- >25-50 percent
- Sample Frame 2013
- Park Boundary



Sample Frame: 19



Sample Frame 20



Sample Frame 35



Figure B-2. The location of 2013 plots in CRMO containing bluebunch wheatgrass, color coded by Daubenmire cover class (continued).

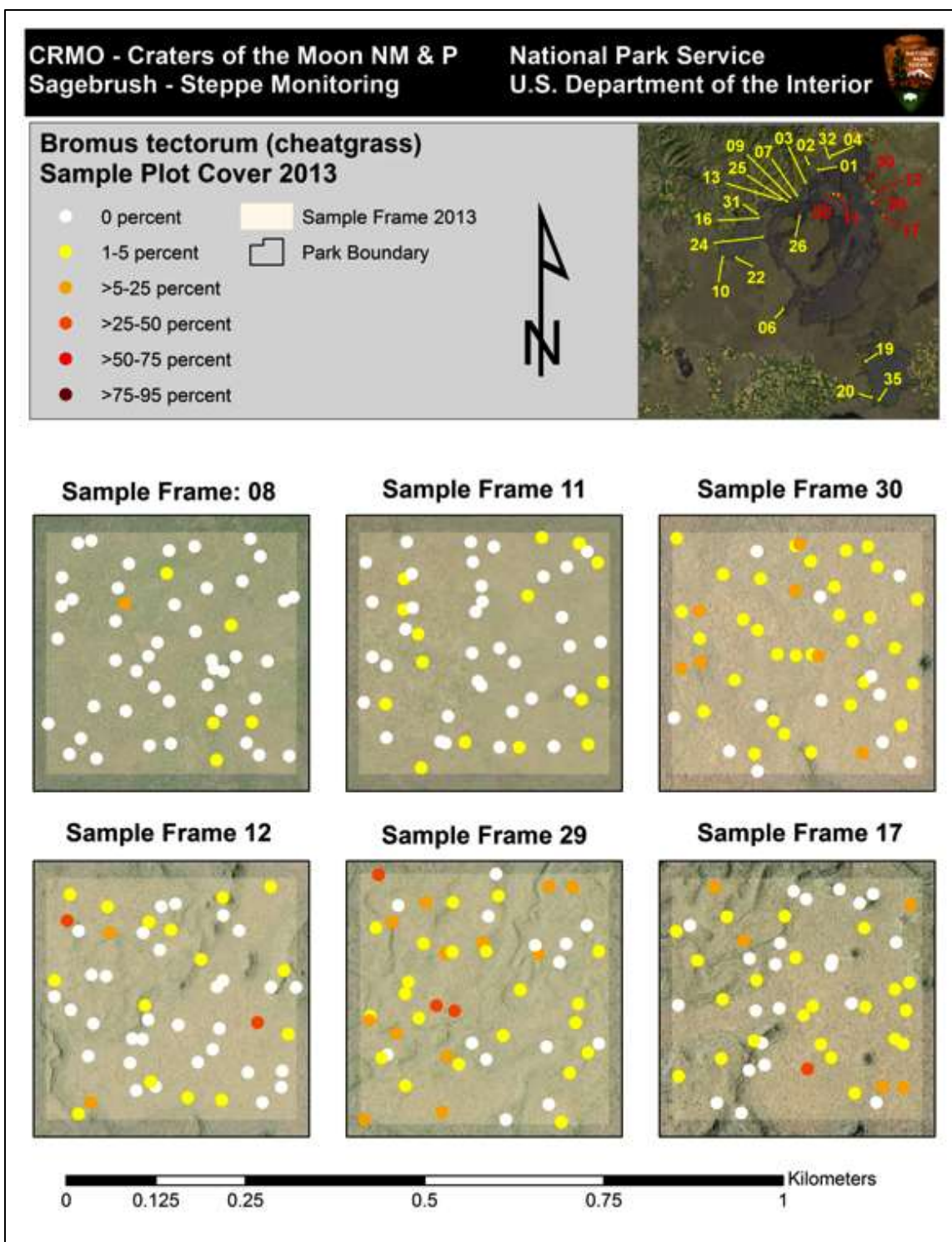
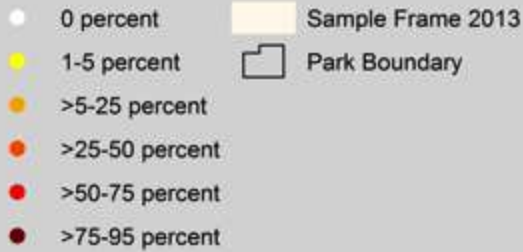


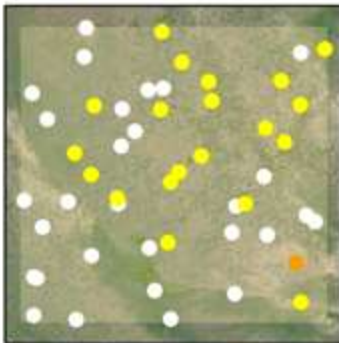
Figure B-3. The location of 2013 plots in CRMO containing cheatgrass, color coded by Daubenmire cover class. Frame numbers correspond to the iterative order of identification and development during protocol development (Yeo et al. 2009), and are grouped for illustration here by geographic proximity.



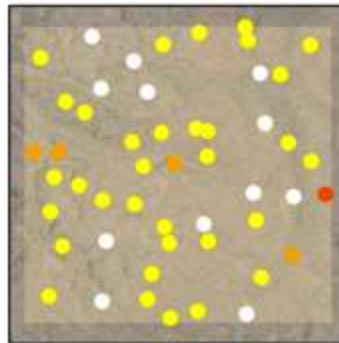
**Bromus tectorum (cheatgrass)
Sample Plot Cover 2013**



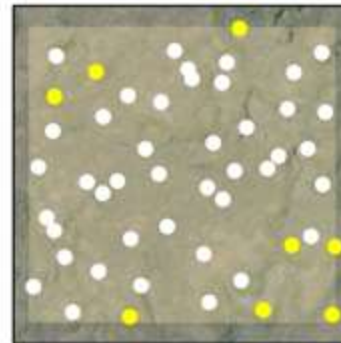
Sample Frame: 02



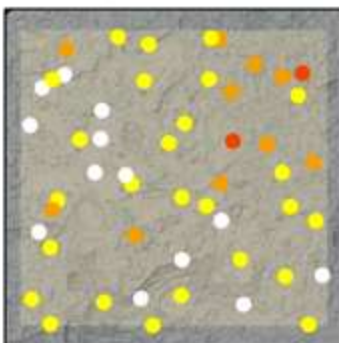
Sample Frame 32



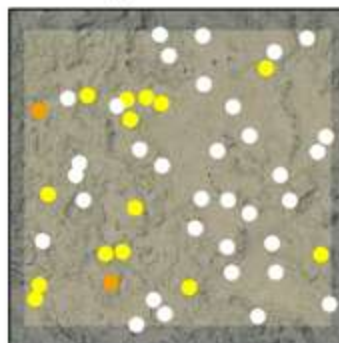
Sample Frame 04



Sample Frame 07



Sample Frame 03



Sample Frame 01

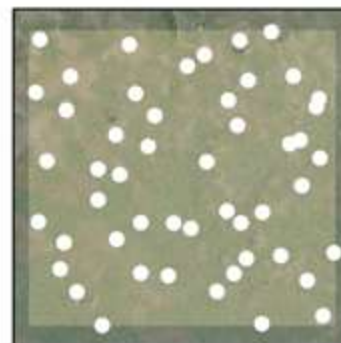
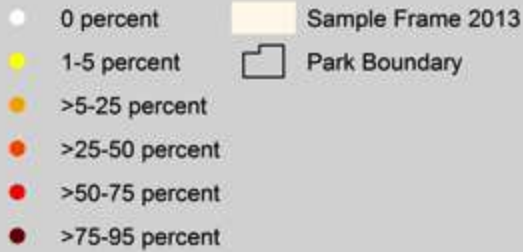


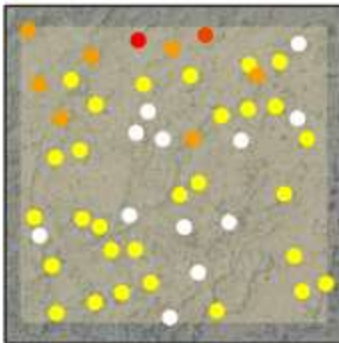
Figure B-3. The location of 2013 plots in CRMO containing cheatgrass, color coded by Daubenmire cover class (continued).



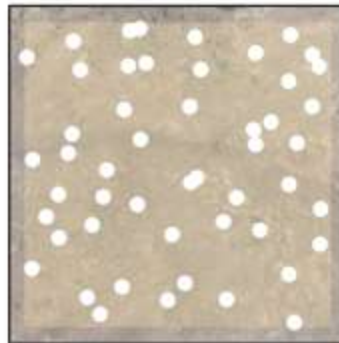
**Bromus tectorum (cheatgrass)
Sample Plot Cover 2013**



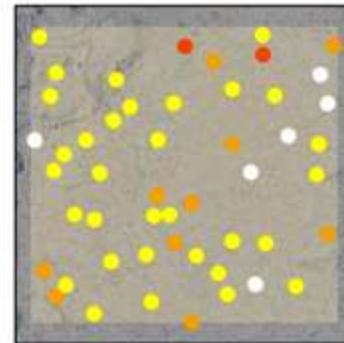
Sample Frame: 13



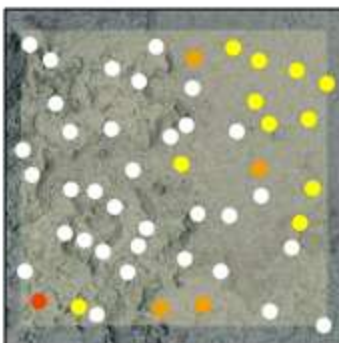
Sample Frame 25



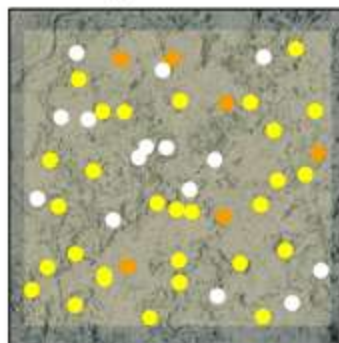
Sample Frame 09



Sample Frame 16



Sample Frame 31



Sample Frame 26

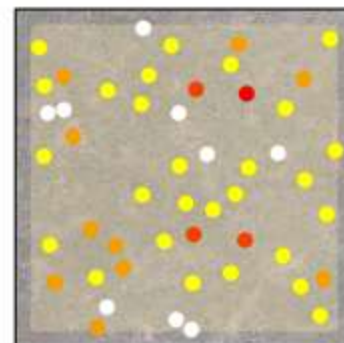
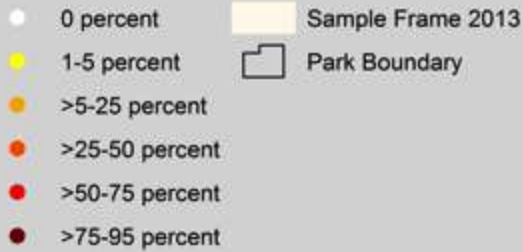


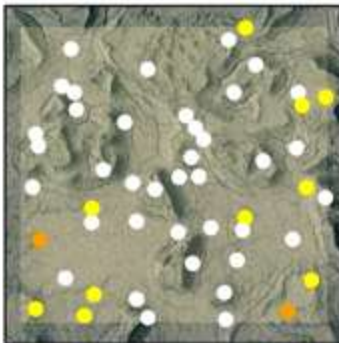
Figure B-3. The location of 2013 plots in CRMO containing cheatgrass, color coded by Daubenmire cover class (continued).



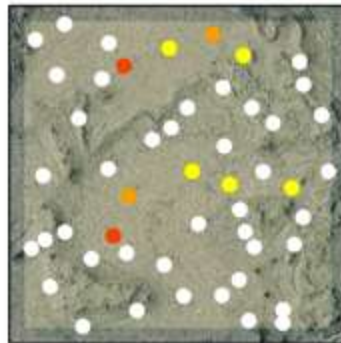
**Bromus tectorum (cheatgrass)
Sample Plot Cover 2013**



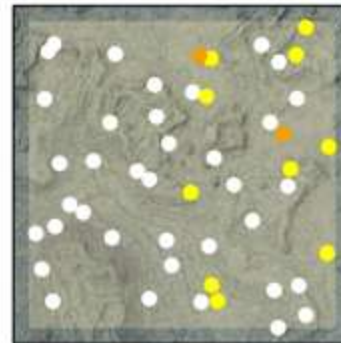
Sample Frame: 10



Sample Frame 22



Sample Frame 24



Sample Frame 06

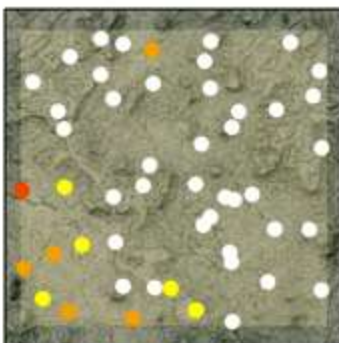
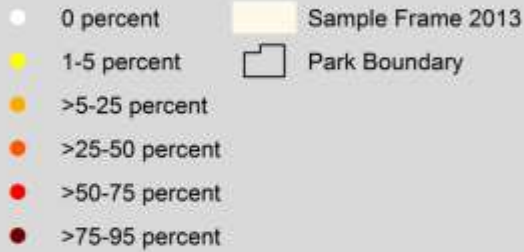


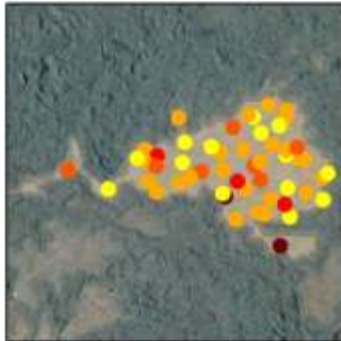
Figure B-3. The location of 2013 plots in CRMO containing cheatgrass, color coded by Daubenmire cover class (continued).



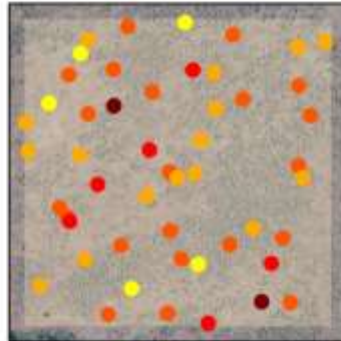
**Bromus tectorum (cheatgrass)
Sample Plot Cover 2013**



Sample Frame: 19



Sample Frame 20



Sample Frame 35

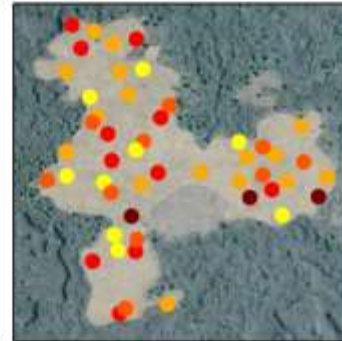


Figure B-3. The location of 2013 plots in CRMO containing cheatgrass, color coded by Daubenmire cover class (continued).

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 131/126598, September 2014

National Park Service
U.S. Department of the Interior



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