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Final Report 2000

Studies of Tallgrass Prairie Plants

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The plants in the tallgrass prairie remnants in Boulder will face different conditions in the next century. Climate change, whether global or due to the proximity of a dense human population, changes in land use, changes in species visiting the site, are all going to be quite different from the conditions 100 years ago. Our ability to predict how these changes will affect the plant species of the Front Range grasslands is greatly hampered by how little is known about their biology under "normal" conditions.

This study collects some of that data. I am recording the ordinary dynamics of plants, in order that, in future, grassland managers will have something to compare to. So little is known about some of these species that this study also provides the first study of their dynamics.

STATUS OF THE PROJECT

I began following *Andropogon gerardii* individuals in Open Space and Mountain Parks grasslands in 1995. Other species were added occasionally, but especially in 1998.

The *Andropogon gerardii* study focused on a direct comparison of two distinct polyploid morphs (cytotypes), with 60 and 90 chromosomes (Keeler and Davis 1999). That data is nearly ready for publication: the manuscript draft is enclosed.

In the process of completing that manuscript, it became clear that I have the data to assess recruitment and death rates for *Andropogon gerardii*.. This is a data set including all the individuals, not just those for which I have cytotype information. I will summarize and analyze that data as my next major project.

In addition, I have mapped other species, recording their presence or absence annually since 1998 (or, in a few cases, earlier). The goal of this is to determine 1) the distribution of plant sizes, 2) deaths and appearance of new individuals. From this information I can estimate population health. Healthy populations ordinarily have many small (young) individuals and a few large (old) ones. Healthy populations also have death rates that are balanced by recruitment rates.

I am recording flowering for all these species to determine frequency of flowering, and rate of growth to flowering size. Another outcome will be a look at how much the number of plants in the population varies and, from that, insight into how each species responds to the variable Colorado climate.

In this report summarizes the number of plants observed. Plant size and flowering data has not been analyzed yet. It should be apparent from the maps (Fig. 1, 2) that I can follow individual plants and determine rates of growth, average lifespan and frequency of flowering. My plan is to begin analysis as soon as the polyploidy manuscript is mailed. Making the first map for each species and checking it for problems is slow. Adding subsequent years' data is much faster.

OVERVIEW OF METHODS

Plots are 10 x 10 meters, the numbering system based on Jane and Carl Bock's permanent plots (Table 1 (Bennett 1997, Bock and Bock 1998)). Plots include winter and summer grazed sites and grazing exclusions.

Table 1. Plot Locations. Plots are 10 m x 10 m., although for some abundant species, not all the plot is mapped.

Bock Plot Number	Description of Plot Location	Finding Plot from Bock Permanent Marker	Management
28	Boulder Greens Venture, Shanahan Ridge	Marker is SW corner of plot	Summer grazed
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	Winter grazed
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.	Ungrazed (burned 1997)
61	Flatirons Vista Wildlife Transect	Marker is NW corner of plot	Summer grazed
102	Chataqua Park Meadow	Plot begins 3 m N of Bock marker, runs 7 m S, 3 m N (10 m W)	Ungrazed (burned 1996)

Selected species were mapped. Every subsequent June, those species were relocated and changes noted. Analytical maps are in Arcview Geographic Information Program (ESRI 1997).

There is no theme to the species selected. Ideally, species are present in several plots, but I am sufficiently interested in a couple of species that I am following them despite an inadequate sample size. The current group of plants are quite diverse: long-lived grasses and forbs (*Andropogon gerardii*, *Yucca glauca*) to short lived species (*Psoralea tenuiflora* and *Corypantha missouriensis*). Major and minor plant families are included. Some plants are clonal, most are not. Most are native but I could not resist the one exotic (*Hypericum*).

Analytical methods: For clonal species, I am drawing the area covered onto the maps, and Arcview will calculate clone area. I will be able to indicate changes in area, not just clonebirth and death. For all species, plants added and plants dying will be used to develop a life table and determine population parameters (e.g. *r*, (Caswell 1989)). The flowering data will be used to look at what proportion of the plants flower, in a given year or in their lifetime.

DATA SO FAR

As noted above, *Andropogon gerardii* cytotype comparisons are virtually complete. Manuscript attached. For other species, numbers observed each year are summarized in Table 2.

Table 2. Species studied and summary of number per plot per year.

Plant species	**Year /Plot**	**95**	**96**	**97**	**98**	**99**	**00**
Andropogon gerardii * (Poaceae)	28	-	22	22	22	21	20
	52	24	24	24	24	24	24
	57	-	22	22	22	22	22
	61	-	41	41	41	41	41
	102	-	16	16	15	15	15
Artemisia frigida (Asteraceae)	61	-	-	-	18	20	13
Artemisia ludoviciana (Asteraceae)	28	-	-	-	36	39	46
	102 (3 m x 6 m area)	-	-	-	12	92	117
Cirsium undulatum (Asteraceae)	52	-	-	-	5	8	11
	57	-	-	-	5	7	8
	61	-	-	-	-	4	8
Corypantha missouriensis (Cactaceae)	52	-	-	54	4	33	34
	57 (half plot)	-	-	-	226	285	253

	61	-	-	-	-	-	2
Dalea purpurea (Fabaceae)	28	-	-	-	58	123	107
	61	-	-	-	4	4	6
Eriogonum alatum (Polygonaceae)	57 flowering	-	-	-	4	10	9
	57 all	-	-	-	-	46	62
	61 flowering	-	-	-	4	4	3
	61 all	-	-	-	-	6	29
Euphorbia robusta (Euphorbiaceae)	52	-	17	54	nr	69	81
Hypericum perfoliatum (Hypericaceae)	28	-	-	-	7	8	19
Liatris punctata (Asteraceae)	61	-	-	-	28	46	80
	102	-	-	-	12	13	17
Opuntia macrorhiza (Cactaceae)	28	-	-	-	24	64	70
	52	36	nr	38	35	67	70
	57	-	19	17	133	154	148
	61	-	-	-	20	29	40
	102	-	-	-	22	21	22
Psoralea tenuifolia (Fabaceae)	28	-	-	-	85	92	In progress
	61 (0.6 of the plot)	-	-	-	55	128	In progress
	102	-	-	-	48	87	In progress
Schizachryium scoparium (Poaceae)	28	-	-	-	41	96	98
	57	-	-	-	52	115	116
Talinum parviflorum (Portulacaceae)	28	-	-	-	0	0	3
	57	-	-	-	6	0	10
Yucca glauca (Agavaceae)	52	26	34	41	24	49	41
	57	-	23	23	20	25	27
	102	-	-	-	6	6	5

*plants of known cytotype of *A. gerardii* only. nr = Not recorded that year.

Number of plants in the plots increased annually in almost every case. The last two years may have been good years, however, I attribute most of the increase between years to finding perennials I missed previously. However, it is clear that none of these species is declining dramatically.

The numbers presented do not indicate level of turnover. *Psoralea tenuiflora* has about 50% death, 50% new plants each year, while *Andropogon gerardii* and *Yucca glauca* are show less than 10% annual change. Working out turnover rates is part of the detailed analysis of each species.

<u>Notes on individual species:</u>

The *Andropogon gerardii* data summarized in Table 2 had 1-2 % turnover in the population annually. This suggests that, if at steady state, plants live many decades. However, since the only data I have ready on *A. gerardii* is is for plants of known cytotype, this includes more data from large plants than small ones. I was unwilling to sample tiny plants for DNA analysis for fear of killing them. The forthcoming analysis of all plants, cytotyped or not, will give a better estimate of survival.

Artemisia ludoviciana is clonal, but that is not obvious from its behavior in Plot 28. I presume the shoots observed represent a number of different genetic individuals, but I have no evidence to support that.

Ambrosia psilostachya is no longer in the list because it is so mobile a clone that I went from scoring individual shoots, to counting the number of shoots per square in the grid, to giving up. I conclude that the right scale to study *A.psilostachya* is greater than 10 m x 10m. At a larger scale, clones and their movements should become clear.

Corypantha in Plot 28 really did drop from 54 to 4 and then recover to 33 (1997-9). The plant size data that will help interpret this. In particular, it will indicate flowering size and how long it takes plants to reach that size. This species appears respond rapidly growing conditions. At the same time, there must be many seeds in the soil.

Eriogonum alatum is a rosette-forming species that dies after flowering (monocarpic). It took me until 1999 to associate the rosette with the flowering plant. It looks like it is a short-lived perennial, not a biennial. A couple of plants not recorded in 1999 flowered in 2000. I am assuming I missed them in 1999, but it will be interesting to know if the species does occassionally flower its first year.

For *Opuntia macrorhiza* my definition of "individual" (whether two separate but adjacent pieces are one plant or two) may shift a bit between years. These numbers need to be carefully rechecked. Note that all plots except Plot 102 increase dramatically in 1999.

For *Schizachryium scoparium*, the numbers in 1999 and 2000 fit my impression of the species: the clones are very stable.

Talinum parviflorum is probably a short-lived perennial. However, my observations show it acting like an annual. I searched for it on Plot 57 in 1999: I am sure it was not there. Likewise, finding it on Plot 28 after 4 years in which I did not see it (I have an unpublished study of *Talinum rugospermum* and *T. calycinum* from the Nebraska sandhills) seems like it is acting like an annual there.

Yucca glauca includes big flowering individuals in Plot 57, but in Plot 52 only one individual, just outside the plot, is large enough to flower. The 40 or so plants in Plot 52 are all tiny individuals with fewer than 10 leaves. In Plot 57, the burn in 1997 killed4 large plants, but 4 survived. In Plot 57, one*Yucca* plant flowered in 1999 and two in 2000, although none of these appear to have produced seeds. In contrast, all of the plants in Plot 52 are too small to flower, so on the basis of the plot alone, Plot 57 with the smaller number of *Y. glauca* plants, is in better shape because it has reproductive individuals. For plants the size of yuccas, though, a 10 x 10 m plot probably includes only part of a population. However, in these plots *Yucca glauca* appears to be doing quite well: it has substantial numbers of small individuals which persisted through the 3 years of observation and so promise flowering individuals in a few years. Plot 102 is very grassy: the yuccas are small and not flowering. Plot 52 is winter grazed and Plot 57 is ungrazed, suggesting*Yucca* seems healthy in the Open Space. However, Plot 57 is on a gravelly soil which reduced plant cover. This is not really a tallgrass prairie plant and conditions that reduce plant cover probably increase its success.

Literature Cited

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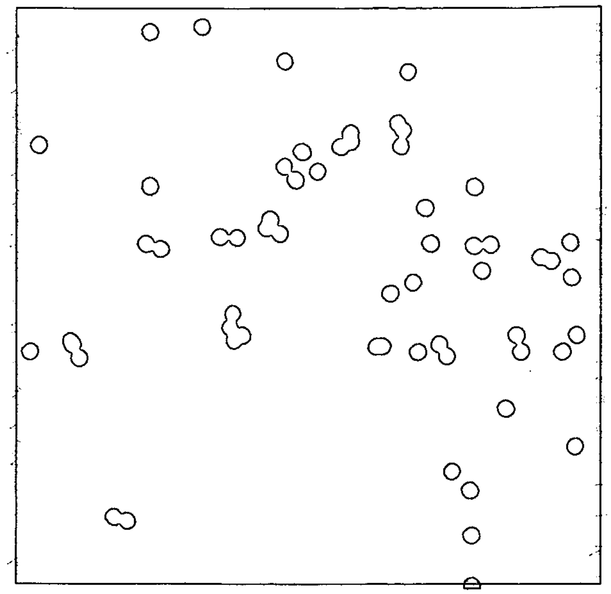
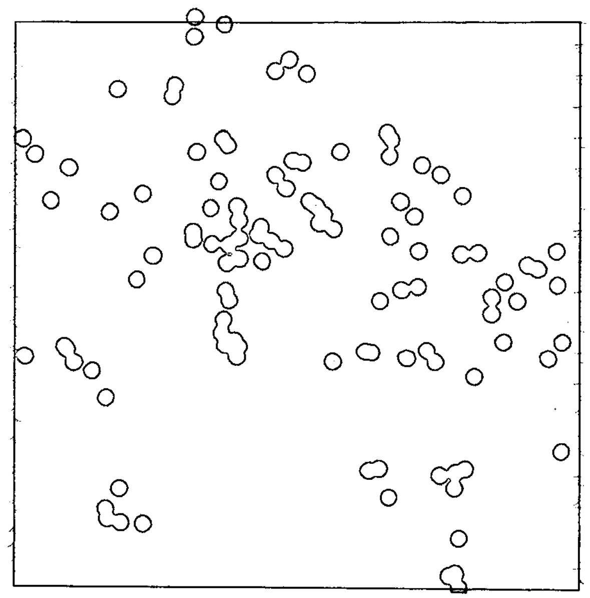
Fig. 1. Plot 28. *Dalea purpurea*

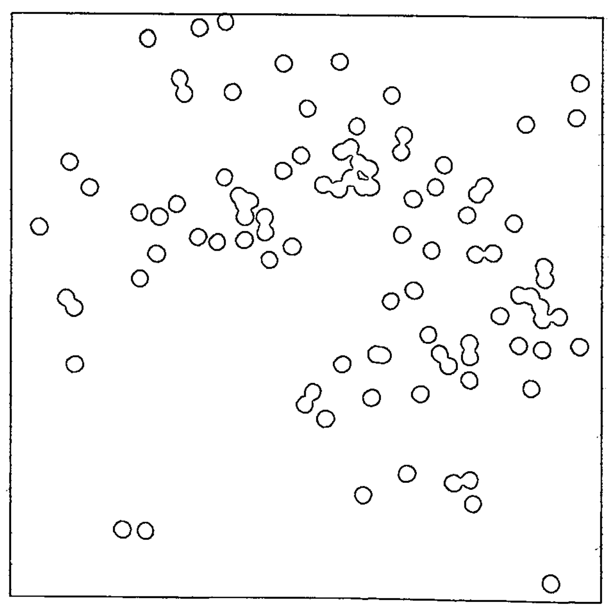
1998



1999



2000



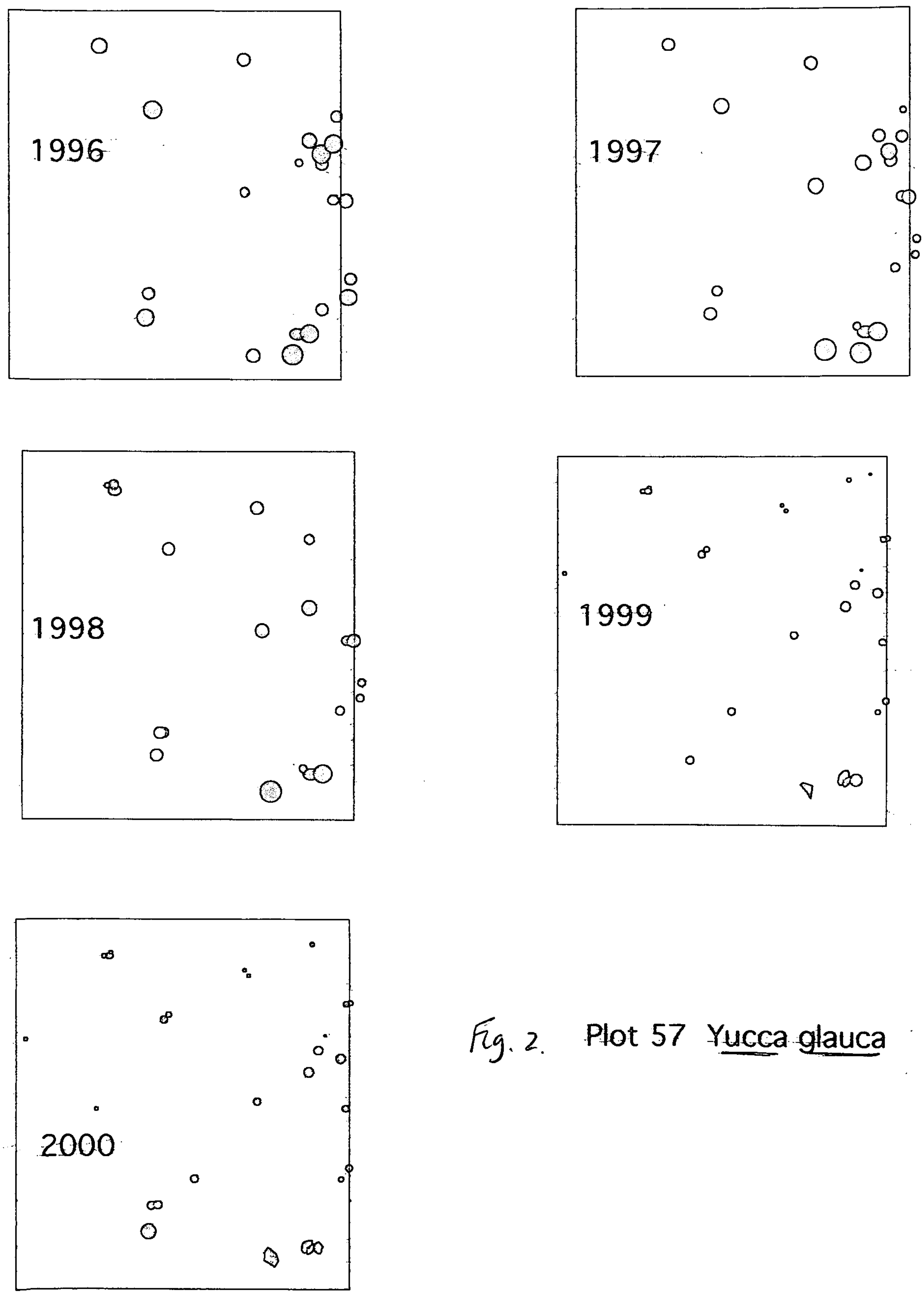


Fig. 2. Plot 57 Yucca glauca