David Little Livestock
Range Management Endowment
AT THE UNIVERSITY OF IDAHO

2015 Project Progress Report:

Revealing the distribution and indicators of Ventenata dubia invasion in sagebrush steppe rangelands

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OBJECTIVES

To help inform future weed management efforts on Idaho rangelands, we performed a series of ventenata-specific field surveys across sagebrush steppe ecosystems in Idaho and Oregon (see Figure 1). Specifically, our work was motivated by the following questions: 1) at the regional scale, how widely does ventenata occur and how does this vary across environmental gradients?; 2) in sites where ventenata can be found, how is it distributed throughout the landscape?; and, 3) at the plot level, are there abiotic or biotic indicators that are either positively or negatively associated with ventenata abundance? Answering these questions will help guide our efforts to assess where ventenata may become a serious problem as it undergoes range expansion.

METHODS

Field surveys were performed between June 2nd and June 16th, 2015 in an attempt to coincide with flowering and seed set stages of ventenata. At these stages identifying characteristics are present and seeds are still attached to the plant, which allowed for us to make collections for future use. Across the region, an attempt was made to stratify sampling according to elevation as well as to slope and aspect. Once an infestation of ventenata was confirmed, a site center was chosen based on access, landscape conditions, and the specific location of ventenata individuals. A site was be defined as a circle of 100 meters surrounding the site center and was classified according to types and abundance of important functional groups and abundant woody species, as well as any significant disturbance regimes (grazing, recreation, energy development, burning, burrowing mammals, etc.).

Within each site, three points were chosen to maximize the diversity of plant communities and abiotic conditions per site, and GPS coordinates, aspect, and slope were recorded. From each point, a 20 m transect was established in a random orientation with 0.25 m by 1 m quadrats placed at 5 m intervals (0, 5, 10, 15, 20 m). Soil depth was recorded on opposite sides of the 0 m quadrat and in each quadrat, % cover of all vascular plant species, biotic crust, and abiotic variables (bare ground, rock, litter) was assessed according to established cover classes (0-5%, 5-12.5%, 12.5-25%, 25-50%, 50-75%, 75-95%, 95-100%). For subsequent statistical analysis, the median percent from each cover class was used to represent estimates of cover.

RESULTS

Over the course of the field surveys, ventenata was found throughout the study region and plot-level information was collected at 15 sites (Figure 1) ranging in elevation from 916 meters to 1662 meters and encompassing a variety of different plant community types associated with sagebrush steppe (Table 1). Though widely distributed throughout the study region, ventenata only appeared in 55% of all the plots across all sites, despite the positively biased nature of the methodology. In addition, ventenata only existed at greater than 50% cover in two of the 225 plots across all sites. We think the low % cover of ventenata and its presence in only about half the plots suggests an early phase of invasion into sage steppe.

Across all sites and all transects, ventenata-free plots exhibited significantly lower species richness than plots with low levels of ventenata cover (<12.5%), but were not significantly different from those plots with higher levels of ventenata cover (>12.5%; Figure 2a). This same trend occurred for diversity indices scores, which take into account not only the number of species but their relative abundance within plots (Figure 2b). Berger-Parker dominance scores, which measure the extent to which the abundance of species within a plot is evenly distributed, showed that plots without ventenata had significantly higher dominance than plots with low levels of ventenata cover (<12.5%), but neither group was significantly different from those plots with higher levels of ventenata cover (>12.5%; Figure 2c). Some disturbance at a site may increase the diversity of plant species and so higher species richness may suggest a mix of early and late seral stage native species with disturbance. As disturbance increases and ventenata increases, the species richness may then be declining.

Rank abundance models show that invasive annual grass species such as cheatgrass (*Bromus tectorum*), medusahead wildrye (*Taeniatherum caput-medusae*), Japanese brome (*Bromus japonicas*), and bulbous bluegrass (*Poa bulbosa*), as well as biological soil crust, were consistently the most abundant across all plots, but their relative abundance rankings changed depending on the level of ventenata (see Figure 3). Chi-squared indicator analysis revealed a number of different species whose presence was either positively or negatively associated with different levels of ventenata cover (see Figure 4). Notably, species such as medusahead wildrye (TACA8), needleleaf pincushion (*Navarretia intertexta*; NAIN2), and tall willowherb (*Epilobium brachycarpum*; EPBR3) were heavily overrepresented in plots containing ventenata and underrepresented in those that did not contain ventenata. Conversely, species such as big sagebrush (*Artemisia tridentata*, ARTR2), three-tip sagebrush (*Artemisia tripartita*; ARTR4), antelope bitterbrush (*Pursia tridentate*; PUTR2), rock buckwheat (*Eriogonum sphearocephalum*; ERSP7) and cheatgrass (BRTE) were all heavily underrepresented in plots containing ventenata and overrepresented in those that did not contain ventenata. So in sage steppe we suggest that our initial search for ventenata should begin where medusahead wildrye is.

Non-metric multidimensional scaling (NMDS) species analysis revealed that ventenata, medusahead wildrye, and biological soil crust were closely associated (see Figure 5). In addition, much of the variation in abundance of these three groups was explained by variation in rock, soil depth, and a north/south gradient. By contrast, bulbous bluegrass abundance was largely influenced by rock, Japanese brome by an east/west gradient, and cheatgrass by a combination of slope, soil depth, and a north/south gradient. In addition, NMDS analysis of plot-level community data revealed that each of the different categories of ventenata abundance (0%, <12.5%, and >12.5%) were all widely distributed in community space and overlapped extensively (see Figure 6).

CONCLUSIONS

Overall, the results of our field surveys suggest that ventenata is widely distributed across elevational gradients associated with sagebrush steppe ecosystems within the Inland Pacific Northwest (PNW) and does not exhibit a significant affinity for specific types of plant communities at the plot level. However, even within these areas where it can be found, it is often quite rare and patchily distributed. Ventenata does not yet appear to be significantly influencing plant community composition by displacing or marginalizing co-occurring species.

Interestingly, our plot-level analyses reveal a strong positive association between ventenata and medusahead and a strong negative relationship with cheatgrass. Cheatgrass seemed to be most abundant in the driest ecotones. Ventenata, however, was nowhere to be found in lower, drier communities and was almost exclusively located in seasonal streambeds within these relatively intact steppe communities at intermediate elevations.

These results suggest that ventenata is still in the early stages of invasion in sagebrush steppe ecosystems but our observations, coupled with this information regarding its distribution in other areas, also suggest that it has the potential to be an influential and largely ubiquitous presence over the long term. In the short term, however, ventenata appears to be most competitive in systems and microhabitats which receive high levels of spring moisture, either through snowpack or seasonal streams, or which are disturbed and have been invaded previously by annual grasses. As such, ventenata management efforts should 1) seek to use medusahead wildrye as an indicator species, such that initial monitoring efforts are focused around areas where medusahead wildrye has previously established or has the potential to be a problem, and (2) focus control and restoration efforts on cooler and wetter habitats, as these may act as source populations where ventenata is most competitive.

FIGURES AND TABLES

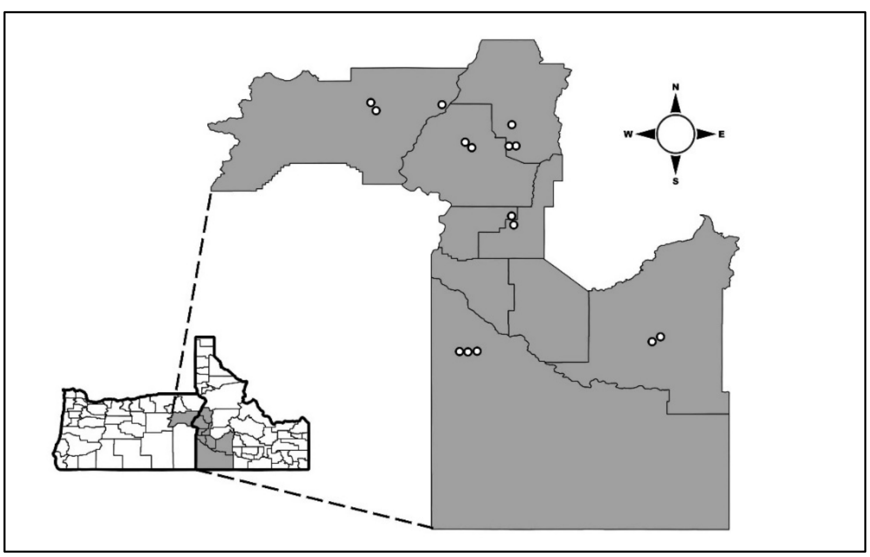

Figure 1. Location of sagebrush steppe survey sites in eastern Oregon and southwestern Idaho. When possible, sites were paired to better control for the effects of ventenata regional dispersal and distribution on plot-level results and to maximize plant community variation within specific ecoregions.

Table 1. List of surveyed sites in sagebrush steppe ecosystems in Oregon and Idaho, including location information, elevation, and plant community type. Community types were defined according to important functional groups and non-herbaceous species and listed from most prevalent to least prevalent within each 100 meter diameter site.

Site	***County, State***	***Coordinates (Lat., Long.)***		***Elevation (m)***	***Community Type***
Bacher Creek	Baker, OR	44.83611	-117.423828	952	Big Sagebrush
Big Flat	Gem, ID	44.04752	-116.483485	999	Annual grassland - Big Sagebrush – Bitterbrush
Chipmunk Road	Owyhee, ID	43.18427	-116.821315	1662	Fescue - Low Sagebrush
Four Mile Road	Payette, ID	44.08847	-116.492265	929	Annual Grassland - Big Sagebrush – Bitterbrush
Gravel Pit	Adams, ID	44.55905	-116.480171	916	Rigid Sagebrush – Big Sagebrush
Highway 20	Elmore, ID	43.25524	-115.542063	1514	Annual Grassland - Low Sagebrush
Ida Belle	Owyhee, ID	43.18533	-116.782931	1483	Big Sagebrush – Bitterbrush - Juniper
Jackson Creek	Adams, ID	44.69916	-116.488506	927	Rigid Sagebrush – Big Sagebrush
Pine Town Road	Baker, OR	44.83442	-116.95562	970	Annual Grassland – Rigid Sagebrush
Prairie Road	Elmore, ID	43.26972	-115.513693	1489	Big Sagebrush – Bitterbrush – Rock Buckwheat
Reeds Grove	Washington, ID	44.57696	-116.79182	1032	Bitterbrush – Big Sagebrush – Rock Buckwheat
Reeds Grove Lower	Washington, ID	44.57157	-116.784993	962	Bitterbrush – Big Sagebrush – Rock Buckwheat
Schwenkfelder	Adams, ID	44.55766	-116.491063	916	Big Sagebrush – Rigid Sagebrush – Annual Grassland
Sparta	Baker, OR	44.84002	-117.425972	952	Big Sagebrush
Whiskey Hill	Owyhee, ID	43.18545	-116.77839	1318	Big Sagebrush – Bitterbrush - Juniper

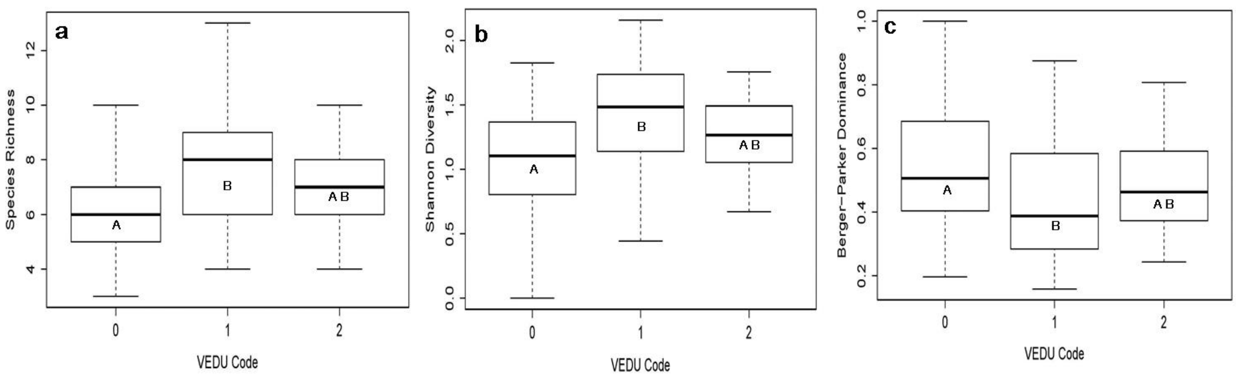

Figure 2. Box plots of average (a) species richness, (b) Shannon diversity, and (c) Berger-Parker Dominance indices for survey plots with no ventenata (0), less than 12.5% ventenata cover (1), and over 12.5% ventenata cover (2). Groups with the same letter are not significantly different (Kruskal-Nemenyi post-hoc P<0.05).

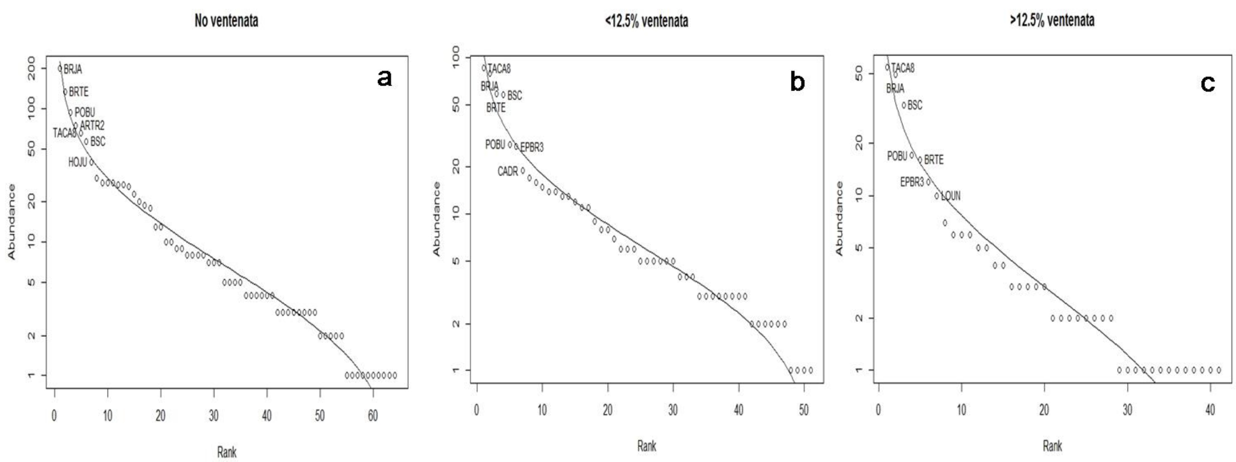

Figure 3. Rank abundance models of plots (a) with no ventenata, (b) with <12.5% ventenata cover, and (c) >12.5% ventenata cover across all sites. The solid line represents the best fit lognormal model for each dataset and the seven most abundant species or functional groups have been labeled to better reveal differences in community structure.

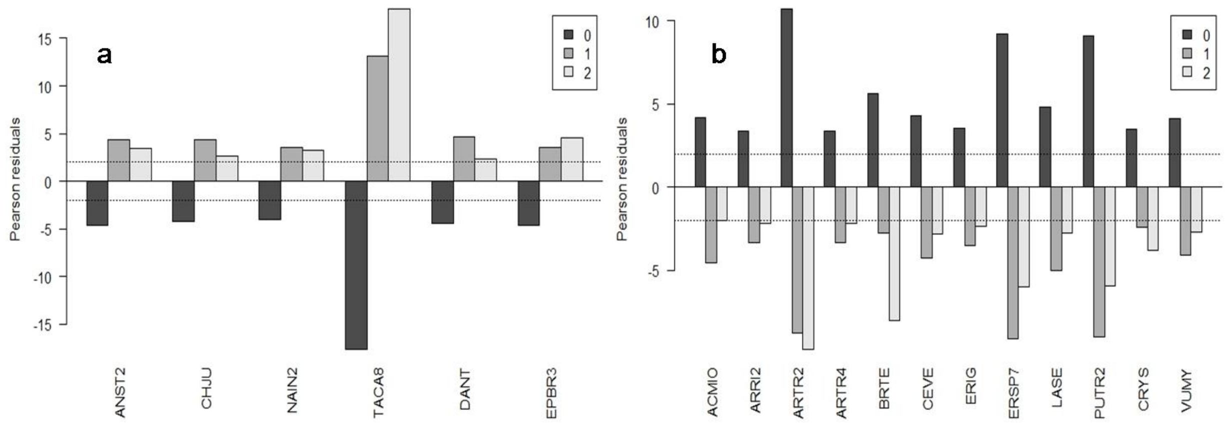

Figure 4. Indicator species in relation to ventenata cover across all survey plots. (a) Positive indicator species are defined as those with significantly negative Pearson residuals (< -2) in plots without ventenata (0), and significantly positive Pearson residuals (>2) for plots with <12.5% ventenata cover (1) and >12.5% ventenata cover (2). (b) Conversely, negative indicator species are defined as those with significantly positive Pearson residuals (>2) in plots without ventenata (0), and significantly negative Pearson residuals (<-2) for plots with <12.5% ventenata cover (1) and >12.5% ventenata cover (2).

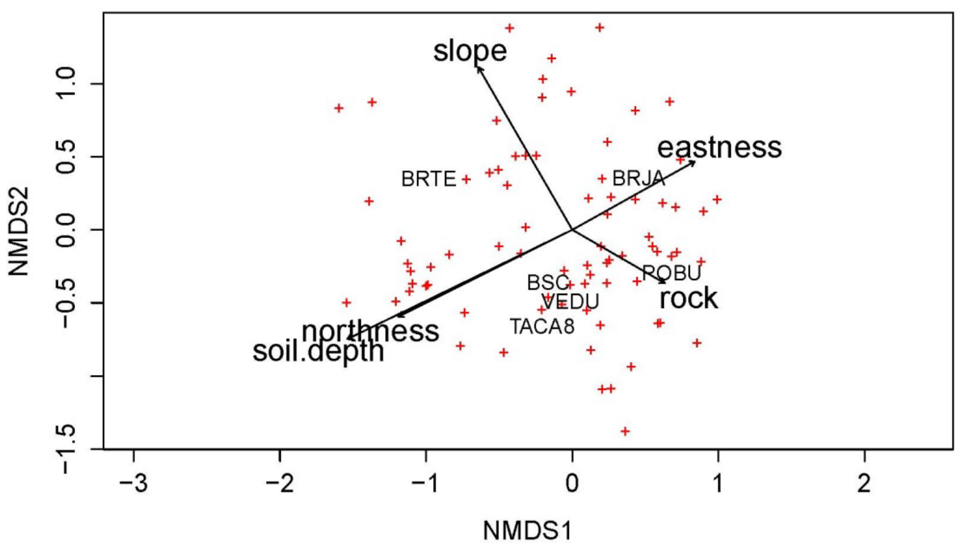

Figure 5. Non-metric multidimensional scaling (NMDS) of species scores in relation to collected environmental variables across all surveyed plots. Only important invasive annual grasses and noteworthy functional groups have been identified by labels (BRTE = *Bromus tectorum*, BRJA = *Bromus japonicas*, POBU = *Poa bulbosa*, TACA8 = *Teaniatherum caput-medusae*, VEDU = *Ventenata dubia*, BSC = Biological Soil Crust. Only significant environmental predictors were included in the plot (P<0.05).

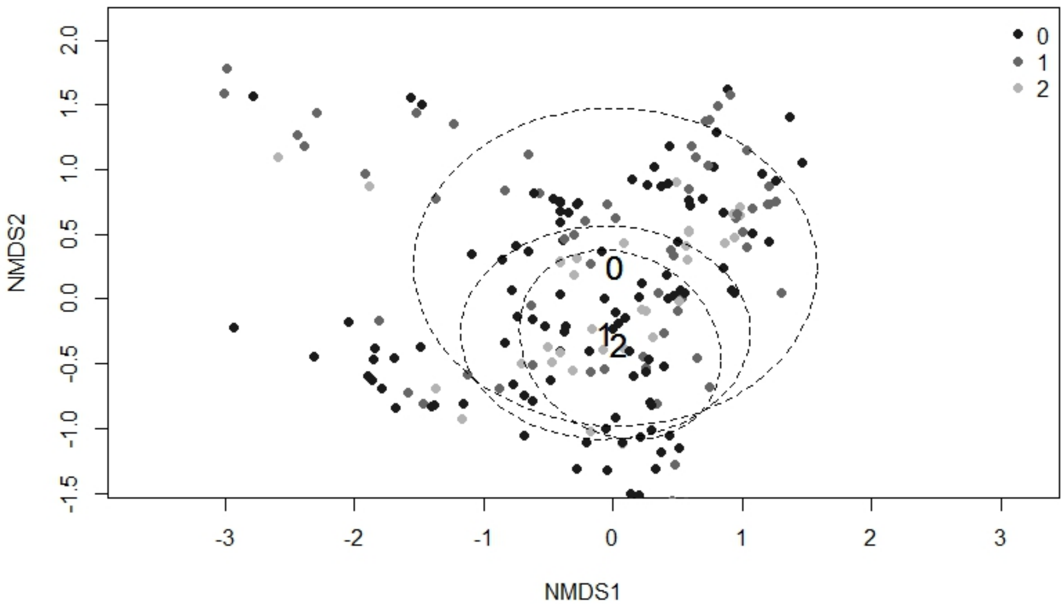

Figure 6. Non-metric multidimensional scaling (NMDS) of plant communities from plots with no ventenata (0), <12.5% ventenata cover (1), and >12.5% ventenata cover (2). Dotted lines represent standard deviations of the weighted average of different ventenata categories at the 95% confidence level.