



# Sagebrush Steppe Vegetation Monitoring in the Clarno Unit of the John Day Fossil Beds National Monument

## *2013 Annual Report*

Natural Resource Data Series NPS/UCBN/NRDS—2013/546



**ON THE COVER**

Bluebunch wheatgrass (*Pseudoeregneria spicata*), yarrow (*Achillea millefolium*), and basalt milk-vetch (*Astragalus filipes*) 2 years after the 2011 wildfire in the Clarno Unit, John Day Fossil Beds National Monument.

Photograph by Tom Rodhouse

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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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## Abstract

As part of the Upper Columbia Basin Network sagebrush steppe vital signs monitoring program, a survey of sagebrush steppe ecological condition was conducted in late May and early June 2013 within the Clarno Unit of John Day Fossil Beds National Monument (JODA) following methods outlined in the UCBN sagebrush steppe monitoring protocol (Yeo et al. 2009). Cover of exposed soil and of principal native and non-native plants or genera were estimated in 215 1 m<sup>2</sup> quadrats randomly placed throughout the sampling frame. The entire Unit was also surveyed in May and June 2012, reported by Esposito et al. (2012). These two most recent survey efforts were outside of the UCBN's 3-year revisit plan, in response to the August 2011 wildfire that swept through the Clarno Unit. Approximately 98% of the vegetated portion of the unit was burned by this fire. Previous wildfires swept the monument in 1985, 1994, and 1995. The entire Monument, including the Clarno Unit, was surveyed during May-June, 2011, as part of the regular 3-year revisit schedule (Yeo and Rodhouse 2012). This created an excellent opportunity to study fire effects in Clarno. This report describes briefly the findings from 2013, the second growing season following the wildfire, and provides some comparisons in the abundances of key principal species of interest with 2011 and 2012 observations. This report provides some early insights into the effects of the fire on Monument upland plant communities, a topic of critical importance to park management.

Late winter and spring weather in early 2013 was cool and dry, with below-average precipitation. However, late fall and early winter precipitation in 2012 was above average. This combination of precipitation may have facilitated a rebounding cheatgrass (*Bromus tectorum*) population, which responds vigorously when cool-season moisture is available, and may have inhibited medusahead (*Taeniatherum caput-medusae*) somewhat, which is better able to utilize moisture availability later into the growing season (e.g., June). This is a pattern opposite to what was observed in 2012 (Esposito et al. 2012). Cheatgrass was more abundant in 2013 than in 2012. The abundance of medusahead was greater in 2012 than in 2013. However, both species continue to dominate much of the Clarno landscape and medusahead presents a major threat to ecological integrity of the unit. Two other invasive annual grasses, Japanese brome (*B. japonicus*) and bulbous bluegrass (*Poa bulbosa*), were rarely abundant. Big sagebrush (*Artemisia tridentata*) was not recorded in any of the 2013 plots (n=215) and many areas that once supported sagebrush (i.e., sage habitat category) have lost shrub cover due to wildfire. Shrub cover in general was very low across the unit, with broom snakeweed (*Gutierrezia sarothrae*), which re-sprouts after fire, encountered in 9% of plots. Cover of native bunchgrasses, which define the steppe aspect of sagebrush steppe, was low to moderate. Principal native grasses included: bluebunch wheatgrass (*Pseudoroegneria spicata*), Sandberg's bluegrass (*Poa secunda*), needlegrasses (*Stipa* spp.), and sand dropseed (*Sporobolus cryptandrus*). Bluebunch wheatgrass, a foundation species in the Clarno landscape, was similarly distributed in 2013 compared with 2011 and 2012. The species appeared to have suffered relatively low mortality from the fire (Esposito et al. 2012), but there were fewer plots in 2013 with high cover class estimates >25%, a worrisome trend if it continues. Native forb cover generally was low. Principal native forb species included: milk-vetch (*Astragalus* spp.), yarrow (*Achillea millefolium*), buckwheats (*Eriogonum* spp.), Blue Mountain prairie clover (*Dalea ornata*) and desert parsley (*Lomatium* spp.). Yarrow was the most abundant native forb encountered. Filaree (*Erodium cicutarium*), a non-native forb, was



widespread throughout the unit, occasionally occurring in dense patches in association with meduahead on flat benches. As is typical of the heterogeneous landscape of JODA, some of the Clarno plots represent good range condition although most of the plots indicate degraded conditions. Based on the combination of exposed bare soil, and native and non-native species cover, 18% (40 plots) were considered to be in good condition.

## **Acknowledgments**

We greatly appreciate the assistance of John Laing, Clarno Ranger, who served as our point of contact for the Clarno Unit. Shirley Hoh, JODA Resource Manager, helped us with logistics, maps, and access. Devin Stucki assisted with field work. Hancock Field Station provided lodging. Gordon Dicus and Meghan Lonneker provided data management support.

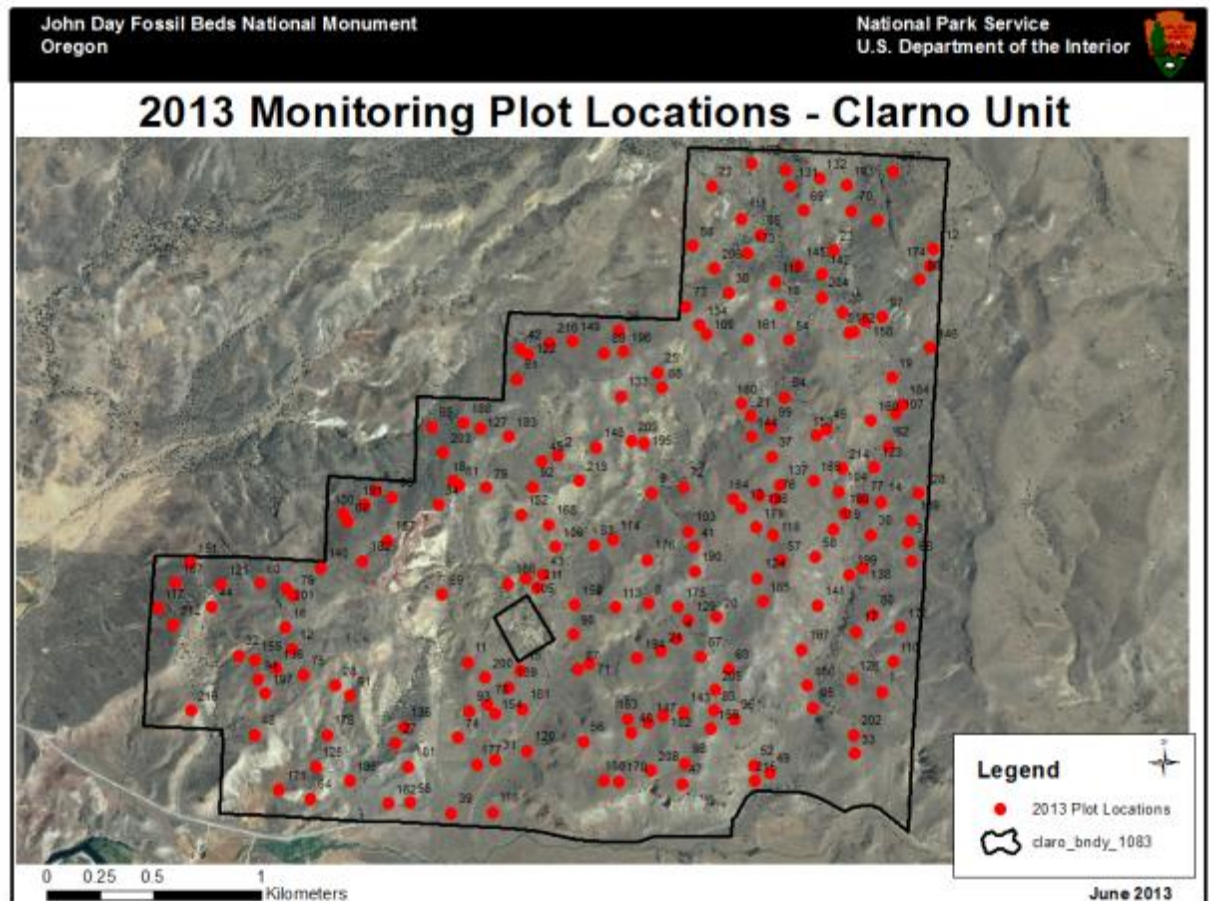
## Introduction

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. The UCBN has identified the ecological condition of sagebrush steppe vegetation as a high priority vital sign and monitoring of its condition is central to the UCBN 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 by non-native plants, increased fire frequencies, long-term trends of increasing cover of exposed soil, declines in cover of principal native plants) signifies a loss of health, and monitoring provides park managers with feedback necessary for developing effective adaptive management strategies. Simple monitoring objectives follow directly from this view:

- Determine the status (current condition) and trends (change in condition over time) in the composition and abundance (cover) of principal native plant species in UCBN sagebrush steppe communities.
- Determine the status and trends in composition and abundance (cover) of principal invasive plant species, including exotic annual grasses, in UCBN sagebrush steppe communities.
- Determine the status and trend in the amount of exposed soil (cover), a fundamental indicator of soil stability.

This report summarizes the data collected in 2013 for the Clarno Unit of the John Day Fossil Beds National Monument, and discusses comparisons with data collected in 2011 (Yeo and Rodhouse 2012) and 2012 (Esposito et al. 2012).

## Study Area and Methods



**Figure 1.** Clarno unit of John Day Fossil Beds National Monument showing the 2013 plot locations.

Within Clarno, 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 used for sampling during prior years (Yeo and Rodhouse 2012, Esposito et al. 2012). However, following surveys in 2011 and 2012, it became clear that the spatial error of the NRCS data was such that strata were not meaningful, and did not confer homogeneity to plots within strata nor reduce variance. In 2013, an unstratified sample was drawn from the frame. The sample design used across all years was the Generalized Random Tessellation Stratified Design that produces spatially-balanced dispersion of sample units (Stevens and Olsen 2004). The overall footprint of the sampling frame did not change. Sample design weights will be used to account for the change from stratified to unstratified sampling in future trend analyses. In 2013, the achieved sample size was 215, the full number called for by Yeo et al. (2009). In 2012, a smaller sample of 100 plots was achieved because of the off-year nature of the survey and lower staff availability. In 2013, staff availability allowed for a full survey.

Sampling procedures followed Yeo et al. (2009). At each plot location, a 1-m<sup>2</sup> quadrat frame was set up and within that frame the cover of exposed bare ground and principal native plants and non-native invasive plants were estimated visually using 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.

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 ( $\leq 5\%$ ) of invasive annual grasses – cheatgrass, Japanese brome, medusahead, or bulbous bluegrass – and exposed soil cover  $\leq 25\%$ . Summary statistics, including 95% confidence intervals, were computed with the GRTS variance estimator using the R package *spsurvey* (Kincaid and Olsen 2012).

### **Weather**

Weather at Clarno (Fossil weather station) during late fall and early winter 2012 was cooler and wetter than average. However, late winter and early spring 2013 was cooler and drier than average. Graphs of the temperature and precipitation patterns recorded at the Fossil weather station for 2012 and 2013 are presented in Appendix 2.

## Results and Discussion

### Bare Ground and Native Vegetation

The Clarno unit was surveyed over the course of 3 days in late May and early June. Spring weather for Clarno in 2013 was drier than the long-term averages for precipitation, and lacked the heavy spring precipitation events and flash-flooding of the previous year (Appendix 2). However, late fall and early winter experienced above-average precipitation, which may have influenced cover of both cheatgrass and medusahead. Exposed soil cover generally was  $\leq 25\%$  although there were several plots with exposed soil greater than 25% (Table 1). One plot with exposed bare soil >75-95% cover was on a flat bench with frost-heaved clay soil, with medusahead and *Helianthella uniflora*. This is a common degraded vegetation pattern on many of the flat benches in Clarno when deep clay soils are repeatedly heaved to the surface. However, on some steep north-facing slopes with recovering bunchgrass communities, exposed bare soil cover can also be relatively high (Figure 2). Based on the combination of bare ground and principal species cover, 18% (40 plots) were considered to be in good ecological condition.

Shrubs continue to be largely absent from the landscape following the 2011 fire. No big sagebrush, rabbitbrushes, nor bitterbrush was encountered. Broom snakeweed, which readily re-sprouts following fire, was encountered in 20 plots (9%; Table 2). Spineless horsebrush, another species that re-sprouts after fire, was observed outside of plots on the west side of the unit.

Bluebunch wheatgrass, needlegrass, and Sandberg's bluegrass were the most abundant native perennial grasses. Bluebunch wheatgrass, which is of particular interest given its dominant role in the Clarno ecosystem, appears to be recovering in some areas of the unit following the 2011 fire (Tables 1 and 2; Figure 3). The frequency of bluebunch wheatgrass occurrence in plots was 47%, up slightly from 2012 (Table 2). However, robust stands dominated by bluebunch wheatgrass with cover >25% remain rare (Figure 3) and appear to be lower than in 2012 (Table 2). Idaho fescue was not encountered. Although there were a variety of forbs encountered, forb cover in general was low. Yarrow is notably abundant in many areas of the unit (Table 1).

**Table 1.** Summary of percentages of plots in each cover class category for bare ground and principal native and non-native species.

	0%	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare Ground	19	45	22	10	3	1	0
<b>Sagebrush</b>							
<i>Artemisia tridentata</i>	100	0	0	0	0	0	0
<b>Shrubs</b>							
<i>Gutierrezia sarothrae</i>	91	8	1	0	0	0	0
<i>Purshia tridentata</i>	100	0	0	0	0	0	0
<b>Native perennial grasses</b>							
<i>Festuca idahoensis</i>	99	0	0	0	0	0	0
<i>Poa secunda</i>	49	33	16	1	0	0	0
<i>Poa</i> spp	98	1	0	0	0	0	0
<i>Pseudoroegneria spicata</i>	53	13	25	8	1	0	0
<i>Sporobolus cryptandrus</i>	98	2	0	0	0	0	0
<i>Stipa</i> spp	65	21	12	1	0	0	0
<b>Native persistent forbs</b>							
<i>Achillea millefolium</i>	78	19	2	1	0	0	0
<i>Antennaria</i> spp	99	1	0	0	0	0	0
<i>Astragalus</i> spp	84	12	4	0	0	0	0
<i>Castilleja</i> spp	99	1	0	0	0	0	0
<i>Cirsium</i> spp	98	2	0	0	0	0	0
<i>Crepis acuminata</i>	100	0	0	0	0	0	0
<i>Dalea ornata</i>	97	3	0	0	0	0	0
<i>Erigeron</i> spp	100	0	0	0	0	0	0
<i>Eriogonum</i> spp	92	7	0	0	0	0	0
<i>Helianthella uniflora</i>	100	0	0	0	0	0	0
<i>Helianthus annuus</i>	100	0	0	0	0	0	0
<i>Lithospermum ruderales</i>	100	0	0	0	0	0	0
<i>Lomatium</i> spp	88	11	0	0	0	0	0
<i>Phacelia</i> spp	100	0	0	0	0	0	0
<i>Phlox</i> spp	98	2	0	0	0	0	0
<i>Sphaeralcea munroana</i>	100	0	0	0	0	0	0
<b>Native other forbs</b>							
<i>Agoseris</i> spp	97	3	0	0	0	0	0
<i>Allium</i> spp	99	1	0	0	0	0	0
<i>Arabis</i> spp	99	1	0	0	0	0	0
<i>Calochortus</i> spp	100	0	0	0	0	0	0
<i>Cryptantha</i> spp	100	0	0	0	0	0	0
<i>Helianthella</i> spp.	99	1	0	0	0	0	0

**Table 1 (continued).** Summary of percentages of plots in each cover class category for bare ground and principal native and non-native species.

	0%	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
<b>Non-native invasive forbs</b>							
Acroptilon repens	99	1	1	0	0	0	0
Descurainia spp	99	1	0	0	0	0	0
Erodium cicutarium	67	15	12	7	0	0	0
Kochia scoparia	99	0	0	0	0	0	0
Sisymbrium altissimum	100	0	0	0	0	0	0
Tragopogon dubius	94	6	0	0	0	0	0
<b>Non-native invasive grasses</b>							
Bromus japonicus	93	5	1	0	0	0	0
Bromus spp	98	2	0	0	0	0	0
Bromus tectorum	5	38	25	19	10	4	0
Elymus caput- medusae	66	13	5	7	3	6	1
Poa bulbosa	92	5	2	1	1	0	0

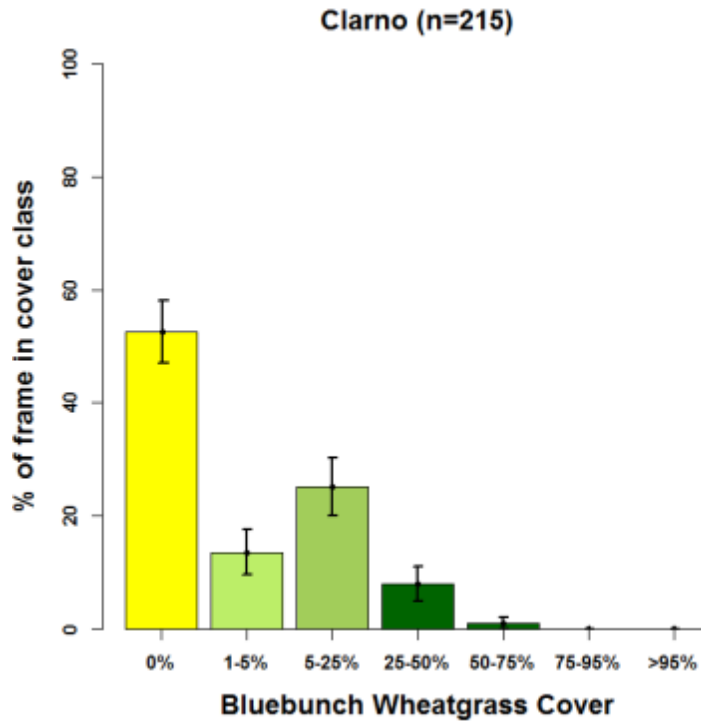
**Table 2.** Summary of bluebunch wheatgrass cover and acreage estimates for 2011, prior to the August 2011 wildfire, and for the two years after the fire.

Clarno Bluebunch Wheatgrass Cover	2011	2012	2013
Total acreage sampled	988.49	988.49	988.49
Total with no bluebunch wheatgrass	556.91	551.05	519.53
Proportion of total sampling area with no bluebunch wheatgrass	0.56	0.56	0.53
Total with at least some bluebunch wheatgrass	431.59	437.44	468.96
Proportion of total sampling area with bluebunch wheatgrass	0.44	0.44	0.47
Good condition acreage (>25% bluebunch wheatgrass cover)	156.52	97.39	87.36
Proportion in good condition	0.16	0.10	0.09





**Figure 2.** A steep north-facing slope overlooking Hancock Canyon in the central portion of the Clarno Unit with a healthy stand of bluebunch wheatgrass and Sandberg's bluegrass. Cheatgrass was largely absent from the interstices between bunchgrass plants, despite the relatively high amount of exposed bare soil.



**Figure 3.** Estimated percentage of the Clarno sampling frame (see Figure 1) in 2013 with bluebunch wheatgrass cover in each of the 7 Daubenmire cover classes, with 95% confidence intervals.

## Non-native Vegetation

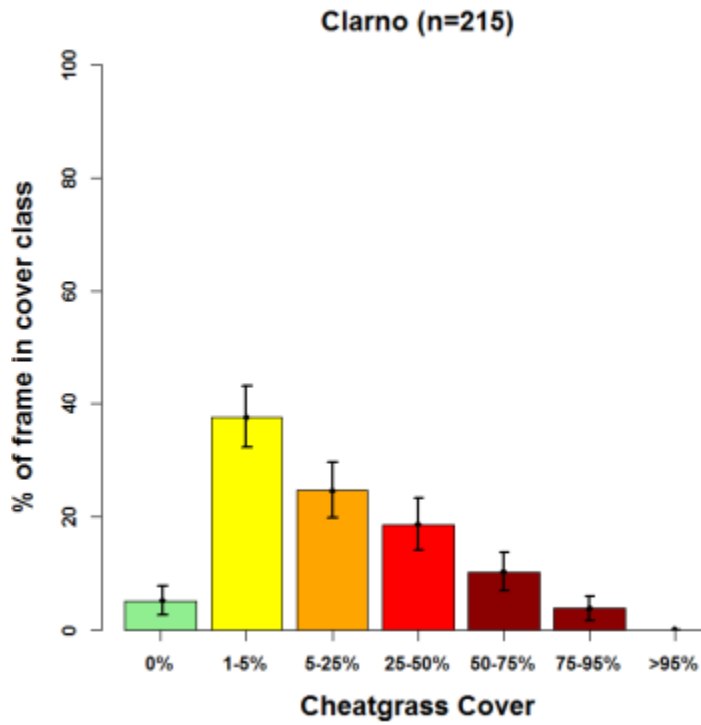
Noxious weeds, particularly filaree (*Erodium cicutarium*), were encountered in a large number of plots (Table 1). This species often co-occurs with medusahead on flat, frost-heaved benches, and may be another good indicator of general ecological condition in the Monument. Alarming, Russian knapweed was encountered in 2 plots, the first time this species has been encountered in upland plots in Clarno. Several other patches of Russian knapweed were also encountered outside of plots and reported to Monument resource management staff. Dalmatian toadflax was not encountered in plots but was observed outside of plots in several locations, also reported to Monument staff. Annual grasses continue to represent the biggest threat to ecological integrity in the Monument; apparently able to penetrate otherwise intact and recovering bunchgrass stands on north-facing slopes (Figure 4). Establishing the rate and magnitude of this trend is a central goal of monitoring over the next few years. Both the frequency and abundance of cheatgrass has increased over 2012 (Table 3). The species is able to take advantage of late fall and early winter precipitation, and the weather patterns in late 2012 may have influenced the increase (Appendix 2). Of particular concern is the increase in areas dominated by cheatgrass with cover >25%, which is estimated to cover >30% of the Unit (Table 3 and Figure 5). Medusahead, although typically contributing less cover than cheatgrass in most plots, had high cover values in some plots particularly across the flat benches in the northern portion of the monument (e.g., Figures 6 and 7), and in many of the less-rocky canyon bottoms and toe slopes. The overall extent and abundance of medusahead across the unit was slightly lower in 2013 than in 2012 (Table 4), possibly a result of the dry late winter and early spring weather (Appendix 2). This species is known to be able to take advantage of precipitation later in the growing season, as was evidently the case in 2012 (Esposito et al. 2012). There was a substantial increase in the medusahead infestation in 2012 following the fire, likely because of the combination of the 2011 fire and the late spring precipitation (Table 4; Esposito et al. 2012). Bulbous bluegrass was also relatively abundant in some areas of the unit, particularly along wetter canyon bottoms (Table 1). Japanese brome, another annual grass found at Clarno, was also encountered in some plots (Table 1).



**Figure 4.** Medusahead and cheatgrass invading a north-facing slope of bluebunch wheatgrass.

**Table 3.** Summary of cheatgrass cover and acreage estimates for 2011, prior to the August 2011 wildfire, and for the two years after the fire.

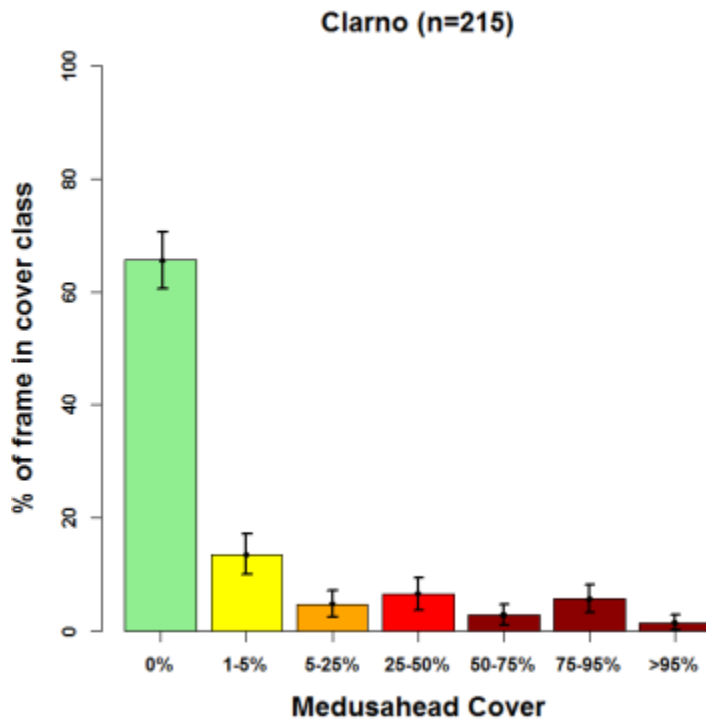
Clarno Cheatgrass Infestation	2011	2012	2013
Total acreage sampled	988.49	988.49	988.49
Total with no cheatgrass	77.90	65.92	50.57
Proportion of total frame area with no cheatgrass	0.08	0.07	0.05
Total with at least some cheatgrass	910.59	922.57	937.92
Proportion of total frame area with cheatgrass	0.92	0.93	0.95
Heavily infested acreage (>25% cover)	460.95	215.09	321.83
Proportion of heavily infested	0.47	0.22	0.33



**Figure 5.** Estimated percentage of the Clarno sampling frame (see Figure 1) in 2013 with cheatgrass cover in each of the 7 Daubenmire cover classes, with 95% confidence intervals.



**Figure 6.** An expansive medusahead infestation at upper Indian Canyon, northeast corner of the Clarno Unit, photographed during the 2013 survey.



**Figure 7.** Estimated percentage of the Clarno sampling frame (see Figure 1) in 2013 with medusahead cover in each of the 7 Daubenmire cover classes, with 95% confidence intervals.

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

**Table 4.** Plant common and scientific names.

Common name	Species name
<b>Sagebrush</b>	
Low sagebrush	<i>Artemisia arbuscula</i>
Scabland sagebrush	<i>Artemisia rigida</i>
Big sagebrush	<i>Artemisia tridentata</i>
<b>Other Shrubs</b>	
Shadscale	<i>Atriplex</i> spp
Curl-leaf mountain mahogany	<i>Cercocarpus ledifolius</i>
Green rabbitbrush	<i>Chrysothamnus viscidiflorus</i>
Grey rabbitbrush	<i>Ericameria nauseosus</i>
Broom snakeweed	<i>Gutierrezia sarothrae</i>
Bitterbrush	<i>Purshia tridentata</i>
Purple sage	<i>Salvia dorrii</i>
Greasewood	<i>Sarcobatus vermiculatus</i>
Grey horsebrush	<i>Tetradymia canescens</i>
<b>Native Grasses</b>	
Wheatgrass	<i>Agropyron</i> spp
Basin wildrye	<i>Elymus cinereus</i>
Idaho fescue	<i>Festuca idahoensis</i>
Indian ricegrass	<i>Achnatherum hymenoides</i>
Sandberg's bluegrass	<i>Poa secunda</i>
Bluegrass	<i>Poa</i> spp
Bluebunch wheatgrass	<i>Pseudoroegneria spicata</i>
Squirreltail	<i>Elymus elymoides</i>
Sand dropseed	<i>Sporobolus cryptandrus</i>
Needlegrass	<i>Stipa</i> spp

**Table 4 (continued).** Plant common and scientific names.

<b>Common name</b>	<b>Species name</b>
<b>Persistent Native Forbs</b>	
Yarrow	<i>Achillea millefolium</i>
Pussytoes	<i>Antennaria</i> spp
Lava aster	<i>Aster scopulorum</i>
Milk-vetch	<i>Astragalus</i> spp
Arrowleaf balsamroot	<i>Balsamorhiza sagittata</i>
Indian paintbrush	<i>Castilleja</i> spp
Native thistle	<i>Cirsium</i> spp
Tapertip hawksbeard	<i>Crepis acuminata</i>
Blue Mountain prairie clover	<i>Dalea ornata</i>
Daisy	<i>Erigeron</i> spp
Buckwheat	<i>Eriogonum</i> spp
Western stoneseed	<i>Lithospermum ruderale</i>
Desert parsley	<i>Lomatium</i> spp
Lupine	<i>Lupinus</i> spp
Prickly pear cactus	<i>Opuntia polyacantha</i>
Penstemon	<i>Penstemon</i> spp
Phacelia	<i>Phacelia</i> spp
Phlox	<i>Phlox</i> spp
Orange globe mallow	<i>Sphaeralcea munroana</i>
<b>Other Native Forbs</b>	
Agoseris	<i>Agoseris</i> spp
Onion	<i>Allium</i> spp
Rockcress	<i>Arabis</i> spp
Douglas' brodiaea	<i>Brodiaea douglasii</i>
Mariposa lily	<i>Calochortus</i> spp
Cryptantha	<i>Cryptantha</i> spp
Larkspur	<i>Delphinium</i> spp
Bitterroot	<i>Lewisia rediviva</i>
Woodland-star	<i>Lithophragma</i> spp
Stonecrop	<i>Sedum lanceolatum</i>



**Table 4 (continued).** Plant common and scientific names.

Common name	Species name
<b>Invasive Grasses</b>	
Crested wheatgrass	Agropyron cristatum
Cheatgrass	Bromus tectorum
Medusahead	Taeniatherum caput-medusae
Bulbous bluegrass	Poa bulbosa
Kentucky bluegrass	Poa pratensis
<b>Invasive Forbs</b>	
Russian knapweed	Acroptilon repens
Whitetop	Cardaria draba
Diffuse knapweed	Centaurea diffusa
Spotted knapweed	Centaurea maculosa
Yellow star thistle	Centaurea solstitialis
Tansy mustard	Descurainia spp.
Filaree	Erodium cicutarium
Leafy spurge	Euphorbia esula
Dalmation toadflax	Linaria dalmatica
Scotch thistle	Onopordum acanthium
Tumble mustard	Sisymbrium altissimum
Common salsify	Tragopogon dubius

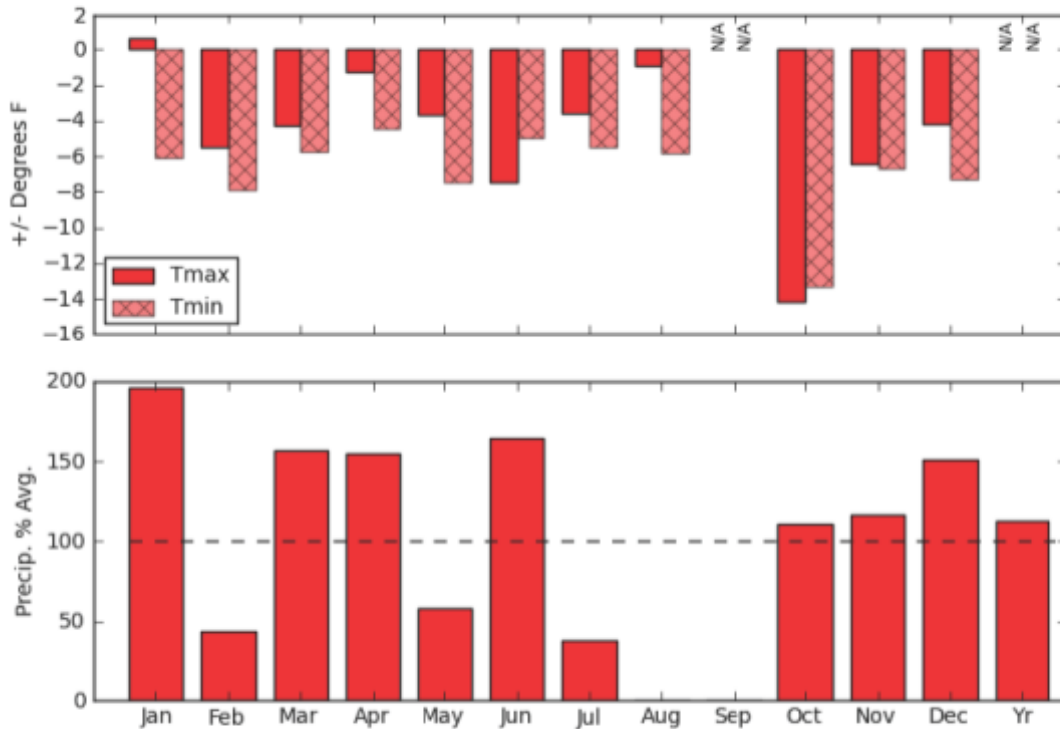
**Table 5.** Some species in this report have been reported with updated taxonomic names. These names deviate from those in previous reports, the table below documents the changes which have occurred within this report

Common name	Current species name	Synonyms
Indian ricegrass	<i>Achnatherum hymenoides</i>	<i>Oryzopsis hymenoides</i>
Medusahead	<i>Taeniatherum caput-medusae</i>	<i>Elymus caput-medusae</i>
Squirreltail	<i>Elymus elymoides</i>	<i>Sitanion hystrix</i>

## Appendix 2: Climate diagrams for the Fossil weather station, 20 km from the Clarno unit, John Day Fossil Beds National Monument.

**Figure 8.** These figures show temperature and precipitation departures from 30-year averages for A) 2012 and B) 2013. Data were retrieved from the Fossil Co-op weather station (#353038, Western Regional Climate Center, <http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?or3038>) and graphed using Climate Analyzer ([www.climateanalyzer.org](http://www.climateanalyzer.org)).

### A Fossil, Oregon (353038) - 2012 - Departure from 1981 - 2010 Avgs.



**B** Fossil, Oregon (353038) - 2013 - Departure from 1981 - 2010 Avgs.

