DEMOGRAPHY AND REPRODUCTION OF

ERIGERON DECUMBENS VAR. *DECUMBENS,*

1993-1994 FIELD STUDIES

Prepared by

Dr. Cheryl A. Ingersoll
Karen K. Finley
Deborah L. Clark

Botany and Plant Pathology
Oregon State University
Corvallis, Oregon

Prepared for

Oregon Department of Agriculture
Plant Conservation Biology Program
635 Capitol Street NE
Salem, Oregon

1 April 1995

INTRODUCTION AND RATIONALE

Erigeron decumbens var. *decumbens*, the Willamette Daisy, is endemic to the Willamette Valley of Oregon. This taxon is a Category 1 Candidate for listing under the federal Endangered Species Act (U.S. Fish and Wildlife Service 1990) and is listed as Endangered under Oregon state law. Herbarium records indicate that *E. decumbens* var. *decumbens* was once widespread in prairies throughout the Valley. In 1934, however, records ceased and *E. decumbens* var. *decumbens* was considered to be extinct until two populations were discovered in 1980, at Willow Creek (Lane County) and Finley National Wildlife Refuge (Benton County; Clark *et al.* 1993). Several populations have been extirpated within the last decade, and there are currently only 18 known populations of *E. decumbens* remaining in the Valley. Most populations are small, consisting of fewer than 50 plants, with the largest concentration of sites occurring in wetland prairies west Eugene area.

Erigeron decumbens var. *decumbens* occurs in both wetland and upland prairie habitats. Willamette Valley wetland prairies are characterized by seasonally flooded hydric soils, and are often dominated by *Deschampsia cespitosa*. The upland prairies occur on well-drained soils and formerly supported a mix of native perennial bunchgrasses, such as *Festuca rubra* and *Elymus glaucus*. Before the mid-19th century, both prairie types were probably maintained by seasonal fires set by the native Kalapuya people (Toepel 1991, Boag 1992) to maintain favored forage plants and to aid in hunting. The prairies of the Willamette Valley are considered to be one of the rarest ecosystems in western Oregon, and much *E. decumbens* habitat has been destroyed by agricultural/urban development and encroachment by woody species and exotic plants.

In 1993, we were requested by the Oregon Department of Agriculture to update the status of *Erigeron decumbens* var. *decumbens* and to initiate a long-term population monitoring program for this taxon. Clark *et al.* (1993) and Ingersoll *et al.* (1993) found major gaps in our knowledge of the biology and ecology of *Erigeron decumbens*, and identified areas of study needed for its protection and management. In 1993, we established permanent demographic monitoring plots, collected first-year data on population and reproductive characteristics, and established a protocol for future monitoring (Ingersoll *et al.* 1993). The objectives of this monitoring program are to assess long-term population trends of *E. decumbens*, particularly patterns of reproduction, recruitment, and mortality. In 1994, we continued demographic monitoring and conducted studies of seed and vegetative regeneration. In this report, we present and discuss the results of two years of demographic monitoring of *E. decumbens*. Regeneration studies are discussed in a companion report (Clark *et al.* 1995).

METHODS

Study Sites

In 1993, we established permanent demographic monitoring plots at three *Erigeron decumbens* var. *decumbens* sites: Fisher Butte (in Fern Ridge Research Natural Area, managed by the U.S. Army Corps of Engineers), Bald Hill Park (City of Corvallis), and Baskett Butte (Baskett Slough National Wildlife Refuge, managed by the U.S. Fish and Wildlife Service). The Fisher Butte population occurs in a high-quality wetland prairie which is prescribed-burned approximately every two years. The Baskett Butte population lies

on a dry slope and summit with shallow, rocky soil. It lies adjacent to *Quercus garryana* (Oregon white oak) woodland and is being invaded by shrub species such as *Rhus diversiloba* (poison oak) and *Rosa* spp. The Bald Hill population occurs in a small, north-facing remnant prairie surrounded by *Quercus garryana - Pseudotsuga menziesii* (Oregon white oak - Douglas fir) forest. All three sites support a mixture of native and introduced species and face some encroachment by woody species. These sites were selected because they are located on city- and federally-managed land and span most of *Erigeron decumbens* var. *decumbens*'s geographic range and habitat. Sites are described in detail in Clark *et al.* (1993) and Ingersoll *et al.* (1993). Background data exist on the vegetation, soils, and hydrology of Fisher Butte (Finley 1994); some vegetation data exist for the Bald Hill site (M.V. Wilson, pers. comm.); and very little is known about environmental or vegetation characteristics of the site on Baskett Butte. Full details of study locations, study design, and data collection are provided in Ingersoll *et al.* (1993) and are summarized below.

Field Methods

Demographic monitoring was conducted during the summers of 1993 and 1994. In 1993, 44 0.5-m^2 permanent marked quadrats were established at Fisher Butte, 21 at Bald Hill, and 43 at Baskett Butte. The small number of quadrats established at Bald Hill reflects the fact that this is the smallest of the three populations. At each site, quadrats were located to encompass at least one randomly-selected reproductive *Erigeron decumbens* plant and to represent the range of *E. decumbens* densities across the site. We defined an individual "plant" as a basal clump at least 5 cm from the nearest neighbor. In both 1993 and 1994,

each *E. decumbens* plant within a quadrat was mapped and the following measurements were taken: longest plant basal diameter, basal diameter at 90 degrees from this diameter, height (of the tallest flowering stem or the longest leaf of vegetative plants), number of flowering stems, and number of heads in bud and in flower. To assess seed production, 7-16 mature fruiting heads were collected annually in July at each site and achenes were counted under a dissecting microscope. In 1994, seeds were also separated into filled (i.e., robust and apparently viable) and unfilled seeds, and the number of filled achenes per head was also recorded.

Analysis

We correlated vegetative characteristics of *Erigeron decumbens* plants (height, basal area, and volume) with reproduction (number of flowering heads) in order understand how measured vegetative characteristics were related to flowering. The basal area of each plant was calculated as an ellipse: $\pi(0.5\ [\text{diameter1} \times \text{diameter2}])^2$. The volume of each plant was calculated as the product of basal area and height. The number of flowering heads was selected as an index of total reproduction because it is readily measurable in the field. Estimates of the number of seeds per head were not used to represent total reproduction because these measurements were taken on a very limited subsample (7-16 heads) from each population (the term "population" as used in this report refers only to the sample population censused within the 0.5-cm^2 quadrats, not to the entire biological population of a site). A plant was considered to have died if it appeared in 1993 but not in 1994; some of these may have been dormant in the latter year. A plant was considered to be a recruit if it appeared in

1994 but not in 1993. For analysis of population size structures, sampled populations were separated into nine size classes based on field observations.

Prior to all statistical analyses, data were square root-transformed to approach normality. We compared plant basal area and density, height, number of heads, and seed production per head among the three sites for each year using analysis of variance (ANOVA) and Fisher's protected least significant difference test (FPLSD). Student's t-test and the paired comparisons t-test were used to compare changes in plant size and reproduction at each site from 1993 to 1994. In order to compare overall population size changes from 1993 to 1994, total plant density and density of reproductive plants were also analyzed between years (paired comparisons t-test). Population sizes reported in Ingersoll *et al.* (1993) were adjusted prior to the 1994 analysis because a data entry error was discovered.

RESULTS

Overall Population Patterns

Sizes of sampled *Erigeron decumbens* populations, 1993 mortality, and 1994 recruitment are summarized in Table 1. At Baskett Butte, 72% of the censused population consisted of reproducing (i.e., flowering) plants in 1993; in 1994, only 41% were reproductive (Table 1), and their density was significantly lower than in 1993 (Table 2). At Fisher Butte, the overall density of plants increased from 1993 to 1994, but the density of reproductive individuals declined significantly (Table 2). The percent of Fisher Butte plants flowering declined from 87% in 1993 to 60% in 1994 (Table 1). At Bald Hill, 1993 and 1994 reproductive plants constituted 81% and 67% of the population, respectively (Table 1);

densities of the overall sampled population and reproductive plants did not change (Table 2). Plant densities did not differ among the three sites, although 1993 basal area per quadrat was significantly higher at Bald Hill than at Baskett Butte (Table 2).

All three populations showed a preponderance of small (<5 cm^2) individuals (Fig. 1). At Fisher Butte and Bald Hill, slightly over one-third of the plants were <1 cm^2 in basal area, while at Baskett Butte, nearly 50% were <1 cm^2 in area. Nearly 30% of the Fisher Butte and Bald Hill populations were ≥ 10 cm^2 in basal area, while at Baskett Butte, slightly more than 10% were in these larger size classes (Fig. 1).

At all sites, the magnitude of reproduction increased exponentially with size class (Fig. 2). Plants in the smallest two classes produced 0-2 flowering heads each, while plants in the largest class (>100 cm^2) averaged 46-62 heads each. At Fisher Butte and Bald Hill, plants in moderate (2-<50 cm^2 basal area) and large (50-100+ cm^2) classes accounted for about 55% and 40% of total population reproduction (Fig. 3). At Baskett Butte, moderate-sized plants accounted for over 75% of total reproduction, and large plants only 11%.

At Baskett Butte, 20% of the censused 1993 population disappeared between 1993 and 1994 (Table 1). At Fisher Butte, 1993-94 mortality was 12%, and at Bald Hill, 19%. Mortality was concentrated in smaller size classes (Fig. 4). At Fisher Butte, 20-25% of plants in each of the smallest three classes died; at Bald Hill, mortality among these size classes ranged from 13% to 33%. At Baskett Butte, 67% of plants in the 0-<0.2 cm^2 class died, and one-third of those in the 0.2-<1 cm^2 class died. Mortality of among moderate (2-<50 cm ^{2}) size classes was generally did not exceed 15%, except at Bald Hill, where mortality in these size classes was higher. No plants in the two largest classes died (Fig. 4).

Patterns of recruitment varied among the three sites. At Baskett Butte, only 15% of the 1994 censused population consisted of new recruits, while at Fisher Butte and Bald Hill, recruits accounted for 29% and 24% of the 1994 populations, respectively (Table 1). Recruits were concentrated in the three smallest size classes (Fig. 5), except at Bald Hill, where one-quarter of all plants in the 50-<100 cm^2 class were new in 1994. At Fisher Butte, 75% of all plants in the smallest class were new in 1994, and 40-52% of the smallest plants at Baskett Butte and Bald Hill were new. At all sites, anywhere from 0-25% of plants in moderate (2-<50 cm^2) size classes were 1994 recruits.

Size and Reproductive Characteristics

All measures of plant growth (basal area, height, number of flowering stems, and plant volume) were significantly correlated with reproduction in 1993 and 1994 (Table 3). Basal area, volume, and number of stems were strong and consistent predictors of reproduction, and plant height was the weakest.

There were marked differences in growth and reproduction among the three sites (Table 4). Despite some year-to-year variation, plants in the Bald Hill and Fisher Butte populations were generally significantly larger and produced more flowering heads and seeds than plants at Baskett Butte (Table 4). While the populations did not differ in the total number of seeds produced per flowering head, plants at Baskett Butte produced significantly fewer filled seeds per head than plants at Bald Hill and Fisher Butte (Table 4). Seed production per plant was significantly higher at Bald Hill and Fisher Butte than at Baskett Butte, and plants at Bald Hill produced significantly more filled seeds (nearly 1500/quadrat)

than did plants at Fisher Butte and Baskett Butte (Table 4). At Baskett Butte and Bald Hill, plant basal area did not change between years, but at Fisher Butte, plants were significantly smaller in basal area in 1994 than in 1993 (Table 4). However, plants at Baskett Butte and Bald Hill were were significantly shorter in the latter year (Table 4). At Baskett Butte and Fisher Butte, plants produced significantly fewer heads and seeds in 1994 than in 1993, but reproduction at Bald Hill was stable between the two years. It should be noted that differences in seed production between the two years may actually be greater than reported here, because some heads collected in 1993 had already begun to disperse seeds, resulting in probable underestimation of 1993 seed production (Ingersoll *et al.* 1993).

We also compared only those plants that were present in both 1993 and 1994 (Table 5). Without this second comparison, we would not know whether observed changes in size and reproduction reflected actual changes within individuals, or whether they resulted from altered population size structures due to recruitment and mortality. Among plants present in both years, plants at Baskett Butte were significantly shorter and produced fewer heads and seeds in 1994 than in 1993 (Table 5). At Fisher Butte, plants had smaller basal areas and produced fewer heads and seeds in 1994; at Bald Hill, the only significant reduction in 1994 was in plant height (Table 5). These patterns match those of the overall populations (Table 4), indicating that between-year differences in growth and reproduction represent actual changes in individual plants, rather than the effects of recruitment and mortality.

DISCUSSION

The term "population" used in the following discussion refers to the sample population in the permanent quadrats at each site; as a result, the patterns described here do not necessarily match patterns occurring throughout the entire (biological) population at each study site. At each site, however, quadrats were located in areas representative of the range of *Erigeron decumbens* densities.

Over the two years, mortality was largely balanced by recruitment, and the Fisher Butte population increased between 1993 and 1994. However, reproduction (both the number of flowering plants and total production of flowering heads and seeds) declined in 1994 at Fisher Butte and Baskett Butte. At all sites, mortality and recruitment were largely restricted to small plants, except at Bald Hill where a larger proportion of moderate-sized plants disappeared between 1993 and 1994.

Reduced plant size and reproduction in 1994 represent actual year-to-year changes within individuals, rather than the effects of mortality and recruitment. Differences in plant growth and reproduction between 1993 and 1994 may have resulted from differences in environmental conditions. For example, weather records from the three stations closest to the sites show that precipitation during the 1994 growing season was much lower than in 1993. Precipitation during April-July 1994 at the Dallas (Baskett Butte area) station was only 29%, Eugene Airport (Fisher Butte area) 24%, and Hyslop Farm (Corvallis) 35%, of 1993 precipitation (Oregon Climate Service, March 1995). Year-to-year variations in other factors, such as temperature, may also influence growth and reproduction of *Erigeron decumbens*.

Population size structures were similar at Fisher Butte and Bald Hill, and in general, plants at these sites were larger and produced more flowering heads than did plants at Baskett Butte. Baskett Butte plants produced very few filled seeds compared to the other two sites. The Baskett Butte population also experienced extremely high mortality of small plants between 1993 and 1994. Most plants at the three sites that were considered dead or new recruits in 1994 were in small size classes, but a few larger plants (particularly at Bald Hill) disappeared or appeared for the first time in 1994. The possibility that some *E. decumbens* plants may remain dormant for a year or more can only be answered through continued mapping and monitoring of individuals.

The factors responsible for the significant differences observed among the three populations in size structure and reproduction are not known. However, biotic and/or abiotic environmental differences among sites may profoundly influence *Erigeron decumbens* growth, mortality, and recruitment. Fisher Butte (a wetland prairie) and Bald Hill (which appears to be intermediate between a wetland and upland habitat) may provide more similar growing conditions for *E. decumbens* than does Baskett Butte, which is an upland prairie on shallow soils. Associated vegetation may also influence patterns observed in these *Erigeron decumbens* populations. These sites are threatened to varying degrees by invasion of woody species and aggressive exotics. Both Fisher Butte and Bald Hill still retain a high proportion of native prairie species, but no data are available for Baskett Butte. Fisher Butte (which is burned requlary) is probably less immediately threatened by encroaching trees and shrubs than are the other two sites.

Recommendations

Differences in abiotic and biotic environmental factors, both among sites and between years, may influence growth, mortality, recruitment, and reproduction of *Erigeron decumbens* var. *decumbens* populations. Potentially important environmental factors include rainfall, air temperature, soil type, seasonal water table, cover of native and non-native associated species, presence of litter and bare ground, and small-scale disturbances (such as rodent excavations). The monitoring program could be expanded to collect this additional data within the permanent plots and to identify major environmental influences on population patterns of *E. decumbens*. Data on plant associates and vegetation changes over time is particularly important in protecting the few remaining *E. decumbens* populations. If woody and/or exotic species are encroaching on *E. decumbens* habitat, active vegetation management may be required. Data on effects of microsite variations (such the presence of litter or bare soil) on regeneration and growth would provide essential information for the restoration and augmentation of existing *E. decumbens* populations.

Priorities for monitoring of populations could be shifted slightly to increase emphasis on the environmental characteristics of these sites. Given budget and time constraints, annual population monitoring can be streamlined by eliminating the time-consuming assessment of flowering stems. Because we found the number of flowering stems to have a nearly 1:1 correspondence with the number of flowering heads, it is an unnecessary measure when flowering heads are actually counted. The number of seeds per head is quite variable, and we estimate that a minimum of 12-15 flowering heads should be collected annually at each site to assess total and filled seed production.

Seed production at Baskett Butte and Fisher Butte was very low in 1994 compared to 1993, and 1994 ratios of filled:total seeds were extremely low at Baskett Butte. Based on only two years of data, we cannot determine whether this is a general pattern for *Erigeron decumbens*, or whether reproduction by seed varies year-to-year with fluctuations in environmental conditions. The possibility of low pollination rates and environmental correlates, such as growing season precipitation, should be examined.

There appear to be differences in growth form between plants at Baskett Butte, where "plants" tend to be looser and fewer-stemmed, and Fisher Butte and Bald Hill, where plants generally form dense, cohesive clumps. It is possible that unknown environmental conditions at Baskett Butte favor the vegetative spread of plants rather than seed production. We have thus far been unable to distinguish between seedlings and vegetatively-regenerated "plants" in the field. Analysis of below-ground growth patterns of *Erigeron decumbens* is needed in order to clearly define "individuals" and to assess the relative importances of vegetative regeneration and seedling recruitment.

Even with low ratios (less than 20%) of filled:total seed production, substantial numbers of apparently viable seeds were dispersed in 1994. Estimates of filled seed production were nearly 3000 seeds/m^2 at Bald Hill and about 1500 seeds/m^2 at Fisher Butte. Studies by Clark *et al.* (1995) suggest that about one-half of these filled seeds are actually viable. However, we have yet to see a clearly identifiable *E. decumbens* seedling in the field. *Erigeron decumbens* germinants are extremely tiny, slow growing, and experience very high mortality under controlled conditions in the laboratory (Clark *et al.* 1995). Despite abundant seed rain, slow growth and low rates of seedling survival may severely limit

seedling recruitment in field populations of *E. decumbens*, or limit it to occasional favorable years. Rhizome cuttings from *E. decumbens* plants have been established under greenhouse conditions (Clark *et al.* 1995), and it is possible that survival and augmentation of populations will depend largely on vegetative spread of established plants. In order to properly manage the remaining populations of *Erigeron decumbens*, we need to begin to identify biotic and abiotic environmental factors influencing its vegetative growth, reproduction, mortality, and recruitment.

LITERATURE CITED

Boag, P.G. 1992. Environment and experience: settlement culture in nineteenth-century Oregon. University of California Press, Berkeley. 209 pp.

Clark, D.L., K.K. Finley, and C.A. Ingersoll. 1993. Status report for *Erigeron decumbens* var. *decumbens*. Prepared for the Conservation Biology Program, Oregon Department of Agriculture, Salem. 55 pp.

Clark, D.L., K.K. Finley, and C.A. Ingersoll. 1995. Regeneration biology of *Erigeron decumbens* var. *decumbens*, an endangered plant of the Willamette Valley. A report to the Conservation Biology Program, Oregon Department of Agriculture, Salem.

Finley, K.K. 1994. Hydrology and related soil features of three Willamette Valley wetland prairies. Unpubl. M.S. Thesis, Department of Rangeland Resources, Oregon State University, Corvallis.

Ingersoll, C.A., K.K. Finley, and D.L. Clark. 1993. A monitoring program for *Erigeron decumbens* var. *decumbens*: a Willamette Valley endemic.

Toepel, K.A. 1991. The western interior. Pages 15-20 *in* The first Oregonians, C.M. Buan and R. Lewis (eds.). Oregon Council for the Humanities, Portland.

United States Fish & Wildlife Service. 1990. Endangered and threatened wildlife and plants; review of plant taxa for listing as endangered or threatened species. Notice of review. Federal Register 55(35). 21 February 1990.

Table 1. Demographic characteristics of censused *Erigeron decumbens* var. *decumbens* populations in 1993-1994. Values in parentheses are percentages of total sampled population. "Number Dying" refers to the number of plants dying between the two field seasons or that remained dormant in 1994. "Number Recruited" refers to the number of plants appearing for this first time in 1994. Discrepancies in totals are due to missing values.

	Baskett Butte	Fisher Butte	Bald Hill
Total Number of Plants Censused			
1993	385	212	132
1994	366	257	140
Number of Reproductive Plants Censused			
1993	277 (72%)	185 (87%)	107 (81%)
1994	151 (41%)	153 (60%)	94 (67%)
Number Disappearing	77 (20%)	26 (12%)	25 (19%)
Number Recruited	56 (15%)	74 (29%)	34 (24%)

Table 2. Mean density and basal area (cm^2) of *Erigeron decumbens* var. *decumbens* in sampled quadrats, 1993 and 1994. "n" refers to the number of 0.5-m^2 quadrats sampled. Data were square root-transformed prior to analysis. Letters differing across rows indicate significant differences among populations (FPLSD, $P \leq 0.01$). Asterisks indicate significant between-year differences within a population (Student's t-test).

	Baskett Butte n=43	Fisher Butte n=44	Bald Hill n=21
Plants per Quadrat			
1993	7.7a	**4.8a	6.3a
1994	7.2a	5.8a	6.7a
Reproductives per Quadrat			
1993	**5.3a	*4.5a	5.0a
1994	3.5a	3.5a	4.5a
Basal Area per Quadrat			
1993	39.9b	75.6ab	98.0a
1994	37.1a	59.1a	71.7a

*: $0.01 < P < 0.05$, **: $0.001 < P < 0.01$

Table 3. Correlation between plant growth parameters (basal area, height, number of stems, and plant volume) and the number of flowering heads. "R" is Pearson's correlation coefficient; "P" is the probability level.

	Baskett Butte		Fisher Butte		Bald Hill		All Sites	
	R	P	R	P	R	P	R	P
Basal Area-Heads								
1993	.730	.0000	.814	.0000	.796	.0000	.801	.0000
1994	.841	.0000	.712	.0000	.923	.0000	.778	.0000
Height-Heads								
1993	.546	.0000	.431	.0000	.572	.0000	.531	.0000
1994	.617	.0000	.553	.0000	.698	.0000	.606	.0000
Stems-Heads								
1993	.972	.0000	.934	.0000	.919	.0000	.931	.0000
1994	.982	.0000	.964	.0000	.963	.0000	.943	.0000
Volume-Heads								
1993	.812	.0000	.795	.0000	.788	.0000	.782	.0000
1994	.876	.0000	.662	.0000	.916	.0000	.813	.0000

Table 4. *Erigeron decumbens* var. *decumbens* size and reproductive characteristics. Values are means based on total 1993-94 sampled populations. Filled seeds were not counted in 1993. Data were square root-transformed prior to analysis. Letters differing across rows indicate significant differences among populations (FPLSD, $P \leq 0.000$). Asterisks indicate significant between-year differences within a population (Student's t-test).

	Baskett Butte	Fisher Butte	Bald Hill
Basal Area / Plant (cm^2)			
1993	5.2b	*15.8a	15.5a
1994	5.2b	10.2a	10.6a
Plant Height (cm)			
1993	***15.2c	20.9b	***25.7a
1994	10.8b	19.7a	19.3a
No. Heads / Plant			
1993	***3.4b	***8.9a	10.0a
1994	2.2c	4.4b	8.5a
Total No. Seeds / Head			
1993	182a	157a	168a
1994	221a	160a	208a
No. Filled Seeds / Head			
1994	4b	30a	26a
Total No. Seeds / Plant			
1993	***619b	***1397a	1680a
1994	486c	704b	1770a
No. Filled Seeds / Plant			
1994	9c	131b	221a
No. Filled Seeds / Quadrat			
1994	61b	745a	1482a

*: $0.01 < P < 0.05$, ***: $P < 0.000$

Table 5. Population and reproductive characteristics. Values are means, based only on plants sampled in both 1993 and 1994. Data were square root-transformed prior to analysis. Letters differing across rows indicate significant differences among populations (FPLSD, $P<0.01$)). Asterisks indicate significant between-year differences within a population (Student's t-test).

	Baskett Butte n=250	Fisher Butte n=181	Bald Hill n=107
Basal Area / Plant (cm^2)			
1993	6.0b	***17.6a	18.4a
1994	6.1b	13.9a	13.0a
Plant Height (cm)			
1993	***16.0c	21.0b	***26.3a
1994	11.4b	21.3a	21.3a
No. Heads / Plant			
1993	***4.0b	***9.8a	11.5a
1994	2.7c	6.0b	10.3a
Total No. Seeds / Plant			
1993	***728b	***1539a	1932a
1994	596c	960b	2219a
No. Filled Seeds / Plant			
1993	---	---	---
1994	11c	179b	268a

***: $P < 0.001$

Figure 1. Size structure of *Erigeron decumbens* var. *decumbens* sample populations at Fisher Butte, Baskett Butte, and Bald Hill, averaged over the 1993-1994 period. Basal area of individual plants was measured in cm^2.

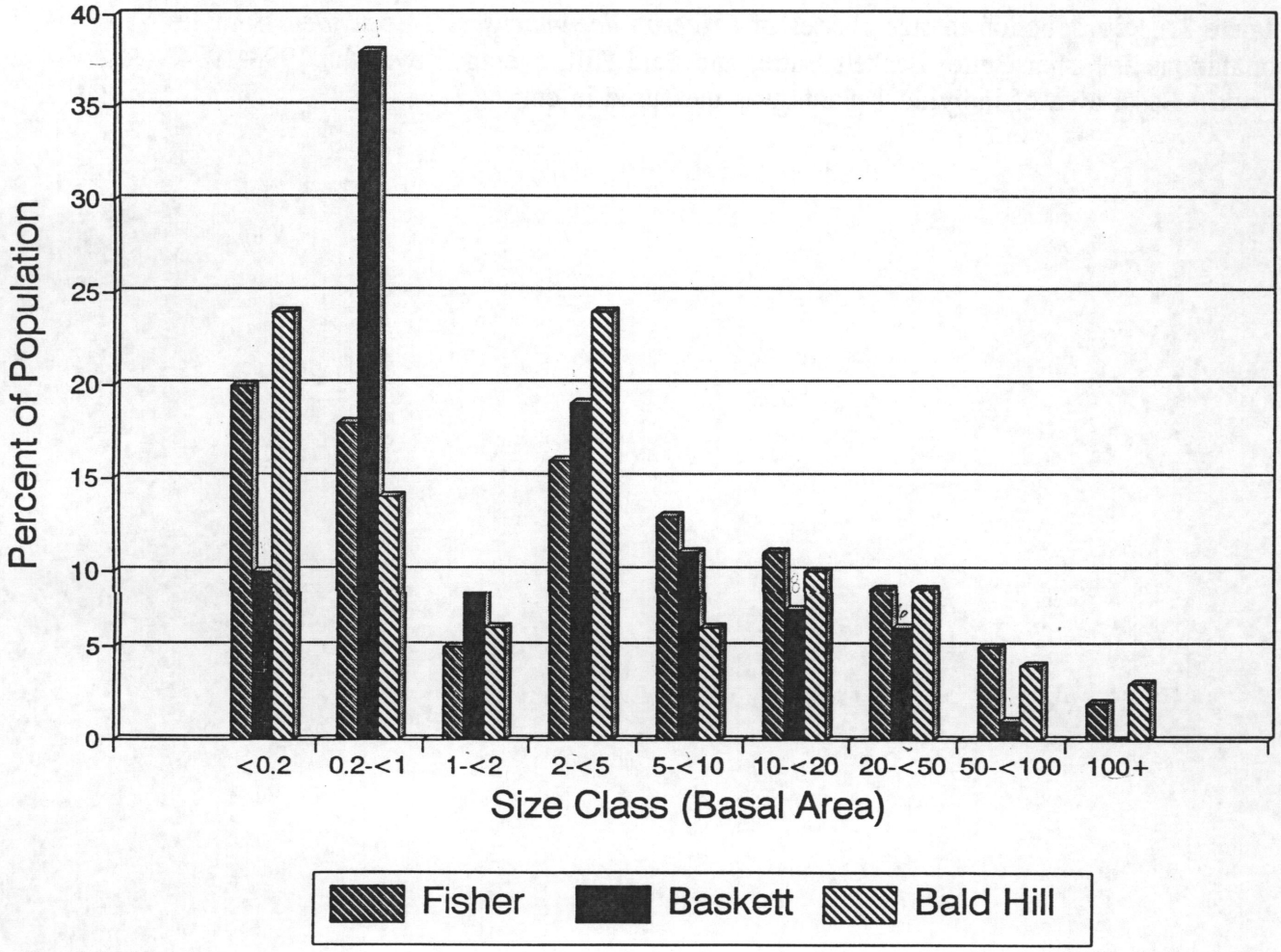

Percent of Population
40
35
30
25
20
15
10
5
0
<0.2
0.2-<1
1-<2
2-<5
5-<10
10-<20
20-<50
50-<100
100+
Size Class (Basal Area)
Fisher
Baskett
Bald Hill

Figure 2. Reproduction in size classes of *Erigeron decumbens* var. *decumbens* sample populations at Fisher Butte, Baskett Butte, and Bald Hill, averaged over the 1993-1994 period. Basal area of individual plants was measured in cm^2.

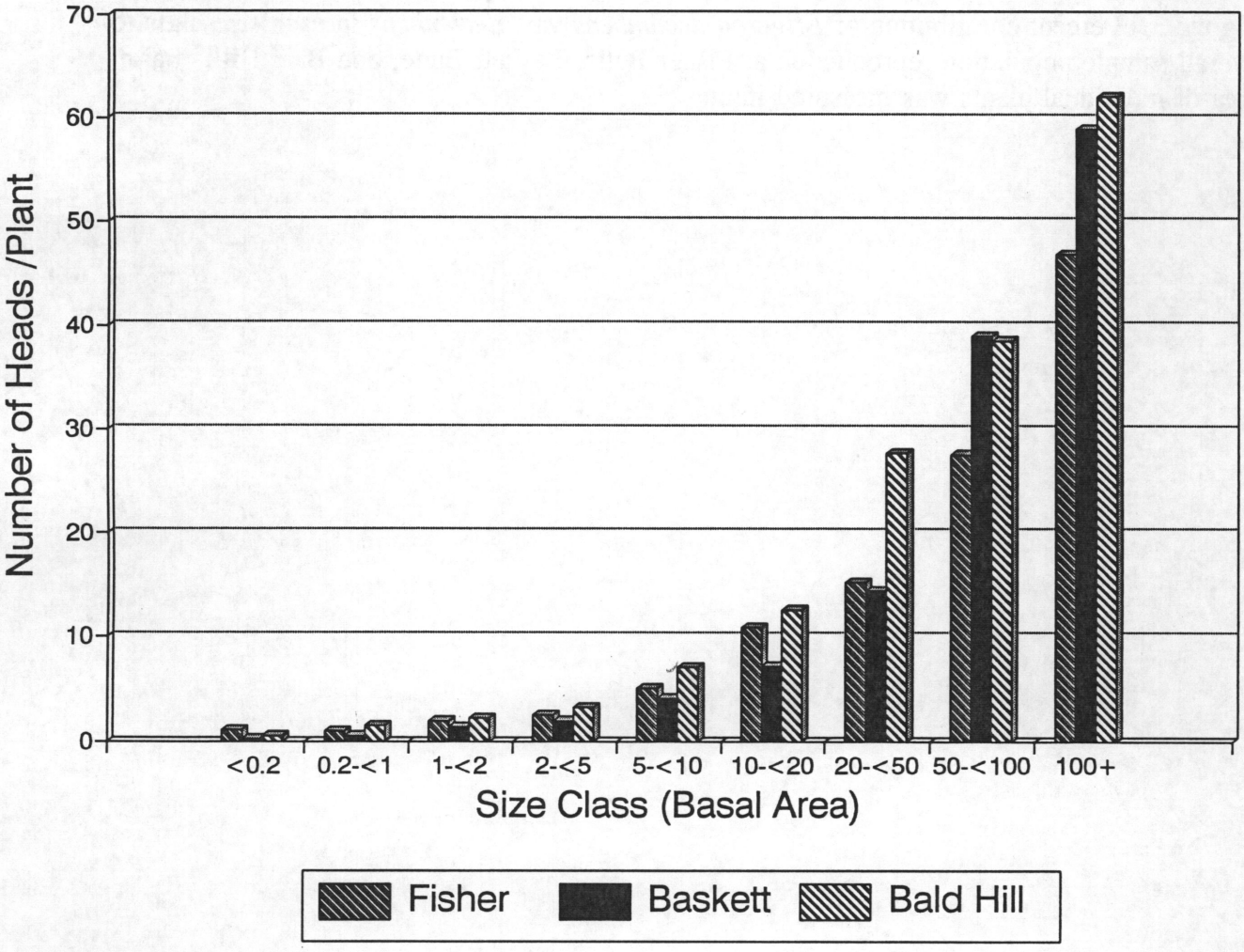

70
60
50
40
30
20
10
0
Number of Heads /Plant
<0.2
0.2-<1
1-<2
2-<5
5-<10
10-<20
20-<50
50-<100
100+
Size Class (Basal Area)
Fisher
Baskett
Bald Hill

Figure 3. Percent contribution of *Erigeron decumbens* var. *decumbens* in each size class to overall sample population reproduction at Fisher Butte, Baskett Butte, and Bald Hill. Basal area of individual plants was measured in cm^2.

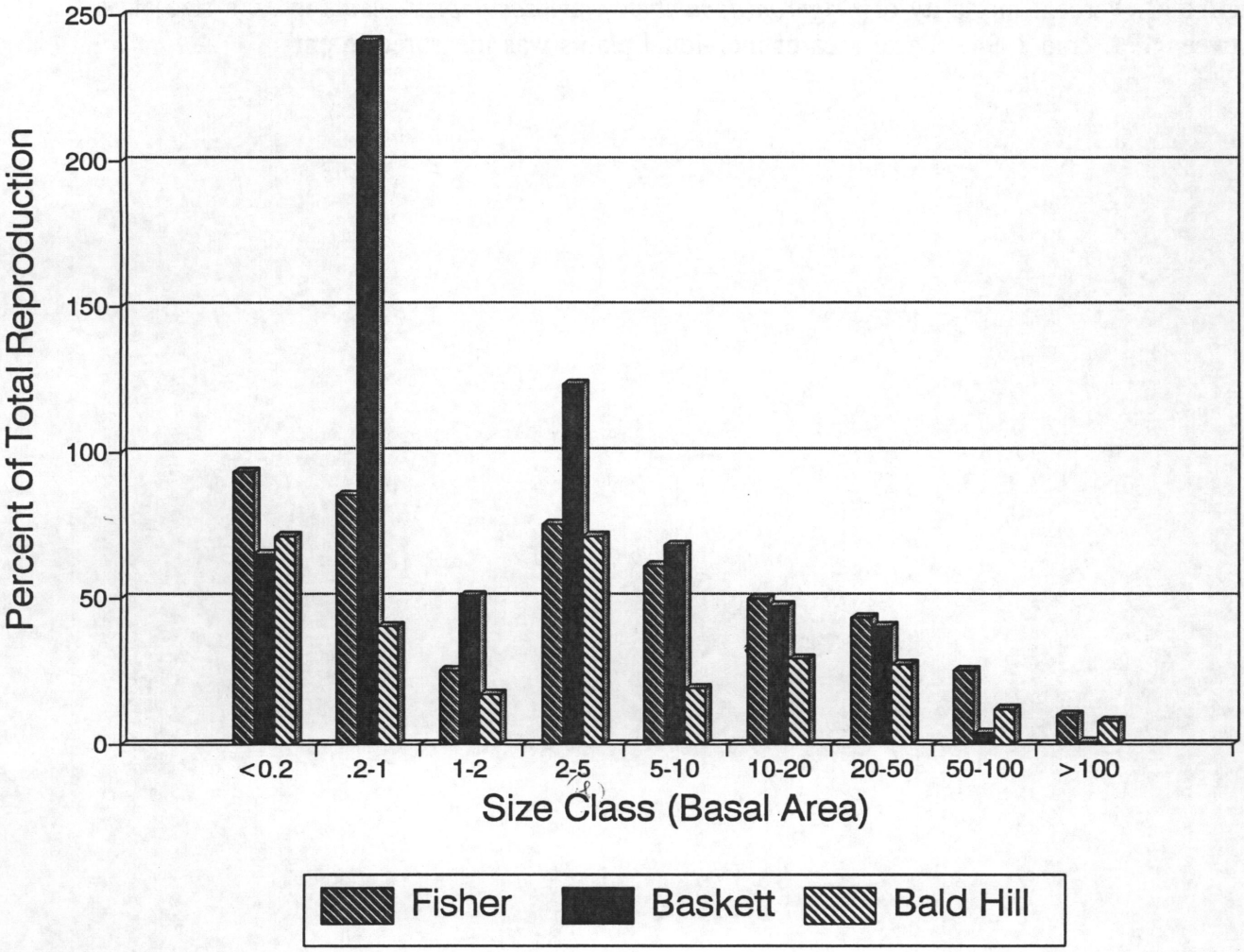

Percent of Total Reproduction
250
200
150
100
50
0
<0.2
.2-1
1-2
2-5
5-10
10-20
20-50
50-100
>100
Size Class (Basal Area)
Fisher
Baskett
Bald Hill

Figure 4. Percent mortality of *Erigeron decumbens* var. *decumbens* plants in each size class between 1993 and 1994. Basal area of individual plants was measured in cm^2.

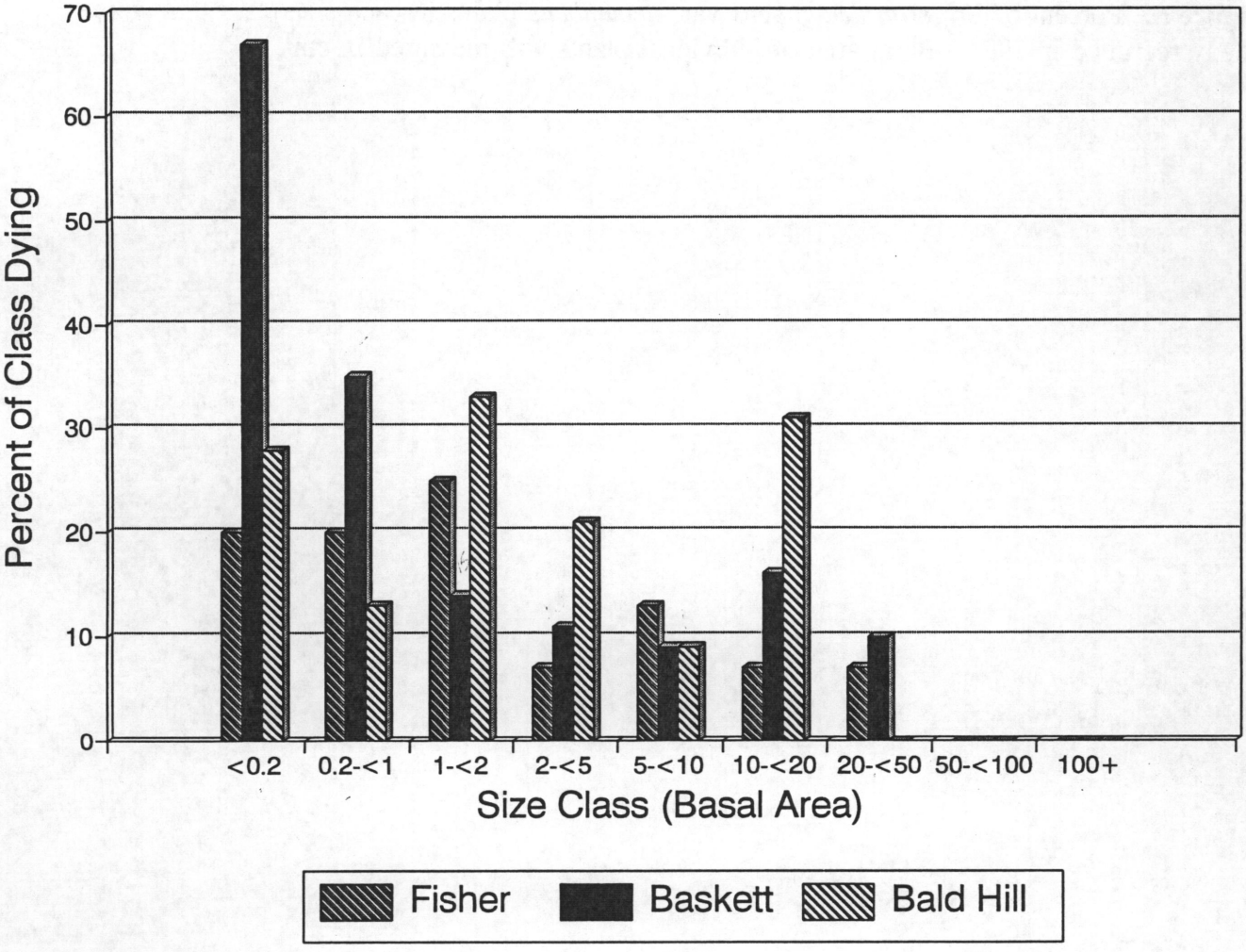
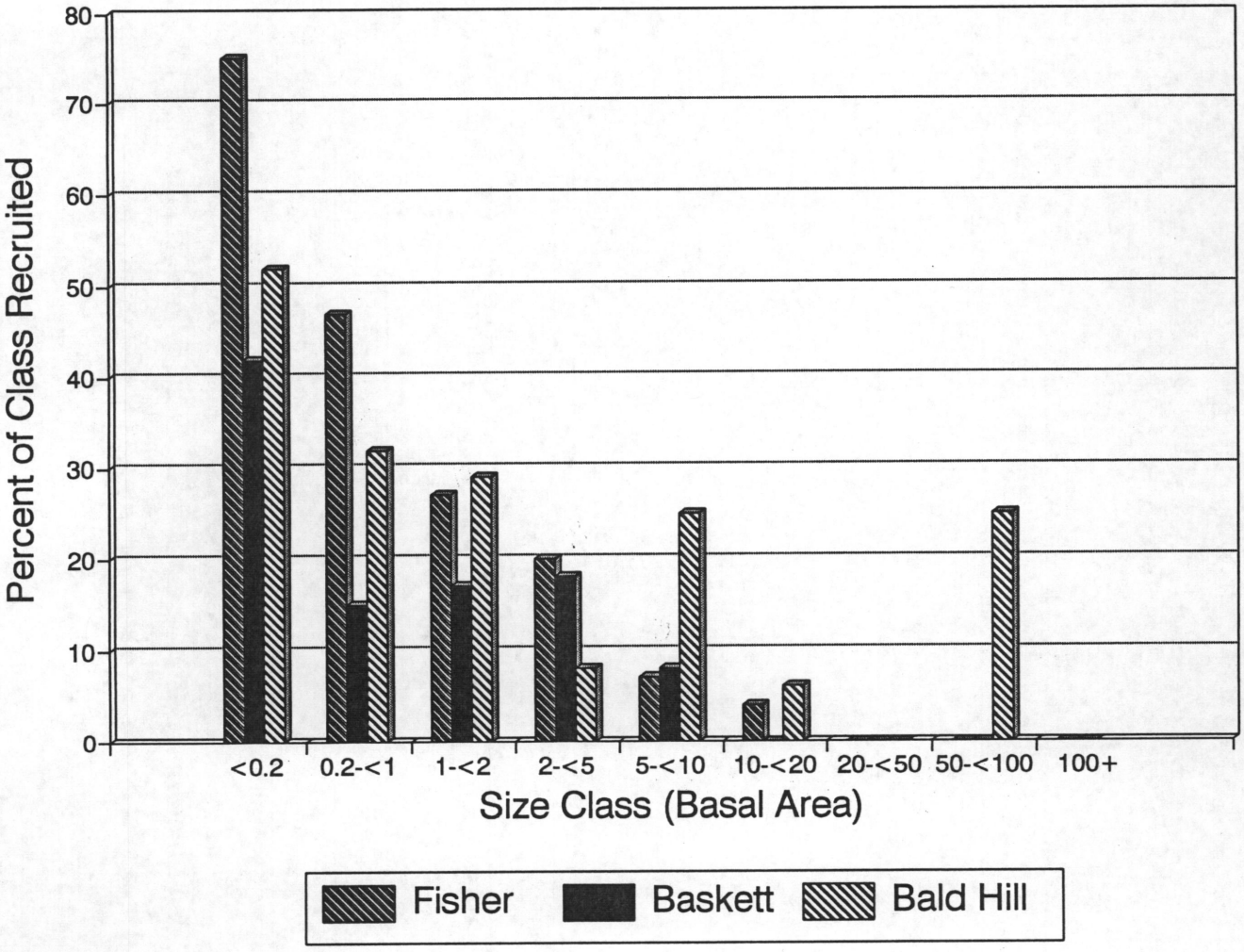

70
60
50
40
30
20
10
0
Percent of Class Dying
<0.2
0.2-<1
1-<2
2-<5
5-<10
10-<20
20-<50
50-<100
100+
Size Class (Basal Area)
Fisher
Baskett
Bald Hill

Figure 5. Percent of *Erigeron decumbens* var. *decumbens* plants in each size class that were newly recruited in 1994. Basal area of individual plants was measured in cm^2.


Percent of Class Recruited
80
70
60
50
40
30
20
10
0
<0.2
0.2-<1
1-<2
2-<5
5-<10
10-<20
20-<50
50-<100
100+
Size Class (Basal Area)
Fisher
Baskett
Bald Hill