National Park Service
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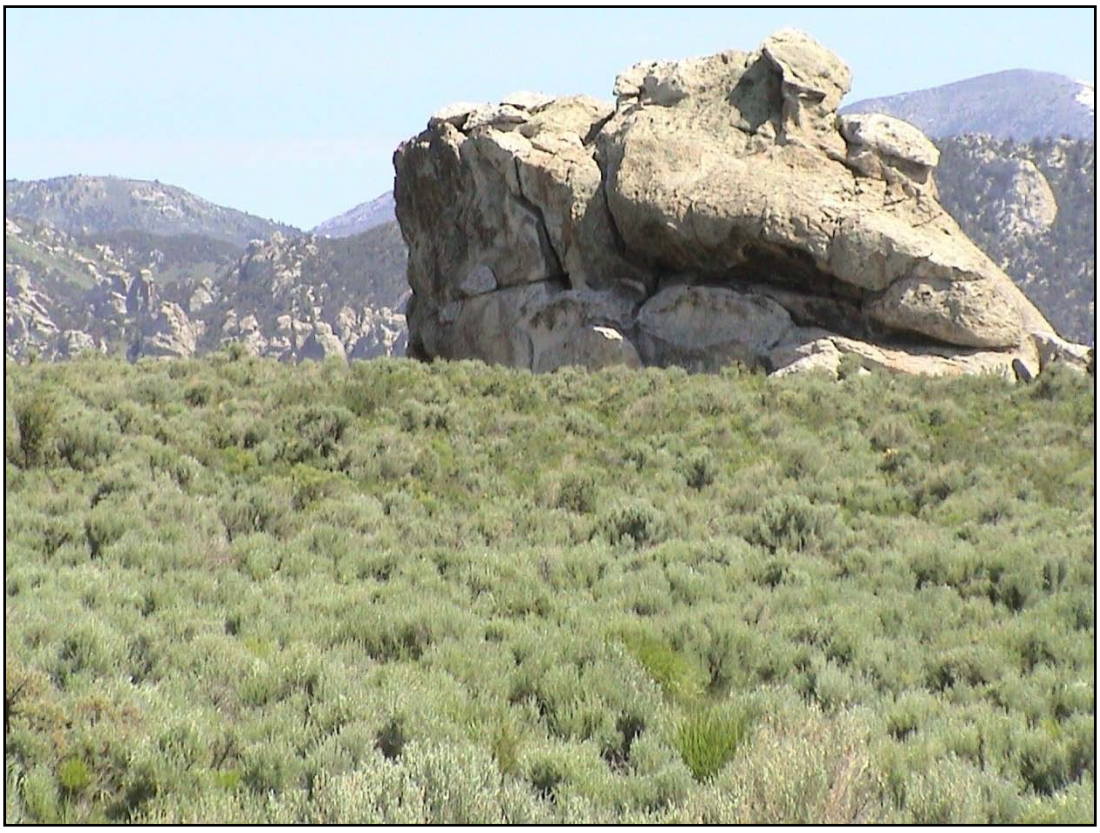
Monitoring Sagebrush-steppe Vegetation in the Upper Columbia Basin Network

2008 Annual Monitoring Report

City of Rocks National Reserve
Hagerman Fossil Beds National Monument
John Day Fossil Beds National Monument

Natural Resource Technical Report NPS/UCBN/NRTR—2009/182



ON THE COVER
Sagebrush-steppe vegetation, City of Rocks National Reserve (CIRO), Idaho
NPS Photograph courtesy of the Upper Columbia Basin Network

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Executive Summary

The Upper Columbia Basin Network of the National Park Service has identified 14 priority park vital signs, indicators of ecosystem health, which represent a broad suite of ecological phenomena operating across multiple temporal and spatial scales. Our intent has been to monitor a balanced and integrated "package" of vital signs that meets the needs of current park management, but will also be able to accommodate unanticipated environmental conditions in the future. Sagebrush steppe is one particularly high priority vital sign for five UCBN parks: City of Rocks National Reserve (CIRO), Craters of the Moon National Monument and Preserve (CRMO), Hagerman Fossil Beds National Monument (HAFO), John Day Fossil Beds National Monument (JODA), and Lake Roosevelt National Recreation Area (LARO). Sagebrush steppe occupies over 50% of land cover in CIRO, HAFO, and JODA, and over 90% of the vegetated area of CRMO. At LARO, sagebrush steppe is present and significant in the southern half of the park and represents an important park ecosystem. Historic and current land use practices both within and adjacent to UCBN park steppe communities continue to fragment and alter steppe ecosystems, and predicted climate change scenarios for the region will likely exacerbate these changes.

This annual report details the status of key indicators of rangeland health obtained from the first season of monitoring in CIRO, HAFO, and JODA, 2008. This season was considered a pilot year, and the UCBN tested a draft protocol that was submitted for peer review in spring 2008. A number of protocol revisions are forthcoming, and will not be detailed here. Over 500 plots were measured across the three parks in 2008. These results clarify the unique community types that occur in each park, ranging from the bunchgrass-dominated steppe at JODA to the dense mountain big sagebrush stands in CIRO. Describing the composition and structure of these communities is a critical first step for managers in understanding their respective park systems, setting desired future conditions, and interpreting future trends. For example, cheatgrass (*Bromus tectorum*) and other annual invasive grasses dominate many areas of HAFO and JODA, two low-elevation parks. At CIRO, a high-elevation park, cheatgrass is widely present but represents only a small fraction of overall plant cover. Identifying trends in cheatgrass invasion at CIRO will be a high priority for that park, given the potential shifts in precipitation predicted under future climate change scenarios. Likewise, in the low-elevation parks where cheatgrass is so ubiquitous, concern may instead be directed towards emerging threats such as invasion by the annual grass medusahead (*Taeniatherum caput-medusae*) in JODA, or loss of perennial bunchgrasses in HAFO. Differences in cover indicators were also detected among some of the grazing allotments in CIRO, illustrating the important feedback for grazing programs at CIRO and LARO that this monitoring effort can provide in the future.

Introduction

Prior to European colonization, sagebrush steppe covered approximately 44 million ha of the Intermountain West (West and Young 2000). Since then the sagebrush steppe ecosystem has undergone radical and 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 heavily grazed rangeland (West and Young 2000; Bunting et al. 2002). Much of the remaining sagebrush steppe has been degraded through altered fire regimes and invasion of introduced plants (Reid et al. 2002). Sagebrush steppe today is one of the most threatened ecosystems in the Intermountain West (Noss et al. 2005). Biological invasions, altered fire regimes, and other stressors continue to cause major, possibly irreversible, changes in steppe ecosystem structure and function (e.g., Knick et al. 2003; 2005; Brooks 2004; Dobkin and Sauder 2004).

Sagebrush steppe is the most extensive ecosystem type in the Upper Columbia Basin Network of US National Parks (UCBN), occupying over 50% of land cover in CIRO, HAFO, and JODA. At CRMO, where bare lava rock comprises 81% of the total land cover, sagebrush steppe represents over 90% of the vegetation cover. At LARO, sagebrush steppe is present and significant in the southern half of the park. Historic and current land use practices both within and adjacent to UCBN parks continue to fragment and alter steppe ecosystems (e.g., Knick and Rotenberry 1997; Hanser and Huntly 2006), and predicted climate change scenarios for the region will likely exacerbate these changes (Smith et al. 2000; Wagner et al. 2003).

The UCBN has identified sagebrush steppe vegetation as a high priority vital sign and monitoring of this ecosystem will be a central element to the UCBN monitoring program (Garrett et al. 2007). Vegetation 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; Beck et al. *in press*). 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 in sagebrush steppe plant community response to drivers and stressors emphasizes 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 regular evaluation of the status of UCBN steppe communities, and for identification of trends over time within parks and across the network. This information will provide the critical feedback required for an adaptive resource management program. I present here the results of a pilot monitoring project on plant and ground cover, frequency of principal species, and evaluations of soil/site stability for three of the five UCBN sagebrush-steppe parks.

Objectives

The monitoring objectives for this vital sign monitoring program are:

- Detect changes in the status (condition) and trends in the composition and abundance (cover) of principal native plant species in UCBN sagebrush steppe communities
- Detect changes in the status and trends in composition and abundance of principal invasive plant species including annual grasses and forbs in UCBN sagebrush steppe communities
- Describe trends in rangeland indicators of soil/site stability
- Evaluate whether trends observed in sagebrush steppe communities are primarily correlated with trends in weather and climate, or with anthropogenic disturbances

This report summarizes rangeland health indicator status estimates obtained for sagebrush steppe communities from CIRO, HAFO, and JODA in 2008. In 2008 the UCBN sampled over 500 plots in these parks in a pilot effort to test the UCBN draft protocol and to establish baseline conditions for park managers to consider.

Methods

The UCBN used a generalized random tessellation stratified (GRTS) sampling design within each sampling frame (Figures 1-5). Sampling frames were constructed for each distinct park management unit or, in the absence of such units, other logical permanent boundaries (e.g., primary roads). Additional considerations for developing sampling frames are discussed by Yeo et al. (*in review*). The UCBN completed sampling in 100 nested plots in the Clarno Unit of JODA in 2008, 94 plots in JODA's Foree Unit, and 82 plots in the Painted Hills Unit. The UCBN completed a sample of 80 plots in HAFO (no subdivision of frames), and in the Castle Rocks State Park (CRSP) portion of City of Rocks National Reserve (CIRO), a unit jointly managed by NPS and Idaho State Parks and Recreation. The UCBN also completed 79 and 100 samples in the northern and southern halves of CIRO itself. These initial sample sizes were driven by a power analysis that was conducted prior to the 2008 season, following methods suggested by Lyles et al. (2007) and detailed in the UCBN draft protocol (Yeo et al. *in review*). Box plots and summary statistics are utilized to present status estimates for each sampling frame. For CIRO, I tested for a difference in cover among allotments with Kruskal-Wallis tests using a 0.05 significance criterion (type I error). Tukey's Honest Significant Difference (HSD) multiple comparison procedure for ranks was used to evaluate pairwise comparisons between allotments when Kruskal-Wallis tests indicated significant differences among groups (Higgins 2004). Tukey's HSD procedure protects against inflated false-change (Type I) error, which can occur when making many different comparisons among groups. There were three grazing allotments sampled in the northern section of CIRO in 2008: Circle Creek, Emery Canyon, and Graham Creek. Sample sizes for these allotments were 37, 24, and 16 nested plots, respectively. Only one plot was sampled outside of an allotment and was not considered in comparisons. Seven allotments were sampled in CIRO south, 11 plots were sampled outside of allotments, and these were included as an 8^{th} group (labeled "Ungrazed" in the Results section Table 4).

Sampling methods followed those detailed by Yeo et al. (*in review*). The approach was based on nested quadrats (plots) of dimensions 0.01, 0.1, 1, and 10 m^2. Presence of principal species was noted in each plot for estimates of frequency of occurrence. Cover was visually estimated in 10 m^2 plots following Daubenmire's (1959) cover class system. Forb richness was estimated for each 10 m^2 plot in the following classes: 0=0 species, 1=1 species, 2=2-4 species, 3=5-10 species, and 4= >10 species. Soil/site stability was evaluated within each 10 m^2 plot on an ordinal scale of five levels for each of five soil surface attributes: surface litter, soil pedestals, flow patterns, rills, and gullies (modified from USDI 1973 and Pellant et al. 2005). Conifer density was measured in each of these 10 m^2 plots. Pinyon-juniper woodland expansion into steppe communities is a concern for CIRO and JODA. Finally, the top three dominant species (based on cover) of annual grasses, perennial bunchgrasses, forbs, and shrubs for each 10 m^2 plot were recorded. These species lists provide a qualitative descriptor of plant community composition, aid in the interpretation of cover estimates for respective strata, and provide the necessary pilot information for refining principal species lists for future monitoring. For this annual report, I focus attention on frequency and cover, the two central indicator types that are addressed in the sagebrush-steppe monitoring protocol. I summarize soil/site stability scores by reporting the proportion of sample units with scores ≥ 3, which represent moderate to severe soil movement and erosion.

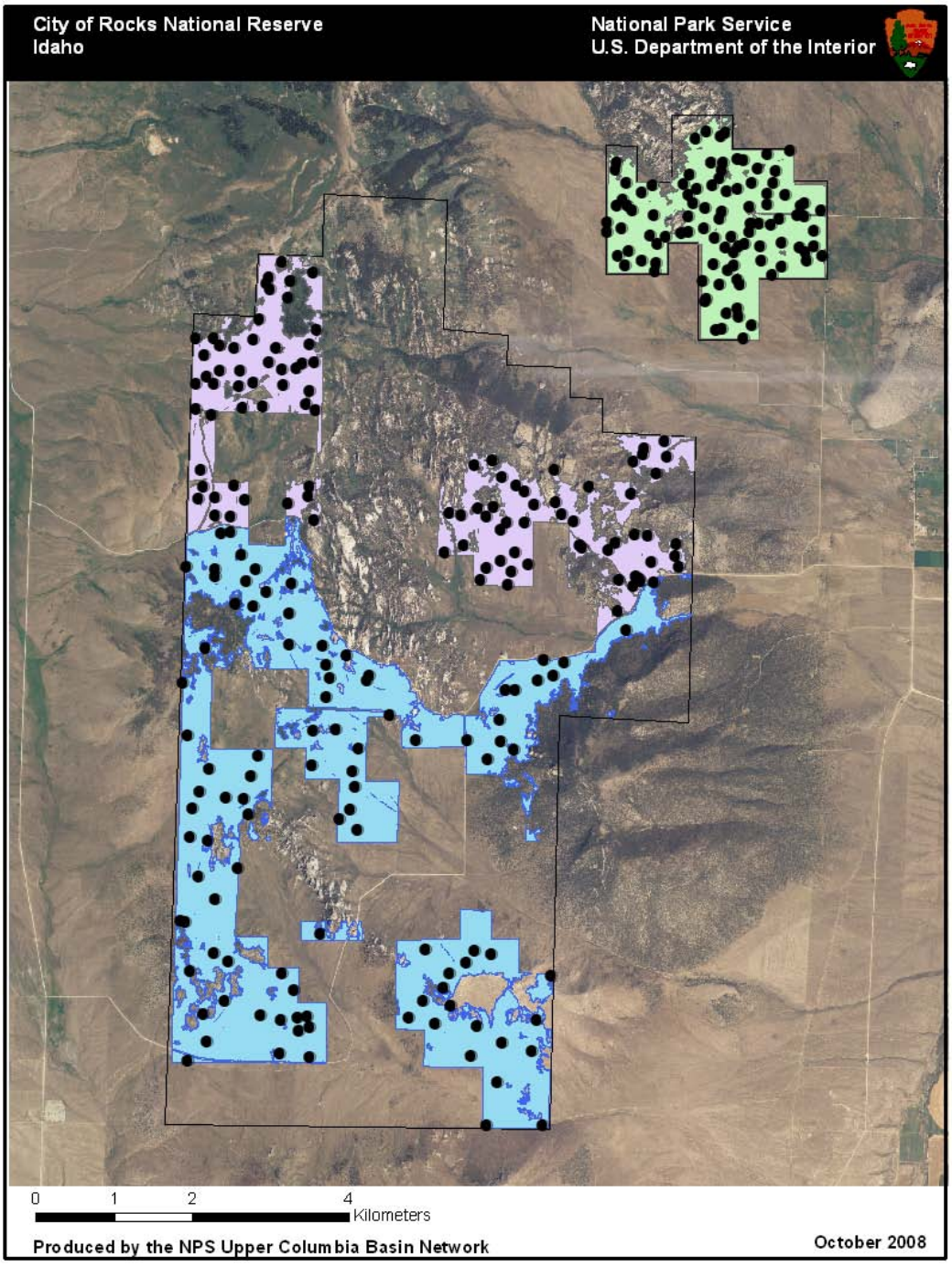

Figure 1. Sagebrush steppe vegetation draft monitoring sampling frames for City of Rocks National Reserve (pink and blue), and Castle Rocks State Park (green). Sampling unit locations are displayed as black points. Private in-holdings, steep slopes, and land cover outside the target population were excluded from the sampling frames. Details of sampling frame development are available in the UCBN sagebrush steppe vegetation draft monitoring protocol (Yeo et al. *in review*).

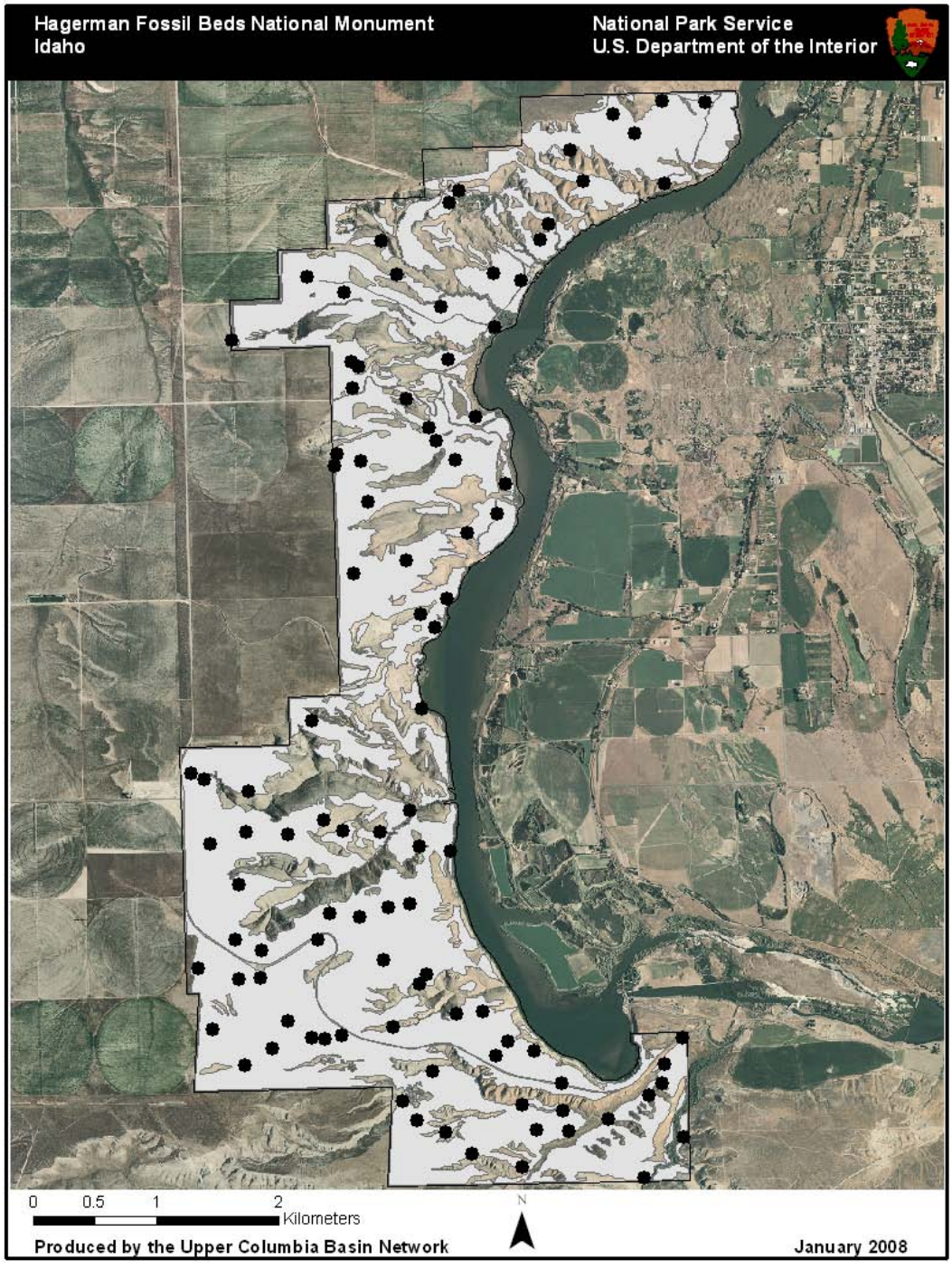

Figure 2. Sagebrush steppe vegetation draft monitoring sampling frame for Hagerman Fossil Beds National Monument. Sampling unit locations are displayed as black points. Steep slopes and land cover outside the target population were excluded from the sampling frame. Details of sampling frame development are available in the UCBN sagebrush steppe vegetation draft monitoring protocol (Yeo et al. *in review*).

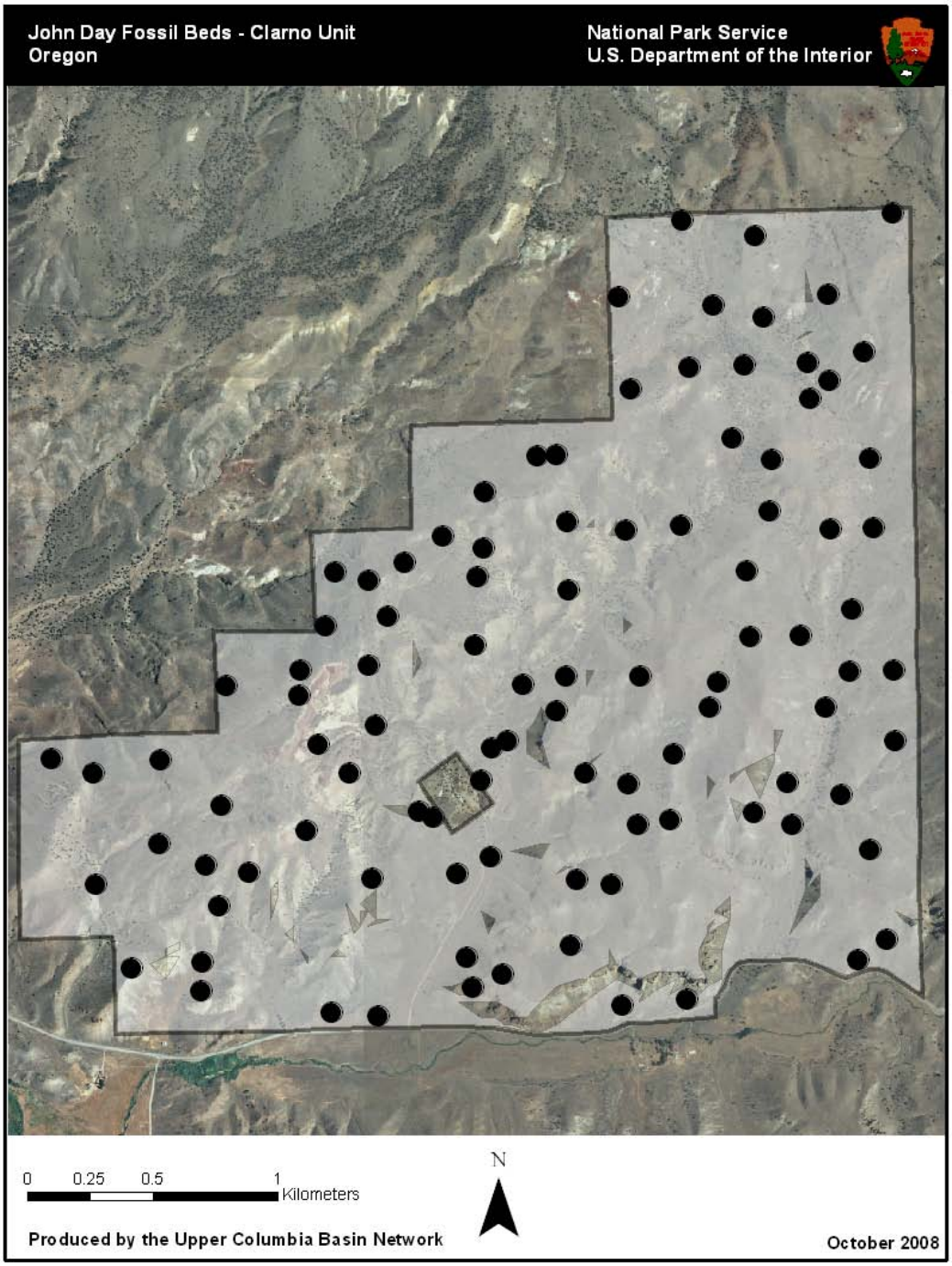

Figure 3. Sagebrush steppe vegetation draft monitoring sampling frame for the Clarno Unit of the John Day Fossil Beds National Monument. Steep slopes and land cover outside the target population were excluded from the sampling frame. Details of sampling frame development are available in the UCBN sagebrush steppe vegetation draft monitoring protocol (Yeo et al. *in review*).

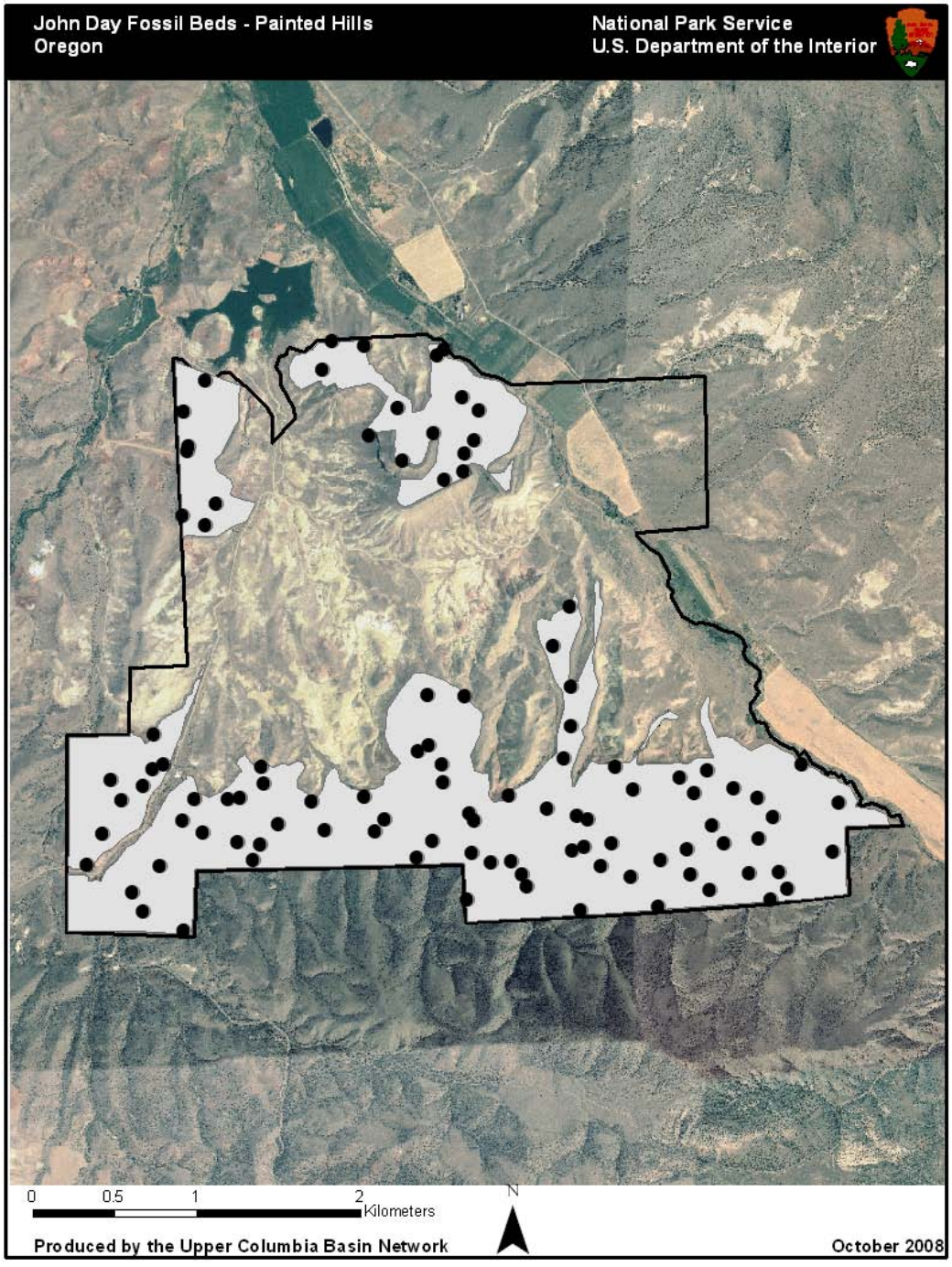

Figure 4. Sagebrush steppe vegetation draft monitoring sampling frame for the Painted Hills Unit of the John Day Fossil Beds National Monument. Steep slopes and land cover outside the target population were excluded from the sampling frame. Details of sampling frame development are available in the UCBN sagebrush steppe vegetation draft monitoring protocol (Yeo et al. *in review*).

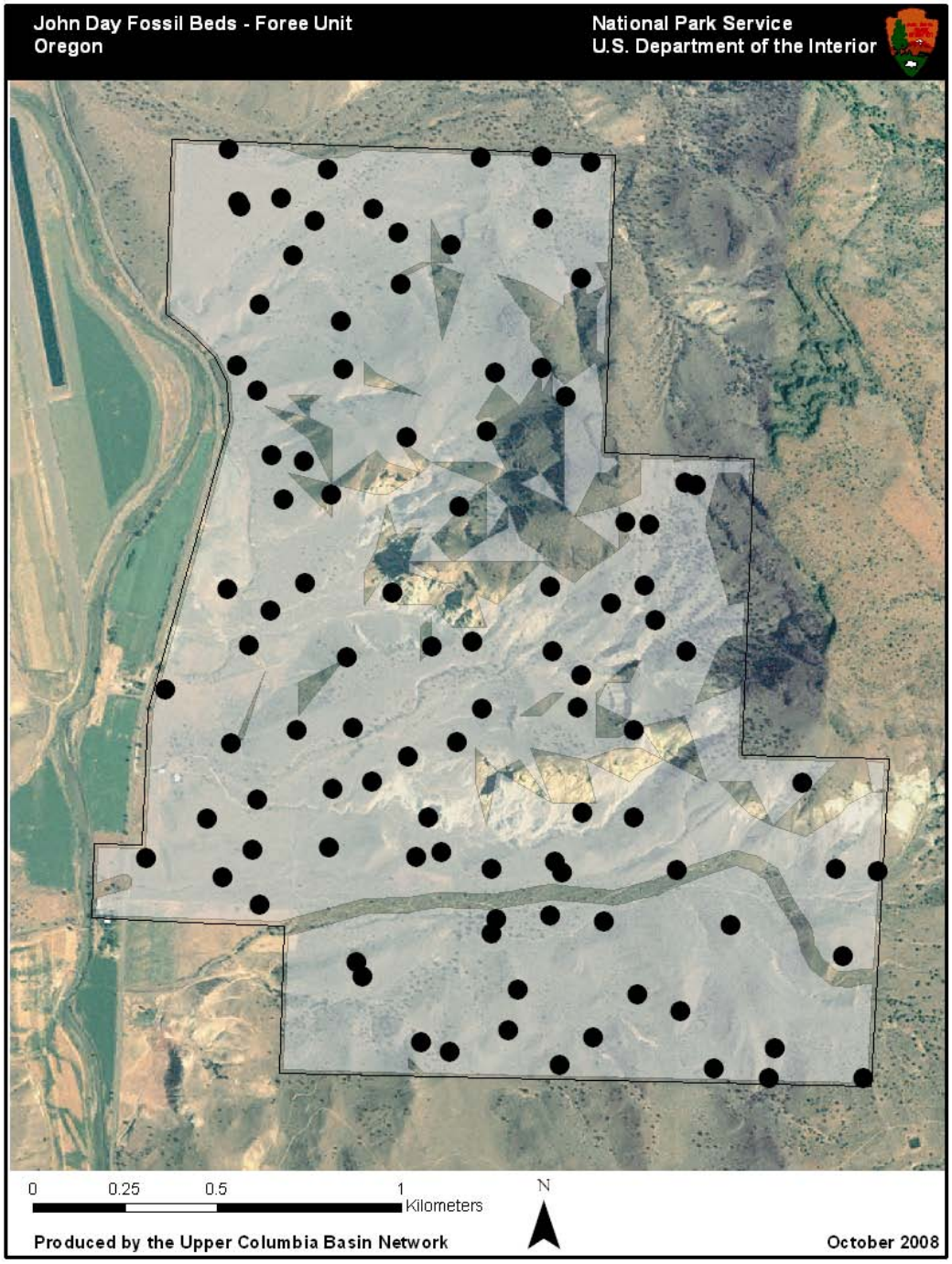

Figure 5. Sagebrush steppe vegetation draft monitoring sampling frame for the Foree Unit of the John Day Fossil Beds National Monument. Steep slopes and land cover outside the target population were excluded from the sampling frame. Details of sampling frame development are available in the UCBN sagebrush steppe vegetation draft monitoring protocol (Yeo et al. *in review*).

Results

City of Rocks National Reserve

Selected indicators of rangeland health for each CIRO sampling frame, focusing on cover, frequency in 1 m^2 plots, and soil/site stability evaluations, are presented in Tables 1-4 and Figures 6-8. There were very few differences in the occurrence of principal indicators between the 1 m^2 and 10 m^2 plots (frequency data from the larger plot are not presented). The order of presentation for table and figure sets is as follows: CIRO North, CIRO South, and CRSP. Sample sizes for these areas were 79, 100, and 80, respectively. Several plots were incompletely measured and plots with missing data were excluded from analyses, reducing the overall sample sizes. The tables and figures provide a succinct summary of some of the most important components of each park's sagebrush steppe plant communities as they were measured in 2008. Figures 6-8 are notched boxplots that summarize the distribution of cover for each unit. Note that the notch points to the median of % cover. I draw attention to the following notable patterns for each frame.

In the northern section of CIRO, median annual grass cover was 0%, and the non-native invasive cheatgrass (*Bromus tectorum*) was encountered at only 31% of 1 m^2 plots (Table 1). Bare ground cover was higher in the North than in the South and CRSP samples (median = 15%), and soil/site stability indicators provide evidence of surface flow, soil and litter movement, and pedestal formation (Tables 1-3). In the southern section of CIRO, annual grass cover was also very low but the frequency of cheatgrass was slightly higher (47% of 1 m^2 plots; Table 2). Median bare ground cover was only 2.5% (Table 2). In CRSP, cheatgrass frequency was considerably higher (84%) but annual grass cover remained low (median = 2.5%; Table 3). Bluebunch wheatgrass (*Pseudoregneria spicata*) and steppe bluegrass (*Poa secunda*) were the dominant native perennial grasses in CIRO. Western wheatgrass (*Agropyron smithii*), a rhizomatous perennial grass, was also significant, particularly in CRSP (Table 3). Crested wheatgrass (*Agropyron cristatum*), a Eurasian perennial introduced widely throughout the West, was significant in CIRO but not in CRSP (26%, 24%, and 1% of plots in each frame, respectively). The non-native invasive forb Canada thistle (*Cirsium arvense*) was encountered in one plot in CRSP, but no other invasive forbs were encountered in the samples. Single-leaf pinyon pine (*Pinus monophylla*) frequency was 7% in CIRO-North, 4% in CIRO-South, and 5% in CRSP. For those sampling units where pinyon pine was encountered, average densities were 2.8, 1, and 1 per 10 m^2 plot, respectively, for each park unit. No other conifer species were encountered in the samples.

Shrub cover and bunchgrass cover did not differ significantly among grazing allotments in the northern section of CIRO ($P>0.05$, Kruskal-Wallis Test). However, the Circle Creek allotment had significantly less forb cover and significantly greater annual grass and bare ground cover than the other two allotments ($P<0.05$, Tukey's HSD procedure).

Kruskal-Wallis tests for each cover category indicated significant differences ($P<0.05$) among groups. Rather than compare all groups, I focused on two allotments, Heath and Tracy Lane ("Tracy"), which clearly differed from the other groups in most cover categories (Table 4). Both these allotments were burned over during wildfires in 2000 and 1999, respectively. I compared

those two allotments with each of the groups that had sample sizes > 10. Using Tukey's HSD procedure, Heath and Tracy Lane allotments had significantly lower shrub cover than other allotment groups (e.g., median cover differences > 35% when compared with the Trail Canyon allotment). The Heath allotment also had significantly lower forb cover and higher annual grass cover than other groups (median cover differences from Trail Canyon were 12.5% and 15%, respectively) except when compared with the Tracy Lane allotment. Tracy Lane also had significantly higher annual grass cover scores when compared with the Trail Canyon allotment sample (median cover difference was 15%), but not when compared with the other groups.

Table 1. Summary information for the sagebrush steppe vital sign in the northern portion of City of Rocks National Reserve (CIRO North), 2008.

UCBN Vital Sign Sagebrush-steppe	Measure	Current Condition
Percent cover (median, mid-point cover class)		
	Bare ground (%)	15
	Annual grass (%)	0
	Bunchgrass (%)	15
	Forbs (%)	15
	Shrubs (%)	37.5
Frequency (% 1 m^2 plots present, n = 78)		
	Big sagebrush (%)	81
	bluegrass (%)	68
	Western wheatgrass (%)	29
	Bluebunch wheatgrass (%)	16
	Basin wildrye (%)	14
	Crested wheatgrass (%)	26
	Cheatgrass (%)	31
Soil/site stability (% plots $\geq$ rank 3; moderate to severe)		
	Flow patterns	24
	Litter movement	19
	Soil pedestals	16
	Rills	1
	Gullies	0

Table 2. Summary information for the sagebrush steppe vital sign in the southern portion of City of Rocks National Reserve (CIRO South), 2008.

UCBN Vital Sign Sagebrush steppe	Measure	Current Condition
Percent cover (median, mid-point cover class)		
	Bare ground (%)	2.5
	Annual grass (%)	0
	Bunchgrass (%)	37.5
	Forbs (%)	15
	Shrubs (%)	37.5
Frequency (% 1 m^2 plots present, n = 100)		
	Big sagebrush (%)	60
	Steppe bluegrass (%)	67
	Western wheatgrass	4
	Bluebunch wheatgrass	44
	Basin wildrye (%)	7
	Crested wheatgrass (%)	24
	Cheatgrass (%)	47
Soil/site stability (% plots $\geq$ rank 3; moderate to severe)		
	Flow patterns	22
	Litter movement	11
	Soil pedestals	27
	Rills	0
	Gullies	0

Table 3. Summary information for the sagebrush steppe vital sign in Castle Rocks State Park (CRSP), 2008.

UCBN Vital Sign Sagebrush steppe	Measure	Current Condition
Percent cover (median, mid-point cover class)		
	Bare ground (%)	2.5
	Annual grass (%)	2.5
	Bunchgrass (%)	15
	Forbs (%)	15
	Shrubs (%)	37.5
Frequency (% 1 m^2 plots present, n =80)		
	Big sagebrush (%)	70
	Steppe bluegrass (%)	59
	Western wheatgrass	44
	Bluebunch wheatgrass	31
	Bottlebrush squirreltail (%)	29
	Basin wildrye (%)	4
	Crested wheatgrass (%)	1
	Cheatgrass (%)	84
Soil/site stability (% plots $\geq$ rank 3; moderate to severe)		
	Flow patterns	4
	Litter movement	4
	Soil pedestals	11
	Rills	0
	Gullies	0

Table 4. Median % cover measured in 10 m^2 plots in grazing allotments and in ungrazed areas of the southern half of City of Rocks National Reserve.

	Bath (n=15)	Circle (n=8)	Emery (n=6)	Heath (n=17)	Kempton (n=9)	Tracy (n=15)	TrailCyn (n=19)	Ungrazed (n=11)
Shrub	37.5	37.5	37.5	0	62.5	2.5	37.5	37.5
Bunchgrass	37.5	37.5	37.5	2.5	37.5	37.5	37.5	37.5
Forb	37.5	15	15	2.5	15	15	15	2.5
Annual grass	0	0	0	15	2.5	15	0	0
Bareground	2.5	15	2.5	2.5	2.5	2.5	2.5	15

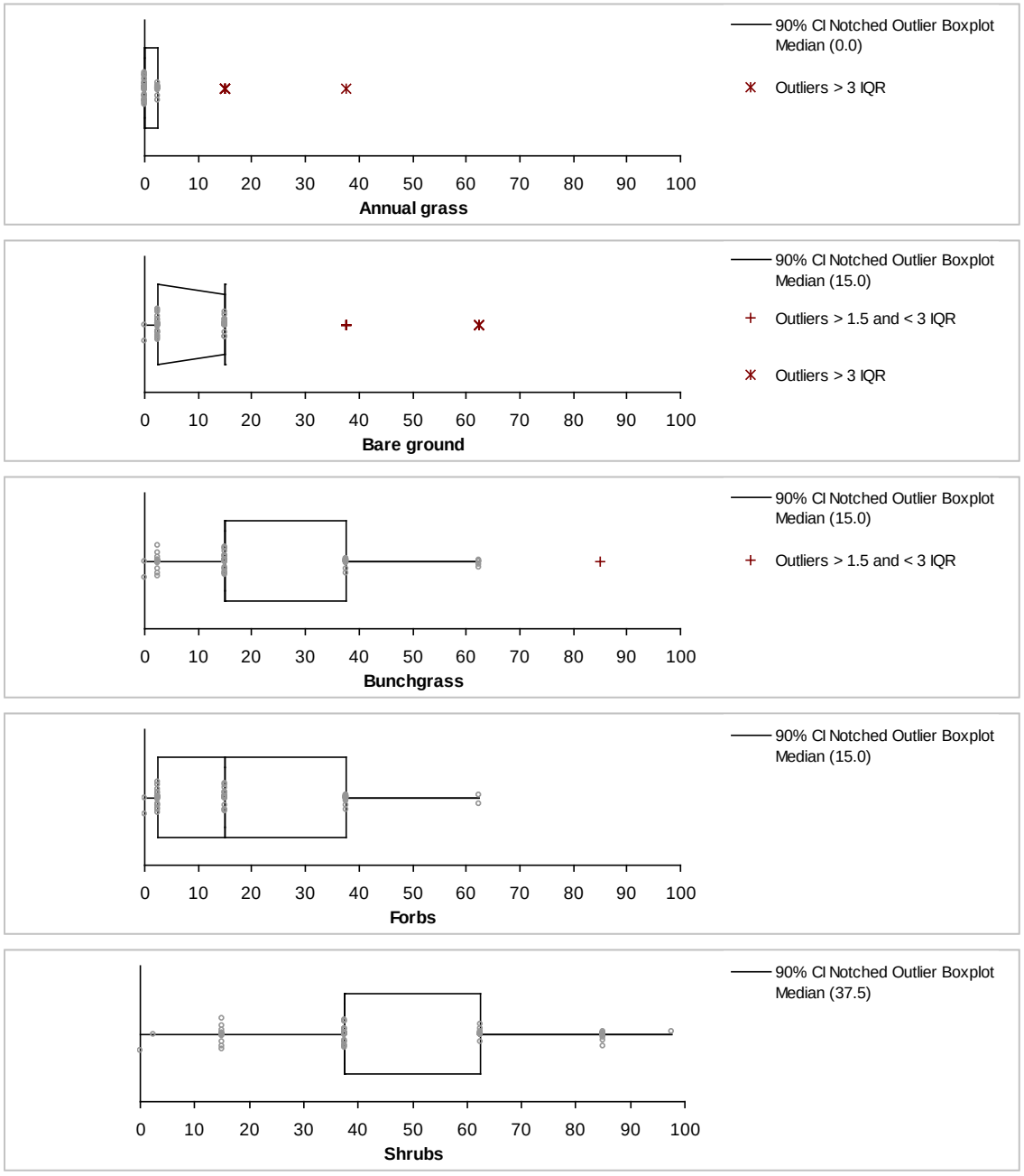

Figure 6. Canopy cover medians, 90% confidence range, and outlier observations for five principal sagebrush steppe indicators in the northern portion of City of Rocks National Reserve. Vegetation was sampled in the following cover categories: 0 = 0%, 1 = 0-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-95%, and 6 = 95-100%.

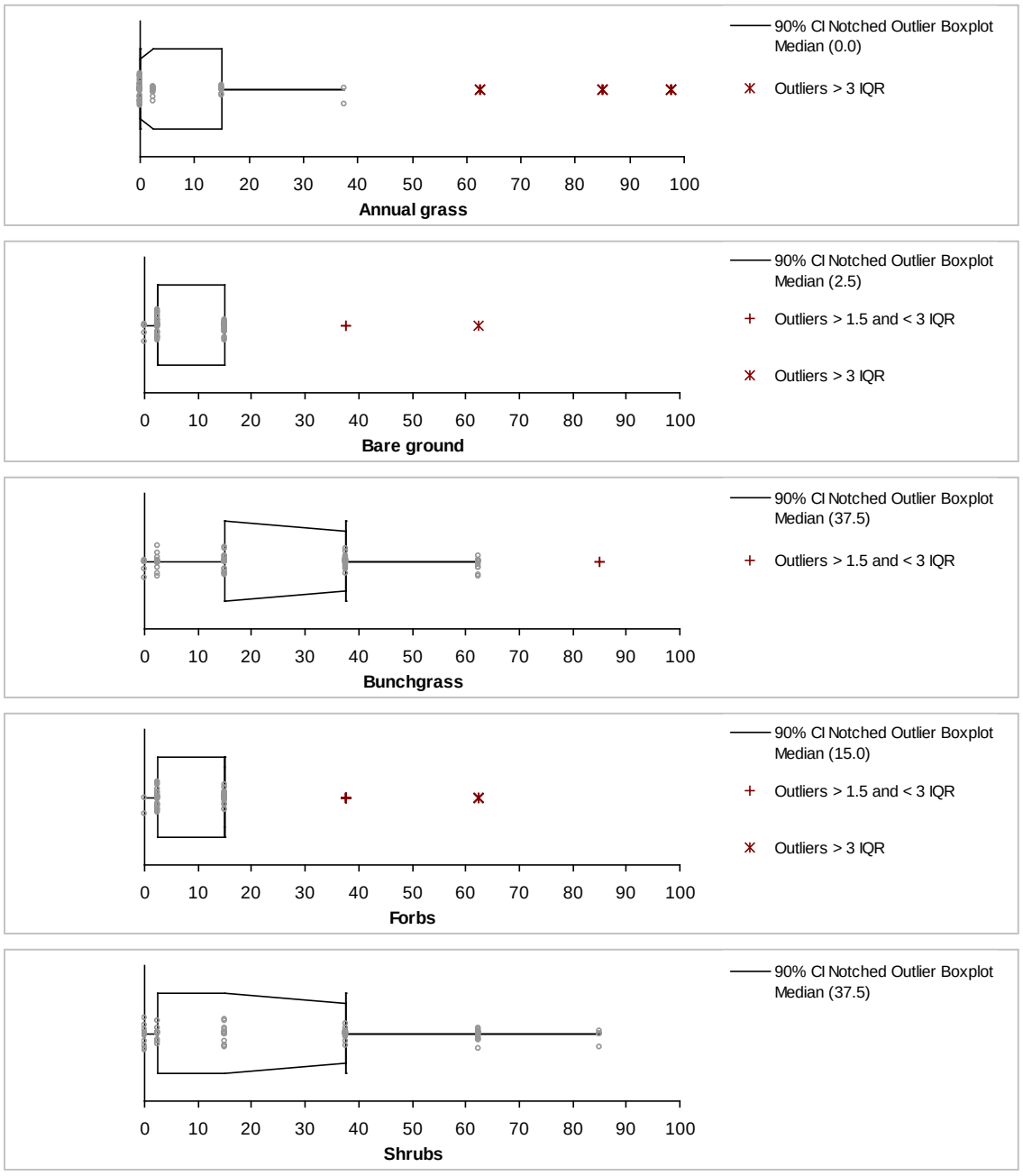

Figure 7. Canopy cover medians, 90% confidence range, and outlier observations for five principal sagebrush steppe indicators in the southern portion of City of Rocks National Reserve. Vegetation was sampled in the following cover categories: 0 = 0%, 1 = 0-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-95%, and 6 = 95-100%.

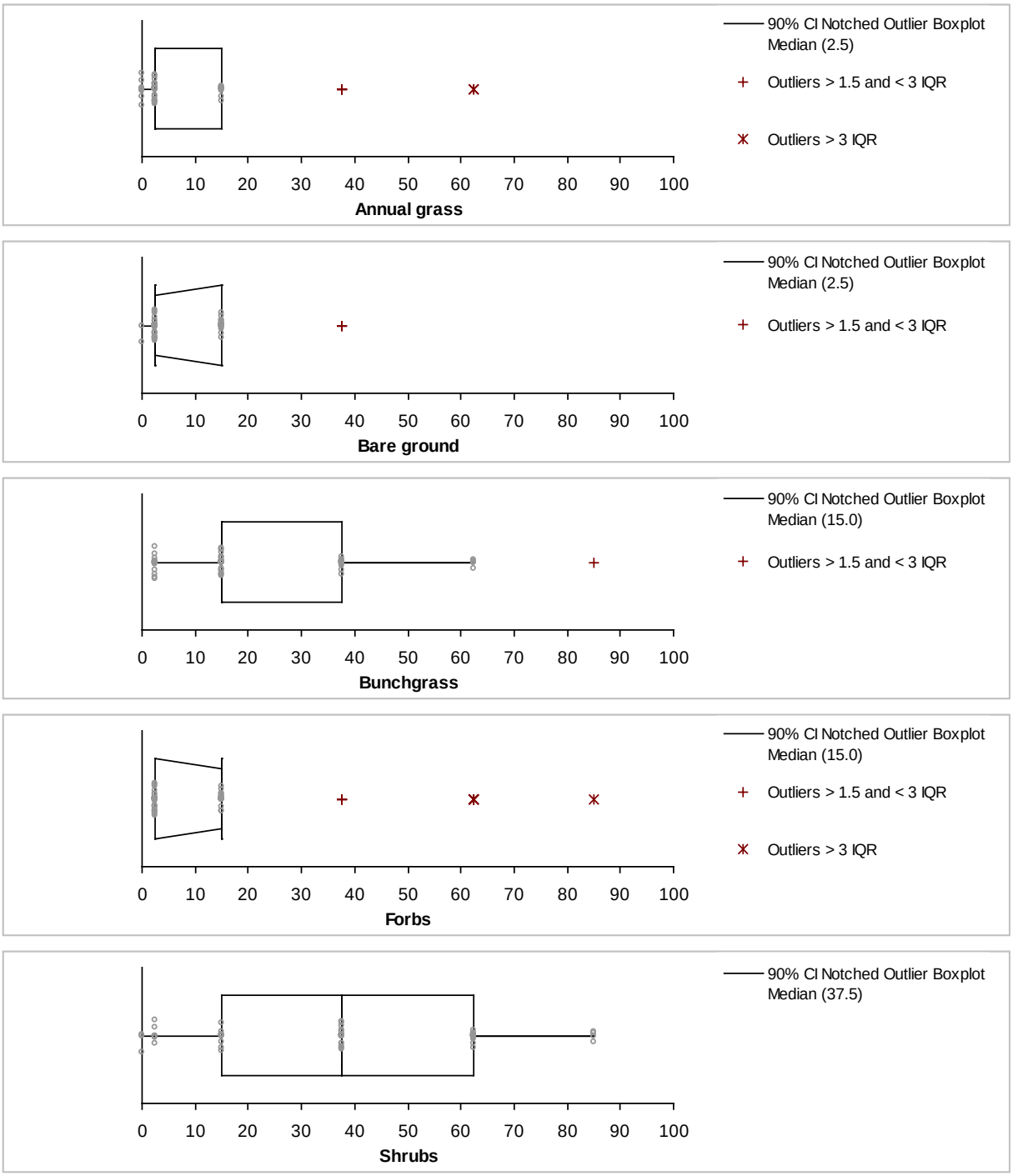

Figure 8. Canopy cover medians, 90% confidence range, and outlier observations for five principal sagebrush steppe indicators in Castle Rocks State Park. Vegetation was sampled in the following cover categories: 0 = 0%, 1 = 0-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-95%, and 6 = 95-100%.

Hagerman Fossil Beds National Monument

Selected indicators of rangeland health for the single HAFO sampling frame, focusing on cover, frequency in 1 m^2 plots, and soil/site stability evaluations, is shown in Table 5 and Figure 9. The sample size for HAFO was 80 and no data were missing for analysis. Table 5 and Figure 9 provide a succinct summary of some of the most important components of the Park's sagebrush steppe plant communities as they were measured in 2008. Figure 9 presents notched boxplots that summarize the distribution of cover. Note that the notch points to the median % cover midpoint.

At HAFO, cheatgrass was encountered at 99% of plots and median annual grass cover was 62.5% (Table 5). Median bunchgrass cover was only 2.5% (Table 5). Bluebunch wheatgrass was absent from the HAFO sample in 2008. Steppe bluegrass and bottlebrush squirreltail (*Sitanion hystrix*) were the most frequently encountered perennial bunchgrass, and these two species represented the majority of bunchgrass cover. Shrub cover was 15% and forb cover was relatively low, with a median of 2.5%. However, bare ground was also quite low, with a median of 2.5%. Soil/site stability rankings were moderately high for flow patterns, litter movement, and pedestals, with 16%, 9%, and 15% of plots ranked 3 or higher for each category (Table 5). No invasive forbs were encountered in the sample.

Table 5. Summary information for the sagebrush steppe vital sign, Hagerman Fossil Beds National Monument, 2008.

UCBN Vital Sign Sagebrush-steppe	Measure	Current Condition
Percent cover (median, mid-point cover class)		
	Bare ground (%)	2.5
	Annual grass (%)	62.5
	Bunchgrass (%)	2.5
	Forbs (%)	2.5
	Shrubs (%)	15
Frequency (% 1 m^2 plots present, n = 80)		
	Big sagebrush (%)	48
	Steppe bluegrass (%)	53
	Bottlebrush squirreltail (%)	29
	Indian ricegrass (%)	8
	Basin wildrye (%)	4
	Crested wheatgrass (%)	13
	Cheatgrass (%)	99
Soil/site stability (% plots $\geq$ rank 3; moderate to severe)		
	Flow patterns	16
	Litter movement	9
	Soil pedestals	15
	Rills	1
	Gullies	0

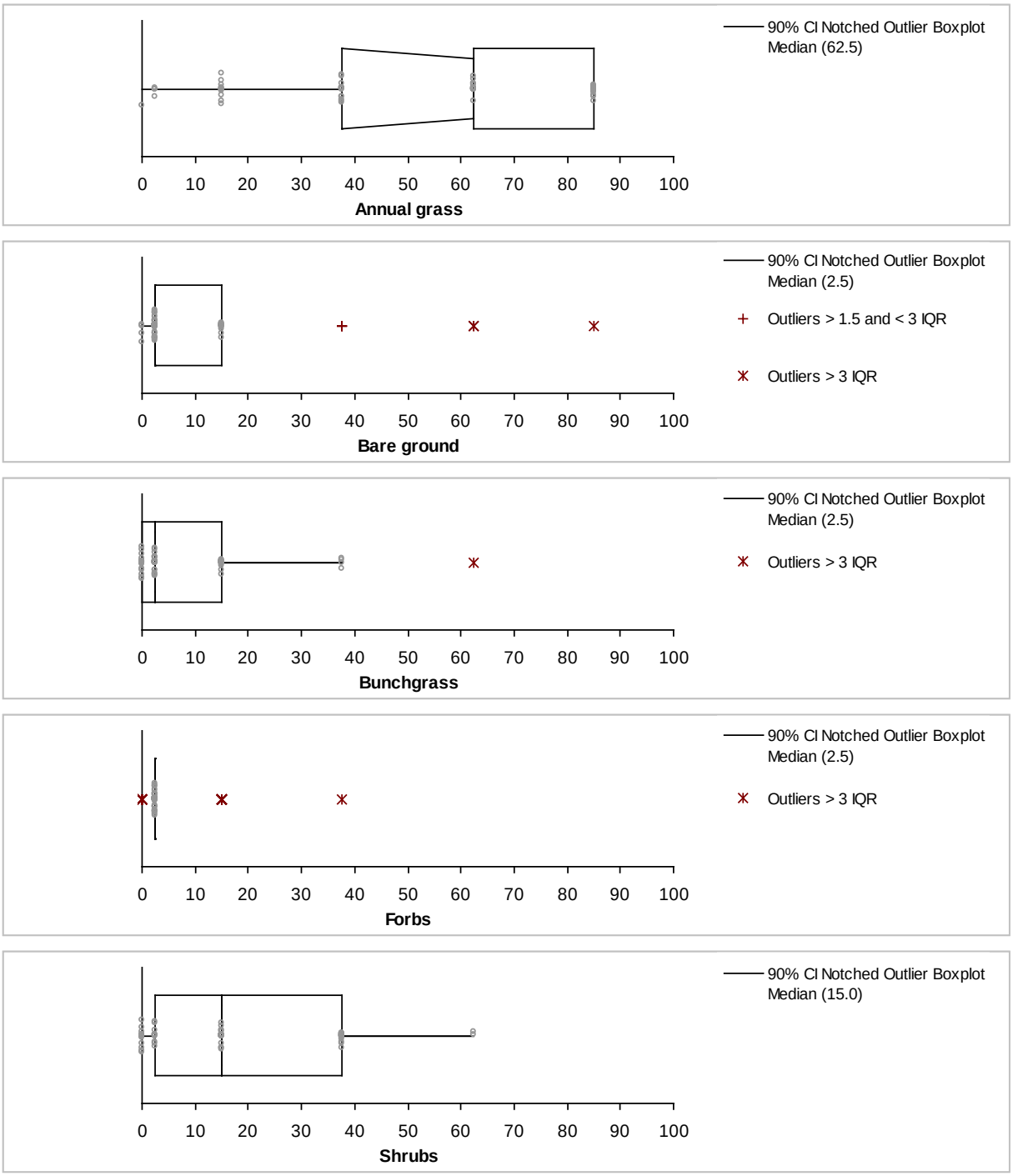

Figure 9. Canopy cover medians, 90% confidence range, and outlier observations for five principal sagebrush steppe indicators at Hagerman Fossil Beds National Monument. Vegetation was sampled in the following cover categories: 0 = 0%, 1 = 0-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-95%, and 6 = 95-100%.

John Day Fossil Beds National Monument

Selected indicators of rangeland health for each JODA sampling frame, focusing on cover, frequency in 1 m^2 plots, and soil/site stability evaluations, are shown in Tables 6-8 and Figures 10-12. The order of presentation for table and figure sets is as follows: Clarno, Painted Hills, and Foree. Sample sizes for these areas were 100, 82, and 94, respectively. Several plots were incompletely measured and plots with missing data were excluded from analyses, reducing the overall sample sizes. The tables and figures provide a succinct summary of some of the most important components of each unit's sagebrush steppe plant communities as they were measured in 2008. Figures 10-12 are notched boxplots that succinctly summarize the distribution of cover for each unit. Note that the notch points to the median % cover midpoint.

At JODA, cheatgrass and annual grass cover was high, with >90% cheatgrass frequency encountered in Clarno and Foree, and median annual grass cover 62.5% in both units (Tables 6 and 8, Figures 10 and 12). At Painted Hills, cheatgrass frequency was slightly lower (84%) and annual grass cover was only 15% (Table 7 and Figure 11). Frequency of the non-native invasive medusahead was 27% in Clarno, 9% in Painted Hills, and 1% in Foree (Tables 6-8). Bunchgrass cover ranged from 15% for Clarno and Foree to 37.5% for Painted Hills, and needlegrasses (*Stipa* spp.) comprised a large component of these communities along with bluebunch wheatgrass and steppe bluegrass (Tables 6-8). Shrub cover was low in all units, as was bare ground cover (median 2.5%). Soil movement scores were also relatively low (Tables 6-8). In Foree, the non-native invasive forb Dalmatian toadflax (*Linaria dalmatica*), was found in 7% of plots. Canada thistle was reported in one Foree plot as well. No other invasive weeds were encountered in park samples. Western juniper (*Juniperus occidentalis*) frequency was 7% in Clarno and 6% in both the Painted Hills and Foree units. Average juniper density among plots where the species was encountered was 1 for all three park units.

Table 6. Summary information for the sagebrush steppe vital sign in the Clarno Unit of the John Day Fossil Beds National Monument, 2008.

UCBN Vital Sign Sagebrush-steppe	Measure	Current Condition
Percent cover (median, mid-point cover class)		
	Bare ground (%)	2.5
	Annual grass (%)	62.5
	Bunchgrass (%)	15
	Forbs (%)	2.5
	Shrubs (%)	2.5
Frequency (% 1 m^2 plots present, n = 100)		
	Big sagebrush (%)	8
	Steppe bluegrass (%)	67
	Needlegrass (%)	48
	Bluebunch wheatgrass (%)	62
	Sand dropseed (%)	5
	Medusahead (%)	27
	Cheatgrass (%)	96
Soil/site stability (% plots $\geq$ rank 3; moderate to severe)		
	Flow patterns	0
	Litter movement	0
	Soil pedestals	1
	Rills	0
	Gullies	1

Table 7. Summary information for the sagebrush steppe vital sign in the Painted Hills Unit of the John Day Fossil Beds National Monument, 2008.

UCBN Vital Sign Sagebrush-steppe	Measure	Current Condition
Percent cover (median, mid-point cover class)		
	Bare ground (%)	2.5
	Annual grass (%)	15
	Bunchgrass (%)	37.5
	Forbs (%)	15
	Shrubs (%)	2.5
Frequency (% 1 m^2 plots present, n = 82)		
	Big sagebrush (%)	29
	Steppe bluegrass (%)	90
	Needlegrass (%)	22
	Bluebunch wheatgrass (%)	67
	Idaho fescue (%)	11
	Medusahead (%)	9
	Cheatgrass (%)	84
Soil/site stability (% plots $\geq$ rank 3; moderate to severe)		
	Flow patterns	9
	Litter movement	3
	Soil pedestals	7
	Rills	0
	Gullies	0

Table 8. Summary information for the sagebrush steppe vital sign in the Foree Unit of the John Day Fossil Beds National Monument, 2008.

UCBN Vital Sign Sagebrush-steppe	Measure	Current Condition
Percent cover (median, mid-point cover class)		
	Bare ground (%)	2.5
	Annual grass (%)	62.5
	Bunchgrass (%)	15
	Forbs (%)	15
	Shrubs (%)	2.5
Frequency (% 1 m^2 plots present, n = 94)		
	Big sagebrush (%)	15
	Steppe bluegrass (%)	72
	Needlegrass (%)	16
	Bluebunch wheatgrass (%)	51
	Idaho fescue (%)	5
	Medusahead (%)	1
	Cheatgrass (%)	100
Soil/site stability (% plots $\geq$ rank 3; moderate to severe)		
	Flow patterns	9
	Litter movement	3
	Soil pedestals	7
	Rills	0
	Gullies	0

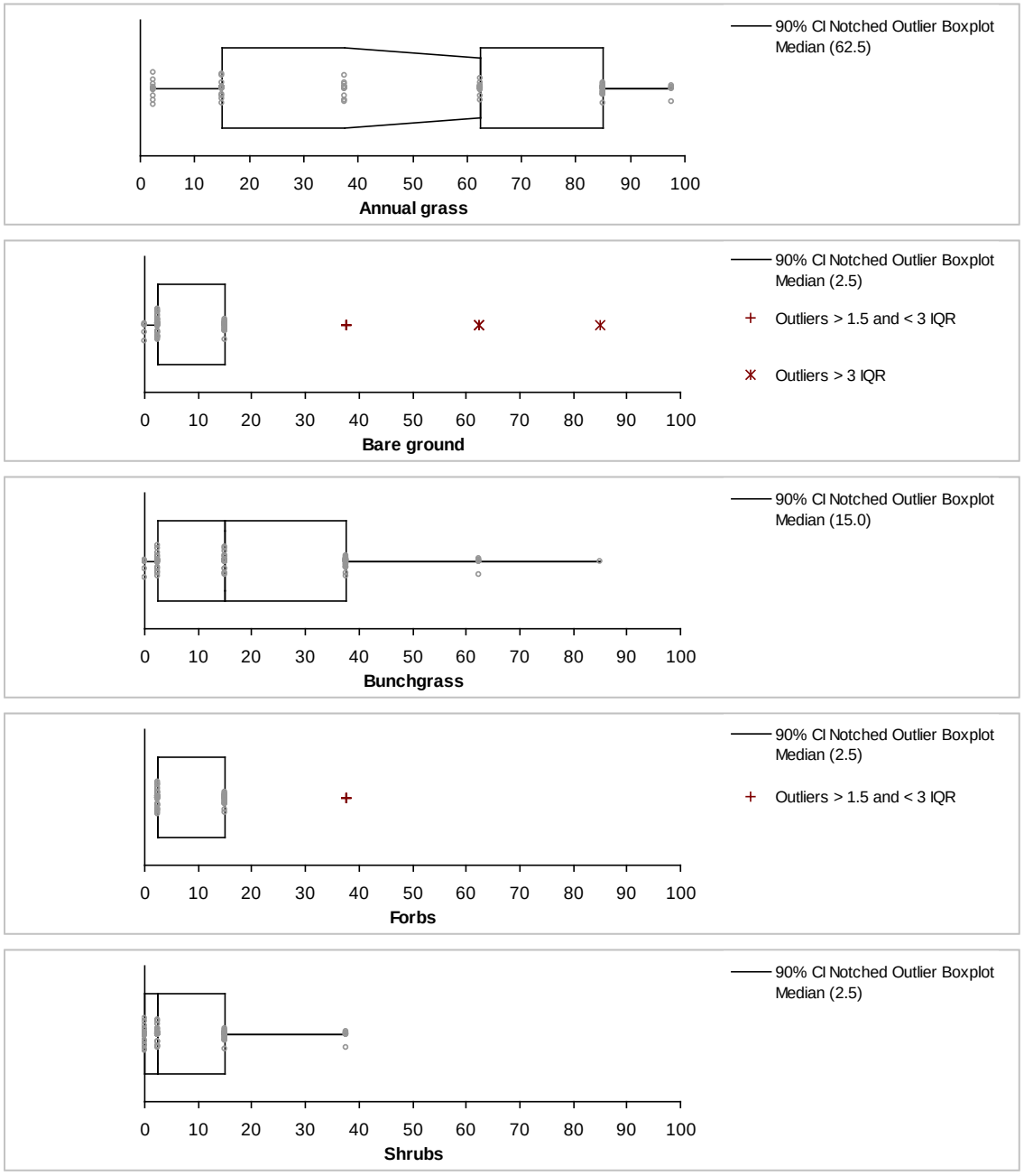

Figure 10. Canopy cover medians, 90% confidence range, and outlier observations for five principal sagebrush steppe indicators in the Clarno Unit of the John Day Fossil Beds National Monument. Vegetation was sampled in the following cover categories: 0 = 0%, 1 = 0-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-95%, and 6 = 95-100%.

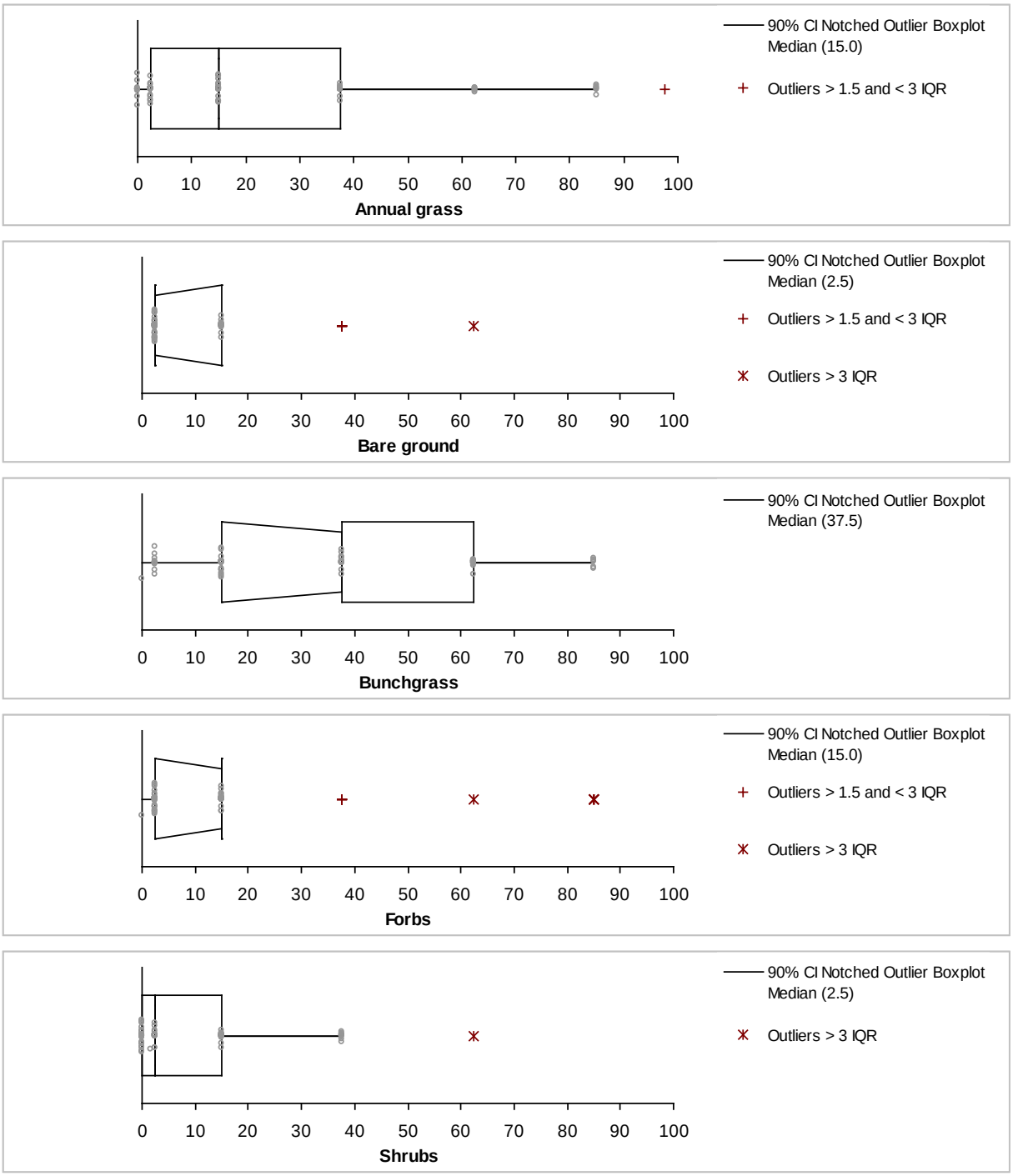

Figure 11. Canopy cover medians, 90% confidence range, and outlier observations for five principal sagebrush steppe indicators in the Painted Hills Unit of the John Day Fossil Beds National Monument. Vegetation was sampled in the following cover categories: 0 = 0%, 1 = 0-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-95%, and 6 = 95-100%.

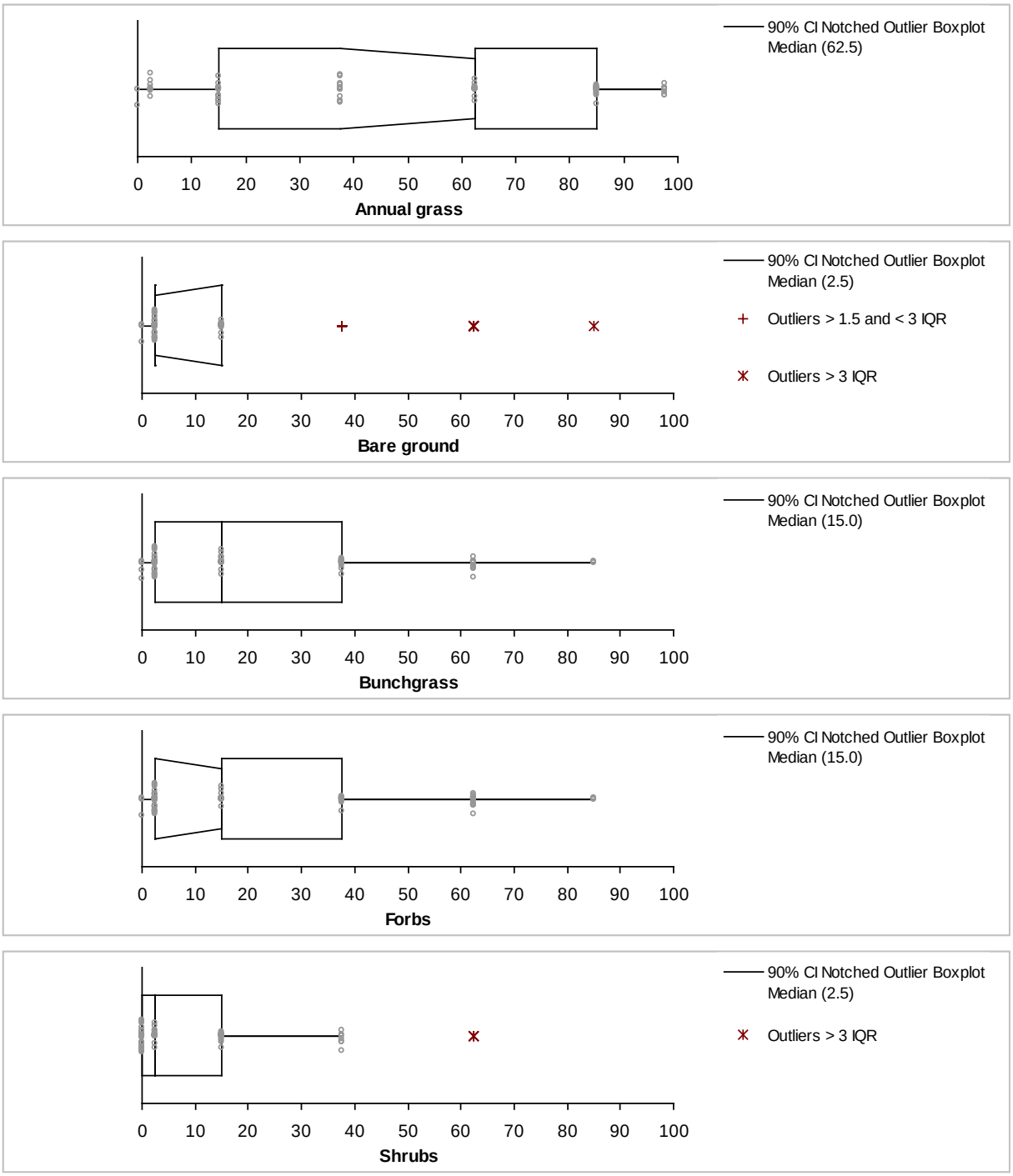

Figure 12. Canopy cover medians, 90% confidence range, and outlier observations for five principal sagebrush steppe indicators in the Foree Unit of the John Day Fossil Beds National Monument. Vegetation was sampled in the following cover categories: 0 = 0%, 1 = 0-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-95%, and 6 = 95-100%.

Discussion

The UCBN sagebrush steppe monitoring program initiated monitoring in CIRO, HAFO, and JODA in 2008, following a draft protocol developed by the UCBN (Yeo et al. *in review*). These preliminary analyses provide one of the first descriptions of sagebrush steppe plant communities in these parks. Sample sizes ranged from 78 to 100 and were extensive enough to support inferences from rangeland health indicator estimates to each of the seven respective park areas (sampling frames). These estimates provide evidence of initial baseline conditions of park steppe ecosystems and will contribute to the foundation of the UCBN steppe monitoring program in these parks. These ecosystems are highly variable, however, and several years of subsequent sampling in each of these parks will be required before a clear picture of sagebrush steppe condition status will emerge.

City of Rocks National Reserve

The low frequency and cover of annual grasses in the park is noteworthy. In areas of high cheatgrass frequency (e.g., CRSP), the species occurs widely but in low abundance. An exception to this pattern was in the Heath and Tracy Lane grazing allotments in the southern and lower elevations of the Reserve. The Heath allotment and surrounding area burned in a very intense wildfire in 2000, and most of the Tracy Lane allotment also burned in a wildfire in 1999. Though the 1999 fire was considerably less intense than the 2000 fire, these fires likely explain the differences in the plant communities in these two allotments (lower shrub cover, higher annual grass cover, lower bunchgrass and forb cover in Heath) as compared to other CIRO allotments. The combination of fire and low elevation increases the risk of weed invasion in sagebrush steppe communities, and our results suggest that invasion risk may occur along the north-south elevational gradient that occurs in CIRO (Chambers et al. 2007, Germino et al. 2004). The Tracy Lane allotment, also in the southern portion of the park, and the Circle Creek allotment in the northern portion of the park, appears to differ in the amounts of plant and bare ground cover from other allotments and from ungrazed areas in the south. While it is clearly premature to suggest possible mechanisms for these differences, park managers may wish to consider differences in soils or other ecological attributes (such as effective precipitation), timing and intensity of grazing, or other site historical factors. Finally, it should be noted that the non-native bunchgrass crested wheatgrass contributes a considerable proportion to bunchgrass cover in CIRO.

Hagerman Fossil Beds National Monument

Annual grass cover and the high frequency of cheatgrass in the park is noteworthy. The low cover of perennial bunchgrasses and the absence of bluebunch wheatgrass, a typically common species in native plant communities along the Snake River Plain, is also noteworthy. Natural Resource Conservation Service (NRCS) ecological site descriptions for HAFO suggest that big sagebrush/bluebunch wheatgrass communities should dominate the area. Bare ground cover was comparatively low, at least in plots within the sample. HAFO has expanses of deeply cut, erodible badlands but these areas were not sampled in 2008 and are not included in our long-term sampling frames because of accessibility and safety concerns. Outside of these areas, however, steppe soils appear to be relatively stable and well armored with native and non-native vegetation.

John Day Fossil Beds National Monument

As with HAFO, the John Day Fossil Beds are also a low elevation park. Big sagebrush, where it occurs in the park, is either basin big sage (*A. t. tridentata*) or Wyoming big sage (*A. t. wyomingensis*). These kinds of low-elevation sagebrush communities are particularly vulnerable to weed invasion (Bunting et al. 2002, Chambers et al. 2007). Cheatgrass and several other species of annual grasses are ubiquitous throughout the park. The cover of annual grass and the frequency of cheatgrass in the Painted Hills Unit sample were lower than in the Clarno and Foree Units. The invasion of medusahead, another annual grass of Eurasian origin, is of great concern to park management. The Clarno Unit appears to have been particularly impacted by this species so far, but the species has invaded the other units as well. JODA supports large stands of perennial bunchgrasses dominated by bluebunch wheatgrass and Thurber's needlegrass (*Stipa thurberiana*), and this is a particularly unique and highly valued plant community type for the park. As in HAFO, highly erodible fossil-bearing badlands also occur in JODA which were not sampled. Outside of these areas, the soils appear to be well vegetated with low amounts of bare ground and high soil/site stability. It is important to consider these preliminary estimates within the context of recent prescribed and natural fires that have been conducted in the park. The entire Clarno Unit burned over the course of three wildfires in 1994 and 1995. Prescribed burns occurred across much of the southern portion of the Painted Hills Unit in 2002 and across most of the Foree Unit in 2005 and 2007. This history may explain some of the patterns in annual grass invasion among the three units, and is a probable cause of the relatively low shrub cover and low juniper density encountered in 2008 samples. Burn perimeters are unavailable for the prescribed fires making it difficult to compare status among burned and unburned areas.

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