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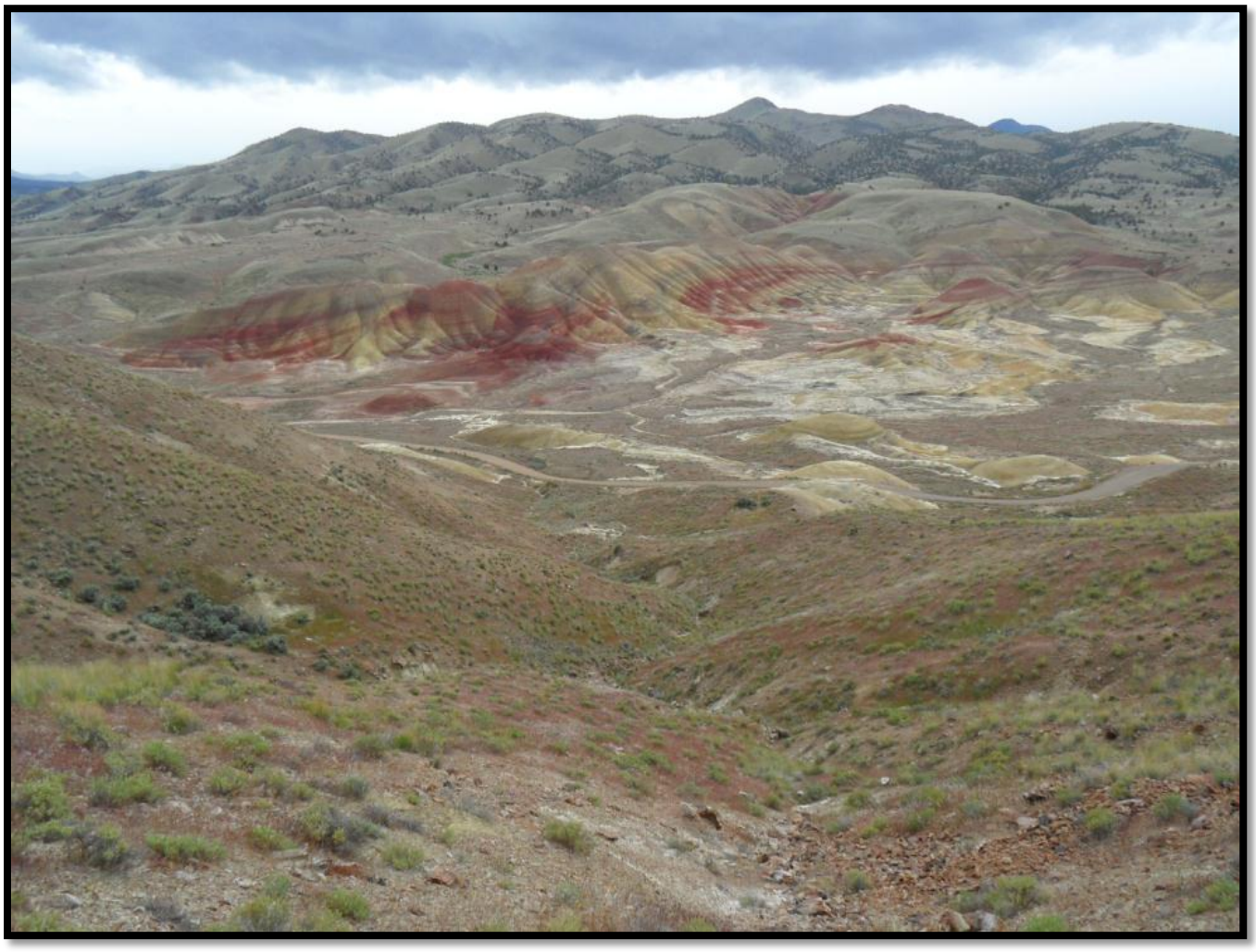
Sagebrush Steppe Vegetation Monitoring in John Day Fossil Beds National Monument

2011 Annual Report

Natural Resource Data Series NPS/UCBN/NRDS—2012/226



ON THE COVER
Painted Hills, looking towards the south end of the unit, John Day Fossil Beds National Monument.

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

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

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Executive Summary

Monitoring of the condition of sagebrush steppe within the John Day Fossil Beds National Monument (JODA) was conducted in May and June 2011. Four units of the monument were monitored: Clarno, Foree, Painted Hills, and Sheep Rock. Sampling occurred within 3 habitat categories of vegetation communities: (1) mesic habitat that typically occurs on wetter northerly sites that have shorter exposure to the sun or on higher elevations that retain snow pack or experience less evaporative loss, (2) xeric habitat that typically occurs on drier southerly sites that have longer exposure to the sun over the course of the year, and (3) sage habitat that typically supports sagebrush because of deeper soils in bottoms of draws and valleys, or flat expanses. Cover of exposed soil and of principal native and non-native plants or genera was estimated following methods detailed in the Upper Columbia Basin Network's (UCBN) protocol for sagebrush steppe monitoring (Yeo et al. 2009). Spring and early summer weather in 2011 generally was cooler and wetter than the long-term average although precipitation records for Sheep Rock and Foree indicate drier than normal conditions.

Invasive annual grasses, principally cheatgrass (*Bromus tectorum*), dominate the sagebrush steppe landscape in all 4 units. Medusahead (*Elymus caput-medusae*), another invasive annual grass, is patchily abundant. Other invasive annual grasses, Japanese brome (*B. japonicus*) and bulbous bluegrass (*Poa bulbosa*), were occasionally abundant and generally widespread. Cover of big sagebrush (*Artemisia tridentata*) overall was low and many areas that once supported sagebrush (i.e., sage habitat category) have burned. Broom snakeweed (*Gutierrezia sarothrae*) was the prominent shrub of these rangelands and always in association with cheatgrass. Cover of native bunchgrasses, which define the steppe aspect of sagebrush steppe, was low to moderate. Principal native grasses included: Idaho fescue (*Festuca idahoensis*), Sandberg's bluegrass (*Poa sandbergii*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and needlegrasses (*Stipa* spp.). There were occasional stands, mostly in mesic habitat, where native bunchgrasses dominated. Native forb cover generally was low. Principal native forb species included: milk-vetch (*Astragalus* spp.), yarrow (*Achillea millefolium*), buckwheats (*Eriogonum* spp.), and desert parsley (*Lomatium* spp.). Dalmatian toadflax (*Linaria dalmatica*) was the most common noxious weed at Foree and Sheep Rock. Whitetop (*Cardaria draba*) also was encountered in these 2 units but was most common at Painted Hills. Knapweeds (*Centaurea* spp.) were observed at Clarno and Painted Hills. An occasional Russian knapweed (*Acroptilon repens*) plant was seen at Painted Hills. Scotch thistle (*Onopordum acanthium*) typically was rare and scattered, occasionally occurring in dense patches. All JODA units had some plots representing good range condition. Painted Hills had more than double the number of plots that were in good condition than the other park units. Brief comparisons are made between results of 2011 monitoring at JODA and monitoring conducted in 2008 at Clarno, Painted Hills, and Foree; and monitoring conducted at Foree and Sheep Rock in 2009.

It appears that fire, whether as wildfire or planned ignitions, by disturbing native plant communities and creating opportunities for invasion by non-native annual grasses, principally cheatgrass and medusahead, is posing a threat to the integrity of sagebrush ecosystems in the monument. We intend to modify sample frames for future monitoring at JODA similar to the approach used at Craters of the Moon National Monument and Preserve. Sample frames would be smaller and positioned to sample different condition categories of sagebrush steppe: those still

dominated by native vegetation, those with a mix of native and non-native species that might be restored to a more healthy condition, and those dominated by non-native annual grasses. Additionally, areas that JODA is actively restoring to native sagebrush steppe communities might be monitored.

Acknowledgments

We greatly appreciate the assistance of John Laing, Clarno Ranger, who provided us access to facilities and insights on the Clarno unit. Scott Ritner, Painted Hills Ranger, not only offered hospitality at Painted Hills but he and his wife, Alicia, provided Jeff with comfortable lodging while working at Foree and Sheep Rock. Shirley Hoh, JODA Resource Manager, helped us with logistics, maps, access through locked gates, and access to river tramways. Conversations with Jim Hammett, JODA Superintendent, filled us in on some of the history of JODA and challenged our thinking about its ecological composition and functioning. Meghan Lonneker, UCBN GIS analyst, created the study area maps. Gordon Dicus, UCBN data manager, developed the database and enabled efficient field data entry into tablet PCs and prompt data retrieval and analysis.

Introduction

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

- Determine the status (current condition) and trends (change in condition over time) in the composition and abundance (cover) of principal native plant species in UCBN sagebrush steppe communities.

- Determine the status and trends in composition and abundance (cover) of principal invasive plant species, including annual grasses, in UCBN sagebrush steppe communities.

- Determine the status and trend in the amount of exposed soil (cover), a fundamental indicator of soil stability.

This report summarizes the data collected in 2011 for JODA, and discusses comparisons with data collected in 2008 and 2009 (Rodhouse 2009, 2010).

Study Area and Methods

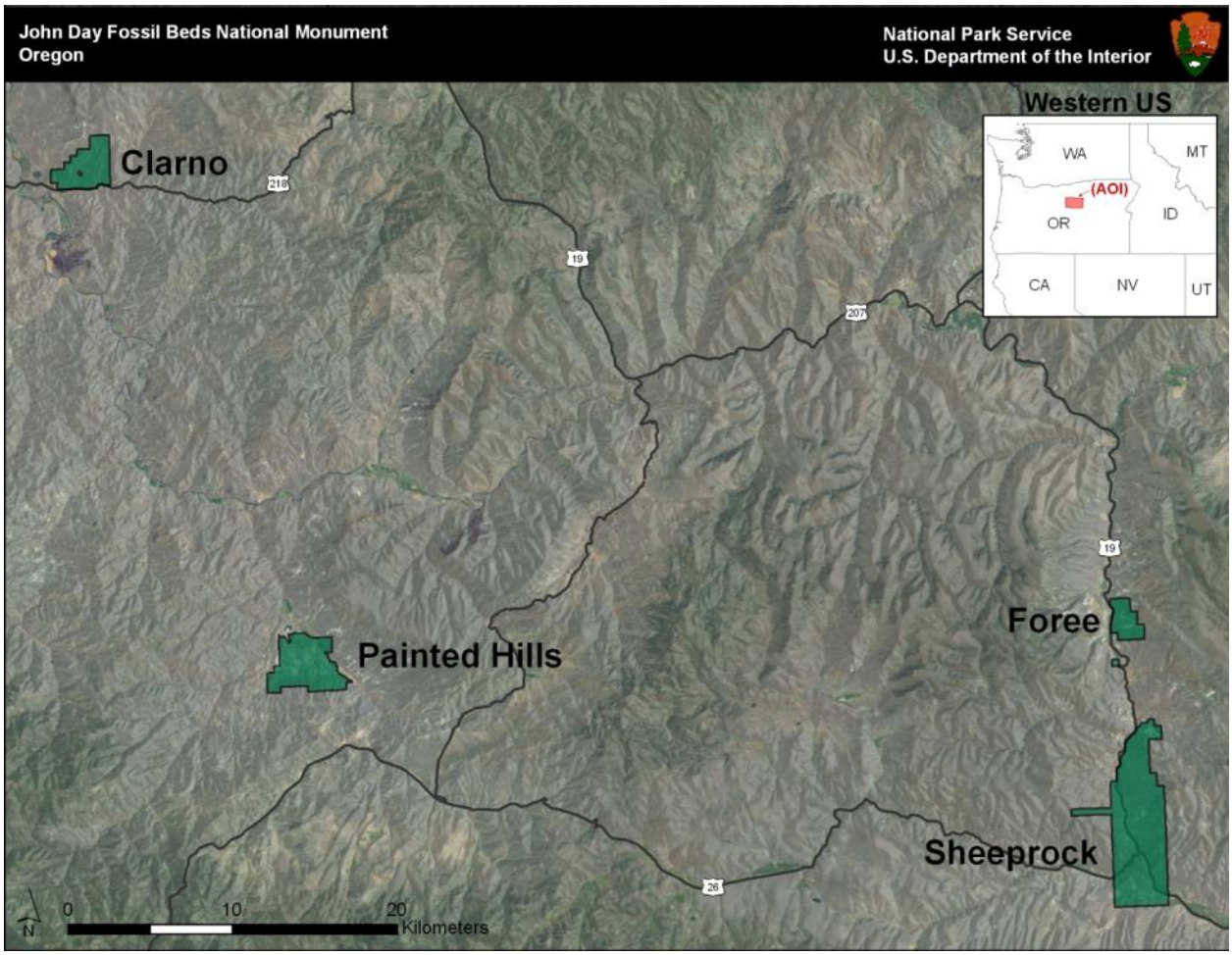

Figure 1. Location of the 4 units of John Day Fossil Beds National Monument monitored in 2011.

Four units within JODA were sampled: Clarno, Foree, Painted Hills, and Sheep Rock (Figure 1). Within each unit, the extent of potential sagebrush steppe communities was mapped using recent soils maps and vegetation maps (Yeo et al. 2009). This extent was then divided into 3 strata based on NRCS ecological site descriptions and expected late succession vegetation. These strata were categorized as: mesic habitat, xeric habitat, and sage habitat. Mesic habitat were those areas within sagebrush steppe that would be expected to retain soil moisture longer through the growing season; typically located on northerly slopes and/or at higher elevations that retain snowpack longer into the spring. Idaho fescue would be expected to be a codominant in the herb layer. Conversely, xeric habitats were delineated as those areas within sagebrush steppe that would be expected to be drier and lose soil moisture more rapidly; typically on southerly exposures at lower elevations. Needlegrasses and Indian ricegrass would be expected to be codominants in the herb layer. Sage habitat was expected to be found on flatter terrain with deeper soils; typically in draws and wider valley bottoms, occasionally on flat benches.

Sample sizes within each habitat category were proportional to the area of each category within each park unit (Table 1). The Sheep Rock unit became the exception because park boundaries

were incorrectly delineated at the time sample allocations were made. Unfortunately, this did not become evident until after we had begun sampling. Therefore some sampling occurred inadvertently on private land and those sample data were dropped. In addition, other plot locations were dropped prior to sampling because either we discovered that they were on private land, or because access to the plot locations would have necessitated crossing private land or treacherous terrain.

Sampling procedures followed Yeo et al. (2009). Within each strata, 1-m² square plots were located using the generalized random tessellation stratified (GRTS) spatially-balanced sampling design (Stevens and Olsen 2004). The GRTS approach provides for randomly located plots and good spatial dispersion across each site. Within each 1-m² plot, we estimated cover of exposed bare ground and principal native plants and non-native invasive plants. Cover estimates were categorized into the following cover classes: 0, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, and 95-100% (Daubenmire 1959). Plant cover was defined as the natural spread of current year's growth outlined using a minimum convex polygon with small gaps included in the cover estimate. Exposed bare ground was defined as soil surface not overlain by plant cover, litter, and rock. Plant common names and their scientific names are listed in Appendix 1.

Table 1. Monitoring site sample sizes for John Day Fossil Beds National Monument sagebrush steppe monitoring, 2011.

Park Unit	Mesic	Sage	Xeric
Clarno	75	85	55
Foree	55	60	50
Painted Hills	80	55	75
Sheep Rock	90	95	69

Plots that we considered in "good" condition were defined as having cover dominated by perennial native plants with no cover of noxious weeds, low cover (≤ 5%) of invasive annual grasses – cheatgrass, Japanese brome, medusahead, or bulbous bluegrass – and exposed soil cover ≤ 25%. These "good" condition plots are highlighted on the maps of each monitoring site.

Sagebrush steppe monitoring occurred in 2008 for Clarno, Painted Hills, and Foree (Rodhouse 2009). Monitoring methods in 2008 differed from the approach used subsequently, however frequency of occurrence within 1-m² plots can be compared among years. In 2009, monitoring occurred in Sheep Rock west of the John Day River, and in sage habitat in Foree. Where data were available for comparisons between years for the same areas (i.e. Foree sage habitat or a portion of Sheep Rock west of the John Day River), we tested for differences among selected parameters using the Mann-Whitney rank sum test. This statistical procedure is the non-parametric alternative to the familiar two-sample *t*-test, and so suitable for the ordinal cover class data collected by our protocol (Higgins 2004). Comparisons were considered statistically significant at $P \leq 0.10$.

Weather

Because of the geographic separation of park units for JODA, three weather stations were used to depict weather patterns for each park unit (Appendices 2-4). Regionally, weather during spring and early summer 2011 was mild with slightly lower than average temperatures and higher than

average precipitation. There was variability among weather station data with spring weather for Clarno (Fossil weather station) and Painted Hills (Mitchell weather station) showing these patterns while records for Sheep Rock and Foree (Dayville weather station) showed patterns similar to the long-term averages for temperature and precipitation. Weather records for previous years for particular weather stations are presented in Appendices 2-4 for those years and park units for which we previously collected monitoring data.

Results and Discussion

Clarno Unit

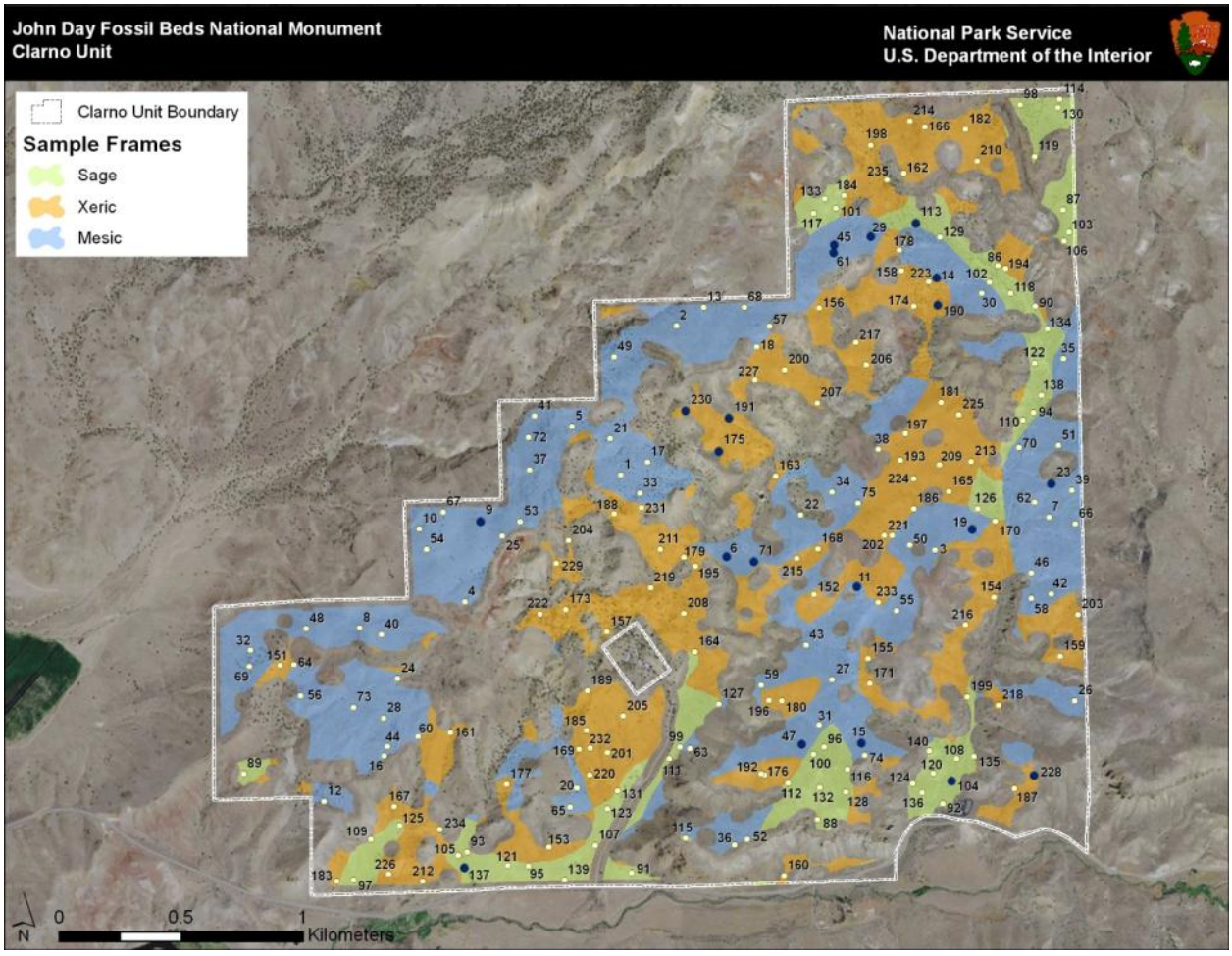

Figure 1. Clarno unit of John Day Fossil Beds National Monument showing three habitat sample frames within sagebrush steppe and plot locations. Dark blue, larger plot locations identify those plots that we deemed in good condition (see Methods for criteria for good condition).

We sampled the Clarno unit from May 16-19, 2011 (Figure 2). Spring weather for Clarno in 2011 was wetter and cooler than the long-term average (Appendix 2). Exposed soil cover generally was ≤ 25% although within sage habitat there were a couple of plots with exposed soil greater than that (Tables 2-4). Big sagebrush cover was low even in sage habitat with frequencies of occurrence ≤ 5%. The shrub species with the highest cover was snakeweed in all three habitats; this was particularly true in xeric habitat (Figure 3). Bluebunch wheatgrass, needlegrass, and Sandberg's bluegrass were the most abundant native perennial grasses. Bluebunch wheatgrass was most abundant in mesic habitat (Figure 4). Idaho fescue was rarely encountered. Although there was a variety of forbs (with mesic habitat the most species rich and sage habitat the least), forb cover in general was low. Yarrow, vetch, buckwheat, and desert parsley were the most abundant forbs in the three habitats.

We encountered no noxious weeds within plots although we did observe knapweeds in several places in the unit. Those locations were reported to park staff. Annual grasses contributed cover to most plots, and were the dominant cover across the unit (Figures 3 & 5). Cheatgrass frequency of occurrence within plots ranged from 91-95%. Cheatgrass cover was > 50% in many plots (Table 2-4). Medusahead, although typically contributing less cover than cheatgrass in most plots, had high cover values in some plots (Table 2-4). Bulbous bluegrass was most abundant in sage habitat although the least abundant of the annual grasses recorded. Cover for Japanese brome, another annual grass found at Clarno, was not recorded in 2011 but will be in future monitoring, as it is increasingly clear that this species is an important non-native and potentially invasive component of the community.

Twenty plots at Clarno were identified as in good condition (Figure 2). These plots were scattered widely across the unit but most were located on upper benches and higher slope positions. Sixty percent (12) of these good condition plots were in mesic habitat, 15% (3) in sage habitat, and 25% (5) in xeric habitat. For most of these plots, bluebunch wheatgrass contributed significantly to herbaceous cover. Although sage habitat had more total plots than the other two habitats (Table 1), it had the least number of plots deemed in good condition.

We sampled the Clarno unit in May 2008 (Rodhouse 2009). Sampling was conducted within sagebrush steppe habitat across the entire unit, not stratified into the three habitats as was done in 2011. Spring and early summer weather in 2008 generally was drier and warmer than in 2011 except for above average precipitation in May 2008 (Appendix 2). Sagebrush cover was low in 2008 as in 2011, attributed to recent fires. Bluebunch wheatgrass, Sandberg's bluegrass, and needlegrass were the most prevalent native bunchgrasses. Although frequencies of native bunchgrasses ranged from 48% to 67%, estimated median cover was only 5-25%.

Frequency of cheatgrass was high in 2008 (96%) similar to 2011 (91-95%). Medusahead frequency was 27% in 2008 compared to 25-39% in 2011. Noxious weeds were not observed in plots in 2008 as was the case in 2011.

Table 2. Clarno Unit, Mesic Habitat, 2011: percentage of plots (n=75 1-m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds, John Day Fossil Beds National Monument.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	48	49	3	0	0	0	0
Sagebrush							
Artemisia tridentata	95	1	1	3	0	0	0
Shrubs							
Ericameria nauseosa	99	1	0	0	0	0	0
Gutierrezia sarothae	83	13	3	1	0	0	0
Native Perennial Grasses							
Festuca idahoensis	97	3	0	0	0	0	0
Poa secunda	55	33	12	0	0	0	0
Poa spp.	99	1	0	0	0	0	0
Pseudoroegneria spicata	44	7	28	17	4	0	0
Sitanion hystrix	96	1	3	0	0	0	0
Sporobolus cryptandrus	99	0	1	0	0	0	0
Stipa spp.	77	13	9	0	0	0	0
Native Persistent Forbs							
Achillea millefolium	76	23	1	0	0	0	0
Antennaria spp.	97	3	0	0	0	0	0
Astragalus spp	72	15	12	1	0	0	0
Castilleja spp.	99	1	0	0	0	0	0
Crepis acuminata	99	1	0	0	0	0	0
Erigeron spp.	97	1	1	0	0	0	0
Eriogonum spp.	80	17	3	0	0	0	0
Lomatium spp.	84	16	0	0	0	0	0
Phlox spp.	97	3	0	0	0	0	0
Sphaeralcea munroana	99	1	0	0	0	0	0
Native Other Forbs							
Agoseris spp.	93	7	0	0	0	0	0
Brodiaea douglasii	96	4	0	0	0	0	0
Calochortus spp.	97	3	0	0	0	0	0
Non-native Invasive Forbs							
Descurainia spp.	99	1	0	0	0	0	0
Erodium cicutarium	89	11	0	0	0	0	0
Sisymbrium altissimum	99	1	0	0	0	0	0
Non-native Invasive Grasses							
B. tectorum	9	15	31	19	16	11	0
Elymus caput-medusae	61	23	5	5	1	4	0
Poa bulbosa	96	4	0	0	0	0	0

NOTE: not all rows sum to 100% because of the error inherent in rounding to whole numbers.

Table 3. Clarno Unit, Sage Habitat, 2011: percentage of plots (n=85 1-m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds, John Day Fossil Beds National Monument.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	51	44	2	4	0	0	0
Sagebrush							
Artemisia tridentata	95	0	5	0	0	0	0
Shrubs							
Ericameria nauseosa	96	2	2	0	0	0	0
Gutierrezia sarothae	67	25	7	0	0	0	0
Purshia tridentata.	98	0	0	0	2	0	0
Salvia dorrii	98	0	2	0	0	0	0
Native Perennial Grasses							
Poa secunda	64	31	4	2	0	0	0
Pseudoroegneria spicata	73	5	9	11	2	0	0
Sporobolus cryptandrus	95	5	0	0	0	0	0
Stipa spp.	53	7	35	5	0	0	0
Native Persistent Forbs							
Achillea millefolium	82	15	4	0	0	0	0
Astragalus spp	85	11	4	0	0	0	0
Cirsium spp.	96	2	2	0	0	0	0
Eriogonum spp.	91	5	4	0	0	0	0
Lomatium spp.	91	9	0	0	0	0	0
Native Other Forbs							
Agoseris spp.	95	4	2	0	0	0	0
Calochortus spp.	87	13	0	0	0	0	0
Non-native Invasive Forbs							
Erodium cicutarium	71	27	2	0	0	0	0
Sisymbrium altissimum	96	4	0	0	0	0	0
Non-native Invasive Grasses							
B. tectorum	5	16	31	25	20	2	0
Elymus caput-medusae	75	9	5	5	2	4	0
Poa bulbosa	87	5	2	4	2	0	0

NOTE: not all rows sum to 100% because of the error inherent in rounding to whole numbers.

Table 4. Clarno Unit, Xeric Habitat, 2011: percentage of plots (n=55 1-m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds, John Day Fossil Beds National Monument.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	58	38	5	0	0	0	0
Sagebrush							
Artemisia tridentata	94	2	2	1	0	0	0
Shrubs							
Atriplex spp.	99	1	0	0	0	0	0
Ericameria nauseosa	99	1	0	0	0	0	0
Gutierrezia sarothae	54	38	8	0	0	0	0
Purshia tridentata.	99	0	1	0	0	0	0
Native Perennial Grasses							
Festuca idahoensis	99	0	1	0	0	0	0
Poa secunda	79	21	0	0	0	0	0
Pseudoroegneria spicata	65	13	12	9	1	0	0
Sporobolus cryptandrus	96	1	2	0	0	0	0
Stipa spp.	55	24	18	4	0	0	0
Native Persistent Forbs							
Achillea millefolium	84	13	4	0	0	0	0
Astragalus spp	81	11	7	1	0	0	0
Castilleja spp.	98	1	1	0	0	0	0
Cirsium spp.	99	1	0	0	0	0	0
Erigeron spp.	99	1	0	0	0	0	0
Eriogonum spp.	74	21	5	0	0	0	0
Lomatium spp.	91	9	0	0	0	0	0
Penstemon spp.	99	1	0	0	0	0	0
Phacelia spp.	98	2	0	0	0	0	0
Phlox spp.	99	1	0	0	0	0	0
Native Other Forbs							
Agoseris spp.	99	1	0	0	0	0	0
Brodiaea douglasii	95	5	0	0	0	0	0
Calochortus spp.	95	5	0	0	0	0	0
Cryptantha spp.	98	2	0	0	0	0	0
Delphinium spp.	99	1	0	0	0	0	0
Non-native Invasive Forbs							
Descurainia spp.	99	1	0	0	0	0	0
Erodium cicutarium	88	12	0	0	0	0	0
Sisymbrium altissimum	98	1	1	0	0	0	0
Non-native Invasive Grasses							
B. tectorum	7	13	32	31	12	6	0
Elymus caput-medusae	64	14	9	4	5	5	0
Poa bulbosa	93	2	4	1	0	0	0

NOTE: not all rows sum to 100% because of the error inherent in rounding to whole numbers.

Figure 3. Stand of medusahead, cheatgrass, and snakeweed in xeric habitat looking south from plot #195.

Figure 4. Stand of bluebunch wheatgrass and Sandberg's bluegrass in mesic habitat looking north from plot #2.

Figure 5. Stand of sparse big sagebrush and snakeweed and dense herb layer of cheatgrass in sage habitat on bench north of Palisades.

Foree Unit

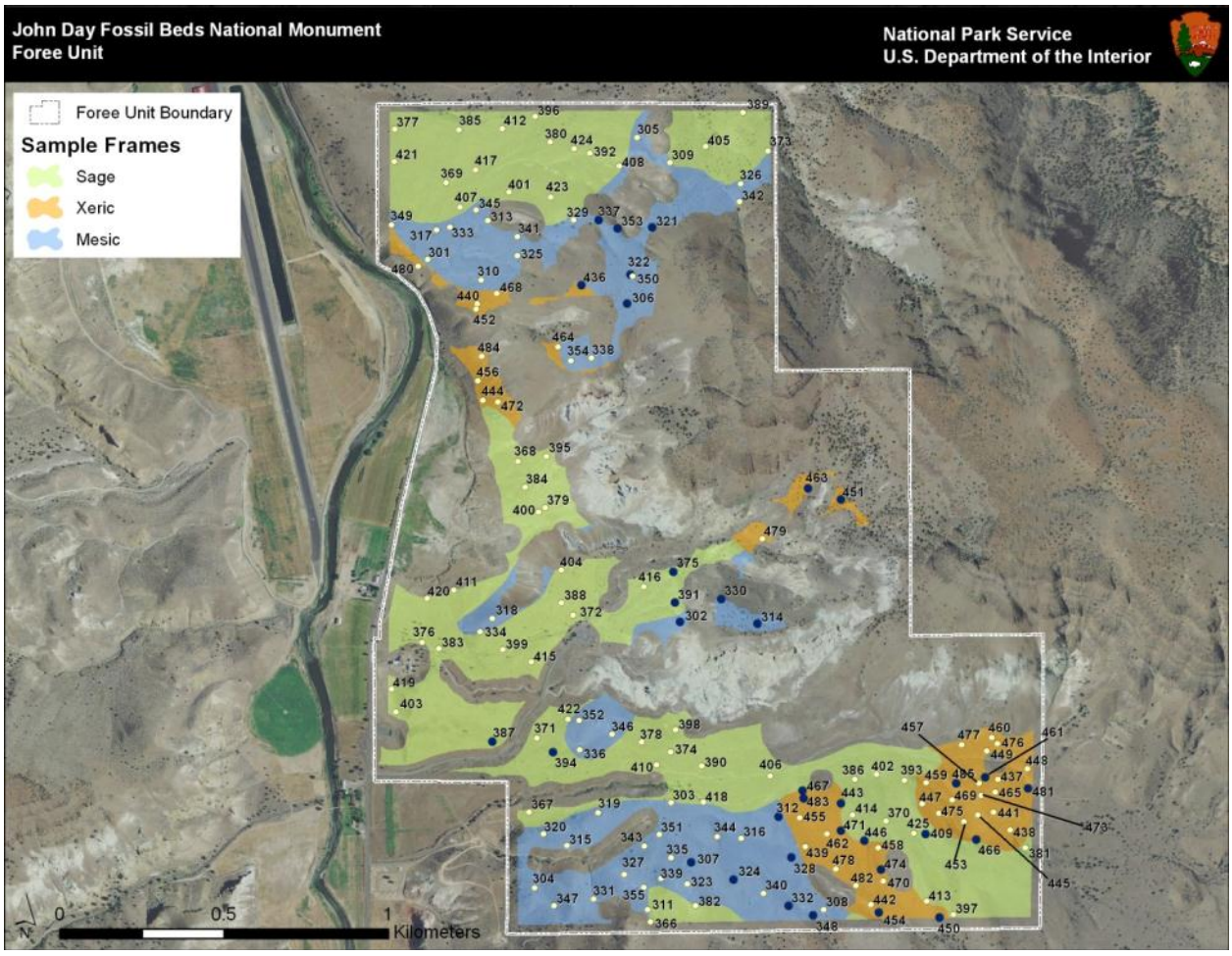

Figure 6. Foree unit of John Day Fossil Beds National Monument showing the three sagebrush steppe habitat sample frames and plot locations. Plots that are dark blue and larger were considered in good condition (see Methods for explanation).

We sampled the Foree unit from June 8-11, 2001 (Figure 6). Spring and early summer weather for Foree in 2011 was cooler but drier than the long-term average (Appendix 3). This differs from regional weather patterns which were wetter than average. Exposed soil cover values were low and similar among habitats although lowest in sage habitat (Tables 5-7). Big sagebrush cover was negligible, but highest in xeric habitat. Snakeweed was the most abundant shrub with similar cover among habitats. Bluebunch wheatgrass and Sandberg's bluegrass were the most common and abundant native grasses. Although bluebunch wheatgrass generally was less frequently encountered, because of its much larger growth form, it occasionally contributed much greater cover than Sandberg's bluegrass. Forb cover typically was low across the three habitats. Mesic habitat had greater forb richness than the other two habitats. Vetch was the most frequently encountered forb with the greatest cover.

Dalmatian toadflax, Scotch thistle, and whitetop, all noxious weeds, were encountered at Foree. Toadflax was by far the most common and widespread, Scotch thistle was widely scattered but

sparse as individual plants or small groups of plants, and whitetop was encountered only in the northwest portion of the unit. Dalmatian toadflax occurred in all three habitats but was encountered infrequently with low cover. Scotch thistle was measured only in mesic habitat in two plots. Other non-native, invasive weeds included mustards and filaree.

Cheatgrass was ubiquitous (frequency of occurrence 96-100%) often with high cover values (Figure 7). In sage habitat, cheatgrass occurred in 100% of plots which is likely correlated with sage habitat having the lowest exposed soil cover. Other annual invasive grasses included medusahead, Japanese brome, and bulbous bluegrass although cover was low for each of these species. Sage habitat had the greatest richness of annual grasses; medusahead was only observed in sage habitat and bulbous bluegrass was most common there (Tables 5-7). Past fire was evident across Foree, and clearly associated with cheatgrass, tumblemustard, and other non-native species on flatter terrain. This condition was most prevalent in sage habitat (Figure 8).

We identified 34 plots at Foree that were in good condition: 14 in mesic habitat, 5 in sage habitat, and 15 in xeric habitat. Most good condition plots were concentrated in the southern portion of the unit (Figure 6). Sage habitat had the greatest number of total plots sampled (Table 1) but the fewest plots in good condition. In most cases, it was more the absence of noxious weeds and low cover of annual grasses rather than the presence of vigorous native plants that identified these plots showing good condition (Figure 9). Eight plots, which were located mostly in mesic and xeric habitat, had > 25% cover of bluebunch wheatgrass.

We sampled Foree in 2008 and 2009 (Rodhouse 2009, 2010). In 2008, sagebrush steppe was sampled as a single habitat category across the entire unit using nested plots (n = 94 nested plots). Spring weather in 2008 was drier than the long-term average but similar to spring 2011 (Appendix 3). In 2008, cheatgrass frequency was 100%, medusahead just 1%. Sandberg's bluegrass, bluebunch wheatgrass, and needlegrass were the principal native grasses (frequency 16-72%) with the median cover averaging 15% (5-25%). Big sagebrush occurred much less frequently (15%). Dalmatian toadflax had a frequency of 7%, Canada thistle 1%.

Only sage habitat was sampled at Foree in 2009 (n = 70 1-m^2 plots; Rodhouse 2010). The same sampling approach was used in 2009 as in 2011 (Yeo et al. 2009). Cover of exposed soil ($P < 0.001$), Sandberg's bluegrass ($P = 0.02$), and cheatgrass ($P = 0.02$) was greater in 2009 in sage habitat than in 2011. Cover of blubunch wheatgrass and big sagebrush was similar between the two years.

Table 5. Foree Unit, Mesic Habitat, 2011: percentage of plots (n=55 1-m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds, John Day Fossil Beds National Monument.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	36	51	13	0	0	0	0
Sagebrush							
Artemisia tridentata	96	2	0	2	0	0	0
Shrubs							
Atriplex spp.	98	0	2	0	0	0	0
Gutierrezia sarothae	58	11	29	2	0	0	0
Native Perennial Grasses							
Festuca idahoensis	98	2	0	0	0	0	0
Oryzopsis hymenoides	98	2	0	0	0	0	0
Poa secunda	45	45	9	0	0	0	0
Pseudoroegneria spicata	71	7	13	5	4	0	0
Stipa spp.	91	7	2	0	0	0	0
Native Persistent Forbs							
Achillea millefolium	91	7	2	0	0	0	0
Antennaria spp.	96	0	4	0	0	0	0
Astragalus spp	76	5	16	2	0	0	0
Balsamorhiza sagittata	98	0	0	2	0	0	0
Castilleja spp.	98	2	0	0	0	0	0
Crepis acuminata	98	2	0	0	0	0	0
Erigeron spp.	98	2	0	0	0	0	0
Eriogonum spp.	95	5	0	0	0	0	0
Lomatium spp.	95	4	2	0	0	0	0
Phacelia spp.	95	5	0	0	0	0	0
Sphaeralcea munroana	98	2	0	0	0	0	0
Native Other Forbs							
Brodiaea douglasii	93	7	0	0	0	0	0
Non-native Invasive Forbs							
Descurainia spp.	82	18	0	0	0	0	0
Erodium cicutarium	82	18	0	0	0	0	0
Linaria dalmatica	91	7	2	0	0	0	0
Onopordum acanthium	96	4	0	0	0	0	0
Sisymbrium altissimum	98	0	0	2	0	0	0
Non-native Invasive Grasses							
Agropyron cristatum	98	0	0	2	0	0	0
B. tectorum	4	25	24	16	11	18	2
Poa bulbosa	95	5	0	0	0	0	0

NOTE: not all rows sum to 100% because of the error inherent in rounding to whole numbers.

Table 6. Foree Unit, Sage Habitat, 2011: percentage of plots (n=60 1-m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds, John Day Fossil Beds National Monument.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	40	55	5	0	0	0	0
Sagebrush							
Artemisia tridentata	97	3	0	0	0	0	0
Shrubs							
Atriplex spp.	98	2	0	0	0	0	0
Chrysothamnus viscidiflorus	98	2	0	0	0	0	0
Gutierrezia sarothae	65	15	18	0	2	0	0
Native Perennial Grasses							
Elymus cinereus	98	0	2	0	0	0	0
Poa secunda	50	43	7	0	0	0	0
Pseudoroegneria spicata	78	8	7	3	2	2	0
Stipa spp.	92	5	2	2	0	0	0
Native Persistent Forbs							
Achillea millefolium	93	7	0	0	0	0	0
Astragalus spp	82	10	8	0	0	0	0
Cirsium spp.	97	3	0	0	0	0	0
Erigeron spp.	97	3	0	0	0	0	0
Eriogonum spp.	95	2	3	0	0	0	0
Lomatium spp.	98	2	0	0	0	0	0
Phacelia spp.	95	3	2	0	0	0	0
Sphaeralcea munroana	97	3	0	0	0	0	0
Native Other Forbs							
Brodiaea douglasii	93	7	0	0	0	0	0
Non-native Invasive Forbs							
Descurainia spp.	77	22	2	0	0	0	0
Erodium cicutarium	68	32	0	0	0	0	0
Linaria dalmatica	88	5	5	2	0	0	0
Sisymbrium altissimum	83	10	3	3	0	0	0
Non-native Invasive Grasses							
Agropyron cristatum	98	0	2	0	0	0	0
Bromus japonicus	98	2	0	0	0	0	0
B. tectorum	0	13	23	27	22	15	0
Elymus caput-medusae	98	2	0	0	0	0	0
Poa bulbosa	88	7	3	2	0	0	0

NOTE: not all rows sum to 100% because of the error inherent in rounding to whole numbers.

Table 7. Foree Unit, Xeric Habitat, 2011: percentage of plots (n=50 1-m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds, John Day Fossil Beds National Monument.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	30	52	18	0	0	0	0
Sagebrush							
Artemisia tridentata	92	2	4	2	0	0	0
Shrubs							
Atriplex spp.	98	0	2	0	0	0	0
Chrysothamnus viscidiflorus	98	0	2	0	0	0	0
Gutierrezia sarothae	58	20	18	4	0	0	0
Native Perennial Grasses							
Festuca idahoensis	98	2	0	0	0	0	0
Poa secunda	36	56	8	0	0	0	0
Pseudoroegneria spicata	62	12	10	10	6	0	0
Stipa spp.	86	8	6	0	0	0	0
Native Persistent Forbs							
Achillea millefolium	92	8	0	0	0	0	0
Astragalus spp	66	22	8	4	0	0	0
Balsamorhiza sagittata	98	0	2	0	0	0	0
Cirsium spp.	86	12	2	0	0	0	0
Erigeron spp.	94	6	0	0	0	0	0
Lomatium spp.	98	2	0	0	0	0	0
Phacelia spp.	96	4	0	0	0	0	0
Native Other Forbs							
Brodiaea douglasii	92	8	0	0	0	0	0
Non-native Invasive Forbs							
Descurainia spp.	80	20	0	0	0	0	0
Erodium cicutarium	80	20	0	0	0	0	0
Linaria dalmatica	90	8	2	0	0	0	0
Sisymbrium altissimum	94	4	2	0	0	0	0
Non-native Invasive Grasses							
B. tectorum	2	32	20	20	20	6	0
Poa bulbosa	96	2	2	0	0	0	0

NOTE: not all rows sum to 100% because of the error inherent in rounding to whole numbers.

Figure 7. Looking west from plot #439.

Figure 8. Looking east from plot #322. Burned bench of juniper at higher elevation within Foree dominated by cheatgrass with a scattering of bluebunch wheatgrass.

Figure 9. Looking northwest from plot #446.

Painted Hills Unit

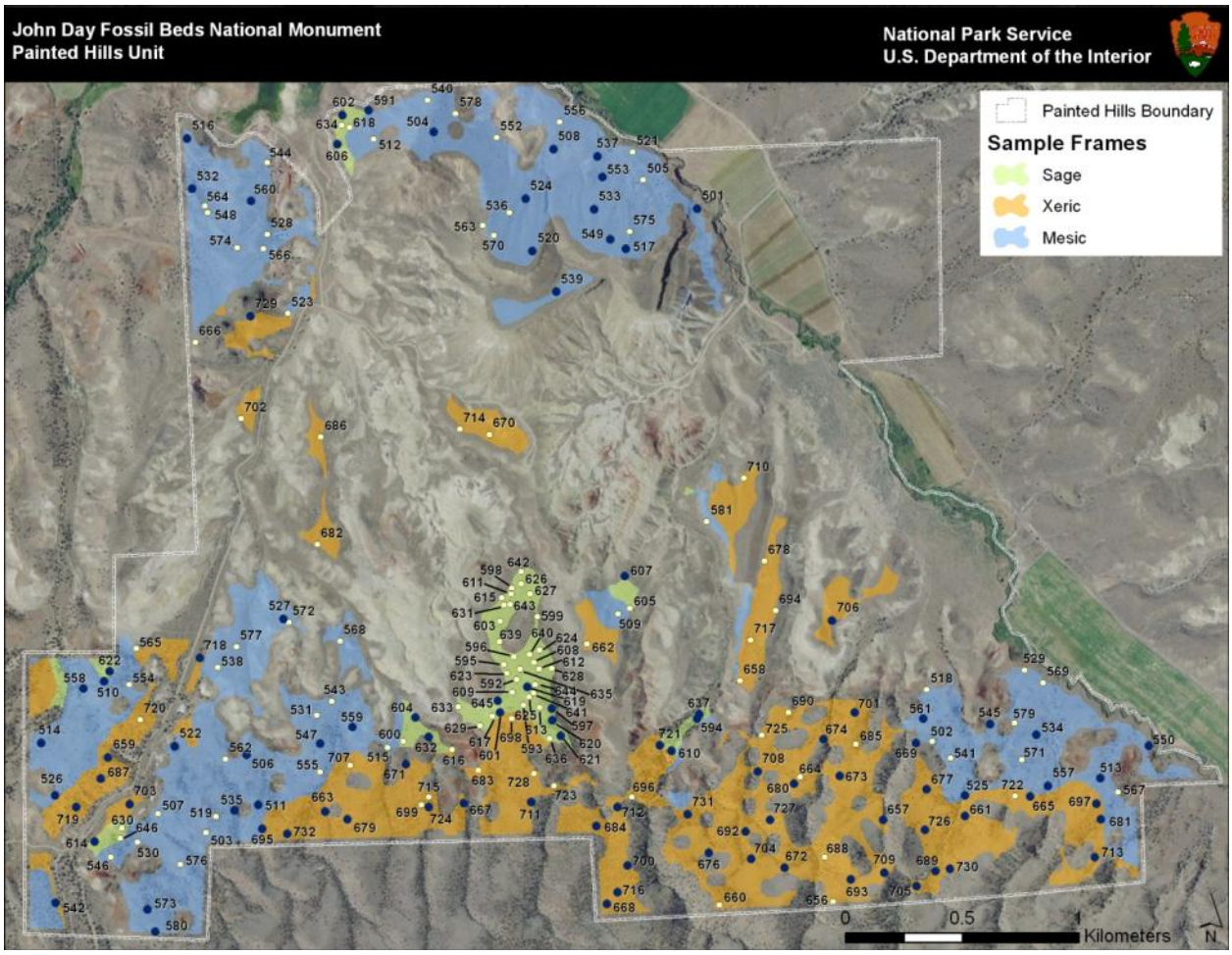

Figure 10. Painted Hills unit of the John Day Fossil Beds National Monument showing the 3 habitat strata within sagebrush steppe and plot locations. Those plots that are dark blue and larger were considered in good condition (see Methods for explanation).

We sampled the Painted Hills Unit from May 23 through May 26, 2011 (Figure 10). Spring weather in 2011 was wet and cool (Appendix 4). We can't compare this with a long-term average weather pattern because records for this station for many months and years are incomplete. Exposed soil cover values generally were low in each of the three habitat strata although a few plots had cover values > 25% (Tables 8-10). Cover of big sagebrush also was low with xeric habitat having the lowest values. Snakeweed had the highest cover of any shrubs across the unit within the three habitat strata.

Steppe bluegrass and bluebunch wheatgrass were the dominant native grasses; bluebunch wheatgrass occasionally had high cover values particularly in mesic and xeric habitat (Figure 11). Native forb cover on all plots was < 25%; desert parsley was the most common and abundant forb across all strata.

Whitetop was the most commonly observed noxious weed although we encountered it in only one plot. Whitetop is widely dispersed across the unit both as sparsely distributed individual plants and as dense patches of hundreds of plants. Cheatgrass was the most abundant of any species, and this was true for all strata (Figure 12). Medusahead was patchily distributed with the least cover in xeric habitat but dense stands were encountered. Japanese brome and bulbous bluegrass generally had low frequencies but occasionally cover exceeded 25% (NOTE: Japanese brome was added to the list of species for cover estimation for JODA on May 24, 2011. So estimation of cover will not be accurate for Painted Hills because it was inconsistently noted prior to May 24.). Evidence of past fires was widespread across Painted Hills. These areas at the time of sampling were supporting stands composed primarily of cheatgrass, medusahead, Japanese brome and snakeweed. While knapweeds did not occur within any plots, they were observed sporadically across Painted Hills. These observations were reported to park staff.

Ninety-eight plots indicated good range condition (Figure 13) at Painted Hills: 35 in mesic habitat, 17 in sage habitat, and 46 in xeric habitat. These plots were located predominately in the higher, northerly aspects across the southern portion of the unit and mostly in mesic habitat in the northern end of the unit (Figure 10). Although there was a disproportionate number in xeric habitat, we question whether much of the area labeled xeric in the southern portion of the unit is in fact xeric. This issue concerning appropriate labeling of habitat is a concern for all of JODA and will be addressed at the end of this report.

We sampled Painted Hills in 2008 using nesting quadrats (n = 82; Rodhouse 2009). Weather records for 2009 are inadequate to depict patterns of precipitation and temperature. Native grasses including Sandberg's bluegrass (frequency = 90%), bluebunch wheatgrass (frequency = 67%), and needlegrass (frequency = 22%) were common. These frequencies were somewhat higher than those encountered for these same grasses in 2011. Cheatgrass frequency of occurrence was 84% (compared to 73-77% in 2011) while medusahead was 9% (compared to 9 – 44% in 2011). Sagebrush frequency was 29% which appears to be higher than we encountered in 2011.

Table 8. Painted Hills Unit, Mesic Habitat, 2011: percentage of plots (n=80 1-m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds, John Day Fossil Beds National Monument.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	25	65	9	1	0	0	0
Sagebrush							
Artemisia arbuscula	99	0	1	0	0	0	0
Artemisia tridentata	85	5	3	5	3	0	0
Shrubs							
Atriplex spp.	96	1	1	1	0	0	0
Ericameria nauseosa	99	0	0	1	0	0	0
Gutierrezia sarothae	80	16	4	0	0	0	0
Salvia dorrii	98	3	0	0	0	0	0
Sarcobatus vermiculatus	98	0	0	3	0	0	0
Native Perennial Grasses							
Festuca idahoensis	96	1	3	0	0	0	0
Poa secunda	45	45	10	0	0	0	0
Pseudoroegneria spicata	55	3	21	16	5	0	0
Sitanion hystrix	96	3	1	0	0	0	0
Stipa spp.	86	5	8	0	1	0	0
Native Persistent Forbs							
Achillea millefolium	98	3	0	0	0	0	0
Antennaria spp.	98	3	0	0	0	0	0
Astragalus spp	94	5	1	0	0	0	0
Castilleja spp.	99	1	0	0	0	0	0
Crepis acuminata	99	1	0	0	0	0	0
Eriogonum spp.	98	8	0	0	0	0	0
Lomatium spp.	86	14	0	0	0	0	0
Phlox spp.	99	1	0	0	0	0	0
Sphaeralcea munroana	98	3	0	0	0	0	0
Native Other Forbs							
Agoseris spp.	91	9	0	0	0	0	0
Allium spp.	96	4	0	0	0	0	0
Brodiaea douglasii	85	15	0	0	0	0	0
Lewisia rediviva	98	3	0	0	0	0	0
Sedum lanceolatum	99	1	0	0	0	0	0
Non-native Invasive Forbs							
Cardaria draba	99	1	0	0	0	0	0
Erodium cicutarium	90	10	0	0	0	0	0
Sisymbrium altissimum	98	3	0	0	0	0	0
Non-native Invasive Grasses							
Bromus japonicus	96	3	0	1	0	0	0
B. tectorum	23	34	18	19	6	1	0
Elymus caput-medusae	81	13	5	0	0	1	0
Poa bulbosa	88	9	3	1	0	0	0

NOTE: not all rows sum to 100% because of the error inherent in rounding to whole numbers.

Table 9. Painted Hills Unit, Sage Habitat, 2011: percentage of plots (n=55 1-m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds, John Day Fossil Beds National Monument.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	33	60	5	0	2	0	0
Sagebrush							
Artemisia tridentata	93	4	0	2	0	2	0
Shrubs							
Atriplex spp.	98	0	0	0	2	0	0
Ericameria nauseosa	96	2	0	2	0	0	0
Gutierrezia sarothae	89	7	2	2	0	0	0
Sarcobatus vermiculatus	98	0	0	0	2	0	0
Native Perennial Grasses							
Poa secunda	56	36	4	4	0	0	0
Pseudoroegneria spicata	84	2	5	9	0	0	0
Sitanion hystrix	98	0	2	0	0	0	0
Sporobolus cryptandrus	98	2	0	0	0	0	0
Stipa spp.	95	2	4	0	0	0	0
Native Persistent Forbs							
Achillea millefolium	96	4	0	0	0	0	0
Antennaria spp.	98	2	0	0	0	0	0
Astragalus spp	96	4	0	0	0	0	0
Crepis acuminata	98	2	0	0	0	0	0
Eriogonum spp.	95	4	2	0	0	0	0
Lomatium spp.	84	16	0	0	0	0	0
Opuntia polyacantha	98	0	2	0	0	0	0
Native Other Forbs							
Agoseris spp.	95	5	0	0	0	0	0
Allium spp.	98	2	0	0	0	0	0
Brodiaea douglasii	93	7	0	0	0	0	0
Calochortus spp.	98	2	0	0	0	0	0
Non-native Invasive Forbs							
Erodium cicutarium	85	15	0	0	0	0	0
Non-native Invasive Grasses							
Bromus japonicus	87	7	5	0	0	0	0
B. tectorum	24	29	7	22	13	5	0
Elymus caput-medusae	56	16	9	9	5	4	0
Poa bulbosa	95	4	2	0	0	0	0

NOTE: not all rows sum to 100% because of the error inherent in rounding to whole numbers.

Table 10. Painted Hills Unit, Xeric Habitat, 2011: percentage of plots (n=75 1-m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds, John Day Fossil Beds National Monument.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	21	61	16	1	0	0	0
Sagebrush							
Artemisia tridentata	95	3	0	3	0	0	0
Shrubs							
Ericameria nauseosa	99	1	0	0	0	0	0
Gutierrezia sarothae	80	9	11	0	0	0	0
Native Perennial Grasses							
Festuca idahoensis	95	3	3	0	0	0	0
Poa secunda	32	63	5	0	0	0	0
Pseudoroegneria spicata	35	8	25	19	12	1	0
Stipa spp.	79	16	5	0	0	0	0
Native Persistent Forbs							
Achillea millefolium	91	7	3	0	0	0	0
Antennaria spp.	83	17	0	0	0	0	0
Astragalus spp	81	15	4	0	0	0	0
Crepis acuminata	97	3	0	0	0	0	0
Eriogonum spp.	84	16	0	0	0	0	0
Lomatium spp.	77	23	0	0	0	0	0
Phlox spp.	97	1	1	0	0	0	0
Sphaeralcea munroana	96	4	0	0	0	0	0
Native Other Forbs							
Agoseris spp.	92	7	1	0	0	0	0
Allium spp.	97	3	0	0	0	0	0
Brodiaea douglasii	79	21	0	0	0	0	0
Non-native Invasive Forbs							
Erodium cicutarium	93	7	0	0	0	0	0
Non-native Invasive Grasses							
Bromus japonicus	93	5	1	0	0	0	0
B. tectorum	27	44	11	7	7	5	0
Elymus caput-medusae	91	8	0	1	0	0	0
Poa bulbosa	99	1	0	0	0	0	0

NOTE: not all rows sum to 100% because of the error inherent in rounding to whole numbers.

Figure 11. Taken from plot #560 looking east; very good condition stand.

Figure 12. Taken from plot #634 looking east; cheatgrass and snakeweed are codominant with big sagebrush.

Figure 13. Between plots #669 & 502 looking west; vigorous stand of PSSP in burned over juniper stand.

Sheep Rock Unit

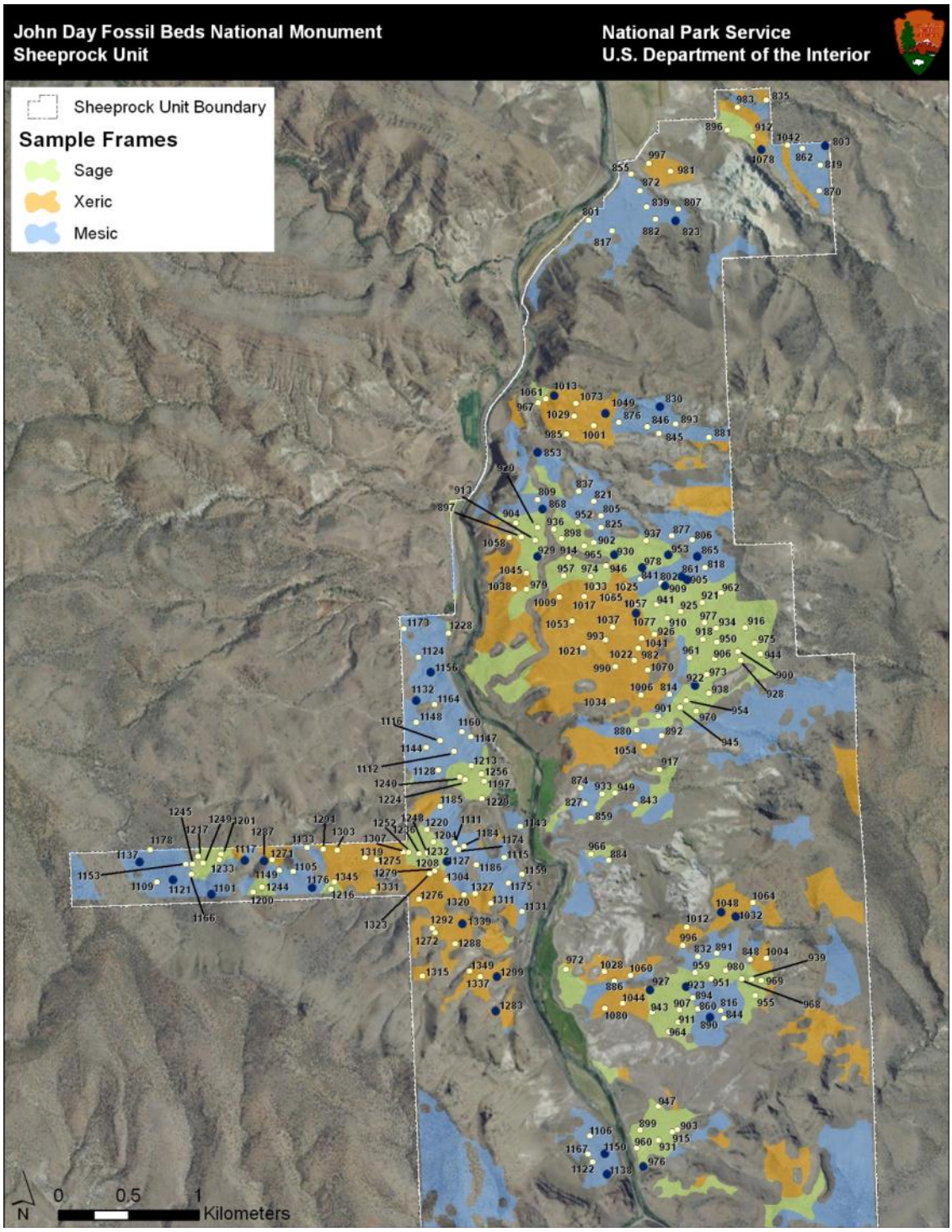

Figure 14. Sheep Rock unit of John Day Fossil Beds National Monument showing 3 habitat sample frames within sagebrush steppe, and plot locations. Darker blue, larger plot locations identify those plots we deemed in good condition (see Methods for criteria for good condition).

We sampled the Sheep Rock unit from June 13 – 20, 2011 (Figure 14). Spring and early summer weather for Sheep Rock, as noted for Foree, was cooler yet drier than the long-term average (Appendix 3). Cover of exposed soil was ≤ 25% in most plots. A couple of plots in xeric habitat had exposed soil cover in the next higher category, >25% - 50% (Tables 11-13). Big sagebrush was infrequent with low cover. Highest sagebrush cover was in xeric habitat. As was found in the other park units, snakeweed was the most abundant shrub with highest cover in xeric habitat. Bluebunch wheatgrass and Sandberg's bluegrass were the principal native grasses. Although we expected Idaho fescue to be restricted to mesic sites, it was found infrequently at low cover in all three habitats. Vetch was the most commonly occurring forb, similar to the other park units, and there was similar forb richness among the three habitats.

Dalmatian toadflax occurred in all three habitats at low cover. Near the mouth of Waterspout Gulch in sage habitat on the east side of Sheep Rock there was a large infestation of Dalmatian toadflax and Scotch thistle as well as a large patch of whitetop. The entire area clearly had burned in recent years. This was the only place that we encountered Scotch thistle in plots. Cheatgrass occurred at high frequency in all three habitats (97-99%) and high cover values were common. All four species of annual grasses monitored occurred in all three habitats. Medusahead cover was greatest in sage habitat, similar to other park units. Additional locations of noxious weeds and medusahead that were observed while traversing between plot locations were reported to park staff.

On the west side of Sheep Rock (i.e., west of the John Day River), evidence of fire was common across most of the area. In the corridor extending west from the unit (Figure 14), patches of medusahead were common at the lower elevations in the eastern portion while juniper woodland mixed with big sagebrush was common in the western higher elevation portion (Figure 15). Snakeweed and cheatgrass-dominated stands on southerly exposures were a common occurrence across the unit, likely accentuated by past fires aimed at removal of sagebrush and juniper (Figures 16 & 17). Patches of medusahead were scattered across the north end of the unit west of the John Day River. Dalmatian toadflax was sporadically common and Scotch thistle was present but rare.

We identified 38 plots at Sheep Rock that represented good range condition as defined in the Methods Section (Figure 14). Forty-seven percent of these good condition plots were located in mesic habitat (compared to 35% of all plots that were in mesic habitat, Table 1). Twenty-six percent of good condition plots were located in sage habitat (compared to 37% of all plots in sage habitat), and 26% of good condition plots were in xeric habitat (compared to 27% of all plots that were in xeric habitat). Seventy of the 213 plots sampled for Sheep Rock (33%) had bluebunch wheatgrass cover > 25% (Figures 18 & 19) but only 18 of these plots were considered in good condition (47% of good condition plots). For the most part, these good condition plots were composed of a mix of native bunchgrasses, occasional high cover of native shrubs (principally big sagebrush), and a mix of native forbs typically with low cover values for a particular species. Vetch was the most commonly encountered forb but only two plots of the group of good condition plots had cover values for vetch > 25%.

The portion of the Sheep Rock unit west of the John Day River was sampled in 2009 (Rodhouse 2010). Weather in 2009 was drier than the long-term average with the dry period beginning

about a month earlier than usual and spring precipitation substantially less than usual (Appendix 3). Spring weather in 2009 also was drier than in 2011. Comparison between 2009 and 2011 is confounded by the consequences of inaccurate park boundaries. Many plots sampled in 2009, particularly those in the southwestern portion, were outside the park. Of the 228 plots sampled, 107 were outside park boundaries leaving 121 valid plots. We selected a subset of plots in 2009 and 2011 (n = 77 in each year) that sampled the same area of the park – from the north end west of the river to south of the westward extending corridor and including the corridor (Figure 14). Cover of exposed soil, Sandberg's bluegrass, and cheatgrass was greater in 2009 than in 2011. Cover of broom snakeweed was greater in 2011. Estimated cover of medusahead and dalmatian toadflax was low and similar between the two years. Cover of other principal species, such as bluebunch wheatgrass, big sagebrush, and Idaho fescue was similar between the two sample periods for this area.

Table 11. Sheep Rock Unit, Mesic Habitat, 2011: percentage of plots (n=90 1-m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds, John Day Fossil Beds National Monument.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	40	54	6	0	0	0	0
Sagebrush							
Artemisia arbuscula	99	0	1	0	0	0	0
Artemisia tridentata	92	3	3	0	1	0	0
Shrubs							
Atriplex spp.	97	0	3	0	0	0	0
Chrysothamnus viscidiflorus	98	1	1	0	0	0	0
Gutierrezia sarothae	79	9	10	2	0	0	0
Native Perennial Grasses							
Festuca idahoensis	98	0	1	1	0	0	0
Poa secunda	50	46	4	0	0	0	0
Pseudoroegneria spicata	57	10	17	16	1	0	0
Sporobolus cryptandrus	96	1	2	1	0	0	0
Stipa spp.	90	7	1	2	0	0	0
Native Persistent Forbs							
Achillea millefolium	91	8	1	0	0	0	0
Antennaria spp.	99	1	0	0	0	0	0
Astragalus spp	82	12	6	0	0	0	0
Cirsium spp.	98	2	0	0	0	0	0
Dalea ornata	98	1	1	0	0	0	0
Erigeron spp.	97	2	1	0	0	0	0
Lomatium spp.	92	8	0	0	0	0	0
Lupinus spp.	99	0	1	0	0	0	0
Sphaeralcea munroana	99	0	1	0	0	0	0
Native Other Forbs							
Brodiaea douglasii	94	6	0	0	0	0	0
Calochortus spp.	99	1	0	0	0	0	0
Non-native Invasive Forbs							
Descurainia spp.	99	1	0	0	0	0	0
Erodium cicutarium	87	12	1	0	0	0	0
Linaria dalmatica	99	1	0	0	0	0	0
Sisymbrium altissimum	89	10	1	0	0	0	0
Non-native Invasive Grasses							
Bromus japonicus	84	8	7	1	0	0	0
B. tectorum	3	27	26	17	17	11	0
Elymus caput-medusae	97	3	0	0	0	0	0
Poa bulbosa	88	7	4	1	0	0	0

NOTE: not all rows sum to 100% because of the error inherent in rounding to whole numbers.

Table 12. Sheep Rock Unit, Sage Habitat, 2011: percentage of plots (n=95 1-m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds, John Day Fossil Beds National Monument.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	58	38	4	0	0	0	0
Sagebrush							
Artemisia tridentata	96	3	1	0	0	0	0
Shrubs							
Chrysothamnus viscidiflorus	98	0	2	0	0	0	0
Gutierrezia sarothae	75	12	13	1	0	0	0
Native Perennial Grasses							
Festuca idahoensis	97	2	1	0	0	0	0
Poa secunda	60	38	2	0	0	0	0
Poa spp.	99	1	0	0	0	0	0
Pseudoroegneria spicata	59	12	15	13	2	0	0
Sporobolus cryptandrus	98	0	2	0	0	0	0
Stipa spp.	94	4	2	0	0	0	0
Native Persistent Forbs							
Achillea millefolium	87	12	1	0	0	0	0
Astragalus spp	84	3	12	1	0	0	0
Cirsium spp.	98	2	0	0	0	0	0
Dalea ornata	99	1	0	0	0	0	0
Erigeron spp.	99	1	0	0	0	0	0
Lomatium spp.	93	7	0	0	0	0	0
Lupinus spp.	99	0	1	0	0	0	0
Sphaeralcea munroana	95	4	1	0	0	0	0
Native Other Forbs							
Brodiaea douglasii	97	3	0	0	0	0	0
Calochortus spp.	98	2	0	0	0	0	0
Non-native Invasive Forbs							
Descurainia spp.	94	6	0	0	0	0	0
Erodium cicutarium	77	20	2	1	0	0	0
Linaria dalmatica	94	2	4	0	0	0	0
Onopordum acanthium	99	0	0	1	0	0	0
Sisymbrium altissimum	80	17	2	1	0	0	0
Non-native Invasive Grasses							
Bromus japonicus	97	1	2	0	0	0	0
*Bromus spp.**	99	0	0	0	1	0	0
B. tectorum	1	21	23	22	23	9	0
Elymus caput-medusae	78	15	0	6	0	1	0
Poa bulbosa	88	6	3	1	1	0	0

NOTE: not all rows sum to 100% because of the error inherent in rounding to whole numbers.
*Not sure about identification but occurred as a large patch.

Table 13. Sheep Rock Unit, Xeric Habitat, 2011: percentage of plots (n=69 1-m² plots) within each cover class for exposed bare ground and principal plant species organized by species guilds, John Day Fossil Beds National Monument.

	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	39	55	3	3	0	0	0
Sagebrush							
Artemisia tridentata	88	4	1	6	0	0	0
Shrubs							
Atriplex spp.	99	0	0	1	0	0	0
Gutierrezia sarothae	67	12	20	1	0	0	0
Purshia tridentata	99	0	1	0	0	0	0
Native Perennial Grasses							
Festuca idahoensis	94	1	3	1	0	0	0
Poa secunda	61	38	1	0	0	0	0
Pseudoroegneria spicata	59	7	22	7	4	0	0
Sporobolus cryptandrus	97	1	1	0	0	0	0
Stipa spp.	94	4	1	0	0	0	0
Native Persistent Forbs							
Achillea millefolium	90	10	0	0	0	0	0
Antennaria spp.	99	1	0	0	0	0	0
Astragalus spp	75	12	12	1	0	0	0
Cirsium spp.	96	4	0	0	0	0	0
Erigeron spp.	99	1	0	0	0	0	0
Eriogonum spp.	97	1	1	0	0	0	0
Lomatium spp.	96	4	0	0	0	0	0
Phacelia spp.	99	1	0	0	0	0	0
Sphaeralcea munroana	99	0	1	0	0	0	0
Native Other Forbs							
Brodiaea douglasii	94	6	0	0	0	0	0
Sedum lanceolatum	99	1	0	0	0	0	0
Non-native Invasive Forbs							
Descurainia spp.	94	6	0	0	0	0	0
Erodium cicutarium	78	22	0	0	0	0	0
Linaria dalmatica	99	0	1	0	0	0	0
Sisymbrium altissimum	91	7	1	0	0	0	0
Non-native Invasive Grasses							
Bromus japonicus	93	7	0	0	0	0	0
B. tectorum	1	19	36	22	19	3	0
Elymus caput-medusae	86	13	1	0	0	0	0
Poa bulbosa	84	12	3	1	0	0	0

NOTE: not all rows sum to 100% because of the error inherent in rounding to whole numbers.

Figure 15. West side of Sheep Rock unit looking east from plot #1137. Juniper woodland with old skeletons of big sagebrush.

Figure 16. West side of Sheep Rock unit looking north from plot #1276. A southerly aspect showing the commonly encountered condition of snakeweed and cheatgrass dominated landscapes on previously burned sites.

Figure 17. East side of Sheep Rock unit looking east from plot #837. Previously burned site dominated by cheatgrass, medusahead, and Japanese brome with low cover of bluebunch wheatgrass (juniper killed by fire in background).

Figure 18. East side of Sheep Rock unit looking southwest from plot#823 showing a good condition stand of bluebunch wheatgrass and Idaho fescue with little cheatgrass cover.

Figure 19. East side of Sheep Rock unit looking west from plot #1032 towards Sheep Rock. Mixed stand of bluebunch wheatgrass, Idaho fescue, Sandberg's bluegrass, and cheatgrass on northerly aspect.

The sagebrush steppe landscape at JODA is dominated by invasive annual grasses and scattered cover of invasive noxious weeds. Cheatgrass dominates with medusahead widely present, sometimes in dense patches. Fire, principally wildfire at Clarno, and prescribed fire at Painted Hills, Foree, and Sheep Rock, has played an extensive role in shaping the composition of vegetation in sagebrush steppe in this park. Two wildfires burned the entire Clarno unit in 1994 and 1995 (Rodhouse 2009). The entire Clarno unit burned again in August 2011. Prescribed fires used to remove sagebrush and juniper (Jim Hammett, JODA superintendent, pers. commun.) occurred in the southern portion of the Painted Hills unit in 2002, and across Foree in 2005 and 2007 (Rodhouse 2009). Much of the Sheep Rock Unit was burned in 1999, 2001, 2002, and 2004 (Rodhouse 2010). Annual grasses are most prevalent in areas that have experienced recent fires based on our sampling and observations. Abundance of medusahead seems clearly tied to past fire. Fire poses the threat of expanding the dominance of invasive plants and further reducing the remaining few stands of predominantly native vegetation. This is the situation across much of sagebrush steppe in western North America, particularly at low elevations such as in JODA. There are a few small stands in JODA still dominated by native bunchgrasses that have burned suggesting some resilience to disturbance. However, as experienced over much of sagebrush steppe in the Upper Columbia Basin, the increase of annual grasses coupled with shorter intervals between fires is most likely going to lead to the loss of native plants and loss of the characteristics of the bunchgrass steppe ecosystem that historically dominated the landscapes in and around JODA (Yeo et al. 2009).

Monitoring at JODA has occurred in both wet and dry years. Vegetation cover generally appears similar between wet and dry years, or at least differences between sample years do not appear attributable to annual variability in precipitation. For the most part, increased precipitation seems to result in reduced cover in exposed soil coupled with some increase in annual grass cover. The large areas within park units disturbed by fire with current cover dominated by annual grasses may be reducing variability among ecological sites (represented by the 3 sampling strata) so that the effects of weather are less apparent.

Our objective in delineating mesic, xeric, and sage habitat as separate habitat categories was to provide the opportunity to compare plant communities expected to respond to disturbances differently due to soil moisture and the expected late seral community, and based on aspect, elevation, and soil moisture (ecological sites). However the use of these three strata at JODA proved to be unsatisfactory and we encountered considerable misclassification errors in the NRCS ecological site descriptions. For example, in Painted Hills almost the entire southern end of the unit consists of northerly aspects at the highest elevations in the unit yet using ecological site criteria these areas were largely depicted as xeric (Figure 10). The existing vegetation, however, was consistent with mesic conditions – stands dominated by bluebunch wheatgrass and Idaho fescue or denser stands of juniper (e.g., Figure 13). This situation was evident in the other park units as well (e.g., Figure 17). Additionally, the same vegetation communities commonly were found in each of the three habitats.

For future monitoring at JODA, we intend to modify the sampling strategy similar to that used at Craters of the Moon National Monument and Preserve. This approach would distribute permanent sample frames (monitoring sites) of about 10-20 ha in size across the park units in select areas. The sample frames would target representative areas of the best remaining

sagebrush steppe range condition, representative areas that could return to good range condition, and representative areas that are in poor condition that might be restored in the future or to monitor what happens in poor condition stands over long periods that although protected from most human disturbances (e.g., livestock grazing) yet experience natural disturbances and potential climate change. Areas that park management is trying to restore to native sagebrush steppe vegetation, such as the area on the western boundary of Foree, could be included. Other areas of significant plant diversity or other long-term management importance also could be included. Logistically, these monitoring sites would be more efficient to monitor and provide a more consistent comparison among years.

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Appendix 1: List of plant species mentioned in the report with common and scientific names.

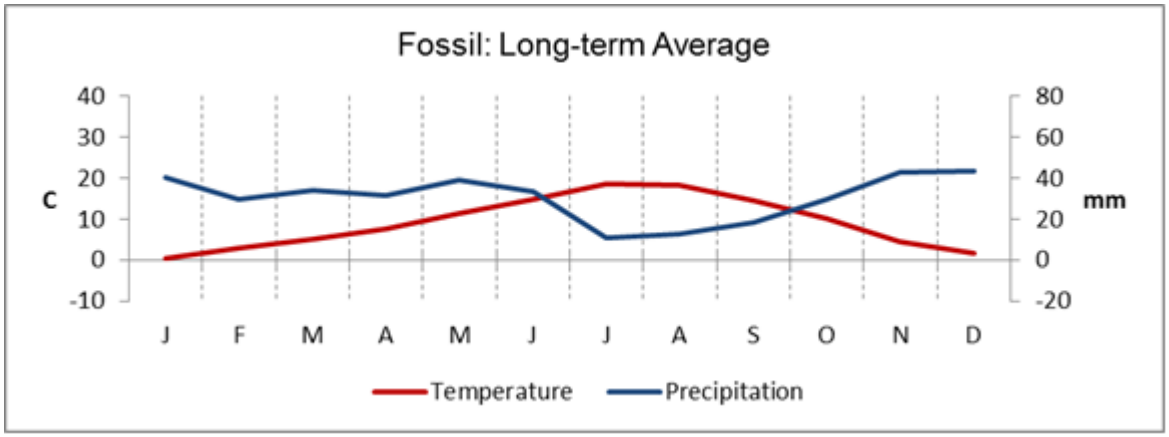
Common Name	Species Name
Sagebrush	
Low sagebrush	*Artemisia arbuscula*
Big sagebrush	*Artemisia tridentata*
Shrubs	
Shadscale	*Atriplex spp.*
Green rabbitbrush	*Chrysothamnus viscidiflorus*
Grey rabbitbrush	*Ericamerica nauseosa*
Broom snakeweed	*Gutierrezia sarothrae*
Bitterbrush	*Purshia tridentata*
Purple sage	*Salvia dorrii*
Greasewood	*Sarcobatus vermiculatus*
Native Perennial Grasses	
Basin wildrye	*Elymus cinereus*
Idaho fescue	*Festuca idahoensis*
Indian ricegrass	*Oryzopsis hymenoides*
Sandberg's bluegrass	*Poa secunda*
Bluegrass	*Poa spp.*
Bluebunch wheatgrass	*Pseudoroegneria spicata*
Squirreltail	*Sitanion hystrix*
Sand dropseed	*Sporobolus cryptandrus*
Needlegrass	*Stipa spp.*
Native Persistent Forbs	
Yarrow	*Achillea millefolium*
Pussytoes	*Antennaria spp.*
Milk-vetch	*Astragalus spp.*
Arrowleaf balsamroot	*Balsamorhiza sagittata*
Indian paintbrush	*Castilleja spp.*
Native thistle	*Cirsium spp.*
Tapertip hawksbeard	*Crepis accuminata*
Prairie-clover	*Dalea ornata*
Daisy	*Erigeron spp.*
Buckwheat	*Eriogonum spp.*
Desert parsley	*Lomatium spp.*
Lupine	*Lupinus spp.*
Prickly pear cactus	*Opuntia polyacantha*
Penstemon	*Penstemon spp.*
Phacelia	*Phacelia spp.*
Phlox	*Phlox spp.*
Orange globe mallow	*Sphaeralcea munroana*
Native Other Forbs	
Agoseris	*Agoseris spp.*
Onion	*Allium spp.*
Douglas' brodiaea	*Brodiaea douglasii*
Mariposa lily	*Calochortus spp.*
Cryptantha	*Cryptantha spp.*
Larkspur	*Delphinium spp.*
Bitterroot	*Lewisia rediviva*
Stonecrop	*Sedum lanceolatum*

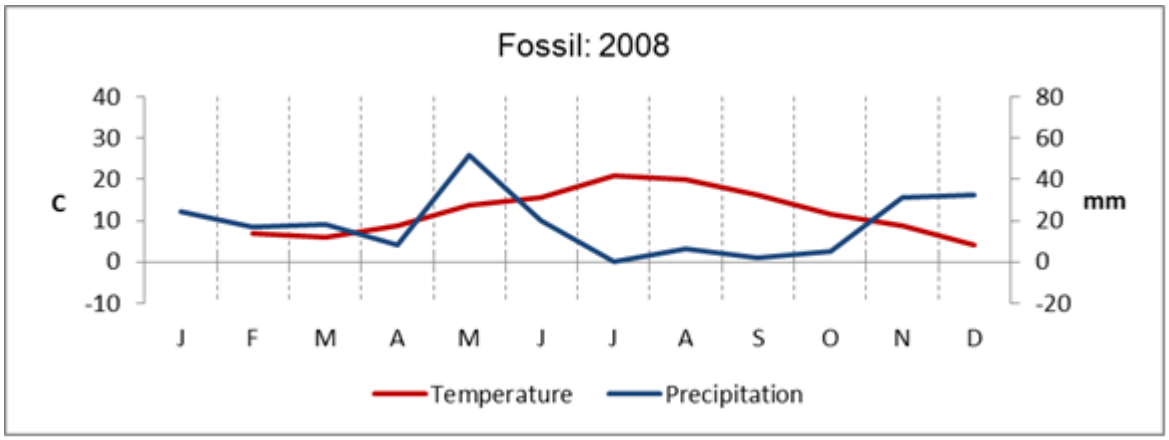
Appendix 1: List of plant species mentioned in the report with common and scientific names (continued).

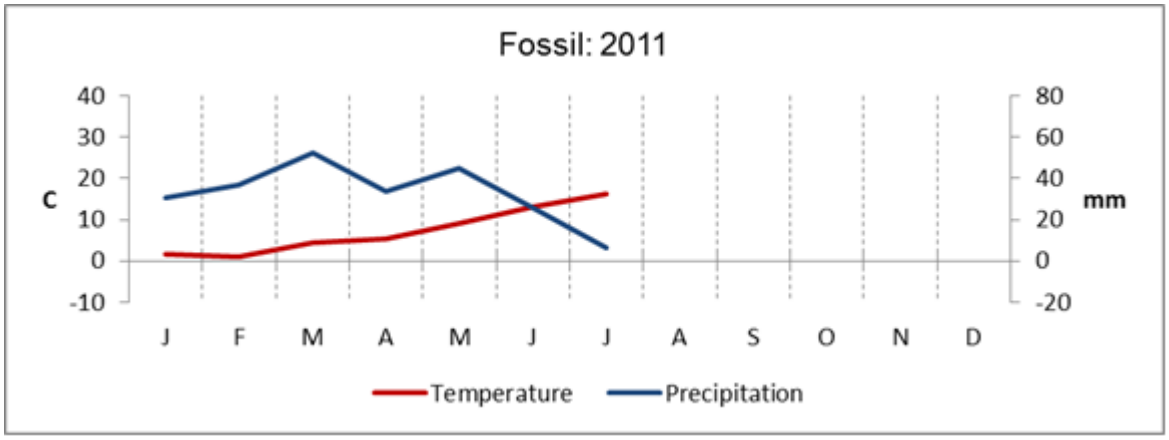
Common Name	Species Name
Non-native Invasive Forbs	
Whitetop	*Cardaria draba*
Tansy mustard	*Descurainia spp.*
Filaree	*Erodium cicutarium*
Dalmatian toadflax	*Linaria dalmatica*
Scotch thistle	*Onopordum acanthium*
Tumble mustard	*Sisymbrium altissimum*
Non-native Invasive Grasses	
Crested wheatgrass	*Agropyron cristatum*
Japanese brome	*Bromus japonicus*
Brome	*Bromus spp.*
Cheatgrass	*Bromus tectorum*
Medusahead	*Elymus caput-medusae*
Bulbous bluegrass	*Poa bulbosa*

Appendix 2: Climate diagrams (Walter et al. 1975) for the Fossil weather station, 20 km from the Clarno unit, John Day Fossil Beds National Monument.

These figures compare the long-term (88 yrs) average monthly temperatures (red line) and monthly average precipitation (blue line) to temperatures and precipitation in 2008 and 2011. The period when the temperature line exceeds the precipitation line defines the arid period for plant growth.

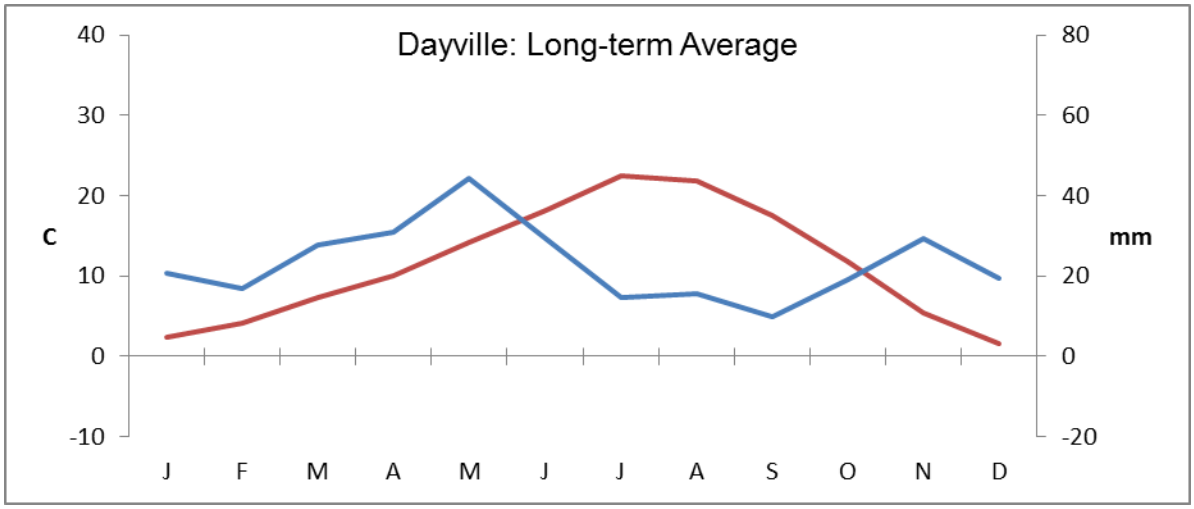


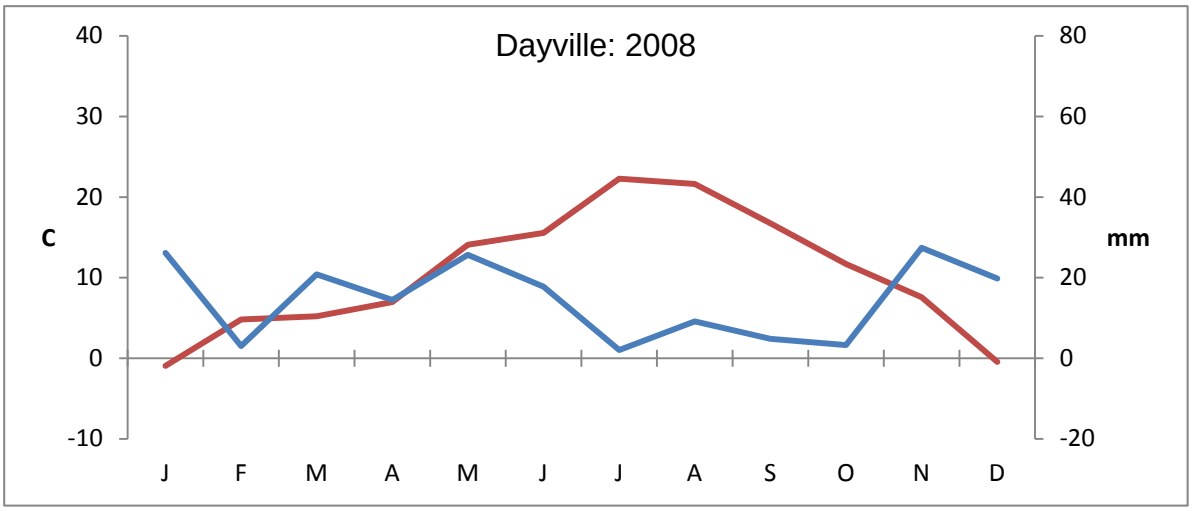




Appendix 3: Climate diagrams (Walter et al. 1975) for the Dayville 8 NW weather station, within the Sheep Rock unit, John Day Fossil Beds National Monument.

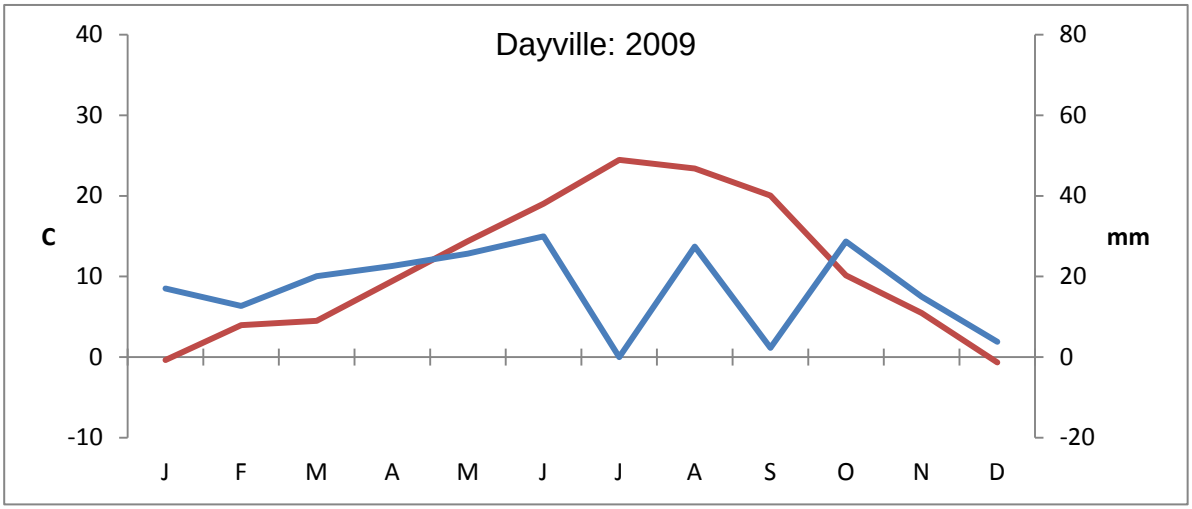
These figures compare the long-term (33 yrs) average monthly temperatures (red line) and monthly average precipitation (blue line) to temperatures and precipitation in 2008, 2009, and 2011. The period when the temperature line exceeds the precipitation line defines the arid period for plant growth.

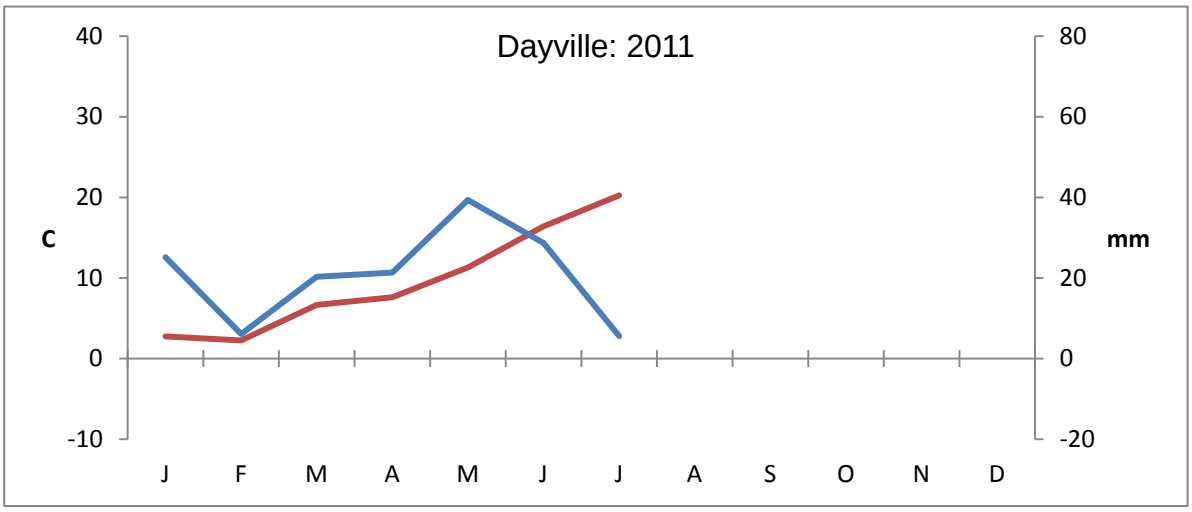




Appendix 3: Climate diagrams (Walter et al. 1975) for the Dayville 8 NW weather station, within the Sheep Rock unit, John Day Fossil Beds National Monument (continued).

These figures compare the long-term (33 yrs) average monthly temperatures (red line) and monthly average precipitation (blue line) to temperatures and precipitation in 2008, 2009, and 2011. The period when the temperature line exceeds the precipitation line defines the arid period for plant growth.





Appendix 4: Climate diagrams (Walter et al. 1975) for the Mitchell 2 E weather station, 10 km from the Painted Hills unit, John Day Fossil Beds National Monument, for 2011.

Monthly temperatures are delineated by the red line and monthly average precipitation by the blue line. The period when the temperature line exceeds the precipitation line defines the arid period for plant growth.