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Natural Resource Stewardship and Science

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

2012 Annual Report

Natural Resource Data Series NPS/UCBN/NRDS—2012/396

ON THE COVER
Clarno Unit, looking east into Indian Canyon in May 2012 following the August 2011 wildfire, John Day Fossil Beds National Monument.
Courtesy of Upper Columbia Basin Network Inventory and Monitoring Program

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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.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

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Executive Summary

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 2012 within the Clarno Unit of John Day Fossil Beds National Monument (JODA) following methods outlined in the Upper Columbia Basin Network monitoring protocol (Yeo et al. 2009). The plot-based surveys occurred within 3 habitat categories (strata) 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. These strata were identified from recent soil survey and ecological site descriptions provided by the Natural Resources Conservation Service. Cover of exposed soil and of principal native and non-native plants or genera were estimated in 102 1 m^2 quadrats randomly placed throughout the stratified sampling frame. The entire Monument was also surveyed in May and June 2011, reported by Yeo and Rodhouse (2012). The 2012 survey effort which was outside of the UCBN's 3-year revisit plan was added 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. This report describes briefly the findings from 2012 and provides some comparisons in the abundances of key principal species of interest between 2011 and 2012. 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.

Winter and spring weather in late 2011-early 2012 was dry, with below-average precipitation punctuated by some intense, short-lived bursts of rainfall in April and June. This combination of dry winter and spring weather and late-spring storms inhibited the growth of cheatgrass (*Bromus tectorum*), which responds vigorously when cool-season moisture is available, but allowed for a vigorous response of medusahead (*Taeniatherum caput-medusae*), which is better able to utilize moisture availability later into the growing season. Cheatgrass was less abundant in 2012 than in 2011, despite the fire, a disturbance which facilitates cheatgrass invasion in low-elevation steppe environments. The abundance of medusahead was greater in 2012 than in 2011. 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 with Japanese brome occasionally exceeding 30% presence and Poa bulbosa not exceeding 5% presence in all three strata. Big sagebrush (*Artemisia tridentata*) was not recorded in any of the 2012 plots (n=102) 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 resprouts after fire, encountered in some plots in the sage and xeric strata and green rabbitbrush (*Chrysothanmus viscidiflorus)* in the mesic stratum. 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.*), sand dropseed (*Sporobolus cryptandrus*), and Idaho fescue (*Festuca idahoensis*). There were occasional stands, mostly in mesic habitat, where native bunchgrasses dominated. Bluebunch wheatgrass, a foundation species in the Clarno

landscape, was similarly distributed in 2012 compared with 2011. The species appeared to have suffered relatively low mortality from the fire, but there were fewer plots in 2012 with high cover class estimates, a direct result of the fire. 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.). Filaree (*Erodium cicutarium*) was widespread throughout all three habitats occasionally occurring in dense patches. Tansy mustard (*Descurainia spp.*) and tumble mustard (*Sisymbrium altissimum*) were scattered throughout the mesic and xeric zones respectively. 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. Brief comparisons are made between results of 2012 monitoring at JODA and monitoring conducted in 2011 at Clarno.

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, threatens the integrity of the steppe ecosystems in the monument. The timing and amounts of precipitation over winter and spring seasons influences the annual dynamics of annual grass invasion in the unit.

Acknowledgments

We greatly appreciate the assistance of John Laing, Clarno Ranger, who provided us access to facilities and insights on the Clarno unit. Shirley Hoh, JODA Resource Manager, helped us with logistics, maps, and access. The coordinators at Hancock Field Station provided Dan and Tom with comfortable lodging while in the park. Gordon Dicus 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 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 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 2012 for Clarno, and discusses comparisons with data collected in 2011 (Yeo and Rodhouse 2012).

Study Area and Methods

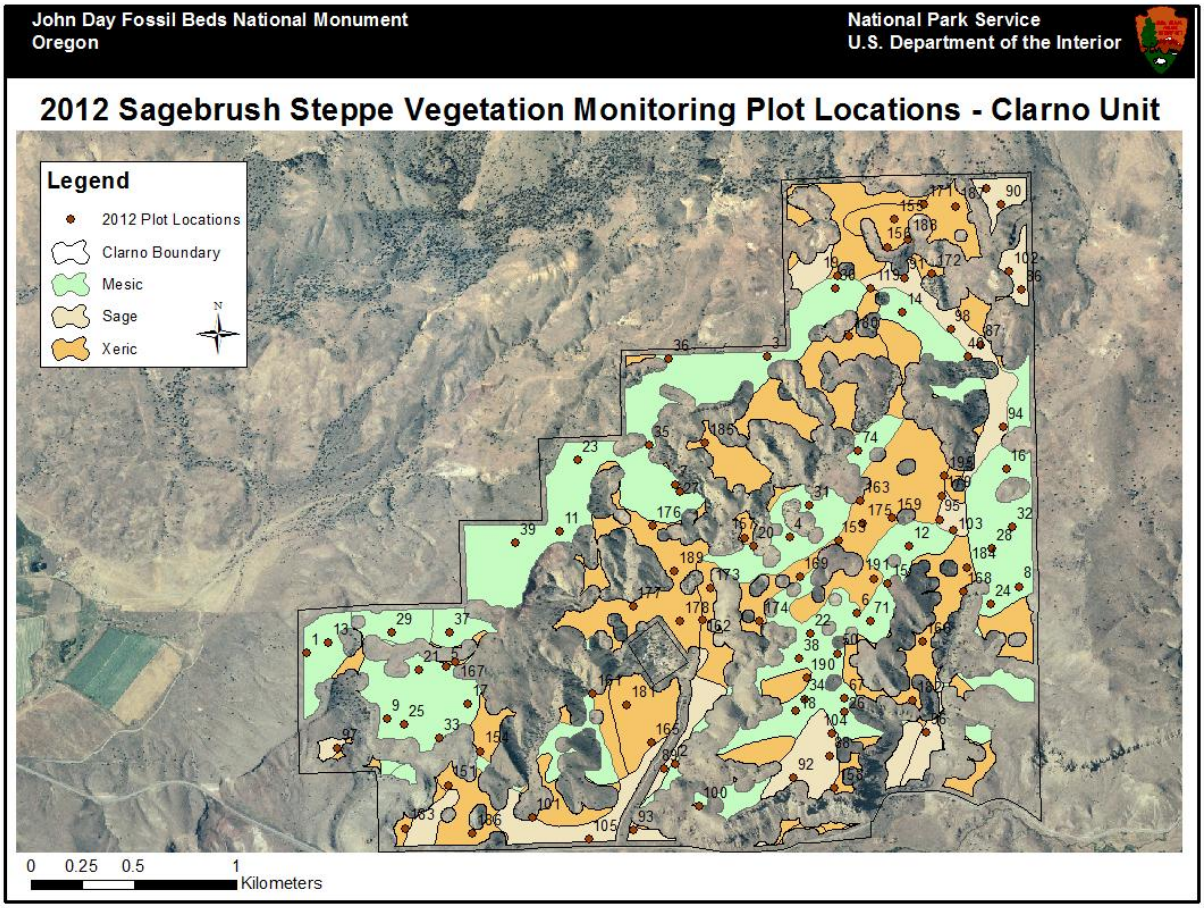

Figure 1. Clarno unit of John Day Fossil Beds National Monument showing the stratified sampling frame and the 2012 plot locations.

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 categorized as: mesic habitat, xeric habitat, and sage habitat (Figure 1). 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. Bluebunch wheatgrass (*Pseudoeregneria spicata*), an important foundation species in the Clarno landscape, dominates 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 (*Stipa spp.*) and Indian ricegrass (*Achnatherum hymenoides*) would be expected to be co-dominants in the herb layer. Sage habitat dominated by big sagebrush (*Artemisia tridentata*) 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 stratum were proportional to the area of each category within Clarno (Table 1). The total sample size in 2012 was smaller than 2011 because this was an extra survey effort in response to the 2011 wildfire, and not part of the typical 3-year revisit strategy of the UCBN monitoring program. Our intention was to quickly capture initial post-fire conditions in the unit.

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 (Figure 1, 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, Clarno unit sagebrush steppe monitoring, 2012 (n=102).

Park Unit	Mesic	Sage	Xeric
Clarno	43	21	38

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%. In 2012 only 12% of plots sampled in Clarno met the criteria for "good" range condition, "good" plots were absent in the xeric zone. Monitoring methods used for sagebrush steppe monitoring which occurred in Clarno during 2011 and 2012 differed from the approach used in 2008, however frequency of occurrence within 1-m² plots can be compared among years. Summary statistics, including 95% confidence intervals shown in the figures of Appendix X, were computed using the "local" GRTS variance estimator, which is more efficient, using the R package *spsurvey* (Kincaid and Olsen 2012).

Weather

Weather at Clarno (Fossil weather station) during spring and early summer 2012 was mild, exhibiting average temperature and precipitation as compared to historical means. Though 2012 averages follow historical trends, it should be noted that precipitation in May, 2012 was unusually low with April and June receiving higher than average precipitation. Additionally, Clarno was exposed to a small cell thunderstorm at 18:00 April 24, 2012 (John Laing, personal communication) which caused considerable erosion at the bottom of Hancock Canyon (Figure 2). Graphs of the temperature and precipitation patterns recorded at the Fossil weather station for 2011 and 2012 are presented in Appendix 2.

Figure 2. Debris and exposed bare ground from the late April thunderstorm that produced flash flooding and considerable erosion.

Results and Discussion

We sampled the Clarno unit May 19th, 20th, 23rd and June 1st, 2012. Spring weather for Clarno in 2012 was close to the long-term averages for precipitation and temperatures but with a higher degree of monthly fluctuation (Appendix 2). Only 2 plots landed in areas that escaped the 2011 wildfire. Exposed soil cover generally was ≤ 25% although within sage habitat there were a considerable number of plots with exposed soil greater than that (Appendix 4). At the bottom of Hancock Canyon and in some other draws flood damage from April was evident and exposed bare ground considerable (Figure 2). Big sagebrush was absent from all three strata. Shrub cover was generally sparse across the study with broom snakeweed present in only 5 plots in the sage and xeric strata, green rabbitbrush present in only 1 plot in the mesic area, and rubber rabbitbrush present in only 1 plot in the xeric stratum. Bluebunch wheatgrass, needlegrass, and Sandberg's bluegrass were the most abundant native perennial grasses. Bluebunch wheatgrass was most abundant in mesic habitat (Appendix 4 and 5). Bluebunch wheatgrass frequencies in 2012 ranged from 34-53%. Stands of abundant bluebunch wheatgrass typically remain on north-facing slopes (Figure 3). There were fewer plots with high cover of bluebunch wheatgrass in 2012 following the 2011 fire (Table 2 and Appendix 5), although anecdotally, we observed relatively low numbers of dead bunchgrass plants in 2012 and most stands of north-facing bunchgrass appeared to be recovering well in 2012 (Figure 3). Idaho fescue was rarely encountered. Although there was a variety of forbs (with mesic habitat being the most species rich and sage habitat the least), forb cover in general was low. Mesic area forbs consisted of yarrow, desert parsley, vetch, and buckwheat. In the sage zone, vetch, buckwheat, Blue Mountain prairie clover, and native thistles (*Cirsium spp.*) were the most abundant forbs. Vetch, yarrow, and Blue Mountain prairie clover were the prominent forbs in the xeric plots.

Table 2. Summary statistics for estimated bluebunch wheatgrass abundance in Clarno, 2011-2012.

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

Figure 3. North-facing slope near plots 26 and 67 (see Figure 1) on the ridge between Hancock and Indian Canyons, exhibiting strong recovery of bluebunch wheatgrass along the upper portion of the slope following the 2011 wildfire. Note the small, unburned patch of bluebunch wheatgrass on the upper-right portion of the slope. A wave of invading medusahead is visible in the foreground, presenting a clear threat to the long-term persistence of healthy stands of native bunchgrass in the Monument.

Noxious weeds, particularly filaree (*Erodium cicutarium*), were encountered in a large number of plots. Annual grasses contributed cover to most plots, and were the dominant cover across the unit (Appendix 4). Cheatgrass frequency of occurrence within plots ranged from 90-97%, similar to 2011. However, the abundance of cheatgrass was lower in 2012, rarely >50% cover (Table 3 and Appendix 4 and 5). This is a likely result of the dry winter and early spring weather (Appendix 2). Medusahead, although typically contributing less cover than cheatgrass in most plots, had high cover values in some plots particularly in the xeric areas (Appendix 4 and 5). 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). Bulbous bluegrass was most abundant in the sage and xeric habitats although the least abundant of the annual grasses recorded in 2012. Japanese brome, another annual grass found at Clarno, was not recorded in 2011 but added to the principal species list in 2012. In 2012, Japanese brome was recorded with a frequency of occurrence ranging from 27-33%. It is apparent that this species is also an important non-native and potentially invasive component of the community.

Table 3. Summary statistics for estimated cheatgrass infestation in Clarno, 2011-2012.

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

Table 4. Summary statistics for estimated medusahead infestation in Clarno, 2011-2012.

Clarno Medusahead Infestation	2012	2011
Total acreage sampled	988.49	988.49
Total acreage sampled with no medusahead	579.00	633.09
Proportion of sampled area with no medusahead	0.59	0.64
Total sampled acreage with at least some medusahead (>0% cover)	409.49	355.40
Proportion of sampled acreage with at least some medusahead	0.41	0.36
Total sampled acreage heavily infested by medusahead (>25% cover)	208.60	115.06
Proportion of sampled acreage heavily infested by medusahead	0.21	0.12

Twelve plots at Clarno were identified as in good condition (e.g. Figure 3). These plots were scattered widely across the unit but most were located on upper benches and higher north-facing slope positions. Eight percent of these good condition plots were in mesic habitat, 4% in sage habitat, and none in xeric habitat. For most of these plots, bluebunch wheatgrass and Sandberg's bluegrass contributed significantly to herbaceous cover.

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. Wildfire at Clarno has played an extensive role in shaping the composition of vegetation in sagebrush steppe in this unit. Two wildfires burned the entire Clarno unit in 1994 and 1995. The entire Clarno unit burned again in August 2011. 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 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 fire 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).

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

Table A-1. Plant common and scientific names.

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

Table A-1. Plant common and scientific names (continued).

Common name	Species name
Persistent Native Forbs	
Yarrow	Achillea millefolium
Pussytoes	Antennaria spp
	Aster scopulorum
Milk-vetch	Astragalus spp
Arrowleaf balsamroot	Balsamorhiza sagittata
Indian paintbrush	Castilleja spp
Native thistle	Cirsium spp
Tapertip hawksbeard	Crepis acuminata
Blue Mountain prairie clover	Dalea ornata
Daisy	Erigeron spp
Buckwheat	Eriogonum spp
Western stoneseed	Lithospermum ruderale
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
Other Native Forbs	
Agoseris	Agoseris spp
Onion	Allium spp
Rockcress	Arabis spp
Douglas' brodiaea	Brodiaea douglasii
Mariposa lily	Calochortus spp
Cryptantha	Cryptantha spp
Larkspur	Delphinium spp
Bitterroot	Lewisia rediviva
Woodland-star	Lithophragma spp
Stonecrop	Sedum lanceolatum

Table A-1. Plant common and scientific names (continued).

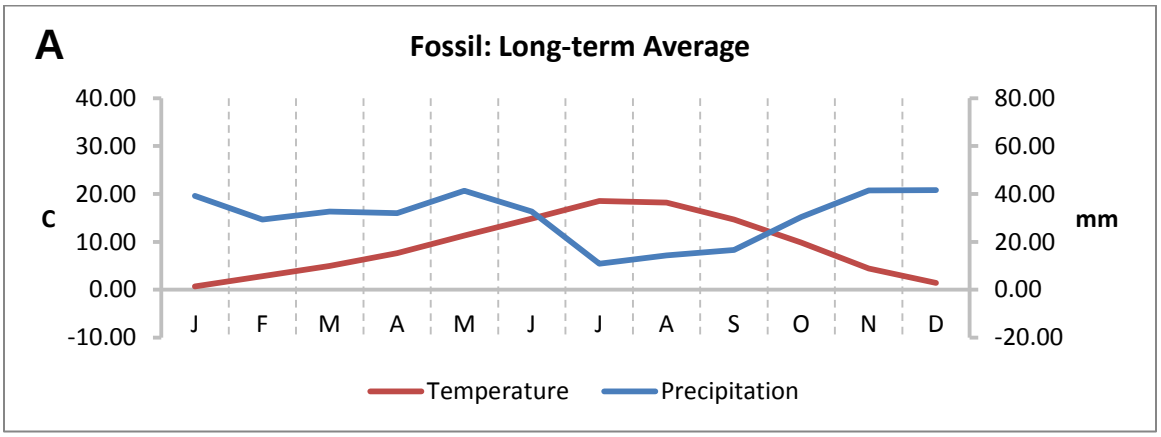
Common name	Species name
Invasive Grasses	
Crested wheatgrass	Agropyron cristatum
Cheatgrass	Bromus tectorum
Medusahead	Taeniatherum caput-medusae
Bulbous bluegrass	Poa bulbosa
Kentucky bluegrass	Poa pratensis
Invasive Forbs	
Russian knapweed	Acroptilon repens
Whitetop	Cardaria draba
Diffuse knapweed	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

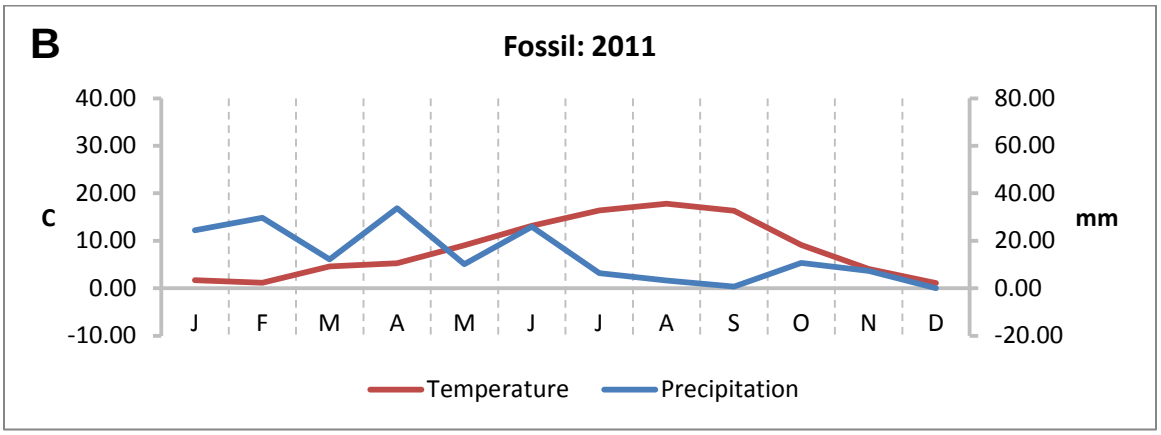
Table A-2. Some species in this report have been reported with updated taxonomic names. These names deviate from those in previous reports, the table below documents the changes which have occurred within this report

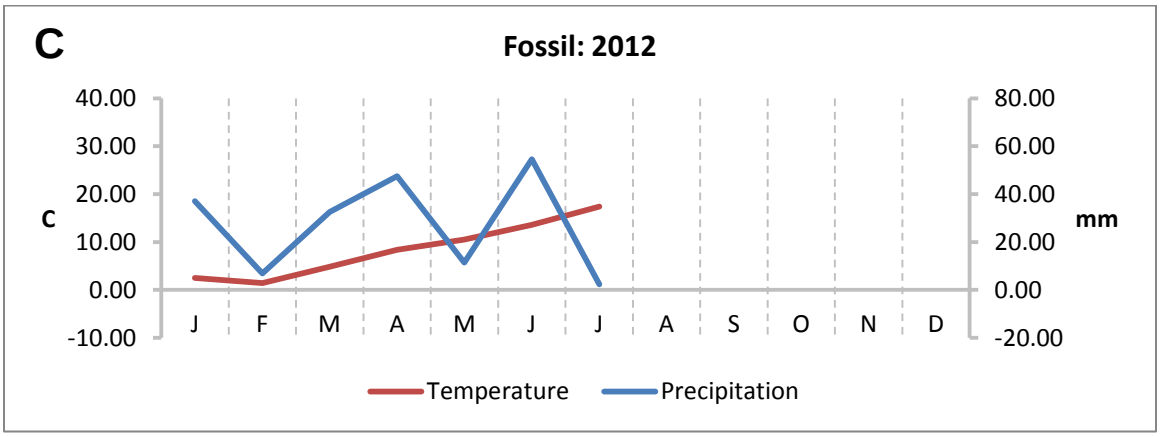
Common name	Current species name	Synonyms
Indian ricegrass	*Achnatherum hymenoides*	*Oryzopsis hymenoides*
Medusahead	*Taeniatherum caput-medusae*	*Elymus caput-medusae*
Squirreltail	*Elymus elymoides*	*Sitanion hystrix*

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

Figures A-1. These figures compare the long-term (88 yrs; panel A) average monthly temperatures (red line) and monthly average precipitation (blue line) to temperatures and precipitation in 2011 (panel B) and 2012 (panel C). The period when the temperature line exceeds the precipitation line defines the arid period for plant growth. Data from the Fossil Co-op weather station (#353038, Western Regional Climate Center, http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?or3038).







Appendix 3: 2011, percentage of plots within each cover class for exposed bare ground and principal plant species organized by guild.

Table A-3. 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 A-7. 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 A-8. 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.

Appendix 4: 2012, percentage of plots within each cover class for exposed bare ground and principal plant species organized by guild.

Table A-9. Clarno Unit, Mesic Habitat, 2012: percentage of plots (n=43 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	0	33	42	21	5	0	0
Sagebrush							
Artemisia tridentata	100	0	0	0	0	0	0
Other shrubs							
Chrysothanmus viscidiflorus	98	2	0	0	0	0	0
Native Perennial Grasses							
Festuca idahoensis	98	0	0	2	0	0	0
Poa secunda	28	51	19	2	0	0	0
Pseudoroegneria spicata	47	7	30	16	0	0	0
Sporobolus cryptandrus	95	5	0	0	0	0	0
Stipa spp	81	9	9	0	0	0	0
Persistent Native Forbs							
Achillea millefolium	79	19	2	0	0	0	0
Astragalus spp	84	9	7	0	0	0	0
Crepis acuminata	98	2	0	0	0	0	0
Dalea ornata	98	0	2	0	0	0	0
Eriogonum spp	86	14	0	0	0	0	0
Lomatium spp	84	14	2	0	0	0	0
Phacelia spp	98	2	0	0	0	0	0
Phlox spp	95	2	2	0	0	0	0
Other Native Forbs							
Agoseris spp	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
Invasive Grasses							
Bromus japonicus	77	21	2	0	0	0	0
Bromus tectorum	9	51	19	16	2	2	0
Elymus caput-medusae	56	28	5	7	2	2	0
Poa bulbosa	98	2	0	0	0	0	0
Invasive Forbs							
Descurainia spp.	88	12	0	0	0	0	0
Erodium cicutarium	70	14	16	0	0	0	0

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

Table A-10. Clarno Unit, Sage Habitat, 2012: percentage of plots (n=21 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	0	24	33	19	24	0	0
Sagebrush							
Artemisia tridentata	100	0	0	0	0	0	0
Other Shrubs							
Ericameria nauseosus	95	5	0	0	0	0	0
Gutierrezia sarothrae	95	0	0	5	0	0	0
Native Perennial Grasses							
Festuca idahoensis	95	5	0	0	0	0	0
Poa secunda	24	38	29	5	5	0	0
Pseudoroegneria spicata	57	10	24	10	0	0	0
Sporobolus cryptandrus	90	10	0	0	0	0	0
Stipa spp	62	19	19	0	0	0	0
Persistent Native Forbs							
Achillea millefolium	95	5	0	0	0	0	0
Astragalus spp	81	10	10	0	0	0	0
Cirsium spp	90	10	0	0	0	0	0
Dalea ornata	90	0	10	0	0	0	0
Erigeron spp	95	5	0	0	0	0	0
Eriogonum spp	86	14	0	0	0	0	0
Other Native Forbs							
Calochortus spp	95	5	0	0	0	0	0
Cryptantha spp	90	10	0	0	0	0	0
Invasive Grasses							
Bromus japonicus	67	33	0	0	0	0	0
Bromus tectorum	10	48	24	19	0	0	0
Elymus caput-medusae	62	14	10	14	0	0	0
Poa bulbosa	95	5	0	0	0	0	0
Invasive Forbs							
Erodium cicutarium	62	19	14	0	5	0	0

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

Table A-11. Clarno Unit, Xeric Habitat, 2012: percentage of plots (n=38 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.

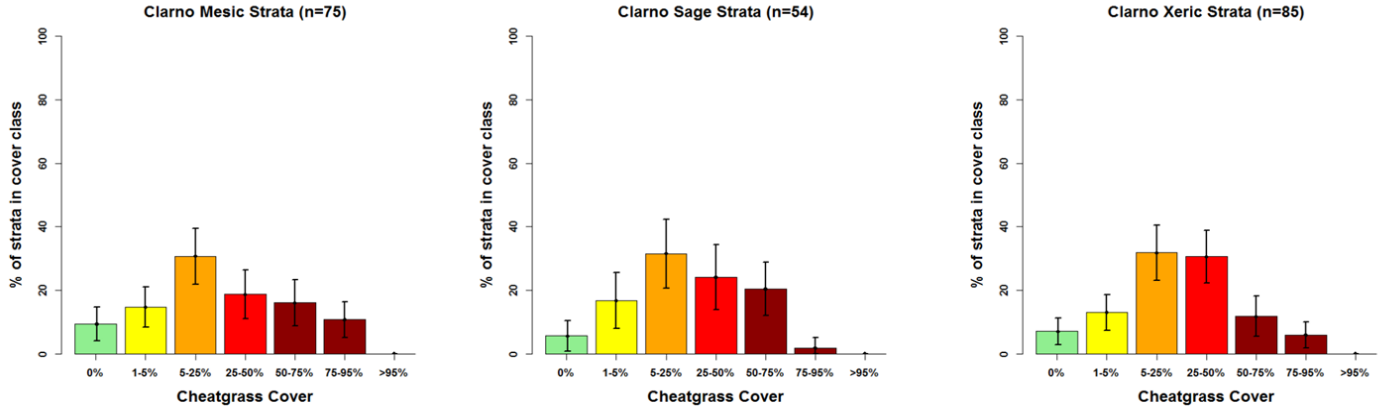
	0	1-5%	>5-25%	>25-50%	>50-75%	>75-95%	>95-100%
Bare ground	5	29	32	18	16	0	0
Sagebrush							
Artemisia tridentata	100	0	0	0	0	0	0
Other Shrubs							
Gutierrezia sarothrae	89	11	0	0	0	0	0
Native Perennial Grasses							
Poa secunda	68	29	3	0	0	0	0
Poa spp	97	3	0	0	0	0	0
Pseudoroegneria spicata	66	13	18	3	0	0	0
Sporobolus cryptandrus	92	8	0	0	0	0	0
Stipa spp	55	34	11	0	0	0	0
Persistent Native Forbs							
Achillea millefolium	87	11	3	0	0	0	0
Astragalus spp	66	13	21	0	0	0	0
Cirsium spp	95	5	0	0	0	0	0
Dalea ornata	89	5	5	0	0	0	0
Eriogonum spp	95	5	0	0	0	0	0
Lomatium spp	92	8	0	0	0	0	0
Phlox spp	97	0	3	0	0	0	0
Other Native Forbs							
Allium spp	97	0	3	0	0	0	0
Cryptantha spp	95	5	0	0	0	0	0
Invasive Grasses							
Bromus japonicus	71	26	3	0	0	0	0
Bromus tectorum	3	42	32	21	0	0	3
Elymus caput-medusae	61	13	11	5	8	3	0
Poa bulbosa	95	3	3	0	0	0	0
Invasive Forbs							
Erodium cicutarium	50	24	26	0	0	0	0
Sisymbrium altissimum	97	0	3	0	0	0	0

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

Appendix 5: 2011 and 2012 graphical comparisons showing percentage of plots within each cover class for cheatgrass, medusahead, and bluebunch wheatgrass.

Figure A-2. Estimated strata area (from proportion of plots) and 95% confidence intervals (estimated with the local "grts" efficient variance estimator; Stevens and Olsen [2004]) in each cover class for cheatgrass in (top) 2011 and (bottom) 2012. .

2011



2012

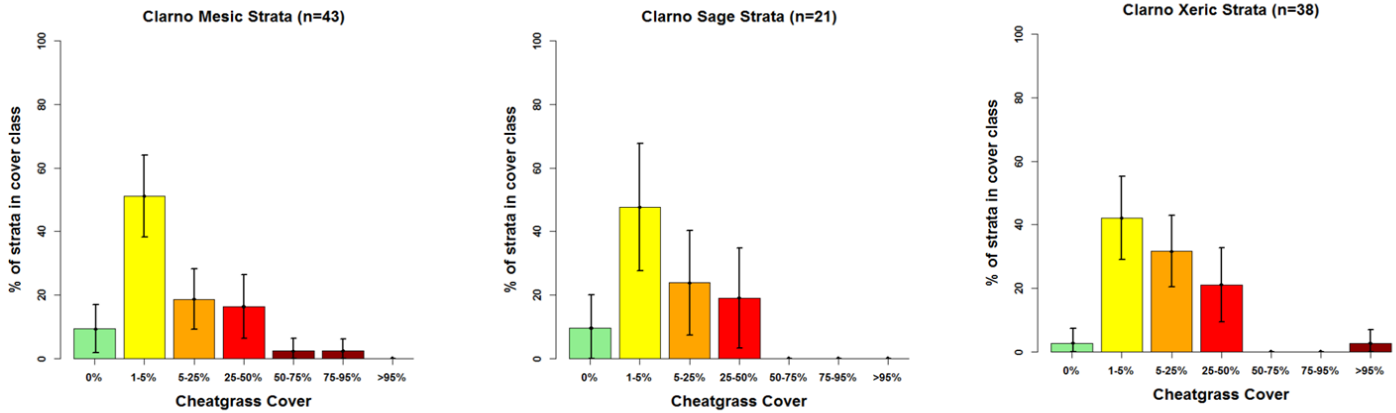


Figure A-3. Estimated strata area (from proportion of plots) and 95% confidence intervals (estimated with the local "grts" efficient variance estimator; Stevens and Olsen [2004]) in each cover class for medusahead in (top) 2011 and (bottom) 2012.

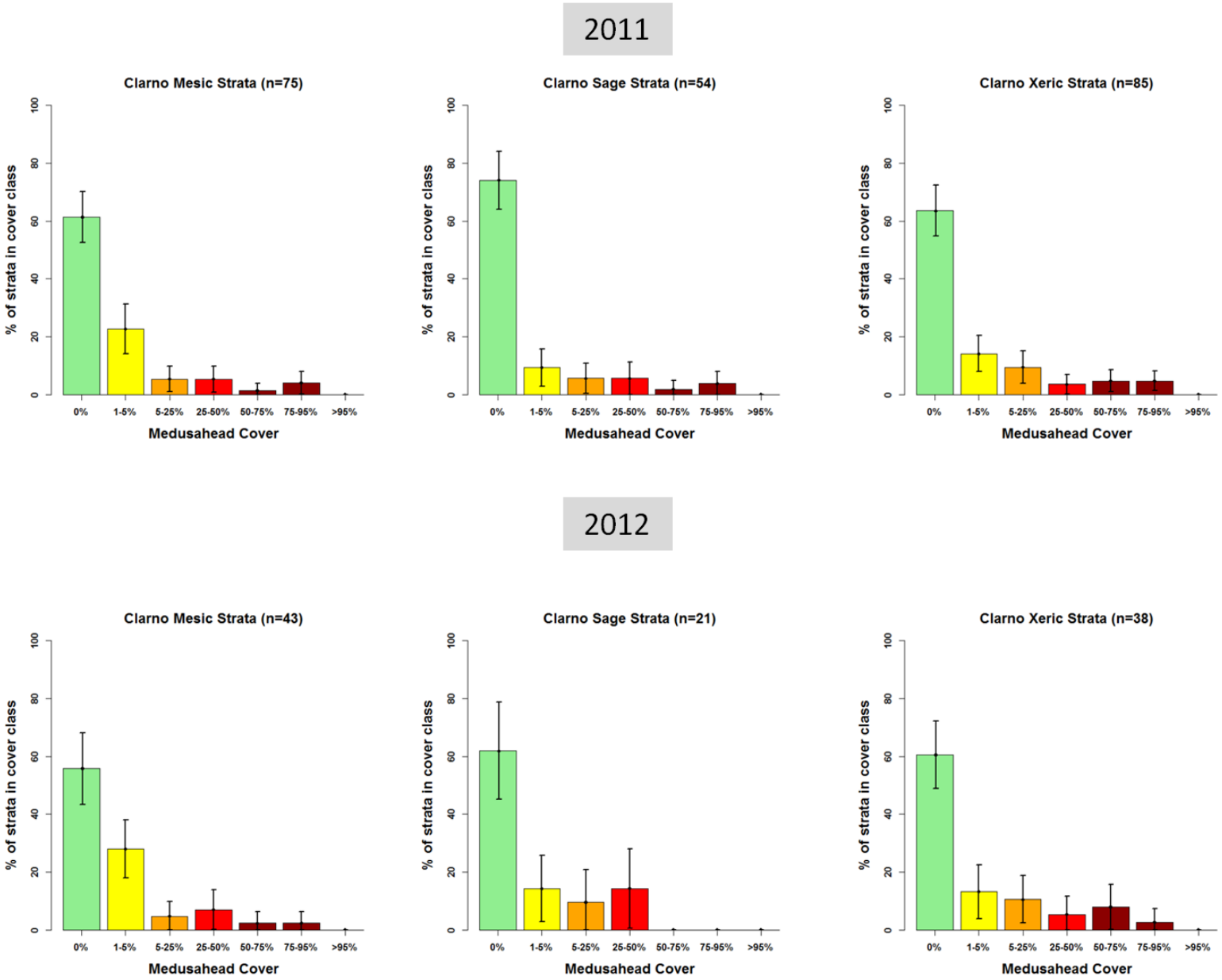
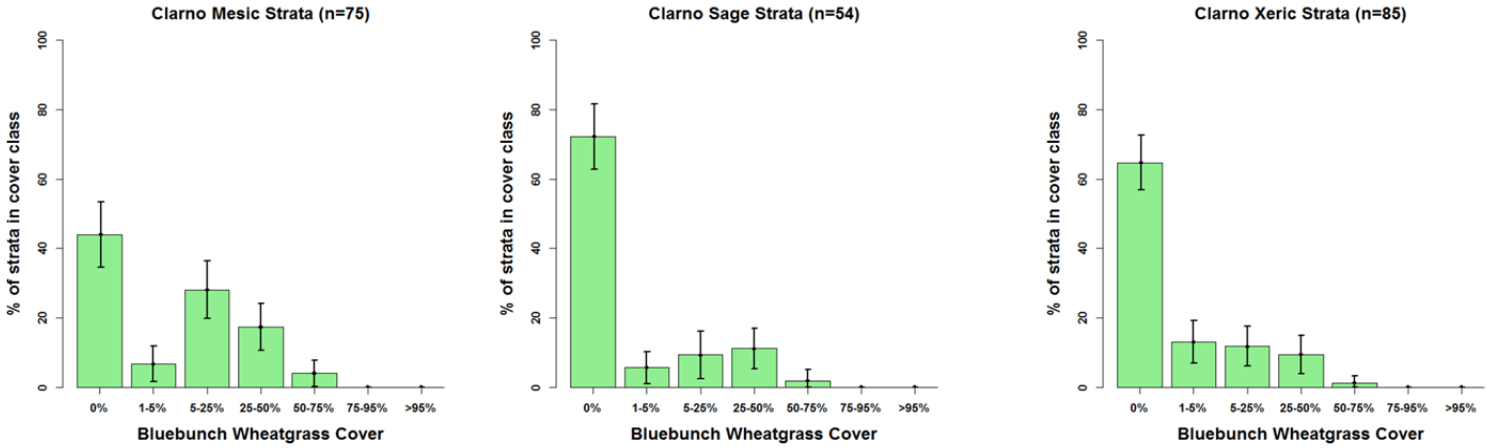


Figure A-4. Estimated strata area (from proportion of plots) and 95% confidence intervals (estimated with the local "grts" efficient variance estimator; Stevens and Olsen [2004]) in each cover class for bluebunch wheatgrass in (top) 2011 and (bottom) 2012.

2011



2012