Katama Plains Conservation Area
Analysis of 1999-2014 Species Composition and Cover Data

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METHODS AND PURPOSE


The primary purpose of this analysis was to assess how total sandplain diversity, guild cover, shrub cover, and rare species have changed over the monitoring period and with respect to burn treatments.

Guild classifications for all species were as defined in the original data files. All averaged cover values were the average over all plots in a management unit, whether or not the species was present. Diversity was calculated using the Shannon-Weiner Diversity Index. Changes in total cover, species richness and diversity over time were evaluated with linear models of richness or diversity versus year and management unit. The significance threshold used was \( p = 0.05 \). All analyses were performed in R (version 3.1.2).

RESULTS

Diversity

Diversity of the sandplain flora did not change clearly in response to fire over the study period. Total species richness of the two management units ranged from 28 to 44 species over the time considered, and was similar between the two units (Figure 2). Overall species richness in MU F appears to be declining slightly over time, but this change is not statistically significant.

Species richness per plot ranged from 3 to 19 species, with an average of 10 species (Figure 3). On average, plots in MU F contained one more species than plots in MU G \( (p < 0.00001) \). Average plot species richness declined slightly over time \(-0.1\) species per year, \( p = 0.001 \). Diversity, which considers evenness of cover as well as number of species, was stable in both management units over this time period (Figure 4).

Total Cover

Total cover, or the sum of the cover of all species in each plot, increased significantly over time \( (p < 0.00001) \), and also was significantly higher in MU G than in MU F \( (p = \)
Cover in 2004 was lower than in other years in both management units, possibly indicating a difference in monitoring. However, number of recorded species was not a good predictor of total cover, suggesting that any difference in total cover resulting from monitoring differences would be in the assignment of cover values rather than missing species.

**Graminoid and Herb Cover**

Graminoid and herb cover stayed fairly constant in MU F, while MU G had more variation in graminoid and herb cover from year to year (Figure 6). Herb cover may increase in the year of a burn, as seen in 2005 in MU F and 2006 in MU G. Additional monitoring in burn years and the years directly before and after would be necessary to confirm this pattern. The increased herb cover in burn years did not appear to persist in the following years, although herb cover didn’t drop by much.

**Changes in Species**

In 2004, the four most common species in MU G were *Schizachyrium scoparium* (little bluestem), *Carex pensylvanica* (Pennsylvania sedge), *Vaccinium angustifolium* (lowbush blueberry), and *Gaylussacia baccata* (black huckleberry; Figure 7), and in MU F were *S. scoparium*, *V. angustifolium*, *Baptisia tinctoria* (yellow wild indigo), and *C. pensylvanica* (Figure 8). In 2014, *V. angustifolium* was by far the most common species in both management units, followed by *Rubus hispidus* (swamp dewberry) in MU G and *S. scoparium* in MU F.

Only a few forb and graminoid species changed in cover very much over this ten year period. The forbs *B. tinctoria*, *Ionactis linariifolia* (flax-leaved stiff-aster), and *Euthamia graminifolia* (flat-top goldenrod) increased by 9.5%, 2.6%, and 2.3% cover respectively in MU G (Figure 9), and 4.6%, 11.3%, and 1.5% cover respectively in MU F (Figure 10), and were the only forbs that increased by more than 2% cover in either management unit over this period. In MU F, the graminoids *C. pensylvanica* and *S. scoparium* increased by 5.5% and 3.4% cover respectively (Figure 10), while in MU G, these two species were the only ones to decline by more than 1% cover, with decreases of 3% cover for *C. pensylvanica* and 9.6% cover for *S. scoparium* (Figure 9). In MU F, the only species that declined more than 1% cover were the woody species *Pinus rigida* (pitch pine; 2.1%) and *Gaylussacia baccata* (black huckleberry; 1.4%)(Figure 10).

**Shrub Cover and Species of Concern**

Shrub cover has increased significantly over time in both management units (p < 0.00001; Figure 6). From 2004 to 2008, shrub cover only decreased on average between 2006 and 2007, and then decreased by only 1.6% cover in MU F and 0.2% cover in MU G (Figure 11). Between 2008 and 2014, shrub cover increased in both management units, but at a much slower rate in MU F than in MU G. These changes in cover did not correspond with burn years (2005 in MU F and 2006 in MU G) and were consistent between management units despite differences in burn years, indicating that shrub cover was likely driven by something other than the burn treatments.
The shrub species of highest concern appears to be *Vaccinium angustifolium*. It occurred in more than 2/3 of all plots and increased more in cover from 2004 to 2014 than any other species in both management units, from 9 to 30% cover on average in MU F and from 10 to 36% cover on average in MU G (Figure 12). Two additional common woody species with increasing cover are *Rubus hispidus* and *Rubus flagellaris* (northern dewberry), which, on average increased by 17% cover in MU G and 7% cover in MU F, and 8% cover in MU G and 9% cover in MU F respectively (Figure 12). *R. flagellaris* increased in 2005 and 2006 and has since remained constant, while *R. hispidus* may be continuing to increase. *Morella pensylvanica* (northern bayberry) increased by 9% cover from 2004 to 2014 in MU F, though its cover remained constant from 2008 to 2014 (Figure 12).

**Rare Species**

Most rare species were not recorded consistently enough in these plots to get a good idea of how their cover is changing over time and with management. However, most rare species were found almost exclusively in MU F. *Helianthemum* spp. were present in two plots in MU F: transect 7 plot 1 in 2000 (*H. dumosum*) and 2007 (*H. bicknellii*), and transect 6 plot 2 in 2004 (*H. propinquum*) and 2006 (*H. bicknellii*). Cover was below 1% in all of these instances. *Linum intercursum* was also recorded only in MU F, in transect 10 plot 3 in 2000, and transect 1 plot 1 in 2004. Cover was 0.5% in both years. No species of *Amelanchier*, including *A. nantucketensis*, were recorded in these plots.

*Sisyrinchium arenicola* was recorded in both MU F and MU G in multiple years. In MU F, it was recorded in one plot in 2000, two plots in 2003, five plots in 2004, and three plots in 2005. In MU G, it was recorded in four plots in 2004 and three plots in 2006. Cover in all of these instances was less than 1%, with the exception of one plot in MU G in 2006 with 2% cover. Two plots in MU F contained *S. arenicola* in multiple years: transect 5 plot 3 (2003 and 2005) and transect 6 plot 3 (2003, 2004, and 2005). *S. arenicola* was not recorded after 2006. There appears to be no correlation between burn events and occurrences of *S. arenicola*.

*Viola pedata* was recorded in MU F in all sampled years, and increased in cover over time. The number of plots it was found in was between 4 and 7 in all years, and cover increased from a low of 0.4 in 2005 to 8.4 in 2014 in plots where it occurred.

**CONCLUSIONS**

These monitoring protocols do not capture rare species well, but are useful for determining change in shrub cover over time and for monitoring the changes in diversity. It is difficult to determine exactly what effects the burn regime is having on the vegetation without a similar unburned area for comparison, but it is possible to monitor changes in the vegetation and respond with changes to the management practices if necessary. Shrub cover is increasing under this management plan. Increase in shrub cover may be reduced in the year or two directly following a burn, but increasing the burn regime to every one to two years for a chance of slowing shrub growth does not seem feasible. Regular monitoring in the years immediately before and after burn treatments as well as in the same year as the burn would help to more
clearly show burn effects. Shrub cover is now over 50% in most plots, indicating a need to consider alternative methods of pushing back or slowing woody expansion.

Management unit F is doing slightly better than MU G in several areas. MU F has higher species richness, slower shrub expansion, and more occurrences of rare species than MU G, while MU G has declining graminoid cover (particularly of the formerly abundant *C. pensylvanica* and *S. scoparium*) in addition to greater increase in shrub cover (when comparing 2004 to 2014). It is possible that time since burning can explain the differences in changes in guild and species cover, as the years compared were either one or two years longer post-burn in MU F than in MU G. However, the trends in species richness and shrub expansion, as well as the occurrence of rare species, are not shifted by burn year between the management units, indicating some original underlying difference in the two (e.g. location, soil differences, or differences in initial vegetation), or a difference resulting from management other than burn treatments. This may be a result of topsoil removal in MU F in 1945, or other early management legacies.
Attached Documents

Included with this analysis are an Excel document of all species data from 1999-2014 used here and the R script file used for this analysis and for all figures. The R code is commented to be understandable and updatable such that similar analyses and plots can be created with additional years of data added.
Figure 1: Map of Katama Plains management units. Numbers refer to larger management units used since 2000 (red boundaries) whereas letters are smaller units (yellow boundaries) established in the late 1980's and used to set up vegetation monitoring and until 1999.
Figure 2: Total recorded species richness in 30 plots in management units F and G from 1999 to 2014. Vertical dashed lines show burn years.
Figure 3: Average recorded species richness in 30 1x1m plots in management units F and G from 1999 to 2014. Error bars show standard deviation. Vertical dashed lines show burn years.

Figure 4: Average Shannon-Weiner Diversity Index for 30 plots in management units F and G from 1999 to 2014. Error bars show standard deviation. Vertical dashed lines show burn years.
Figure 5: Average total cover per plot in each management unit and year. Total cover is the sum of the percent covers of all species. Error bars show standard deviation. Vertical dashed lines show burn years.
Figure 6: Average percent cover in 30 1x1m plots of species in each guild. Cover values shown are the sum of cover values for all species in the guild, and so may be more than 100%. Error bars show standard deviation. Vertical dashed lines show burn years.
Figure 7: Average percent cover of each species in management unit G in 2004 and 2014.

Figure 8: Average percent cover of each species in management unit F in 2004 and 2014.
Figure 9: Average change in percent cover of each species in management unit G from 2004 to 2014.

Figure 10: Average change in percent cover of each species in management unit F from 2004 to 2014.
Figure 11: Average change in percent cover of shrub species from the previous measured year in management units F and G. Vertical dashed lines show burn years.
Figure 12: Average percent cover of the four most common shrub species in management units F and G. Error bars show standard deviation. Vertical dashed lines show burn years.