Annual Report 2004: Dynamics of Prairie Plant Populations in the Open Space and Mountain Parks

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SECTION 1, Abstract:

Permanently marked prairie plants in the Open Space were monitored to determine changes in numbers compared to previous years. Species recorded were: *Andropogon gerardii, Artemisia frigida, Asclepias speciosa, A. stenophylla, A. viridiflora, Cirsium undulatum, Dalea purpurea, Escobaria (Coryphantha) missouriensis, Eriogonum (Pterogonum) alatum, Euphorbia brachycera, Evolvulus nutallianus, Liatris punctata, Opuntia macrorhiza, Psoralidium (Psoralea) tenuifolium, Talinum parviflorum,* and *Yucca glauca*. This data is being mapped into ArcView Geographic Information System program for analysis and future use. Flowering and plant size have been recorded in most species. These data provide baseline information on plant survival patterns that indicate whether these populations are healthy and to which future changes can be compared.

Section 2, Methods and Sites

Objectives: Determine changes the populations in 2004, by recording deaths and births (recruitment). Determine rates of growth of plants to size at flowering and estimate normal lifespans.

Plots – The plots were established near the permanent markers of Jane and Carl Bock. Plants have been mapped in 1 x 1 meter grids and the maps digitized in the GIS program ArcView. The plots are: 28 (Shanahan Ridge) 52 (Davidson Mesa), 57 (exclosure near Water Treatment Plant), 61 (Flatirons Vista), 102 (Chataqua Park Meadow). An additional site ("plot 70") was added in 2002 (see Table 1).

Table 1. Plots Studied (map at end)

Bock Plot Number	Plot Location	Finding Plot from Bock Permanent Marker
28	Boulder Greens Venture, Shanahan Ridge	Marker is SW corner of plot
52	Davidson Mesa	Plot is in same pasture as marker but orients to the fence line: it is 3 m N, 3 m W of the second post, running N & W
57	Open Space Maintenance, grazing exclosure	Marker 57 is in the same half of the exclosure as the plot but the plot orients to the fence: about 100 m from the NW corner of the exclosure; 8.4 m E of 20th fence post (counting all types of posts) or 9.8 m. at 300° from the 7th wooden fence post. Plot runs 10 m E and 10 S of that spot.
61	Flatirons Vista Wildlife Transect	Marker is NW corner of plot
70 (Keeler #)	Greenbelt Plateau Trailhead. Not a Bock & Bock number.	Plot is W of trailhead, at NE side of intersection of 93 and 128. This is not a standard demographic plot but a site of extended investigations.
102	Chataqua Park Meadow	Plot begins 3 m N of Bock marker, runs 7 m S, 3 m N (10 m W)

Plants --The species studied (Table 2) are all perennials, ranging from short-lived to very long-lived, from a variety of families. The plants have diverse heights and microhabitat preferences, to better detect change in the OS&MP.

Table 2. Distribution of species studied among plots.
Names from USDA Plants data base (2004).

Plant	Family					
		28	52	57	61	102
Andropogon gerardii Vitman	Poaceae		x	x	x	x
Artemisia frigida Willd.	Asteraceae		x	x	x	
Artemisia ludoviciana Nutt.	Asteraceae	x				x
Asclepias speciosa Torr.,	Apocynaceae		x			

A. stenophylla Gray, *A. viridiflora* Raf.	(Asclepiadaceae)					
Cirsium undulatum (Nutt.) Spreng.	Asteraceae		x	x	x	
Escobaria (Coryphantha) missouriensis (Sweet) Britt. & Rose	Cactaceae	x	x	x	x	
Dalea purpurea Vent.	Fabaceae	x			x	
Eriogonum alatum Torr.	Polygonaceae		x	x	x	
Euphorbia brachycera Engelm. *(E. robusta)*	Euphorbiaceae		x			
Evolvulus nutallianus J. A. Schultes	Convolvulaceae		x	x		
Liatris punctata Hook.	Asteraceae			x	x	x
Opuntia macrorhiza Engelm.	Cactaceae	x	x	x	x	x
Psoralidium (Psoralea) tenuiflorum (Pursh) Rydb.	Fabaceae	x			x	x
Talinum parviflorum Nutt.	Portulacaceae	x		x		
Yucca glauca Nutt.	Agavaceae		x	x		

Plants are mapped. In July 2004 the maps from 2003 were compared to the actual plots and changes in the populations recorded.

Supplemental activities in 2004: I am trying to focus on a couple of species and write them up for publication. *Eriogonum alatum* was going to be first, since it's a short-lived monocarpic perennial. This plan got a setback in 2002 when I determined that the species is dioecious, with hermaphrodite and female individuals (technically, gynodioecious). Bisexuality is not mentioned in the literature. Additional rosettes, especially large ones, were marked in 2002 to determine whether the two sexes differed in population dynamics. Many of the plants from 2002 flowered in 2003. I checked on the survivors in 2004 (below).

In addition to *Eriogonum alatum*, I am hoping to summarize and publish demography of *Opuntia macrorhiza* and *Talinum parviflorum* soon. I would like to summarize *Escobaria (Corypantha) missouriensis* but I may want to focus on it for a couple of years to get a better estimate of percent flowering and seed production: right now I am not sure whether flowering is rare or just easily missed.

Section 3, Publications from This Work:

New:

Keeler, K.H. 2004. Impact of intraspecific polyploidy in *Andropogon gerardii* (Poaceae) populations. *American Midland Naturalist* 152: 63-74

Previous:

Keeler, K.H. and G. Balogh. 2003. Host range extension for *Chlorochlamys chloroleucaria* (Geometrinae, Geometridae) to include *Eriogonum alatum* (Polygonaceae). *Great Lakes Naturalist.* 36 (1&2): 14-15.

Section 4. Summary of Results:

Andropogon gerardii, big bluestem – this study is basically complete (Keeler 2004). I expect in a year or two to resurvey the plots to see if there has been noticeable change in the big bluestem distributions.

Artemisia frigida, sand sage – This plant had a very good year in 2003 in Plot 61, and in 2004 in 57. In plot 52, populations dropped by half in 2003 and stayed low in 2004. (Table 3). This is clearly a plant capable of sudden changes in abundance.

Table 3. *Artemisia frigida* Populations.
- = not recorded.

Plot	1999	2000	2001	2002	2003	2004
52	-	-	-	43	22	26
57	-	-	14	18	29	94
61	19	19	19	19	122	134

Asclepias speciosa, A. stenophylla and A. viridiflora – the showy milkweed, slimleaf milkweed and green comet milkweed. These are too rare for a valid sample but I note them whenever they are present on the plots, specifically Plot 52.

Cirsium undulatum, wavy leaf thistle – This plant is a long-lived perennial which sends up shorter-lived flowering stalks from deep roots. The mark recapture method used here is not very good for following this plant. However, wavyleaf rosettes are so distinctive that I can't resist recording them. Numbers fluctuate, but I hope to be able to describe its abundance.

Dalea purpurea – purple prairie clover. Plants of this legume appear to be relatively long-lived: two (of four) individuals marked on Plot 61 in 1998 are still alive after 7 years. 2004 was a very good year for them in Plot 28: the numbers greatly increased.

(Table 4). In Plot 57 the population increased in 2003 and Plot 61's population was stable. Despite having three replicates, this is not very likely to provide an adequate sample.

Table 4. *Dalea purpurea* Populations.
- = not recorded.

Plot	1998	1999	2000	2001	2002	2003	2004
28	-	-	98	-	70	67	124
57	-	-	-	-	5	17	19
61	4	5	6	8	7	6	5

Eriogonum (Pterogonum) alatum, winged wild buckwheat. After finding that this plant is gynodioecious (female and hermaphrodite plants) and had a significant excess of female plants in the Open Space plots, I determined sex ratios along the Front Range and across northern Utah in 2003: while many were strongly female-biased like Boulder Open Space, there was no great consistency. I collected additional sex ratio data in 2004 (see below).

I marked plants and am following the growth to flowering: plants ordinarily flower in their third year but a few flower earlier and later. Plants die after flowering. As far as I can tell, the size of females and hermaphrodites and the rate at which the achieve maturity do not differ, but there is a lot of variation which may be masking patterns.

The herbivore, *Chlorochlamys chloroleucaria* (Geometrinae, Geometridae) reported on from 2002 (Keeler and Balogh 2003) was present in 2003 and 2004 but not as abundant. My first hypothesis is that it appeared to be very abundant in 2002 because the drought limited the number of flowering *Eriogonum* plants. However, I have not critically evaluated other hypotheses, such as that the timing of my observations determines the numbers seen.

Questions for which I have partial answers include:

1) How long do plants live?
   Plot 57: mean of 1.86 years, SD = 1.10 N=126
   Plot 61: mean = 1.77 years SD = 0.96 N=88.

Figure 1 shows distributions of lifespans for plants that have died. This data is perhaps a bit skewed to the left because I have not yet corrected for plants I did not find until they were more than a year old. However, the first plants were marked in 1998 (plot 61) and 1999 (plot 57), and so the emerging pattern that *Eriogonum alatum* lives 2-3 years, not 5 or 10, is probably valid

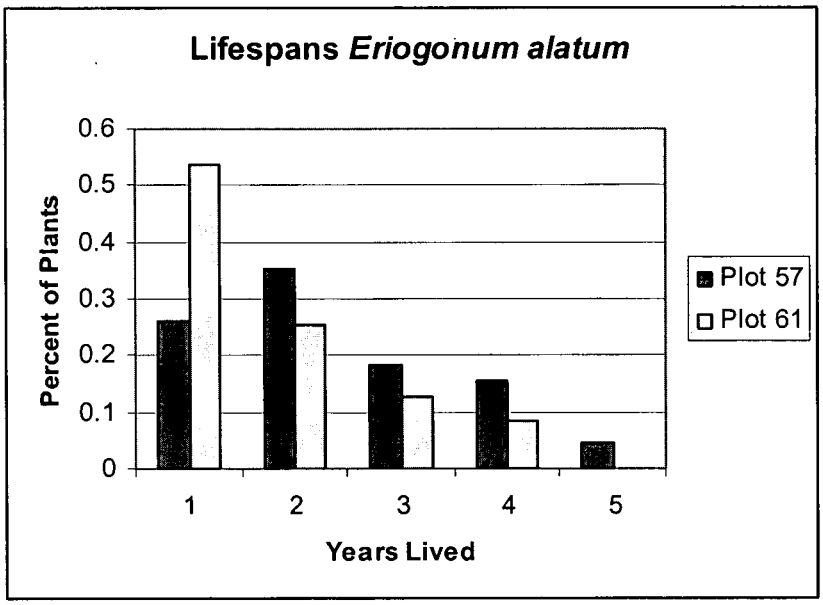

Fig. 1. Lifespans for *Eriogonum alatum*.
Plants with completed lives only. Plot 57 covers 1998-2004, Plot 61 is 1999-2004.
N = 65 (plot 57) and 71 (plot 61).

2) At what age do they flower?
Plot 57: mean = 2.89 SD = 1.31 N = 45
Plot 61: mean = 2.35, SD =1.01 N=34

3) What was the frequency of females compared to frequency of males and hermaphrodites in the population?

a) In 2002: 0.90, 0.75, 0.97 (in Boulder Co. Open Space N= 30, 15, 30)
b) In 2003: 0.56, 0.75 (N= 57, 12) in the Open Space
0.64, 0.63, 0.50 for three Colorado sites N of Boulder Co., (N = 47, 11,106)
0.71, 0.75 for two Front Range Wyoming sites (N= 103, 16, 107);
and 0.44, 0.4, 0.28, 0.45, 0.49and 0.63 for 6 northern and central Utah sites (N=,47,104, 90,103,104,98,101).
c) In 2004: 0.76, 0.75 (Boulder Open Space, N = 22, 16)

d) In marked plants following a population as plants matured and flowered:
(1) behind the Sans Souci Trailer Park (in the north part of the exclosure):
2003: frequency of females 0.589 (N =17)
2004: frequency of females; 0.5 (N = 2)

(2) "Plot 70" Greenbelt Plateau Trailhead pasture
2003: frequency of females 0.655 (N = 29)
2004: only one flowered, hermaphrodite

These continue to suggest a ratio with more females than males or hermaphrodites, although there is considerable variation.

Escobaria (Coryphantha) missouriensis called Missouri nipple cactus in Weber and Wittmann (2001) or Missouri foxtail cactus of USDA-NCRS (2004). This little cactus is very common on plot 57, the ungrazed gravel at the N end of the exclosure that includes the Bocks' Plot 57 and rare to absent in plots 28 and 61, which are equally gravelly but summer grazed (Table 5). It is uncommon on the winter grazed plot 52. Consequently I think that it is not very tolerant of trampling. (Weber and Wittmann 2001) call it inconspicuous and probably uncommon. Numbers fluctuate (Table 5).

The plant appears to be relatively short-lived although 47 plants in plot 57 that were present in 1998 were still alive in 2004 (20.7%). The oldest individuals in plot 52 are from 1999, the last from 1998 was alive in 2003 and dead in 2004.

I took the species name from (Bennett 1997) but looking critically at a variety of pictures online (USDA-NRCS 2004), I may have the name wrong. Regardless, small "button" cacti appear to live less than a decade and to do better where they are not competing with taller plants, but where it is not grazed.

Table 5. *Escobaria (Coryphantha) missouriensis* Populations
- = not recorded.

Plot	1998	1999	2000	2001	2002	2003	2004
28	-	-	-	-	5	5	5
52	30	34	26	15	17	34	33
57	227	238	255	276	316	266	198
61	-	-	-	4	5	6	7

Euphorbia brachycera horned spurge – occurs only on plot 52. Numbers have risen and decreased slightly since I started following it. It is too rare in my data to make a valid study.

Evolvulus nutallianus – This small, inconspicuous bindweed relative looks to be a long-lived, slow-growing perennial. It is very common at plot 57, less so elsewhere.

Liatris punctata gayfeather – This plant is rather sparse and my sample sizes are probably not adequate. It is common enough that an expanded study area would be effective, however.

Opuntia macrorhiza, bigroot prickly pear cactus. My initial study of this plant defined individuals as those currently or very recently connected. However, a study of another species of *Opuntia* from Mexico (Mandujano et al. 2001; Mandujano et al. 1998) used a very strict definition of individuals, so that if the cladodes were not connected, it was counted as a separate plant. In order to compare my work to Mandujano's excellent studies, I redefined individuals. This makes comparison to the first few years rather iffy and so extended the study. I am surprised how much change there is between years in

these populations, although individuals apparently can live 10-20 years. They are pretty tolerant of grazing but not of fire.

Table 6. *Opuntia macrorhiza* populations

Plot	1998	1999	2000	2001	2002	2003	2004
52	29	56	56	73	60	83	101
57	135	161	118	116	137	130	102
61	21	28	39	42	44	61	41
102	24	20	21	23	22	32	not done

Psoralidium (Psoralea) tenuifolium – This is a short-lived perennial. Individuals may live a decade. It can be so abundant that it is difficult to follow single individuals but I think it would be rewarding to focus on.

Talinum parviflorum, fameflower is uncommon enough to be listed as Threatened in Iowa (NRCS 2004). This plant appears to be a short-lived perennial that depends on a long-lived seed bank in the soil. It has increased in numbers dramatically in Plot 28 in the last year (Table 7). I think this is a combined result of rest from grazing on Plot 28 and moisture availability.

The oldest individual is about 4. I think they can probably be aged by branching pattern.

Table 7. *Talinum parviflorum* Populations
- = not recorded

Plot	1998	1999	2000	2001	2002	2003	2004
28	-	-	3	0	27	59	295
52	0	0	0	0	0	0	0
57	7	4	11	7	14	28	23
61	0	0	0	0	0	0	0

Yucca glauca small soapweed, yucca. A conspicuous and common western plant, it was so distinctive that I noted yucca as reference points on my maps.

The big individuals at the edge of my plot 52 on the top of Davidson Mesa have been present since 1995, but none of the seedlings recruited into the plot (currently about 80) have reached flowering size in that period. I think the dip in numbers in 2002 in this plot reflects death of small plants, followed by recruitment of additional individuals in 2003, but I have not yet checked that in detail.

Table 8. *Yucca glauca* Populations
- = not recorded

Plot	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
52	27	24	43	25	51	44	64	35	79	81
57	-	23	22	20	26	28	21	25	21	21

The controlled burn of Plot 57 in 2001 killed a number of mature individuals, and the disease in the following year killed the rest of the adults. It does not show up in total numbers that the reproductive population of the plot was wiped out. Plot 57 currently has 21 immature individuals but no mature ones.

Thus, of all 100 individuals in the two plots, only 2, just outside Plot 52 but counted in the study, have flowered, and those were reproducing in 1995 when the study started. The other three plots lack yucca populations although seedlings have come and gone in plots 28, 61 and 102.

Yuccas are long lived but slow to mature. On the other hand, there may be a soil seed bank: it is not clear where the seeds responsible for the recruits came from.

Section 5, Discussion:

Plot 28 had not been grazed yet when I got there in mid-July. This probably explains a lot of the recruitment of *Dalea* and *Talinum* there.

Section 6, Literature Cited

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