



Upland Vegetation Monitoring in Bighorn Canyon National Recreation Area

2013 Data Summary

Natural Resource Data Series NPS/GRYN/NRDS—2014/608



ON THE COVER

Fence line contrast at the Pryor Mountain Wild Horse Range boundary in Bighorn Canyon National Recreation Area.
Photograph by: National Park Service

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Contents

- Acknowledgementsvii
- Introduction1
 - Monitoring Objectives1
- Methods5
- Results and Discussion7
 - Weather and Climate.....7
 - Soil Cover7
 - Sagebrush Cover10
 - Non-native Plant Species10
 - Tree Recruitment11
 - Permanent Photo Points.....11
 - Sample Frame Summaries11
- Literature Cited32
- Appendix A Plant Species and Ground Cover Attributes33
- Appendix B Plant Cover Frequency Charts35

Figures

Figure 1. Plant communities selected for long-term monitoring include (from top to bottom) Utah juniper—curl-leaf mountain mahogany woodlands, Utah juniper woodlands, and sagebrush shrublands.....	2
Figure 2. Map showing the sample frames that were monitored in 2013 (colored polygons) and sample frames scheduled for monitoring in future years (grey polygons). Inset map shows the location of the sample frames (red) relative to the boundary of Bighorn Canyon National Recreation Area.....	3
Figure 3. The 1 m ² quadrat sample unit used to measure species cover. Dashed white lines depict 5% area (smallest square in lower portion of quadrat), and 25% areas (larger four squares nested within quadrat).	5
Figure 4. The seasonal climate water balance at Hillsboro, MT RAWs weather station in Bighorn Canyon National Recreation Area during 2013.	7
Figure 5. Percent frequency of quadrats with bare ground in the 2013 sampling frames. Estimates of bare ground cover were made using Daubenmire cover class categories. Error bars show one standard error, calculated from the local variance estimator.	8
Figure 6. Percent frequency of quadrats with cryptobiotic crust cover in the 2013 sampling frames. Estimates of cryptobiotic crust cover were made using Daubenmire cover class categories.	9
Figure 7. Percent of (sagebrush shrubland) quadrats in each cover class with black sagebrush (<i>Artemisia nova</i>) or Wyoming sagebrush (<i>A. tridentata</i> spp. <i>wyomingensis</i>).	10
Figure 8. Example of two permanent photo points established in 2013 as part of the strategy for long-term vegetation monitoring at Bighorn Canyon National Recreation Area.	11
Figure 9. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg020. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.	12
Figure 10. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg030. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.	14
Figure 11. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg070. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.	16
Figure 12. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg080. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.	18
Figure 13. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg090. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.	20
Figure 14. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg100. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.	22
Figure 15. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg110. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.	24
Figure 16. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg120. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.	26
Figure 17. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg130. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.	28

Figures (continued)

Figure 18. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg140. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area. 30

Figure B-1. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg020 in 2013. Error bars show one standard error, calculated from the local variance estimator. 35

Figure B-2. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg030 in 2013. Error bars show one standard error, calculated from the local variance estimator. 36

Figure B-3. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg070 in 2013. Error bars show one standard error, calculated from the local variance estimator. 37

Figure B-4. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg080 in 2013. Error bars show one standard error, calculated from the local variance estimator. 38

Figure B-5. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg090 in 2013. Error bars show one standard error, calculated from the local variance estimator. 39

Figure B-6. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg100 in 2013. Error bars show one standard error, calculated from the local variance estimator. 40

Figure B-7. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg110 in 2013. Error bars show one standard error, calculated from the local variance estimator. 41

Figure B-8. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg120 in 2013. Error bars show one standard error, calculated from the local variance estimator. 42

Figure B-9. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg130 in 2013. Error bars show one standard error, calculated from the local variance estimator. 43

Figure B-10. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg140 in 2013. Error bars show one standard error, calculated from the local variance estimator. 44

Tables

Table 1. Indicators for rangeland health and their quantitative attributes for Bighorn Canyon National Recreation Area.	4
Table 2. Daubenmire cover classes used during the 2013 sampling and analysis year.....	5
Table 3. Sample size and number of quadrats rejected in each sample frame during the 2013 field season.....	6
Table 4. Percent of quadrats with non-native plants present within the 2013 sample frames.	10
Table 5. Number of trees ≤ 10 cm tall counted within sampling quadrats in 2013.....	11
Table 6. Percent of quadrats (n=50) for sample frame BICA_LTM_Veg_020 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.	13
Table 7. Percent of quadrats (n=78) for sample frame BICA_LTM_Veg_030 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.	15
Table 8. Percent of quadrats (n=51) for sample frame BICA_LTM_Veg_070 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.	17
Table 9. Percent of quadrats (n=53) for sample frame BICA_LTM_Veg_080 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.	19
Table 10. Percent of quadrats (n=52) for sample frame BICA_LTM_Veg_090 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.	21
Table 11. Percent of quadrats (n=36) for sample frame BICA_LTM_Veg_100 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.	23
Table 12. Percent of quadrats (n=77) for sample frame BICA_LTM_Veg_110 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.	25
Table 13. Percent of quadrats (n=51) for sample frame BICA_LTM_Veg_120 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.	27
Table 14. Percent of quadrats (n=76) for sample frame BICA_LTM_Veg_130 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.	29
Table 15. Percent of quadrats (n=51) for sample frame BICA_LTM_Veg_140 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.	31
Table A-1. Vascular plants and ground cover attributes targeted for monitoring in the Upland Vegetation Monitoring Protocol in 2013.....	33

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TYSON ROTH

The 2013 field crew at Bighorn Canyon National Recreation Area. Not shown are Tyson Roth and Erin Shanahan.

Introduction

This report summarizes the Upland Vegetation Monitoring Protocol implemented by the Greater Yellowstone Inventory & Monitoring Network (GRYN) at Bighorn Canyon National Recreation Area (Bighorn Canyon) in 2013. Sagebrush shrublands and woodland communities are emphasized for long-term monitoring in this protocol. These communities are important as wildlife habitat, but there are concerns that overgrazing, invasive species, and climate change impacts may alter their condition.

In Bighorn Canyon, sagebrush shrubland is a mix of Wyoming sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and black sagebrush (*Artemisia nova*) with patches of grasslands dominated by bluebunch wheatgrass (*Pseudoroegneria spicata*). Adjacent woodland communities are composed of Utah juniper (*Juniperus osteosperma*) and in places, curl-leaf mountain mahogany (*Cercocarpus ledifolius* var. *ledifolius*). These upland communities are among the most common vegetation types in Bighorn Canyon and occur on over 60% of the land area inside the National Recreation Area (Knight et al. 1987).

Utah juniper and curl-leaf mountain mahogany are important cover and shelter species for several large mammals, including mule deer (*Odocoileus hemionus*), bighorn sheep (*Ovis canadensis*), wild horses (*Equus caballus*), and mountain lion (*Puma concolor*). Curl-leaf mountain mahogany is also good forage for many species of browsing animals in both summer and winter. Its highly nutritious leaves and stems provide protein to wintering big game animals (Gucker 2006). Utah juniper is used by many birds and mammals, both wildlife and livestock, for cover and food (Zlatnik 1999). Sagebrush steppe provides habitat for ungulates, principally mule deer and bighorn sheep, and sagebrush obligate birds, such as the sage sparrow (*Amphispiza belli*) and Brewer's sparrow (*Spizella breweri*). Both bird species require stands of specific density for successful nesting to occur.

Sagebrush shrublands and woodland communities occur on habitats that are characterized by deep, steep-walled canyons; isolated grassy plateaus; rocky, shrub-dominated foothill slopes; and benches above the main canyon formed by the Bighorn River. Many of the sample frames used for monitoring sagebrush communities are in proximity to important habitat features, such as water or steep-walled cliffs used as escape habitat for bighorn sheep.

In the south district of Bighorn Canyon, vegetation communities are influenced by past and present grazing, fire, and climatological changes. Historically, cattle ranches operated in the area and cattle trailing is permitted along the road that passes through the National Recreation Area (NRA) and in two holding pastures. Wild horses roam freely in the Pryor Mountain Wild Horse Range (PMWHR) and a rangeland health assessment conducted by the Natural Resource Conservation Service determined that more than 50% of the area within the National Park Service unit to be in a downward trend and unhealthy (Ricketts et al. 2004).

Monitoring Objectives

The Upland Vegetation Monitoring Protocol (Tercek et al. 2013) addresses the following monitoring objectives within three target plant communities at Bighorn Canyon: Utah juniper woodland, Utah Juniper—curl-leaf mountain mahogany woodland and sagebrush shrublands (see Figures 1 and 2). The specific monitoring objectives are to:

1. Determine the status and trends in the composition and abundance of principal native plant species.
2. Determine the status and trends in composition and abundance of principal invasive plant species, including annual grasses.
3. Determine the status and trend in the amount of exposed soil, a fundamental indicator of soil stability.



Figure 1. Plant communities selected for long-term monitoring include (from top to bottom) Utah juniper—curl-leaf mountain mahogany woodlands, Utah juniper woodlands, and sagebrush shrublands.

4. Determine the status and trend in the amount of cryptobiotic crust, another fundamental indicator of soil stability.

For monitoring purposes, we focus on a subset of ecological indicators (refer to Table 1) commonly used to assess rangeland vegetation and soil condition. Generally, new or expanding non-native annual grass populations, increases in the amount of exposed soil subject to erosion, and declines in frequency of key forage plants signal a deteriorating condition (Pellant et al. 2000, Stoddart et al. 1955). Increases in the amount of protective ground cover and desirable forage species generally signify improving conditions.

Routine data collected on these key features of plant community health will assist with the detection of long-term changes resulting from human impacts such as grazing and biological invasions and ecological processes such as fire and climate change.

Results from 2013, the third year of data collection, document baseline conditions and consequently readers are cautioned not to draw wide-reaching conclusions. Status and trend assessments are more meaningful after many years of monitoring as comparable data accumulate over time (Witwicki 2012).

2013 Sample Frames

National Park Service
U.S. Department of the Interior



Legend

- Juniper - Mountain Mahogany Woodland
- Juniper Woodland
- Sagebrush Shrubland
- Sample Frames
- Bighorn Lake
- Bighorn Canyon NRA



November 2013
NPS Inventory and Monitoring Division

Figure 2. Map showing the sample frames that were monitored in 2013 (colored polygons) and sample frames scheduled for monitoring in future years (grey polygons). Inset map shows the location of the sample frames (red) relative to the boundary of Bighorn Canyon National Recreation Area.

Table 1. Indicators for rangeland health and their quantitative attributes for Bighorn Canyon National Recreation Area. Refer to Appendix A for a complete list of principal plant species targeted for monitoring in this protocol (Tercek et al. 2013).

Indicator	Quantitative attributes	Interpretation
Hydrologic function	Percent exposed bare ground, defined as bare soil (mineral soil) not covered by plant canopies.	Bare ground is positively correlated with run-off and erosion.
	Gravel greater than 6.35 mm (¼”), rock, cryptogamic crust, and litter are excluded from bare ground cover estimates.	Non-native plants colonize and increase on bare ground.
Soil/site stability	Percent litter cover defined as detached dead stems, leaves, and other plant debris in contact with the ground	Litter and cryptogamic crust cover protect soil from erosion.
	Percent cryptogamic crust ground cover. Cryptogams include cryptobiotic soil crusts and/or other non-vascular plants (e.g., mosses, lichens) and fungi growing on the soil surface.	
Biotic integrity	Percent plant (foliar) cover of principal trees and shrubs, including, but not limited to Utah juniper, sagebrush, and curl-leaf mountain mahogany and native grasses, including but not limited to, bluebunch wheatgrass, needle and thread, and Sandburg’s bluegrass.	Changes in species composition can signal a direction of change in ecological status.
	Plant cover is the percentage of the ground covered by a vertical projection of the outermost perimeter of the natural spread of foliage of plants. The visual cover estimate is for current year’s growth, including senescent annual grasses of the year.	
	Stem counts of juniper, limber pine and curl-leaf mountain mahogany shrubs/trees less than 10 cm (3”) in height.	
	Percent (foliar) cover of principal non-native and invasive species.	Increasing numbers of non-native plant species and their cover signify a deteriorating condition.

Methods

Methods for this study follow the GRYN Upland Vegetation Monitoring Protocol (Tercek et al. 2013) and Standard Operating Procedures (SOP; Jean et al. 2013). The monitoring design includes 15 permanent sampling frames located within one of three target plant communities: sagebrush shrubland, Utah juniper woodland, or Utah juniper—curl-leaf mountain mahogany woodland.

The monitoring schedule includes a panel of sample frames monitored each year and another panel that is monitored on a three year rotating basis. The sample frames are distributed along a north to south axis in the south district of Bighorn Canyon. Figure 2 shows a map with all 15 sample frame locations and identifies those that were monitored in 2013.

The monitoring design uses temporary 1 m² and 3.16 m² quadrats (Figure 3) that are randomly assigned each year within the permanent sampling frames which were geographically delineated to meet long-term monitoring objectives (see a “never revisit” design [1-n] *sensu* McDonald 2003). In this design, quadrat locations change from year to year, but the areas of inference (the sample frames) remain constant.

The locations for temporary quadrats were determined within each sample frame by a Generalized Random Tessellation Stratified (GRTS) spatially balanced sampling design (Stevens and Olsen 2004). The randomly located points provide the location for subsequent quadrat-based estimation of vegetation and soil cover, tree recruitment, and as geographic coordinates for establishing permanent repeat photography.

The target sample size ranged from 50 to 75 quadrats per sample frame, with frames of greater spatial extent requiring a larger number of samples.

The principal monitoring metric is the ocular estimate of plant and ground cover recorded in cover classes developed by Daubenmire (1959), herein referred to as “Daubenmire’s cover class” (Table 2). Within each quadrat,



Figure 3. The 1 m² quadrat sample unit used to measure species cover. Dashed white lines depict 5% area (smallest square in lower portion of quadrat), and 25% areas (larger four squares nested within quadrat).

Table 2. Daubenmire cover classes used during the 2013 sampling and analysis year.

Cover Class	Cover Range
0	0%
1	>0-5%
2	>5-25%
3	>25-50%
4	>50-75%
5	>75-95%
6	>95%

live canopy cover, or in the case of annual plants, current year’s foliage is estimated for all target indicator plant species and soil cover attributes. In this approach, cover estimates are made within the 1 m² quadrat for ground cover and target plants other than trees, and the 3.16 m² quadrat is used for trees, including curl-leaf mountain mahogany.

Specific plants targeted for this monitoring protocol are listed in Appendix A and include grasses, shrubs, and trees and many non-native invasive or state listed noxious weeds, several of which are on the park non-native watch list.

Two-person field crews completed field work by recording field data directly into a portable tablet computer with built-in database and quality controls. They backed up the database frequently throughout each field day. This largely eliminated the need to write down observation data and later enter the values manually into the database.

Sample frame boundaries were validated by the field crew, who had the option to reject sample quadrats within each frame if they were located within a non-target vegetation type (e.g., riparian) or were located in an area of human development (e.g., road bed). As needed, rejected quadrats were replaced with quadrats from a list of oversample locations in the GRTS sequence to achieve the desired sample size.

Roughly 7.2% of the pre-determined quadrats were rejected by the field crew in 2013. Most of these were in BICA_LTM_Veg100, and were rejected because the fence line separating the PMWHR did not follow the mapped boundary. The southern edge of this sample frame has now been redrawn to reflect the fence location. Table 3 shows the final sample size and the number of rejected quadrats for each sample frame.

Following the field season, data were evaluated for quality, documented with metadata, and certified prior to analysis. Routine summary statistics involved calculating the frequency and standard error of quadrats in each Daubenmire cover class and reporting the results in graphical, spatial, and tabular formats. Analyses were performed in Microsoft™ Excel and with the spsurvey GRTS package using the R statistical platform (R Development Core Team 2011). Margins of errors, computed with a GRTS local variance estimator were calculated with the spsurvey package.

Climate water balance metrics were calculated using the Thornthwaite-Mather (1955) method described in Dingman (2002). These calculations were performed in Microsoft™ Excel using Remote Automated Weather Station (RAWS) data collected at Hillsboro, Montana (MT) station (HBOM8) during 2011, 2012, and 2013.

Table 3. Sample size and number of quadrats rejected in each sample frame during the 2013 field season.

Sample Frame	Sample Size	# Rejected (or missing)
BICA_LTM_Veg020	50	2
BICA_LTM_Veg030	78	0
BICA_LTM_Veg070	51	1
BICA_LTM_Veg080	53	0
BICA_LTM_Veg090	52	0
BICA_LTM_Veg100	36	39
BICA_LTM_Veg110	77	0
BICA_LTM_Veg120	51	0
BICA_LTM_Veg130	76	3
BICA_LTM_Veg140	51	1
Total	575	45

Rejection rate=approximately 7.2%.

Results and Discussion

In 2013, we completed annual monitoring of ten sample frames; four were dominated by Utah juniper—curl-leaf mountain mahogany woodland, four by sagebrush shrubland, and two were dominated by Utah juniper woodland. Within these sample frames, visual estimates of ground and vegetation cover were made at 575 sample quadrat locations between 21 May and 19 June.

Weather and Climate

The weather prior to sampling was characterized as cool and dry. Precipitation recorded at the Lovell COOP station was well below the 30-year (1981-2010) average from February through June and monthly precipitation totals from the Hillsboro RAWS station were below most values recorded since the inception of this station in 2003. Furthermore, the U.S. Drought Monitor classified the Bighorn Basin as having abnormally dry to moderate drought conditions during this period (U.S. Drought Monitor 2013).

Climate water metrics were calculated for the 2013 monitoring season to illustrate the seasonal interaction of temperature and precipitation and their combined influence on evapotranspiration (ET) and drought

(D), also referred to as water deficit. Figure 4 shows a water deficit at the Hillsboro, MT RAWS station, starting in June and lasting through August. Compared to a wet year in 2011, the water deficit began a month sooner (June vs. July), but lasted the same amount of time (three months). Compared to a dry year in 2012, the water deficit began around the same time (June), but lasted half the length of time (three vs. six months).

Many of the forage species in Bighorn Canyon have drought-tolerant characteristics that help a plant survive during abbreviated periods of low precipitation, but not necessarily for extended dry periods. The climate water deficit (D) is the evaporative demand not met by available water and is a measure of drought stress that has a direct physiological effect on plants (Stephenson 1990, 1998). Depending on the frequency and duration, drought can cause changes in species composition and abundance and will be tracked as a climate response variable in the Upland Vegetation Monitoring Protocol.

Soil Cover

Soil cover effects hydrologic function and the soil stability of an area. Across all sample frames, 67% of the sampled quadrats characterized bare ground as less

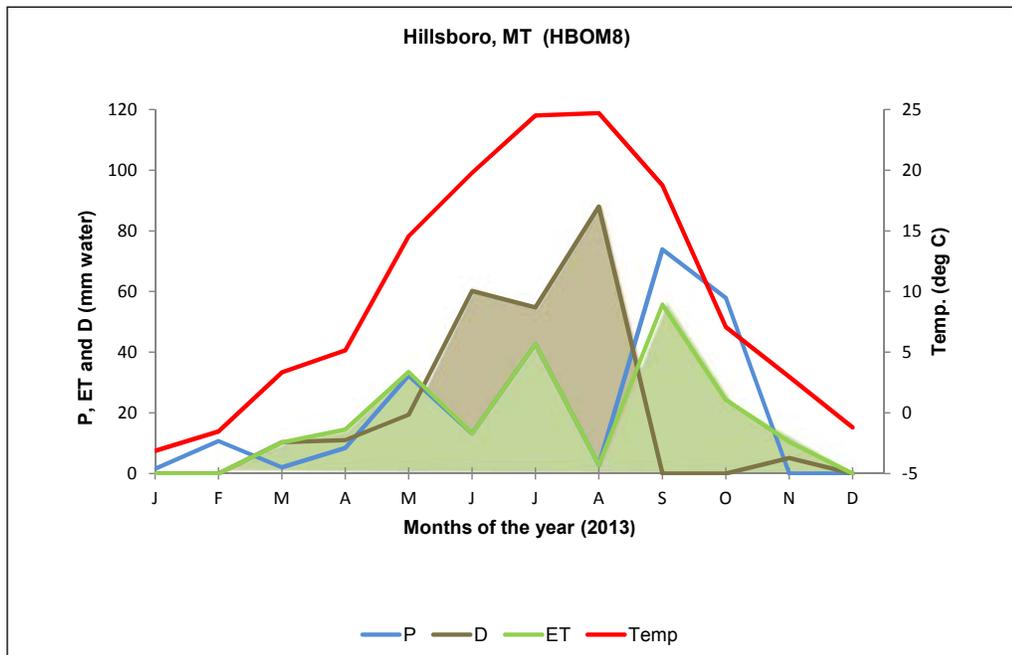


Figure 4. The seasonal climate water balance at Hillsboro, MT RAWS weather station in Bighorn Canyon National Recreation Area during 2013. The right axis shows monthly mean temperature (red line); the left axis shows millimeters (mm) of water for accumulated monthly precipitation “P” (blue line), evapotranspiration “ET” (green line and shading), and water deficit “D” (brown line). The brown shaded area shows the period dominated by a climate water deficit or drought.

than or equal to 5% and another 22% were characterized as having between >5-25% bare ground (Figure 5). Juniper woodlands

tend to be rocky and are characterized with the lowest amount of bare ground.

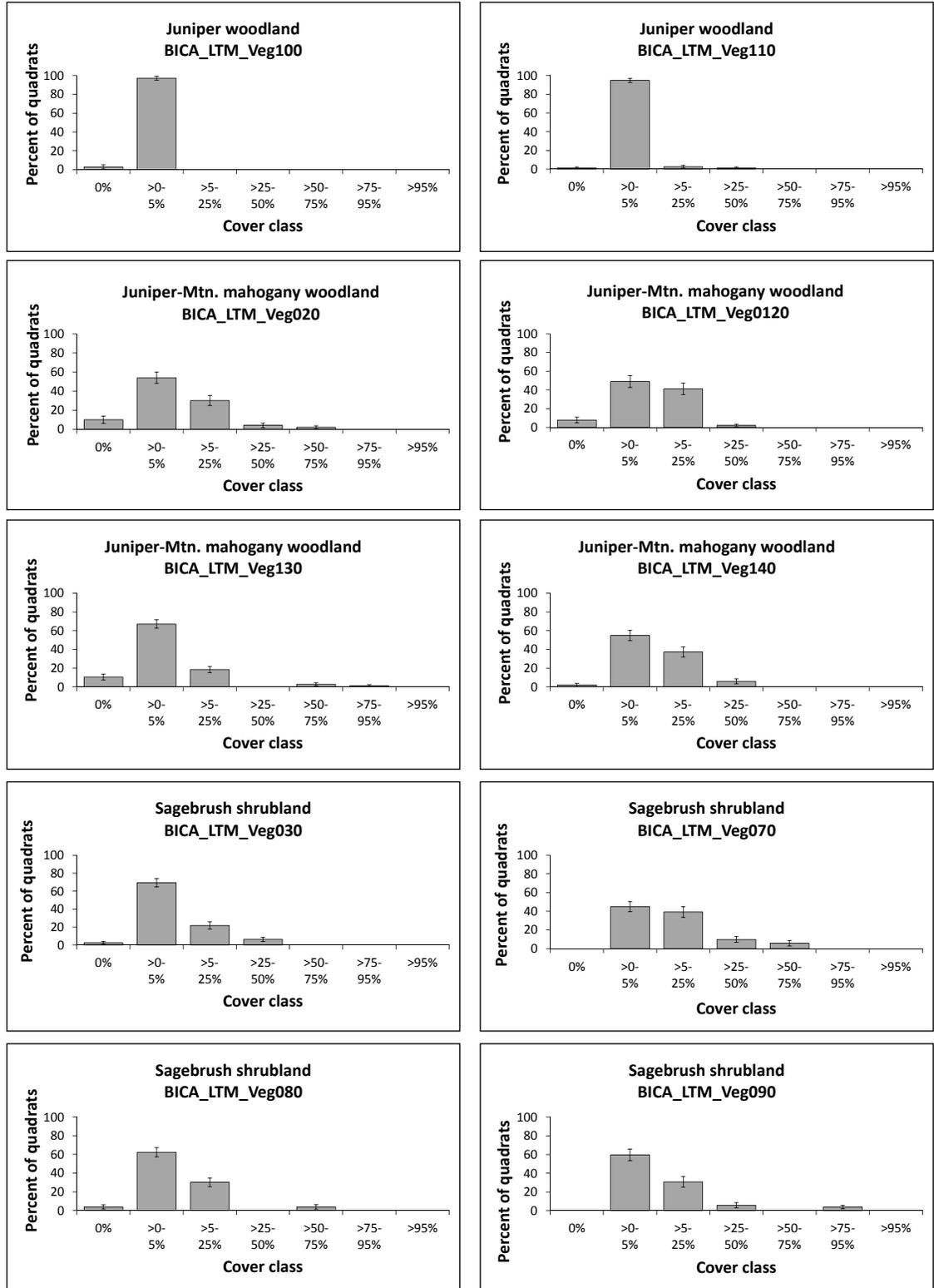


Figure 5. Percent frequency of quadrats with bare ground in the 2013 sampling frames. Estimates of bare ground cover were made using Daubenmire cover class categories. Error bars show one standard error, calculated from the local variance estimator.

Cryptobiotic crusts include lichens and mosses growing on soil and exclude lichens growing on bedrock. Cryptobiotic crust cover is well represented across all the

sample frames, with the majority of quadrats sampled having <5% crust cover (refer to Figure 6).

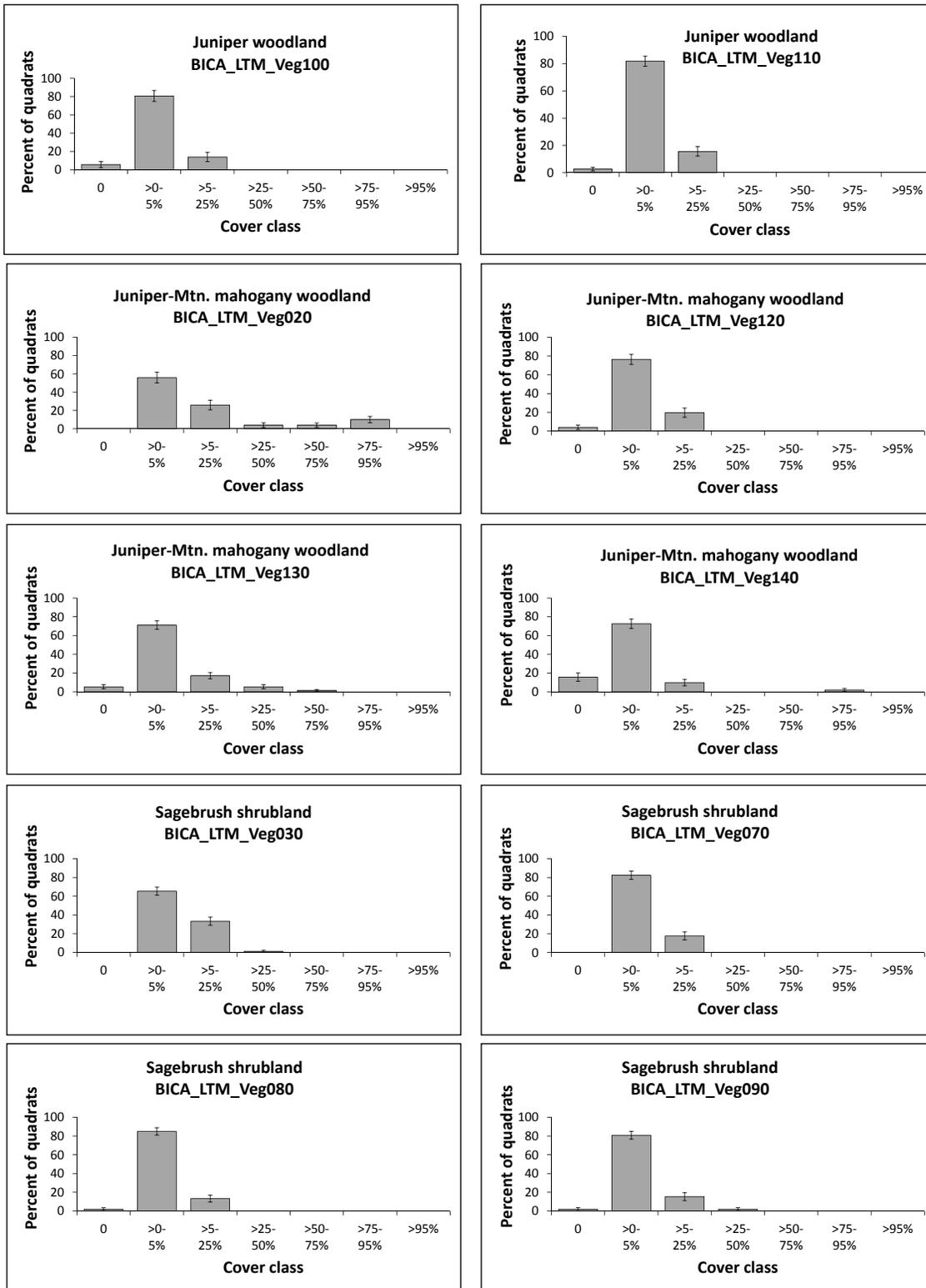


Figure 6. Percent frequency of quadrats with cryptobiotic crust cover in the 2013 sampling frames. Estimates of cryptobiotic crust cover were made using Daubenmire cover class categories. Error bars show one standard error, calculated from the local variance estimator.

The Utah juniper—curl-leaf mountain mahogany woodland communities tend to have more cryptobiotic crust cover than the other communities sampled.

Sagebrush Cover

Sagebrush cover varied greatly within the sagebrush shrubland sample frames, as shown in Figure 7.

Black sagebrush is more abundant in the northern portion of the sample area and is the dominant sagebrush species in BICA_LTM_Veg030. Small amounts of sagebrush cover were also reported in the Utah juniper and Utah juniper—curl-leaf mountain mahogany woodland sample frames. Black sagebrush was reported in both woodland

types, whereas Wyoming sagebrush was reported in the Utah Juniper—curl-leaf mountain mahogany woodland only.

Non-native Plant Species

Four non-native plant species were reported in 2013: cheatgrass (*Bruomus tectorum*), Russian thistle (*Salsola tragus*), halogeton (*Halogeton glomeratus*), and crested wheatgrass (*Agropyron cristatum*). These plants were found in seven of the ten sample frames, and cheatgrass was the most widespread occurring in all seven. The number of quadrats, expressed as a percent, with non-native plants present is shown in Table 4. The locations of non-native plants are shown in Figures 9 through 18.

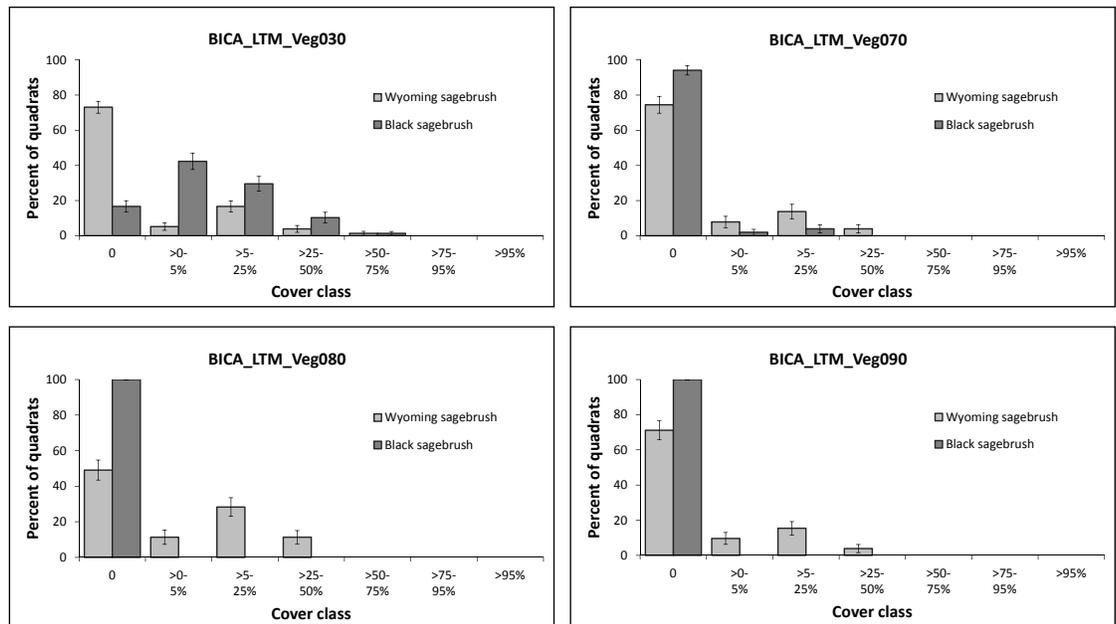


Figure 7. Percent of (sagebrush shrubland) quadrats in each cover class with black sagebrush (*Artemisia nova*) or Wyoming sagebrush (*A. tridentata* spp. *wyomingensis*). Error bars show one standard error, calculated from the local variance estimator.

Table 4. Percent of quadrats with non-native plants present within the 2013 sample frames.

Non-native Species	Veg020	Veg070	Veg080	Veg090	Veg110	Veg130	Veg140
Cheatgrass	2	24	11	2	1	1	2
Crested wheatgrass	4	0	9	0	0	0	8
Halogeton	0	0	0	0	0	1	0
Russian thistle	0	2	0	0	0	0	0

Tree Recruitment

Young trees ≤ 10 cm tall were found in eight of the ten sample frames (refer to Table 5). Overall, Utah juniper recruitment density is widespread, but sparse. Young curl-leaf mountain mahogany was encountered less frequently, but in higher numbers, especially in BICA_LTM_Veg120.

Permanent Photo Points

We established permanent photo points at six of the ten sample frames in 2013. Each photo point includes a series of four pictures, one facing each cardinal direction. Figure 8 shows an example of two permanent photographs and associated metadata.

Table 5. Number of trees ≤ 10 cm tall counted within sampling quadrats in 2013.

Non-native Species	Veg020	Veg030	Veg090	Veg100	Veg110	Veg120	Veg130	Veg140
Utah juniper	6	1	4	6	9	0	5	4
Rocky mtn. juniper	0	0	0	0	0	0	3	0
Curl-leaf mtn. mahogany	2	0	0	0	0	28	12	10

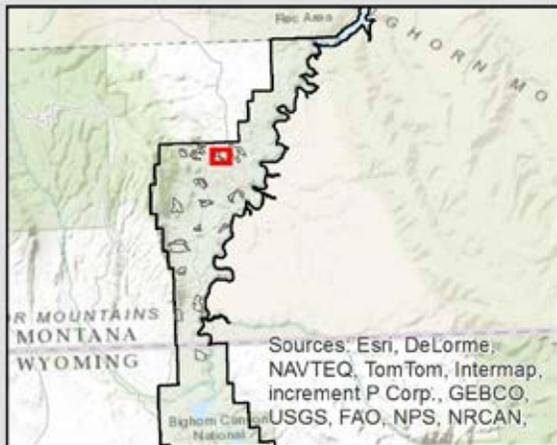
<ol style="list-style-type: none"> 1. Sample frame name: BICA_LTM_Veg130 2. Camera make and model: Olympus Stylus 770 SW 3. GPS location (UTM Zone 11N, NAD 83): Easting 715700; Northing 498662 4. Date of acquisition (month/day/year): 06/19/2013 5. Time of acquisition (hours:minutes AM/PM): 2:55 PM 6. Azimuth direction in degrees: 90° 7. A brief description: Extensive landscape view from near Devils Canyon Overlook showing extensive <i>Juniperus osteosperma</i> and <i>Cercocarpus ledifolius</i> woodlands 8. Name of the person taking the photo: Cathie Jean 9. Digital file name: BICA_LTM_Veg130_NA_2013_PermPhotoPoint_E.JPG 	
<ol style="list-style-type: none"> 1. Sample frame name: BICA_LTM_Veg110 2. Camera make and model: Olympus Stylus 770 SW 3. GPS location (UTM Zone 11N, NAD 83): Easting 714757; Northing 4994312 4. Date of acquisition (month/day/year): 06/18/2013 5. Time of acquisition (hours:minutes AM/PM): 9:40 AM 6. Azimuth direction in degrees: 180° 7. A brief description: Lower slopes of the Pryor Mountains in the background. In the foreground, a <i>Pseudoroegneria spicata</i> grassland interspersed with patches of <i>Juniperus osteosperma</i> woodland 8. Name of the person taking the photo: Cathie Jean and Kristin Legg 9. Digital file name: BICA_LTM_Veg110_56_2013_PermPhotoPoint_S.JPG 	

Figure 8. Example of two permanent photo points established in 2013 as part of the strategy for long-term vegetation monitoring at Bighorn Canyon National Recreation Area.

Sample Frame Summaries

Monitoring results from the ten sample frames monitored in 2013 are shown in the following section. Maps showing the locations of quadrats sampled and the locations of non-native plants encountered are found in Figures 9 through 18. A

summary for each sample frame showing ground and vegetation cover estimates are provided in Tables 6 through 16. Charts showing the percent frequency of quadrats by Daubenmire cover class and error bars, calculated from the local variance estimator are shown in Appendix B.



Legend

- ⊙ Quadrat location
- ▲ Crested wheatgrass
- Cheatgrass
- Sample frame boundary

0 50 100 200 300
Meters

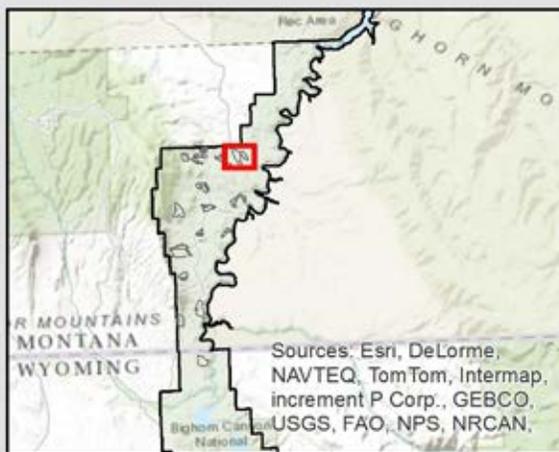
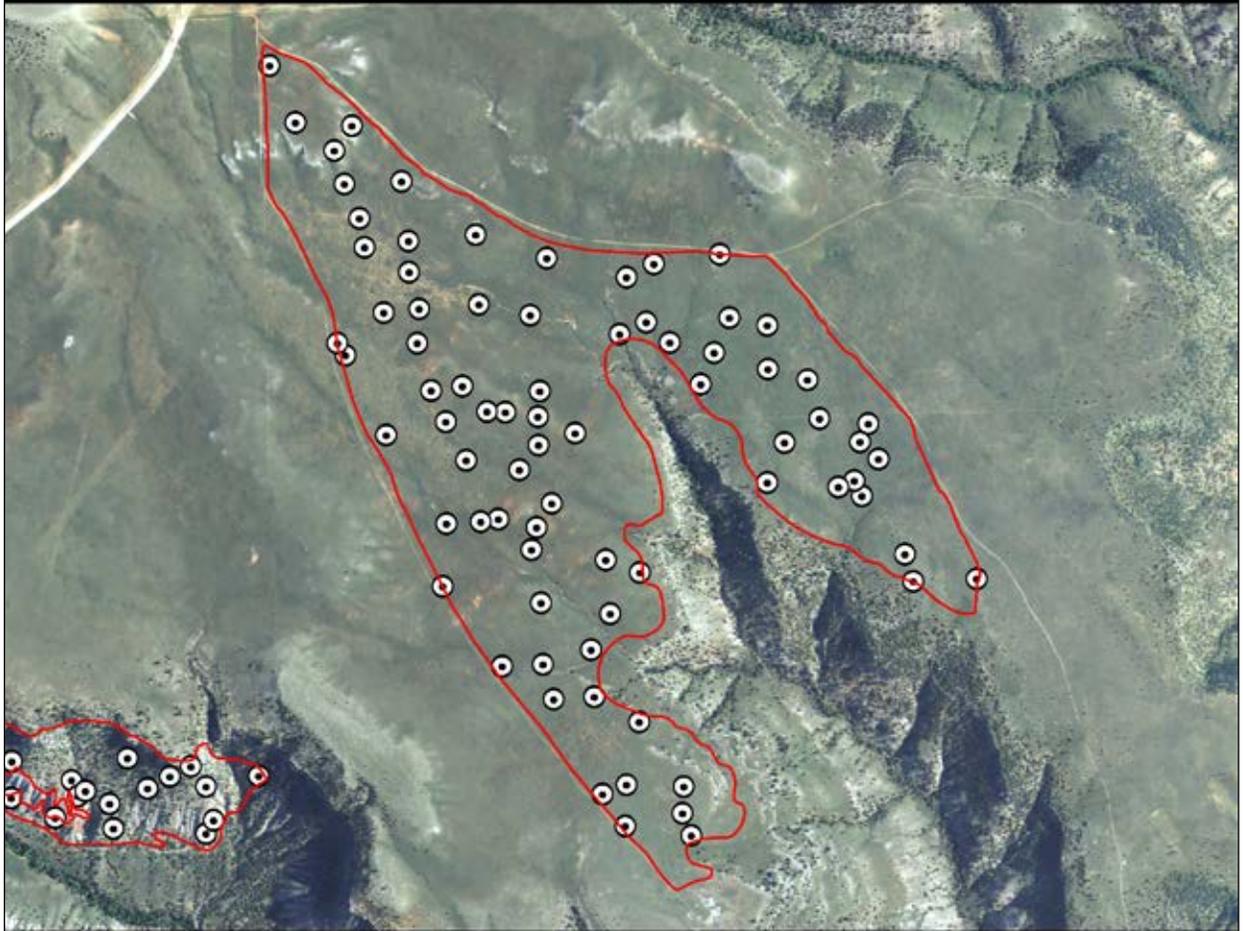


November 2013
NPS Inventory and Monitoring Division

Figure 9. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg020. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.

Table 6. Percent of quadrats (n=50) for sample frame BICA_LTM_Veg_020 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.

BICA_LTM_Veg_020	0%	>0-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Ground cover							
Bare ground	10	54	30	4	2	0	0
Litter	0	68	20	6	6	0	0
Cryptogams	0	56	26	4	4	10	0
Trees							
Curl-leaf mountain mahogany (<i>Cercocarpus ledifolius</i>)	88	2	8	2	0	0	0
Limber pine (<i>Pinus flexilis</i>)	98	0	2	0	0	0	0
Utah juniper (<i>Juniperus osteosperma</i>)	44	16	14	16	8	2	0
Shrubs							
Black sagebrush (<i>Artemisia nova</i>)	84	14	2	0	0	0	0
Broom snakeweed (<i>Gutierrezia sarothrae</i>)	60	34	6	0	0	0	0
Prickly pear cactus (<i>Opuntia polyacantha</i>)	76	20	4	0	0	0	0
Saltbush (<i>Atriplex</i> spp.)	98	2	0	0	0	0	0
Skunkbush (<i>Rhus aromatica</i> var. <i>trilobata</i>)	98	2	0	0	0	0	0
Winterfat (<i>Krascheninnikovia lanata</i>)	90	10	0	0	0	0	0
Wyoming Sagebrush (<i>Artemisia tridentata</i>)	98	2	0	0	0	0	0
Grasses and grass-like plants							
Blue grama (<i>Bouteloua gracilis</i>)	96	4	0	0	0	0	0
Bluebunch wheatgrass (<i>Pseudoroegneria spicata</i>)	24	52	22	2	0	0	0
Indian ricegrass (<i>Achnatherum hymenoides</i>)	92	8	0	0	0	0	0
Junegrass (<i>Koeleria macrantha</i>)	98	2	0	0	0	0	0
Needle and thread (<i>Hesperostipa comata</i> var. <i>comata</i>)	72	28	0	0	0	0	0
Sandberg's bluegrass (<i>Poa secunda</i>)	84	16	0	0	0	0	0
Sedges (<i>Carex</i> spp.)	66	30	4	0	0	0	0
Three awn (<i>Aristida purpurea</i> var. <i>fendleriana</i>)	88	12	0	0	0	0	0
Western wheatgrass (<i>Pascopyrum smithii</i>)	98	2	0	0	0	0	0
Non-native - present in park							
Cheatgrass (<i>Bromus tectorum</i>)	98	2	0	0	0	0	0
Crested wheatgrass (<i>Agropyron cristatum</i>)	96	2	0	0	0	2	0



Legend

- Quadrat location
- Sample frame boundary

0 50 100 200 300 400 500
Meters



November 2013
NPS Inventory and Monitoring Division

Figure 10. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg030. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.

Table 7. Percent of quadrats (n=78) for sample frame BICA_LTM_Veg_030 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.

BICA_LTM_Veg030	0%	>0-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Ground cover							
Bare ground	3	69	22	6	0	0	0
Litter	0	74	24	1	0	0	0
Cryptogams	0	65	33	1	0	0	0
Trees							
Utah juniper (<i>Juniperus osteosperma</i>)	97	3	0	0	0	0	0
Shrubs							
Black sagebrush (<i>Artemisia nova</i>)	17	42	29	10	1	0	0
Broom snakeweed (<i>Gutierrezia sarothrae</i>)	50	49	1	0	0	0	0
Prickly pear cactus (<i>Opuntia polyacantha</i>)	87	13	0	0	0	0	0
Wyoming Sagebrush (<i>Artemisia tridentata</i>)	73	5	17	4	1	0	0
Grasses and grass-like plants							
Blue grama (<i>Bouteloua gracilis</i>)	96	3	1	0	0	0	0
Bluebunch wheatgrass (<i>Pseudoroegneria spicata</i>)	8	71	22	0	0	0	0
Indian ricegrass (<i>Achnatherum hymenoides</i>)	97	3	0	0	0	0	0
Junegrass (<i>Koeleria macrantha</i>)	5	85	10	0	0	0	0
Needle and thread (<i>Hesperostipa comata</i> var. <i>comata</i>)	74	26	0	0	0	0	0
Sandberg's bluegrass (<i>Poa secunda</i>)	27	73	0	0	0	0	0
Sedges (<i>Carex</i> spp.)	71	26	4	0	0	0	0
Western wheatgrass (<i>Pascopyrum smithii</i>)	96	4	0	0	0	0	0

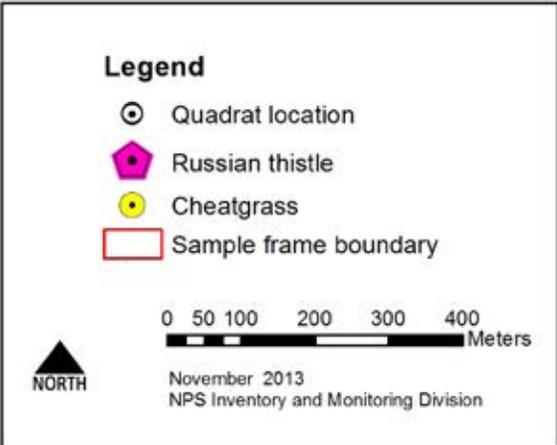
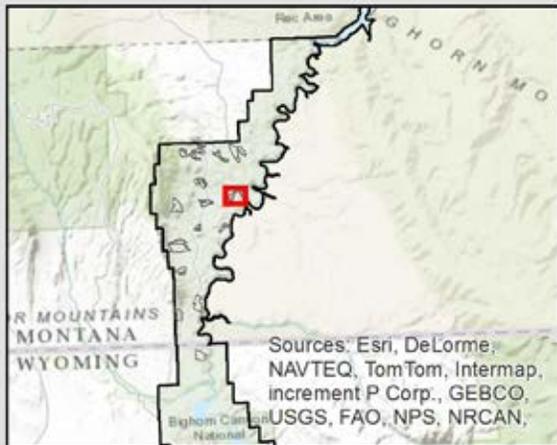
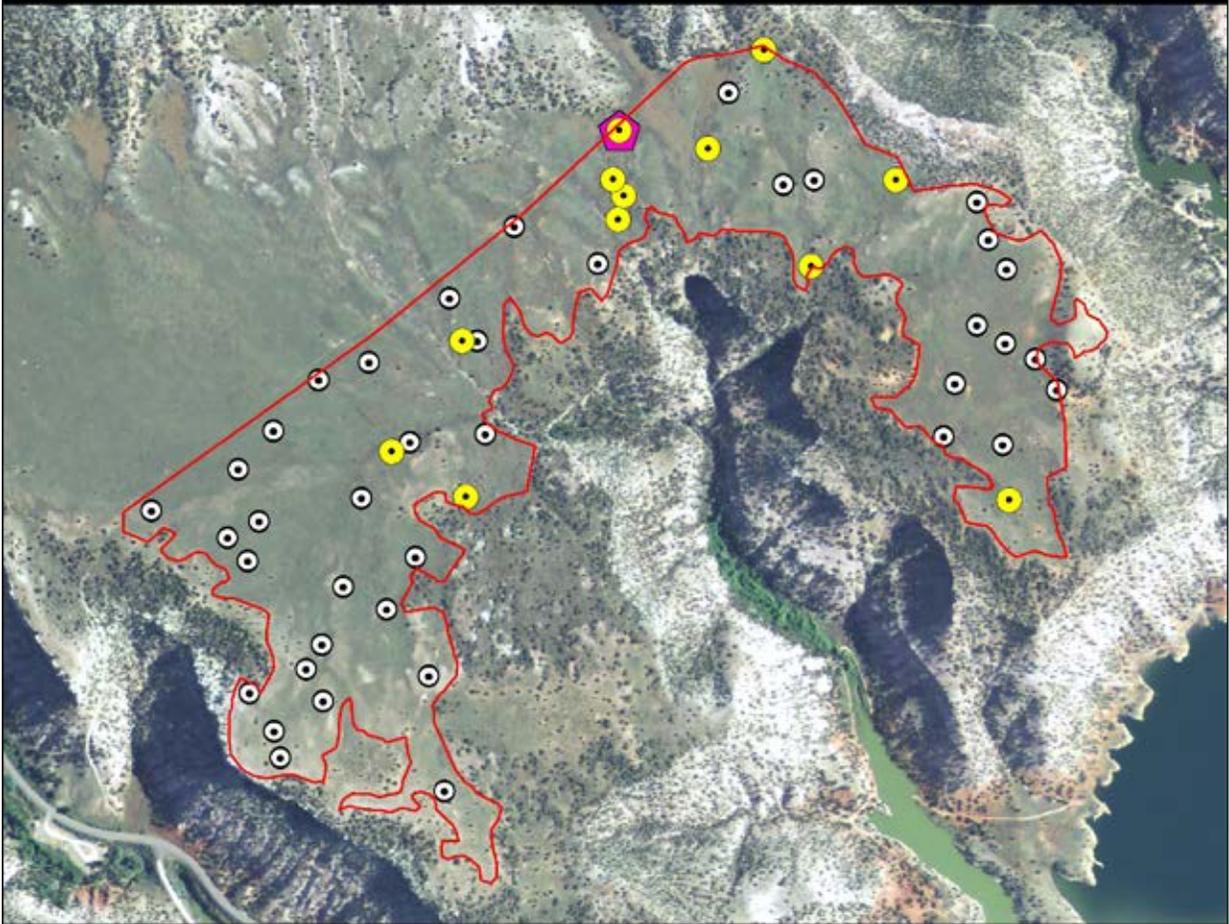


Figure 11. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg070. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.

Table 8. Percent of quadrats (n=51) for sample frame BICA_LTM_Veg_070 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.

BICA_LTM_Veg070	0%	>0-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Ground cover							
Bare ground	0	45	39	10	6	0	0
Litter	2	65	31	2	0	0	0
Cryptogams	0	82	18	0	0	0	0
Trees							
Utah juniper (<i>Juniperus osteosperma</i>)	94	4	0	2	0	0	0
Shrubs							
Black sagebrush (<i>Artemisia nova</i>)	94	2	4	0	0	0	0
Broom snakeweed (<i>Gutierrezia sarothrae</i>)	75	24	2	0	0	0	0
Prickly pear cactus (<i>Opuntia polyacantha</i>)	57	25	18	0	0	0	0
Winterfat (<i>Krascheninnikovia lanata</i>)	98	2	0	0	0	0	0
Wyoming Sagebrush (<i>Artemisia tridentata</i>)	75	8	14	4	0	0	0
Grasses and grass-like plants							
Blue grama (<i>Bouteloua gracilis</i>)	43	31	20	4	2	0	0
Bluebunch wheatgrass (<i>Pseudoroegneria spicata</i>)	41	37	18	4	0	0	0
Indian ricegrass (<i>Achnatherum hymenoides</i>)	98	2	0	0	0	0	0
Junegrass (<i>Koeleria macrantha</i>)	98	2	0	0	0	0	0
Needle and thread (<i>Hesperostipa comata</i> var. <i>comata</i>)	18	61	20	2	0	0	0
Sandberg's bluegrass (<i>Poa secunda</i>)	41	59	0	0	0	0	0
Sedges (<i>Carex</i> spp.)	71	22	8	0	0	0	0
Three awn (<i>Aristida purpurea</i> var. <i>fendleriana</i>)	84	14	2	0	0	0	0
Western wheatgrass (<i>Pascopyrum smithii</i>)	90	10	0	0	0	0	0
Non-native - present in park							
Cheatgrass (<i>Bromus tectorum</i>)	76	18	6	0	0	0	0
Russian thistle (<i>Salsola tragus</i>)	98	2	0	0	0	0	0

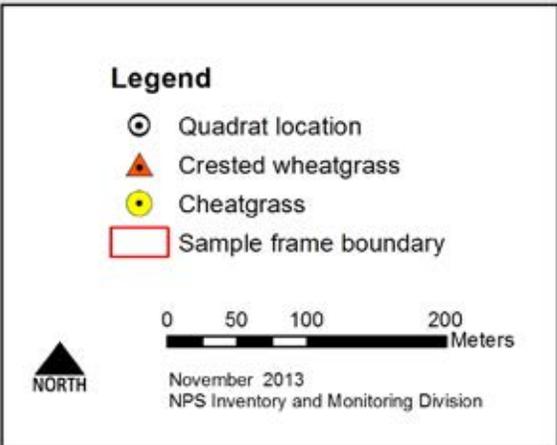
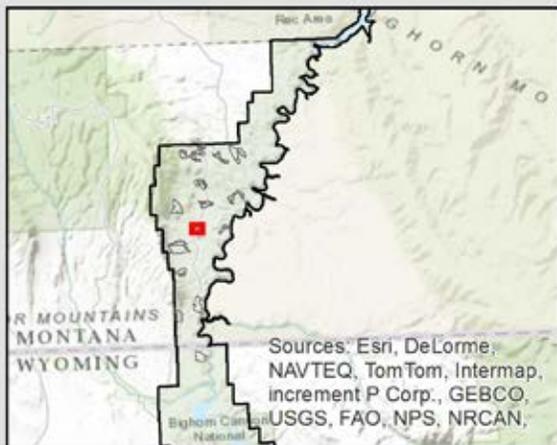
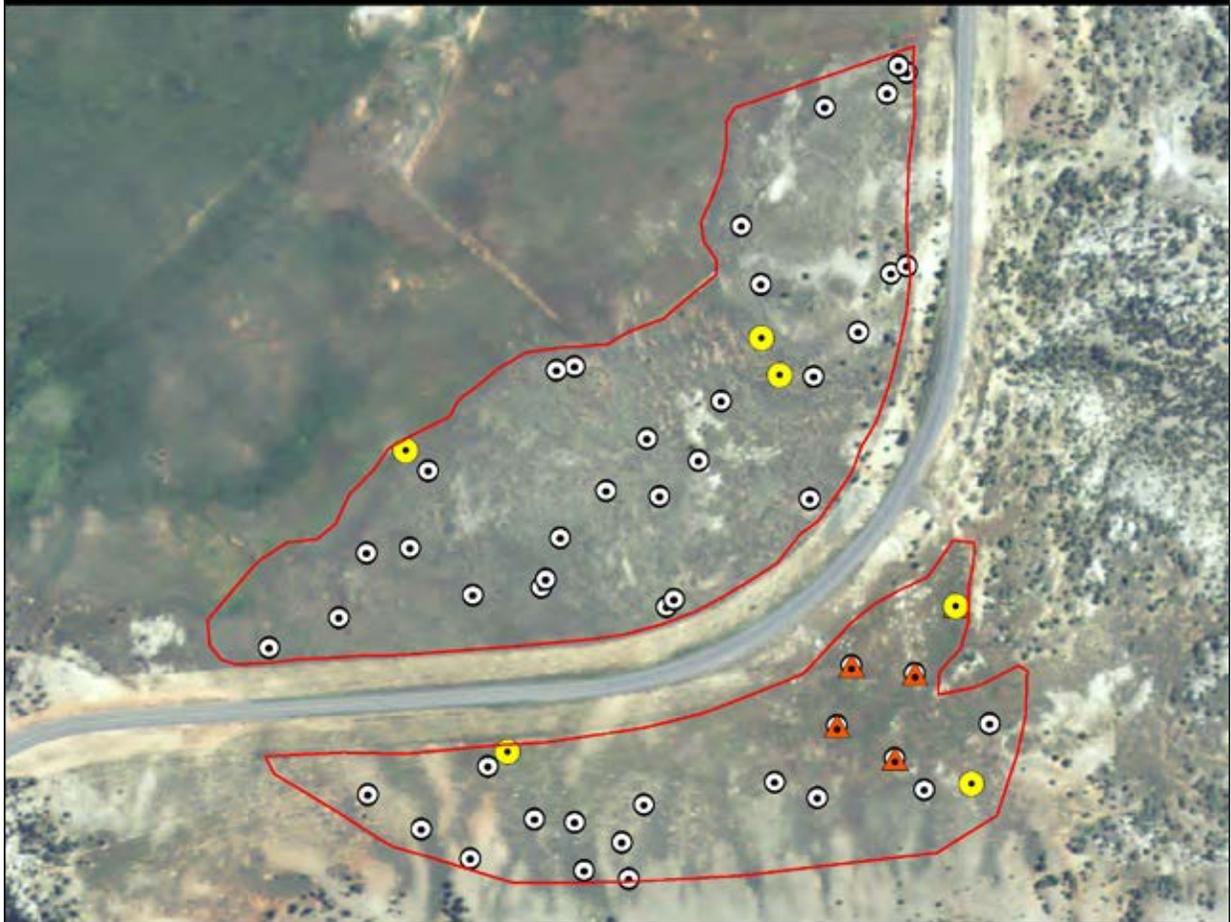


Figure 12. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg080. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.

Table 9. Percent of quadrats (n=53) for sample frame BICA_LTM_Veg_080 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.

BICA_LTM_Veg080	0%	>0-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Ground cover							
Bare ground	4	62	30	0	4	0	0
Litter	0	58	32	8	2	0	0
Cryptogams	2	85	13	0	0	0	0
Shrubs							
Broom snakeweed (<i>Gutierrezia sarothrae</i>)	81	17	2	0	0	0	0
Prickly pear cactus (<i>Opuntia polyacantha</i>)	62	36	2	0	0	0	0
Winterfat (<i>Krascheninnikovia lanata</i>)	94	6	0	0	0	0	0
Wyoming Sagebrush (<i>Artemisia tridentata</i>)	49	11	28	11	0	0	0
Grasses and grass-like plants							
Blue grama (<i>Bouteloua gracilis</i>)	43	47	9	0	0	0	0
Bluebunch wheatgrass (<i>Pseudoroegneria spicata</i>)	38	51	11	0	0	0	0
Drop seed (<i>Sporobolus</i> spp.)	98	2	0	0	0	0	0
Junegrass (<i>Koeleria macrantha</i>)	98	2	0	0	0	0	0
Needle and thread (<i>Hesperostipa comata</i> var. <i>comata</i>)	51	42	8	0	0	0	0
Sandberg's bluegrass (<i>Poa secunda</i>)	23	77	0	0	0	0	0
Sedges (<i>Carex</i> spp.)	98	2	0	0	0	0	0
Western wheatgrass (<i>Pascopyrum smithii</i>)	94	6	0	0	0	0	0
Non-native - present in park							
Cheatgrass (<i>Bromus tectorum</i>)	89	11	0	0	0	0	0
Crested wheatgrass (<i>Agropyron cristatum</i>)	91	4	6	0	0	0	0



Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN,

Legend

- ⊙ Quadrat location
- Cheatgrass
- Sample frame boundary

0 50 100 200
Meters



November 2013
NPS Inventory and Monitoring Division

Figure 13. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg090. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.

Table 10. Percent of quadrats (n=52) for sample frame BICA_LTM_Veg_090 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.

BICA_LTM_Veg_090	0%	>0-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Ground cover							
Bare ground	0	60	31	6	0	4	0
Litter	0	92	8	0	0	0	0
Cryptogams	2	81	15	2	0	0	0
Trees							
Utah juniper (<i>Juniperus osteosperma</i>)	75	17	8	0	0	0	0
Shrubs							
Broom snakeweed (<i>Gutierrezia sarothrae</i>)	46	54	0	0	0	0	0
Prickly pear cactus (<i>Opuntia polyacantha</i>)	46	50	4	0	0	0	0
Winterfat (<i>Krascheninnikovia lanata</i>)	98	2	0	0	0	0	0
Wyoming Sagebrush (<i>Artemisia tridentata</i>)	71	10	15	4	0	0	0
Grasses and grass-like plants							
Blue grama (<i>Bouteloua gracilis</i>)	46	21	23	6	4	0	0
Bluebunch wheatgrass (<i>Pseudoroegneria spicata</i>)	40	50	10	0	0	0	0
Indian ricegrass (<i>Achnatherum hymenoides</i>)	87	12	2	0	0	0	0
Junegrass (<i>Koeleria macrantha</i>)	98	2	0	0	0	0	0
Needle and thread (<i>Hesperostipa comata</i> var. <i>comata</i>)	56	44	0	0	0	0	0
Sandberg's bluegrass (<i>Poa secunda</i>)	60	40	0	0	0	0	0
Three awn (<i>Aristida purpurea</i> var. <i>fendleriana</i>)	62	37	2	0	0	0	0
Western wheatgrass (<i>Pascopyrum smithii</i>)	96	4	0	0	0	0	0
Non-native - present in park							
Cheatgrass (<i>Bromus tectorum</i>)	98	2	0	0	0	0	0



Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN,

Legend

- ⊙ Quadrat location
- Sample frame boundary

0 50 100 200
Meters



November 2013
NPS Inventory and Monitoring Division

Figure 14. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg100. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.

Table 11. Percent of quadrats (n=36) for sample frame BICA_LTM_Veg_100 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.

BICA_LTM_Veg100	0%	>0-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Ground cover							
Bare ground	3	97	0	0	0	0	0
Litter	0	81	8	8	0	3	0
Cryptogams	6	81	14	0	0	0	0
Trees							
Curl-leaf mountain mahogany (<i>Cercocarpus ledifolius</i>)	97	3	0	0	0	0	0
Limber pine (<i>Pinus flexilis</i>)	97	0	3	0	0	0	0
Utah juniper (<i>Juniperus osteosperma</i>)	31	22	17	11	19	0	0
Shrubs							
Black sagebrush (<i>Artemisia nova</i>)	94	0	6	0	0	0	0
Broom snakeweed (<i>Gutierrezia sarothrae</i>)	44	56	0	0	0	0	0
Prickly pear cactus (<i>Opuntia polyacantha</i>)	97	3	0	0	0	0	0
Winterfat (<i>Krascheninnikovia lanata</i>)	89	11	0	0	0	0	0
Grasses and grass-like plants							
Blue grama (<i>Bouteloua gracilis</i>)	97	3	0	0	0	0	0
Bluebunch wheatgrass (<i>Pseudoroegneria spicata</i>)	6	86	8	0	0	0	0
Indian ricegrass (<i>Achnatherum hymenoides</i>)	97	3	0	0	0	0	0
Junegrass (<i>Koeleria macrantha</i>)	92	8	0	0	0	0	0
Needle and thread (<i>Hesperostipa comata</i> var. <i>comata</i>)	58	42	0	0	0	0	0
Sandberg's bluegrass (<i>Poa secunda</i>)	75	25	0	0	0	0	0
Sedges (<i>Carex</i> spp.)	69	28	3	0	0	0	0
Three awn (<i>Aristida purpurea</i> var. <i>fendleriana</i>)	75	25	0	0	0	0	0



Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN,

Legend

- ⊙ Quadrat location
- Cheatgrass
- Sample frame boundary

0 50 100 200 300 400 Meters



November 2013
NPS Inventory and Monitoring Division

Figure 15. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg110. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.

Table 12. Percent of quadrats (n=77) for sample frame BICA_LTM_Veg_110 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.

BICA_LTM_Veg_110	0%	>0-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Ground cover							
Bare ground	1	95	3	1	0	0	0
Litter	25	65	6	1	0	3	0
Cryptogams	3	82	16	0	0	0	0
Trees							
Rocky Mountain juniper (<i>Juniperus scopulorum</i>)	97	0	1	1	0	0	0
Utah juniper (<i>Juniperus osteosperma</i>)	27	29	21	14	8	1	0
Shrubs							
Black sagebrush (<i>Artemisia nova</i>)	97	0	1	1	0	0	0
Broom snakeweed (<i>Gutierrezia sarothrae</i>)	43	55	3	0	0	0	0
Prickly pear cactus (<i>Opuntia polyacantha</i>)	92	8	0	0	0	0	0
Grasses and grass-like plants							
Blue grama (<i>Bouteloua gracilis</i>)	81	18	1	0	0	0	0
Bluebunch wheatgrass (<i>Pseudoroegneria spicata</i>)	13	84	3	0	0	0	0
Drop seed (<i>Sporobolus</i> spp.)	99	1	0	0	0	0	0
Indian ricegrass (<i>Achnatherum hymenoides</i>)	97	3	0	0	0	0	0
Junegrass (<i>Koeleria macrantha</i>)	96	4	0	0	0	0	0
Needle and thread (<i>Hesperostipa comata</i> var. <i>comata</i>)	60	40	0	0	0	0	0
Sandberg's bluegrass (<i>Poa secunda</i>)	69	31	0	0	0	0	0
Sedges (<i>Carex</i> spp.)	88	12	0	0	0	0	0
Three awn (<i>Aristida purpurea</i> var. <i>fendleriana</i>)	64	36	0	0	0	0	0
Non-native - present in park							
Cheatgrass (<i>Bromus tectorum</i>)	99	1	0	0	0	0	0

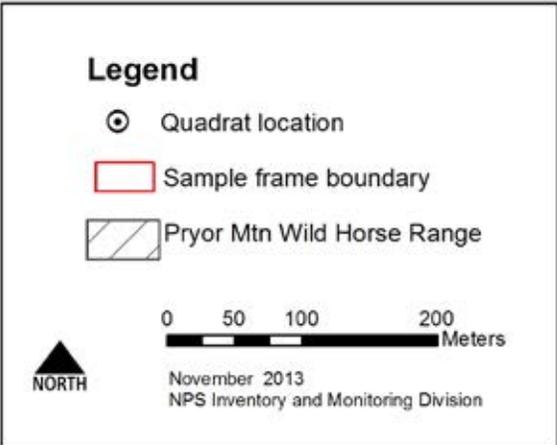
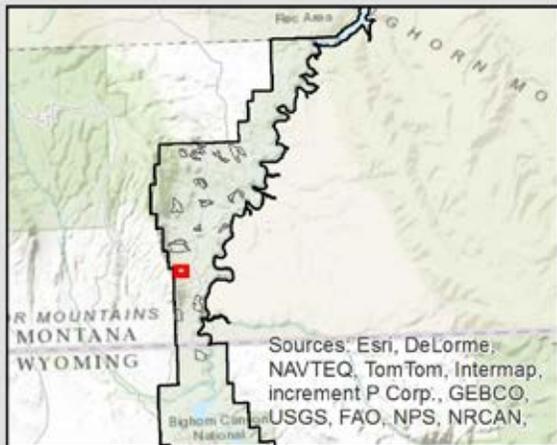
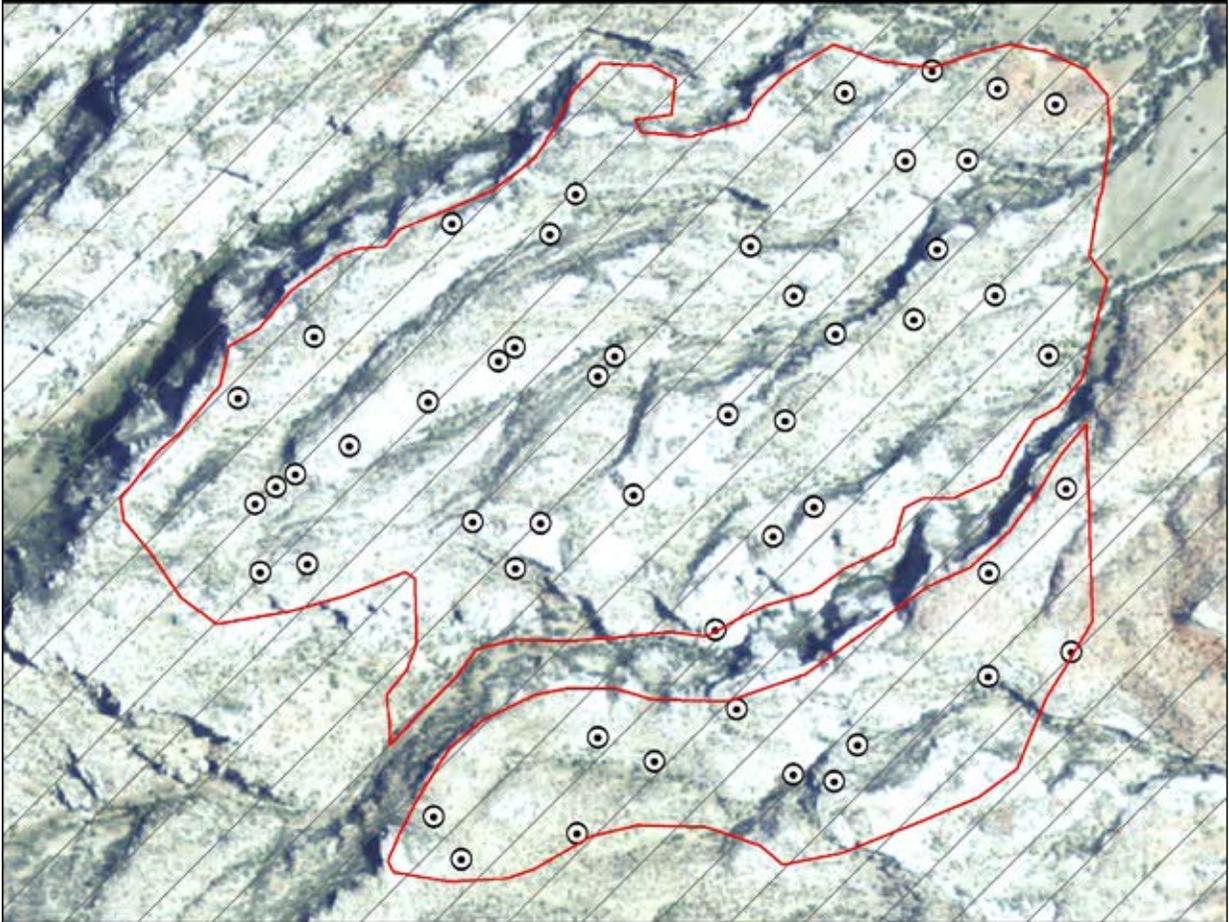


Figure 16. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg120. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.

Table 13. Percent of quadrats (n=51) for sample frame BICA_LTM_Veg_120 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.

BICA_LTM_Veg_120	0%	>0-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Ground cover							
Bare ground	8	49	41	2	0	0	0
Litter	0	61	31	6	2	0	0
Cryptogams	4	76	20	0	0	0	0
Trees							
Curl-leaf mountain mahogany (<i>Cercocarpus ledifolius</i>)	10	22	47	14	8	0	0
Rocky Mountain juniper (<i>Juniperus scopulorum</i>)	96	0	4	0	0	0	0
Utah juniper (<i>Juniperus osteosperma</i>)	80	10	10	0	0	0	0
Shrubs							
Broom snakeweed (<i>Gutierrezia sarothrae</i>)	71	27	2	0	0	0	0
Prickly pear cactus (<i>Opuntia polyacantha</i>)	98	2	0	0	0	0	0
Saltbush (<i>Atriplex</i> spp.)	98	0	2	0	0	0	0
Winterfat (<i>Krascheninnikovia lanata</i>)	90	10	0	0	0	0	0
Grasses and grass-like plants							
Blue grama (<i>Bouteloua gracilis</i>)	98	2	0	0	0	0	0
Bluebunch wheatgrass (<i>Pseudoroegneria spicata</i>)	2	63	35	0	0	0	0
Junegrass (<i>Koeleria macrantha</i>)	92	8	0	0	0	0	0
Needle and thread (<i>Hesperostipa comata</i> var. <i>comata</i>)	98	2	0	0	0	0	0
Sandberg's bluegrass (<i>Poa secunda</i>)	80	18	2	0	0	0	0
Sedges (<i>Carex</i> spp.)	71	29	0	0	0	0	0
Three awn (<i>Aristida purpurea</i> var. <i>fendleriana</i>)	88	12	0	0	0	0	0

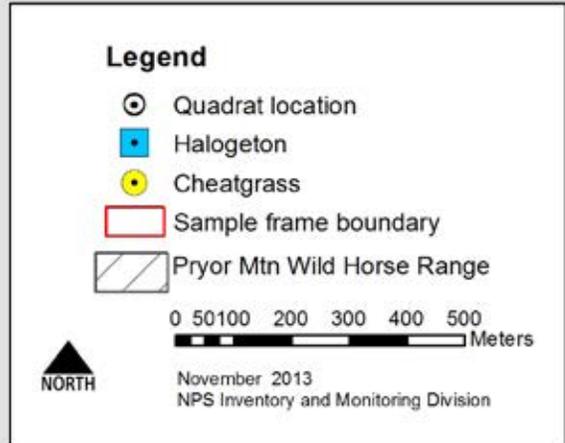
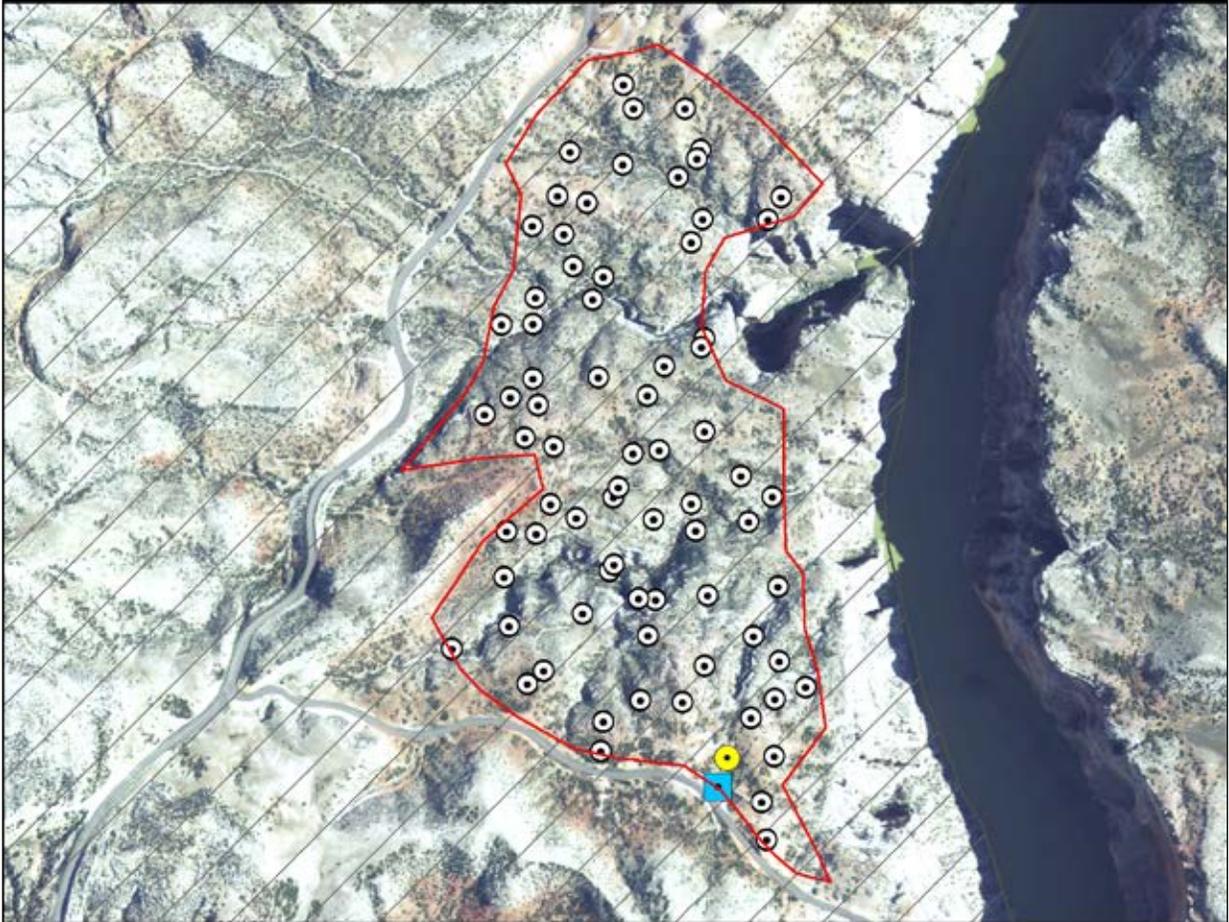


Figure 17. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg130. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.

Table 14. Percent of quadrats (n=76) for sample frame BICA_LTM_Veg_130 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.

BICA_LTM_Veg_130	0%	>0-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Ground cover							
Bare ground	11	67	18	0	3	1	0
Litter	3	80	11	4	0	3	0
Cryptogams	5	71	17	5	1	0	0
Trees							
Curl-leaf mountain mahogany (<i>Cercocarpus ledifolius</i>)	57	14	18	11	0	0	0
Rocky Mountain juniper (<i>Juniperus scopulorum</i>)	96	3	1	0	0	0	0
Utah juniper (<i>Juniperus osteosperma</i>)	38	16	22	14	7	3	0
Shrubs							
Black sagebrush (<i>Artemisia nova</i>)	84	11	5	0	0	0	0
Broom snakeweed (<i>Gutierrezia sarothrae</i>)	63	37	0	0	0	0	0
Prickly pear cactus (<i>Opuntia polyacantha</i>)	91	8	1	0	0	0	0
Skunkbush (<i>Rhus aromatica</i> var. <i>trilobata</i>)	99	1	0	0	0	0	0
Winterfat (<i>Krascheninnikovia lanata</i>)	89	11	0	0	0	0	0
Wyoming Sagebrush (<i>Artemisia tridentata</i>)	96	1	3	0	0	0	0
Grasses and grass-like plants							
Blue grama (<i>Bouteloua gracilis</i>)	93	7	0	0	0	0	0
Bluebunch wheatgrass (<i>Pseudoroegneria spicata</i>)	28	71	1	0	0	0	0
Indian ricegrass (<i>Achnatherum hymenoides</i>)	88	12	0	0	0	0	0
Junegrass (<i>Koeleria macrantha</i>)	96	4	0	0	0	0	0
Needle and thread (<i>Hesperostipa comata</i> var. <i>comata</i>)	79	21	0	0	0	0	0
Sandberg's bluegrass (<i>Poa secunda</i>)	80	20	0	0	0	0	0
Sedges (<i>Carex</i> spp.)	82	18	0	0	0	0	0
Three awn (<i>Aristida purpurea</i> var. <i>fendleriana</i>)	68	32	0	0	0	0	0
Non-native - present in park							
Cheatgrass (<i>Bromus tectorum</i>)	99	1	0	0	0	0	0
Salt lover (<i>Halogeton glomeratus</i>)	99	1	0	0	0	0	0

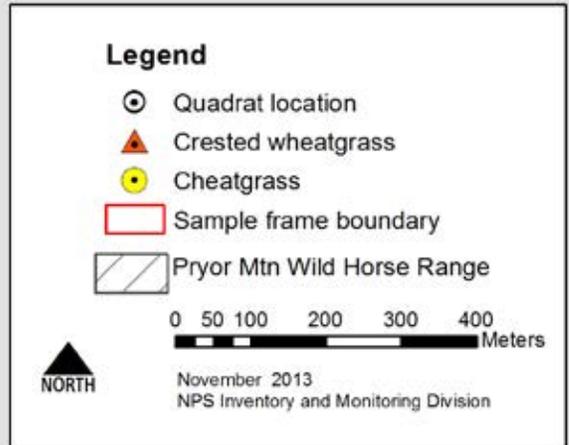
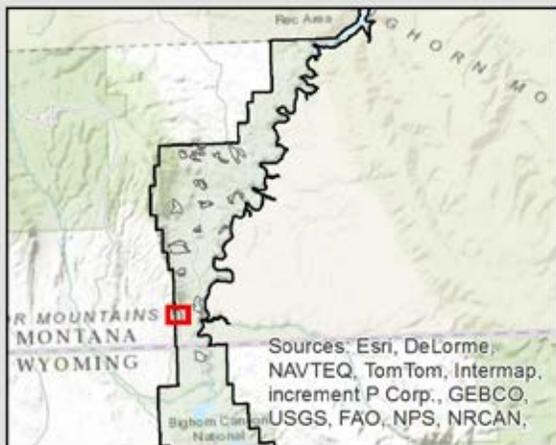
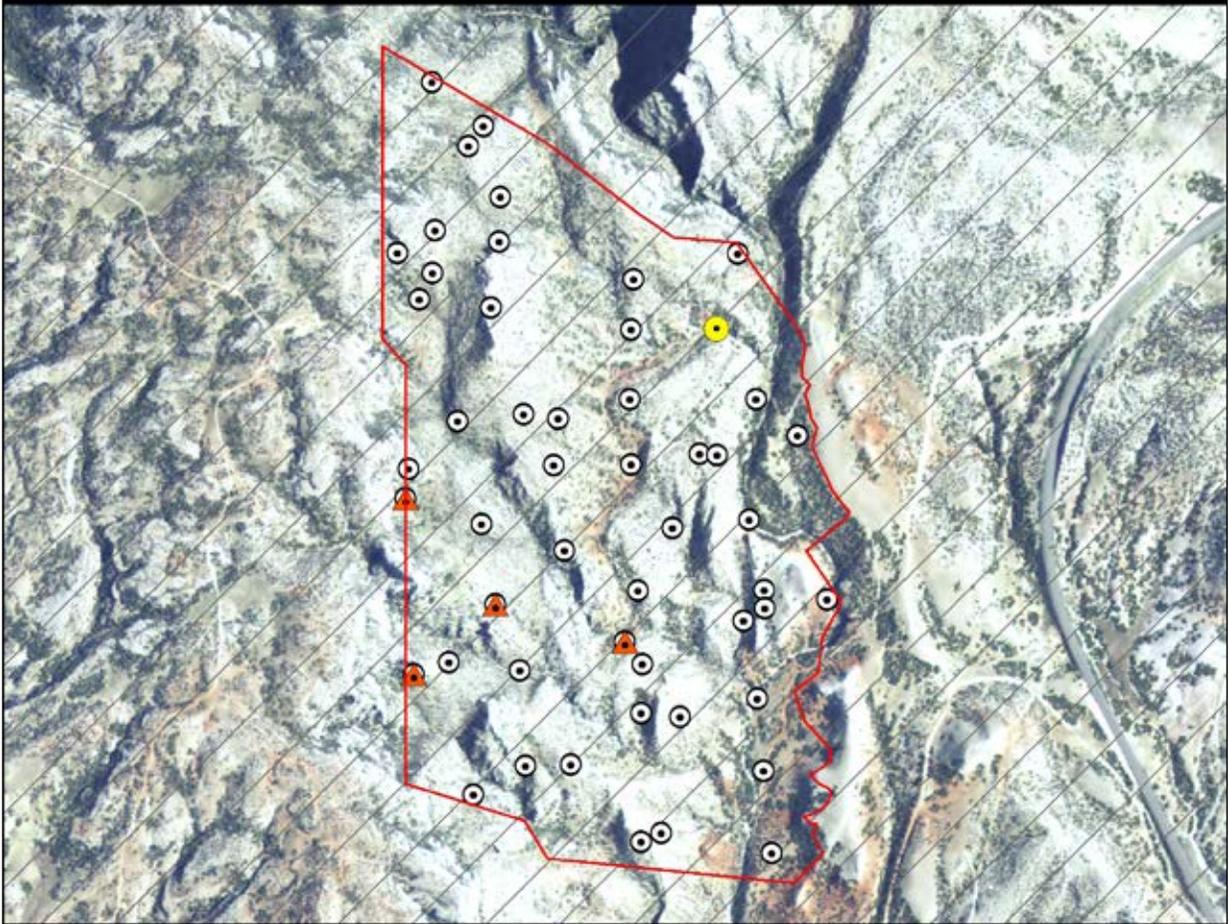


Figure 18. Map showing quadrats sampled in 2013 within sample frame BICA_LTM_Veg140. The inset map shows the location of this sample frame relative to all 15 sample frames in Bighorn Canyon National Recreation Area.

Table 15. Percent of quadrats (n=51) for sample frame BICA_LTM_Veg_140 within each Daubenmire cover class category for ground cover attributes and plant species of interest organized by species guilds, Bighorn Canyon National Recreation Area 2013.

BICA_LTM_140	0%	>0-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Ground cover							
Bare ground	2	55	37	6	0	0	0
Litter	0	67	29	4	0	0	0
Cryptogams	16	73	10	0	0	2	0
Trees							
Curl-leaf mountain mahogany (<i>Cercocarpus ledifolius</i>)	43	16	29	8	2	2	0
Utah juniper (<i>Juniperus osteosperma</i>)	49	16	18	12	6	0	0
Shrubs							
Black sagebrush (<i>Artemisia nova</i>)	78	8	14	0	0	0	0
Broom snakeweed (<i>Gutierrezia sarothrae</i>)	63	35	2	0	0	0	0
Prickly pear cactus (<i>Opuntia polyacantha</i>)	96	4	0	0	0	0	0
Winterfat (<i>Krascheninnikovia lanata</i>)	86	14	0	0	0	0	0
Wyoming Sagebrush (<i>Artemisia tridentata</i>)	96	0	4	0	0	0	0
Grasses and grass-like plants							
Blue grama (<i>Bouteloua gracilis</i>)	98	2	0	0	0	0	0
Bluebunch wheatgrass (<i>Pseudoroegneria spicata</i>)	10	76	14	0	0	0	0
Drop seed (<i>Sporobolus</i> spp.)	98	2	0	0	0	0	0
Indian ricegrass (<i>Achnatherum hymenoides</i>)	82	18	0	0	0	0	0
Needle and thread (<i>Hesperostipa comata</i> var. <i>comata</i>)	90	10	0	0	0	0	0
Sandberg's bluegrass (<i>Poa secunda</i>)	76	24	0	0	0	0	0
Sedges (<i>Carex</i> spp.)	82	18	0	0	0	0	0
Three awn (<i>Aristida purpurea</i> var. <i>fendleriana</i>)	86	14	0	0	0	0	0
Non-native - present in park							
Cheatgrass (<i>Bromus tectorum</i>)	98	2	0	0	0	0	0
Crested wheatgrass (<i>Agropyron cristatum</i>)	92	8	0	0	0	0	0

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Appendix A Plant Species and Ground Cover Attributes

Table A-1. Vascular plants and ground cover attributes targeted for monitoring in the Upland Vegetation Monitoring Protocol in 2013 (Tercek et al. 2013).

Scientific Name	Common Name
Ground cover	
Bare ground	bare ground
Cryptobiotic soil crust	cryptobiotic soil crust
Litter	litter
Grasses and grass-like plants	
<i>Achnatherum hymenoides</i>	Indian ricegrass
<i>Aristida purpurea</i> var. <i>fendleriana</i>	three awn
<i>Bouteloua gracilis</i>	blue grama
<i>Carex</i> spp.	sedges
<i>Festuca idahoensis</i>	Idaho fescue
<i>Hesperostipa comata</i> var. <i>comata</i>	needle and thread
<i>Koeleria macrantha</i>	Junegrass
<i>Pascopyrum smithii</i>	western wheatgrass
<i>Poa secunda</i>	Sandberg's bluegrass
<i>Pseudoroegneria spicata</i>	bluebunch wheatgrass
<i>Sporobolus</i> spp.	drop seed
Shrubs	
<i>Artemisia nova</i>	black sagebrush
<i>Artemisia tridentata</i>	Wyoming sagebrush
<i>Atriplex</i> spp.	saltbush
<i>Gutierrezia sarothrae</i>	broom snakeweed
<i>Krascheninnikovia lanata</i>	winter fat
<i>Opuntia polyacantha</i>	prickly pear cactus
<i>Rhus aromatica</i> var. <i>trilobata</i>	skunkbush
Trees	
<i>Cercocarpus ledifolius</i>	curl-leaf mountain mahogany
<i>Juniperus osteosperma</i>	Utah juniper
<i>Juniperus scopulorum</i>	Rocky Mountain juniper
<i>Pinus flexilis</i>	limber pine
Non-native present in park	
<i>Agropyron cristatum</i>	crested wheatgrass
<i>Arctium minus</i>	common burdock
<i>Bassia sieversiana</i>	kochia
<i>Bromus inermis</i>	smooth brome
<i>Bromus japonicus</i>	Japanese brome
<i>Bromus tectorum</i>	cheatgrass
<i>Cardaria chalapensis</i>	white top
<i>Cardaria pubescens</i>	hoary cress

Table A-1. Vascular plants and ground cover attributes targeted for monitoring in the Upland Vegetation Monitoring Protocol in 2013 (Tercek et al. 2013).

Scientific Name	Common Name
Non-native present in park (continued)	
<i>Centaurea diffusa</i>	diffuse knapweed
<i>Centaurea maculosa</i>	spotted knapweed
<i>Centaurea repens</i>	Russian knapweed
<i>Cirsium arvense</i>	Canada thistle
<i>Cirsium vulgare</i>	bull thistle
<i>Convolvulus arvensis</i>	field bindweed
<i>Cynoglossum officinale</i>	houndstongue
<i>Dactylis glomerata</i>	orchard grass
<i>Elaeagnus angustifolia</i>	Russian olive
<i>Elymus repens</i>	quackgrass
<i>Halogeton glomeratus</i>	salt lover
<i>Melilotus</i> spp.	sweet clover
<i>Salsola tragus</i>	Russian thistle
<i>Tamarix chinensis</i>	salt cedar
<i>Tanacetum vulgare</i>	common tansy
<i>Tribulus terrestris</i>	puncture vine
Non-native watch list	
<i>Carduus acanthoides</i>	plumeless thistle
<i>Cardaria draba</i>	hoary cress
<i>Carduus nutans</i>	musk thistle
<i>Chondrilla juncea</i>	rush skeletonweed
<i>Chrysanthemum leucanthemum</i>	ox-eye daisy
<i>Euphorbia esula</i>	leafy spurge
<i>Hypericum perforatum</i>	St. John's wort
<i>Isatis tinctoria</i>	Dyer's woad
<i>Lepidium latifolium</i>	perennial pepperweed
<i>Linaria dalmatica</i>	dalmatian toadflax
<i>Linaria vulgaris</i>	yellow toadflax
<i>Lythrum salicaria</i>	purple loosestrife
<i>Onopordum acanthium</i>	Scotch thistle
<i>Sonchus arvensis</i>	perennial sowthistle

Appendix B Plant Cover Frequency Charts

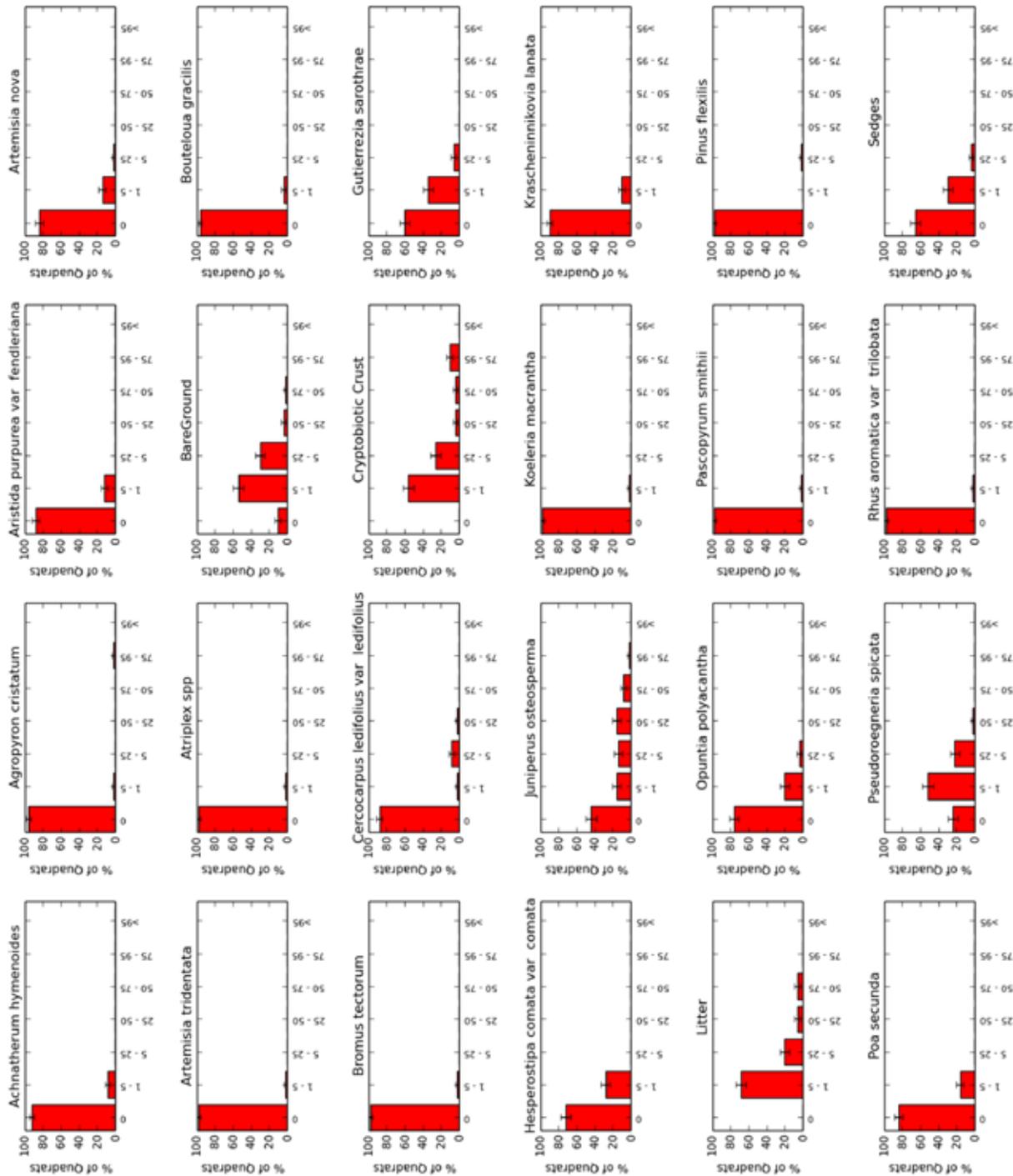


Figure B-1. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg020 in 2013. Error bars show one standard error, calculated from the local variance estimator.

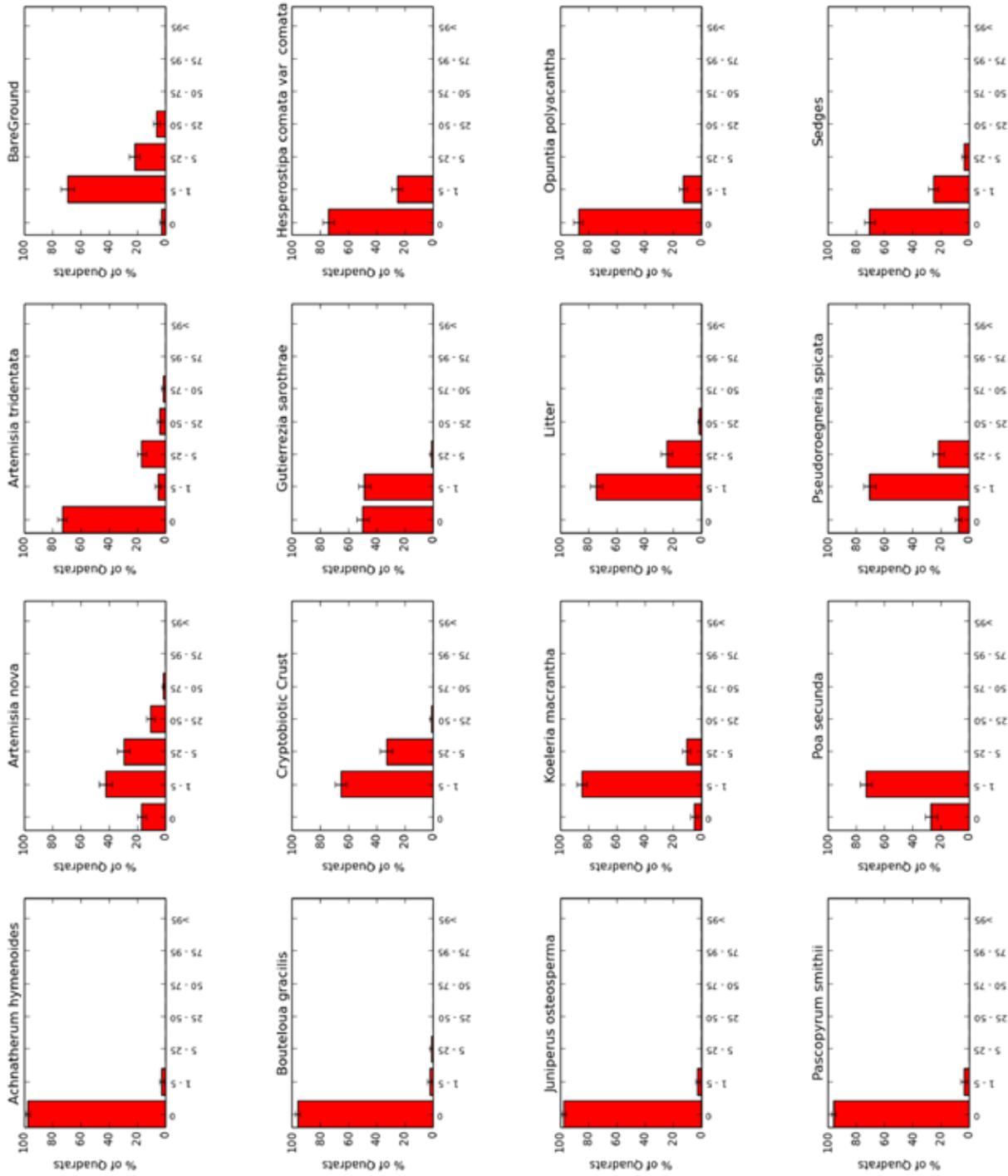


Figure B-2. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg030 in 2013. Error bars show one standard error, calculated from the local variance estimator.

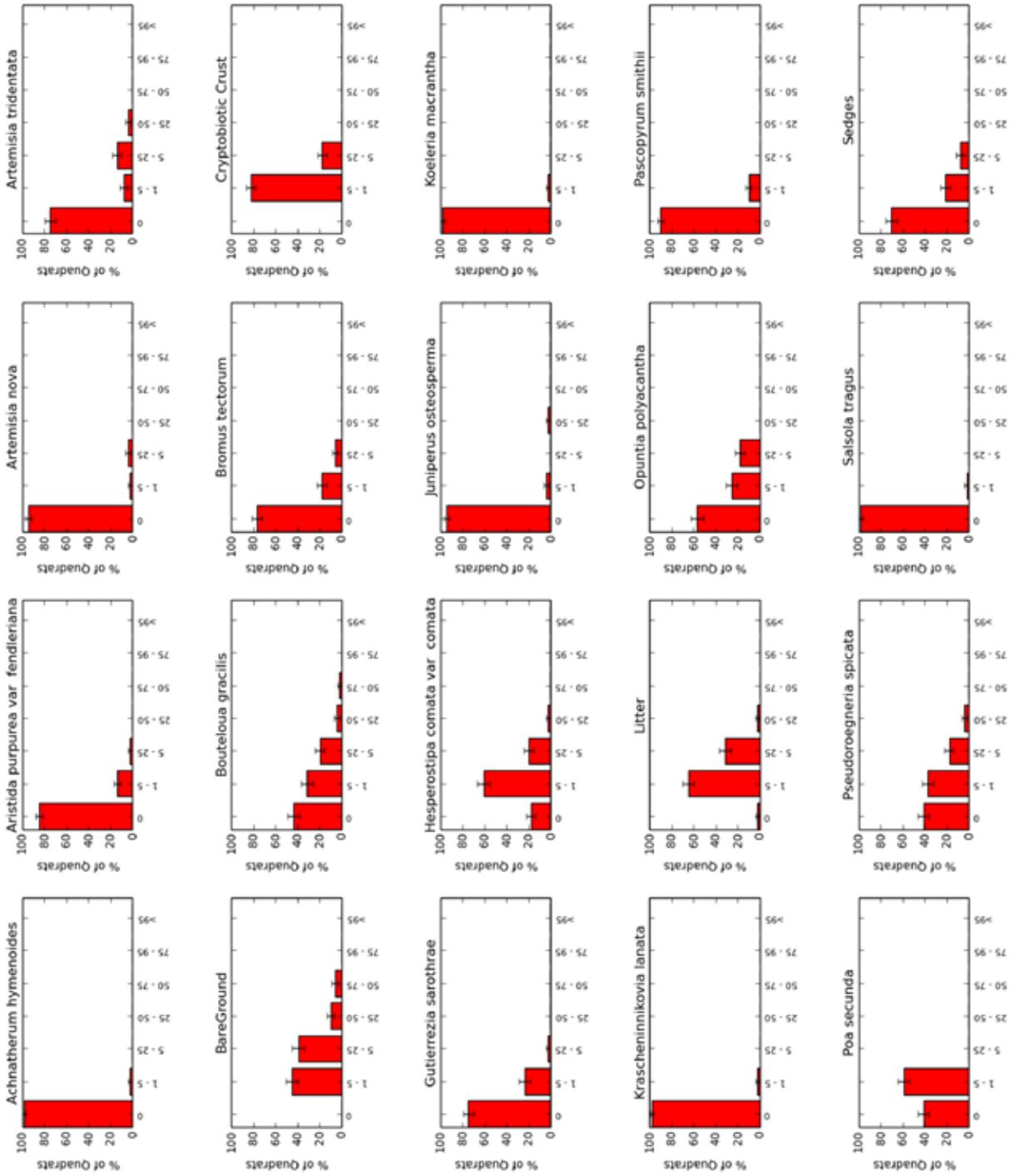


Figure B-3. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg070 in 2013. Error bars show one standard error, calculated from the local variance estimator.

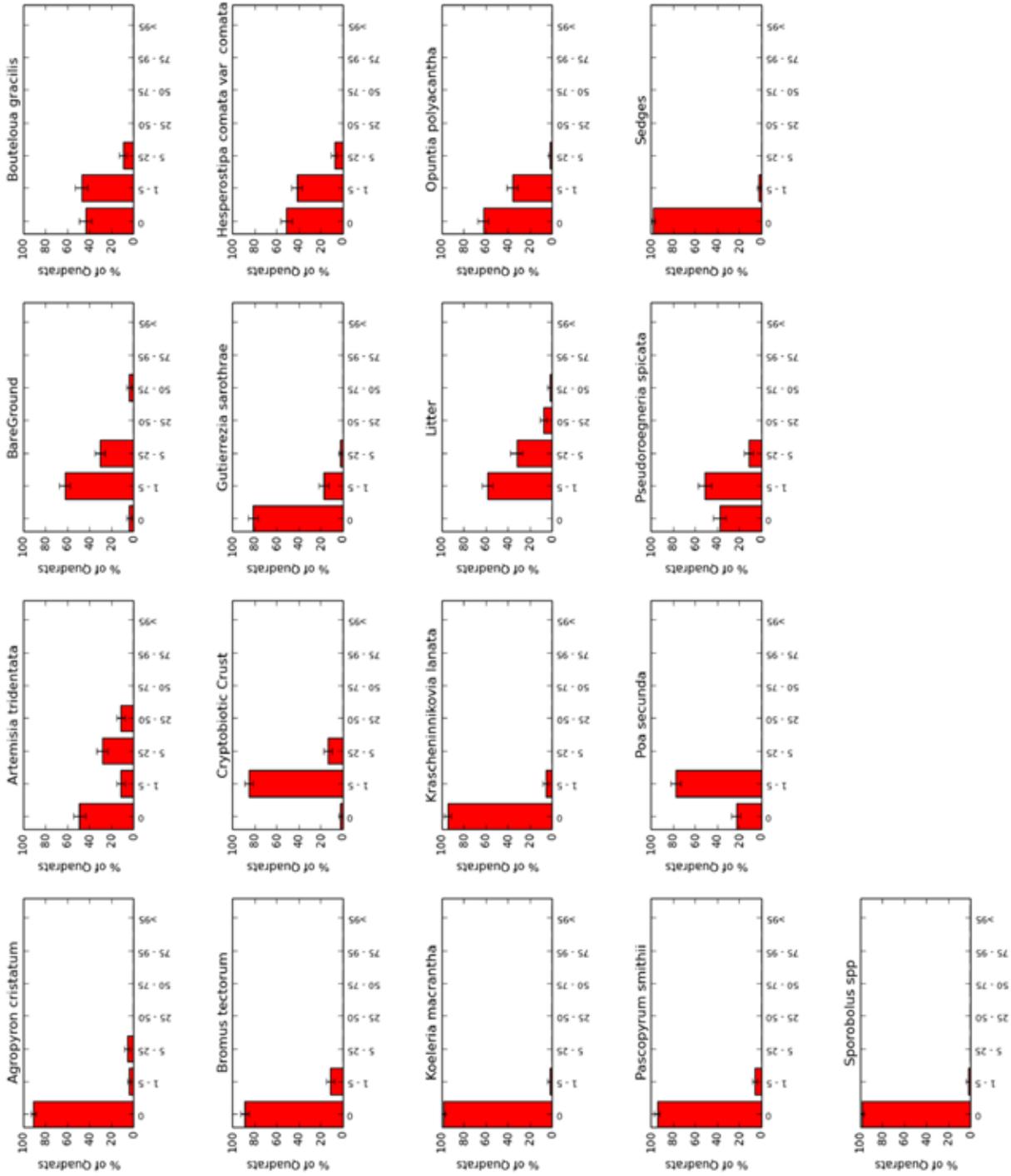


Figure B-4. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg080 in 2013. Error bars show one standard error, calculated from the local variance estimator.

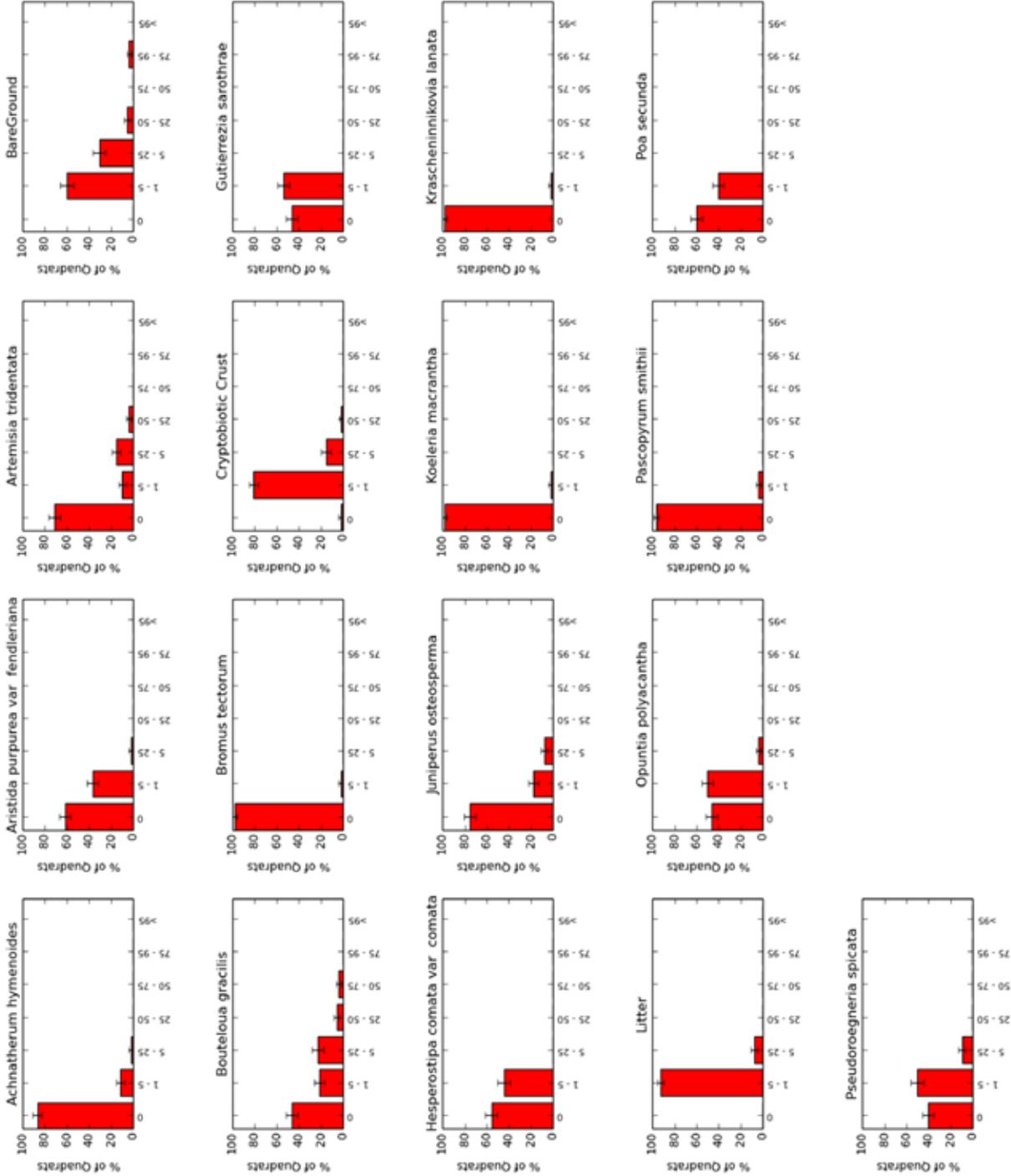


Figure B-5. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg090 in 2013. Error bars show one standard error, calculated from the local variance estimator.

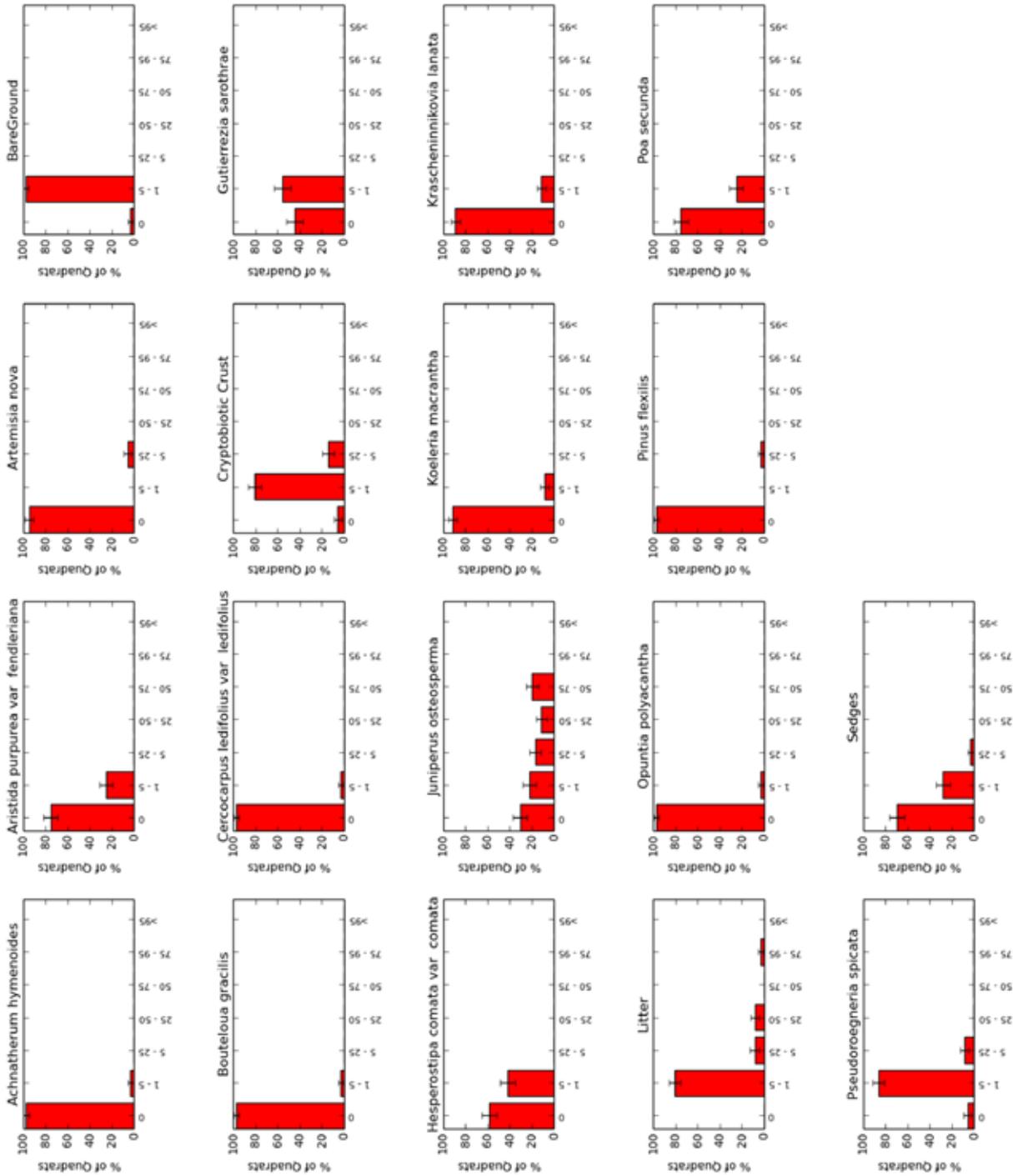


Figure B-6. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg100 in 2013. Error bars show one standard error, calculated from the local variance estimator.

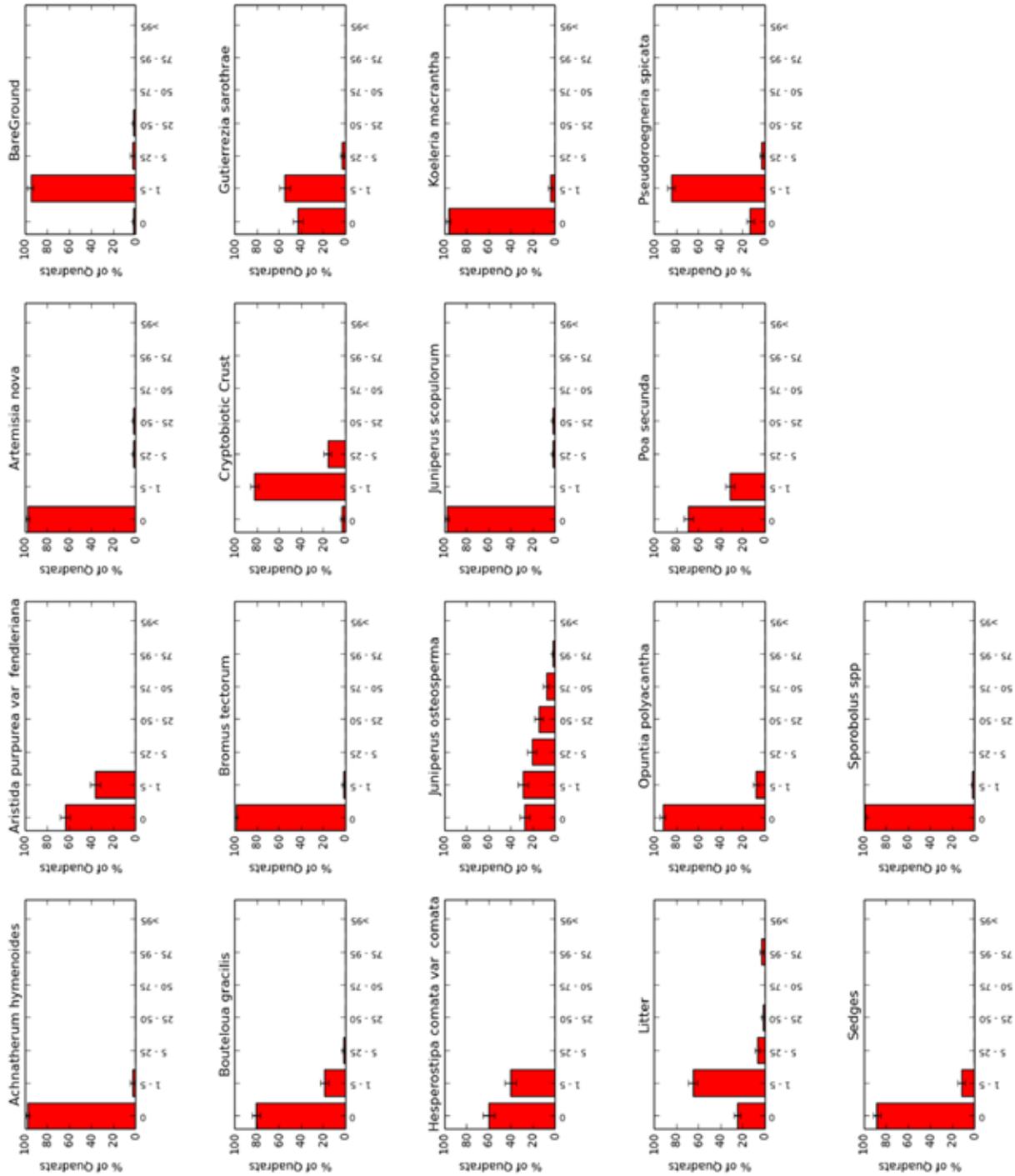


Figure B-7. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg110 in 2013. Error bars show one standard error, calculated from the local variance estimator.

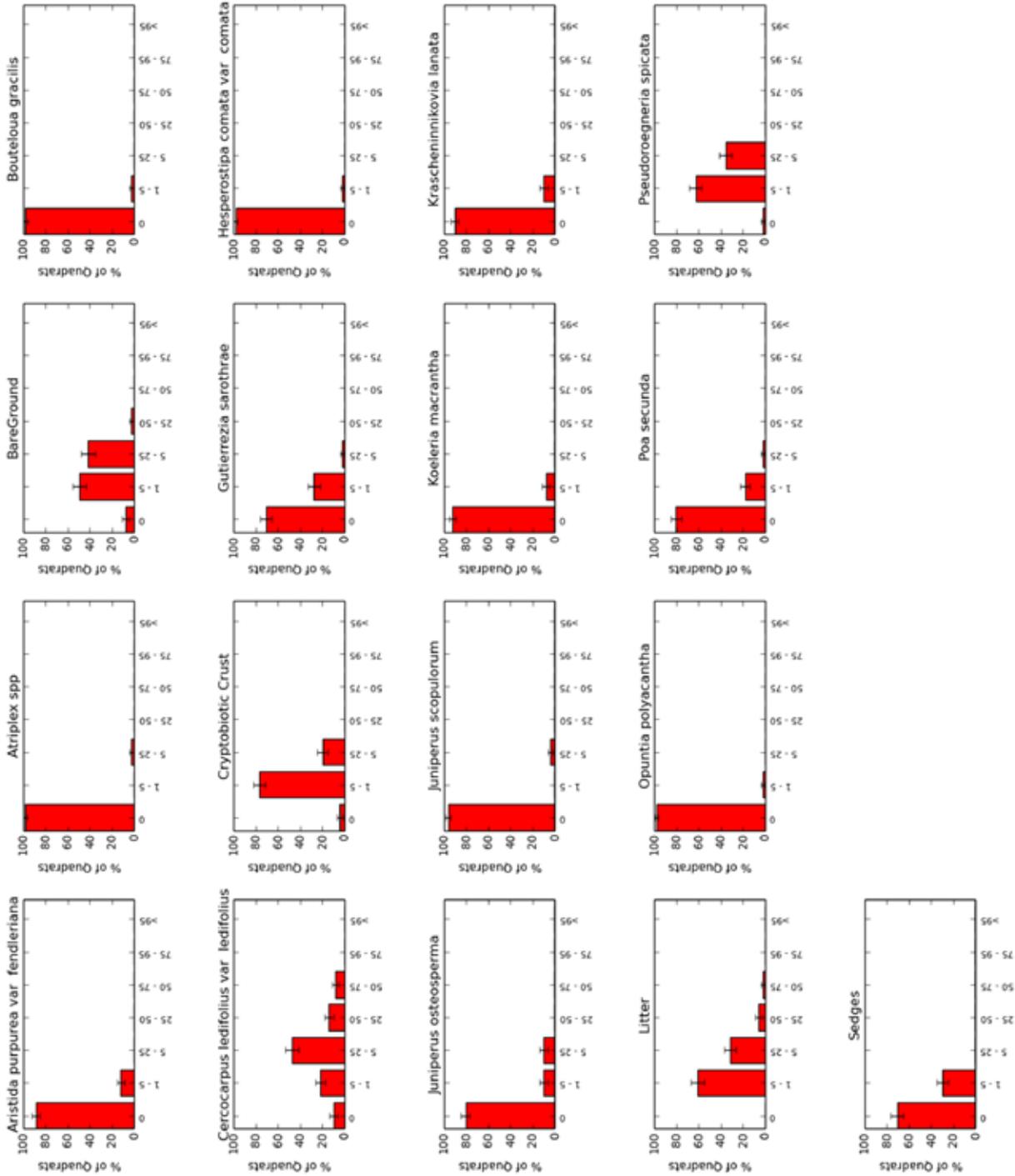


Figure B-8. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg120 in 2013. Error bars show one standard error, calculated from the local variance estimator.

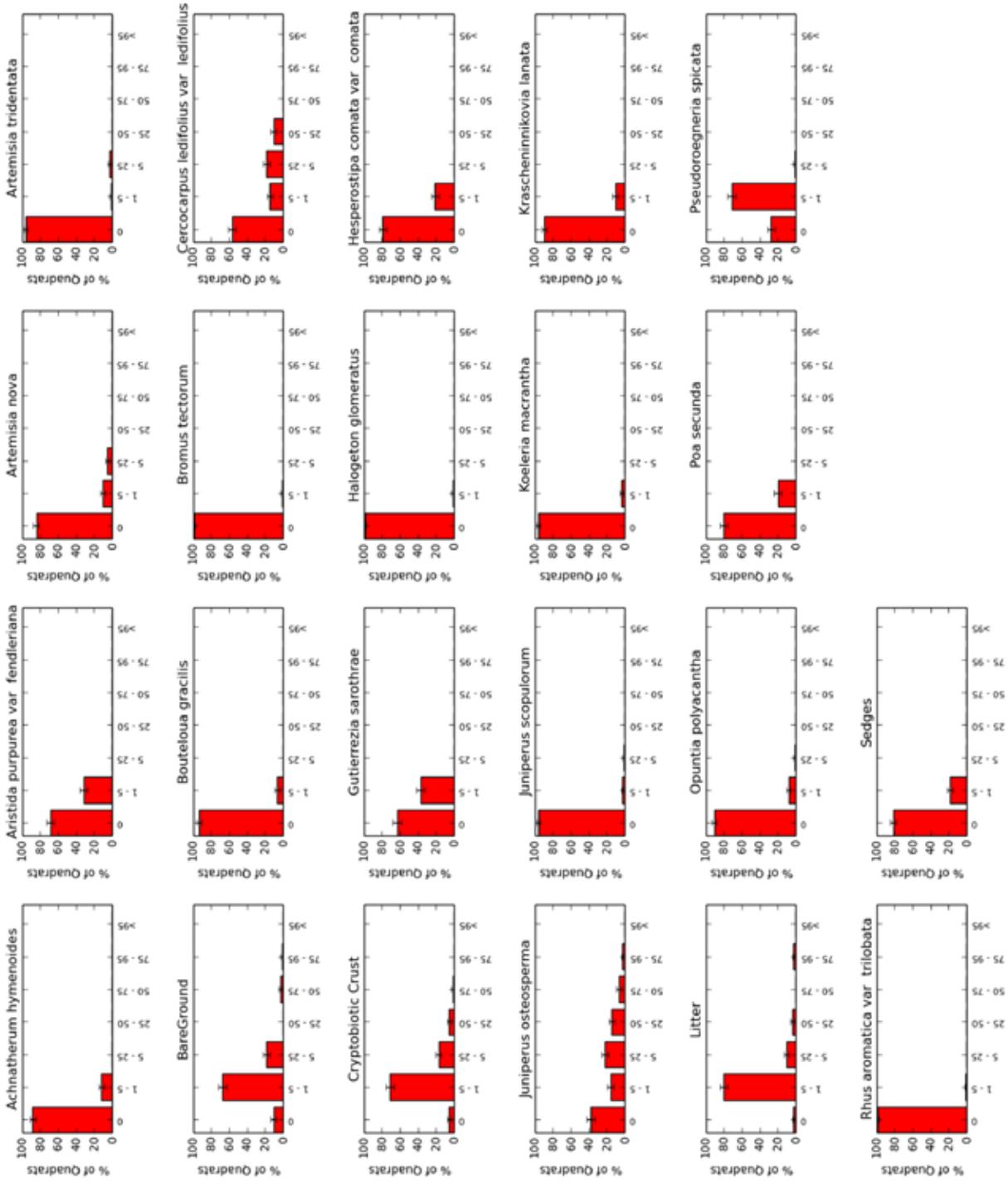


Figure B-9. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg130 in 2013. Error bars show one standard error, calculated from the local variance estimator.

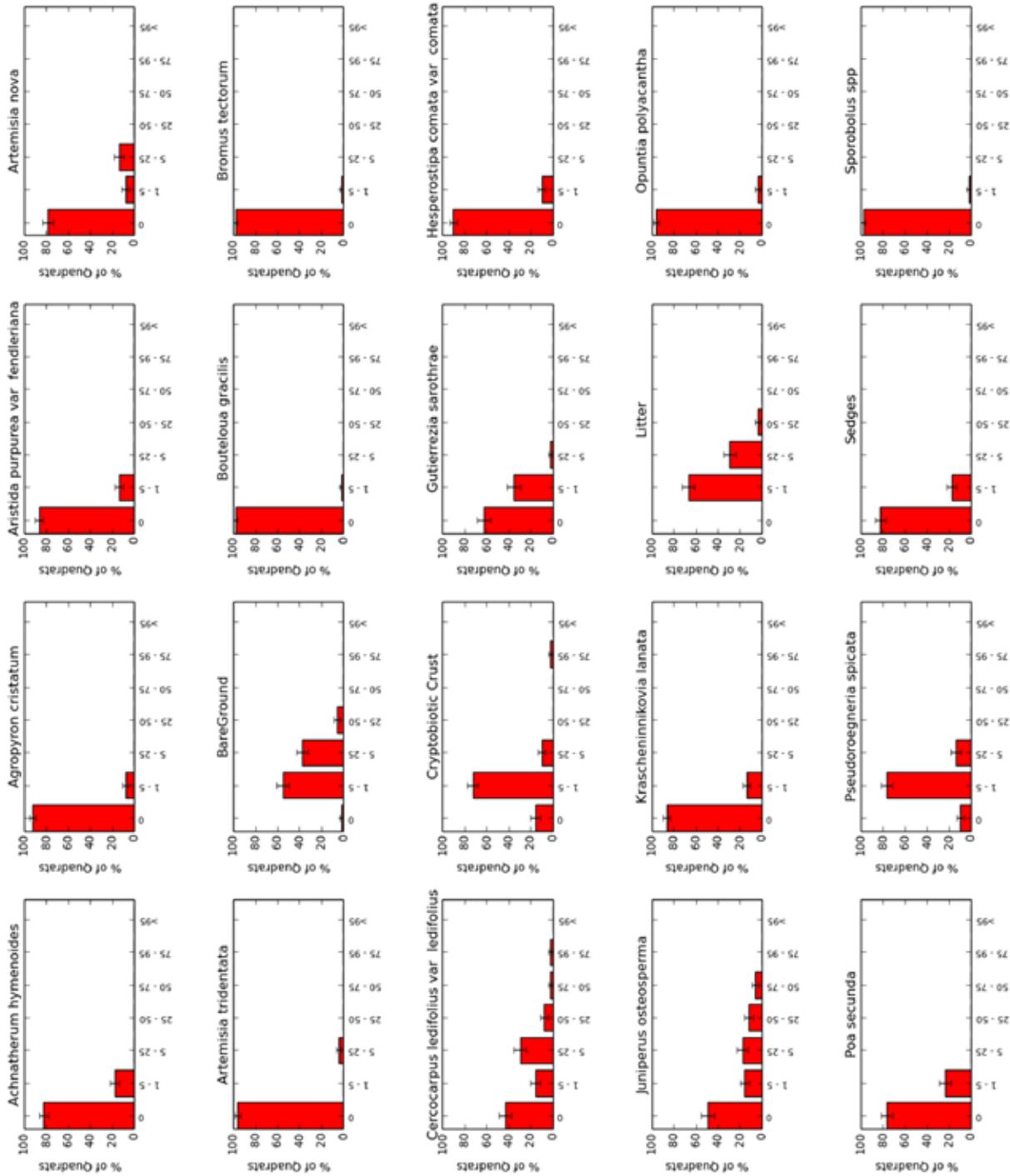


Figure B-10. Percent frequency of quadrats by Daubenmire (1959) cover class categories (refer to Table 1) for all target plant species reported in sample frame BICA_LTM_Veg140 in 2013. Error bars show one standard error, calculated from the local variance estimator.

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.

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