Ecological Monitoring of Vascular Plant Resources at the Governor Tom McCall Preserve at Rowena Plateau: Initiation of Long-term Studies for Management.

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Introduction

Until recently, the floristically rich and ecologically intricate bluffs and plateaus of the eastern Columbia River Gorge of north-central Oregon have received little phytosociologic attention. A descriptive study of the unique scabland vegetation on the Gov. Tom McCall Preserve at Rowena Plateau includes delineation of several distinct or intergrading native and non-native vegetation units (Magee and Meinke 1984). Also provided in this report were comments and recommendations regarding the utilization of fire as a management option in the protection and improvement of the quality of vascular plant communities on the preserve. Due to the pervasive, high cover of mostly introduced annual grasses in the swale-mound mosaic of the plateau proper as well as on the southern addition unit (Toule Addition), fire was tentatively ruled out as an effective measure to curb the abundance of exotic species.

In the current study we (1) established permanent transects in the swale-mound mosaic for monitoring compositional changes over time, in order to determine trends in community dynamics; (2) implemented a permanent plot system to monitor population demography of Astragalus hoodianus; and (3) resampled the vernal pool communities.

Monitoring of the vegetation existing in the swale-mound mosaic grasslands is expected to provide information regarding whether the exotic annuals are continuing to increase at the expense of the indigenous flora, or if an equilibrium has been reached due to the cessation of grazing. Astragalus hoodianus is a rare and potentially threatened endemic, thus it is important to monitor this population's stability in terms of recruitment, mortality, and the apparent effects of competing vegetation on recruitment and on mortality. The third aspect of this project was the continuation of an ongoing comparative study of the flora and ecology of the Rowena Plateau vernal pools.

Project Objectives

a. Establishment and first year monitoring of permanent transects or plots for (1) disturbed mound-swale vegetation units on the original purchase land, (2) grassland vegetation of Toule Addition, and (3) Astragalus hoodianus populations. Vegetation units included in the mound-swale mosaic of the original purchase were the swales, mounds, transitional mounds, and transitional swales (Magee and Meinke 1984).

b. Resampling of the upper plateau vernal pools.

c. General vascular plant species inventory for continued update of the McCall Preserve checklist.

d. Preparation of a final report, herein, including map with locations of permanent transects and plots, 35 mm slide photographs of each transect and general vegetation conditions, raw data for each transect or plot, and summary data for each vegetation unit.

Methods

a. Permanent Transects. The permanent transects were established in representative stands of each of the following disturbance communities of the swale-mound mosaic (original purchase); swales, mounds, transitional mounds, and transitional swales. Additional transects were placed in the previously unsampled Toule addition property. Sampling was conducted in each of these communities when cover of vascular plant vegetation was maximum. Transects were marked for relocation by sinking a rebar stake at each end of a line and marking the transect location and compass direction on a map. Data was collected from Daubenmire microplots (0.1 m2) at one meter intervals, beginning at the 0 m mark, along a taut meter tape extended down the transect line. The direction in which the transect was read and the side of the tape on which the microplots were placed are indicated on the raw data forms. Transect lines may vary in length, but all extend at least 20 m. Data taken from each microplot included percent cover, by taxon, of vascular plant species, percent cover of bryophyte crust, percent

cover of exposed mineral soil, and percent cover of exposed rock. Baseline data was summarized in terms of stand cover averages for each species and stand frequencies for each species. Additional summary data included total vascular plant cover, total number of vascular plant species, total number of exotic taxa, % number of exotic taxa, and relative percent cover exotic taxa. This information was calculated both for each stand and each vegetation unit.

b. Astragalus hoodianus permanent plots. Four 2 X 2 m permanent plots to track population development (increase or decline) of Astragalus hoodianus were established. The plots were located in areas with different complements of associated species and varying numbers of Astragalus hoodianus. The plots were marked at the corners with approximately 1 foot lengths of rebar. The rebar was then flagged near ground level. A twine gridwork of 1 m squares was set up over each plot. The approximate locations of reproductive and non-reproductive (generally juvenile) individuals were mapped within each 1 m2 quadrat. Cover of associated species was estimated using a technique employed by J. F. Franklin to avoid problems of parallax encountered in larger samplling plots. The entire plot is divided in two and cover estimated in each half, with maximum cover for a particular species per half not to exceed 50%. The cover values are then summed for each species. The division of the Astragalus plots was along the horizontal line of the gridwork.

c. Vernal pool studies. The two large pools sampled in 1983 were resampled to evaluate changes in composition. For sampling methods see Magee and Meinke (1984).

d. Update of species list. The great diversity of taxa which inhabit the Tom McCall Preserve made it desirable to continue to conduct general floristic inventory, especially considering our 1983 list was based on only two seasons work. A reasonably accurate checklist for the area is particularly important because this region of "east meets west" embraces many taxa reaching their geographic (and in some cases ecologic) limits here.

Results and Discussion

The first year results for a monitoring study are necessarily composed of numerous raw data forms, summary tables, and maps. Preceding the series of tables is a brief summary for each community. Where possible, comparisons with the 1983 community description data are made. Data and descriptive information for 1983 are extracted from Rowena Plateau Nature Preserve Ecological Floristic Inventory: Vascular Plant Resources (Magee and Meinke 1984). The reader is directed to refer to this report for more detail. It is important to note that these comparisons are based on information from different sites in the McCall Preserve. This means they should be viewed with caution since any differences that exist may be site related rather than the

result of growing season variance or other change in growing season conditions. Also, each of the disturbance communities is subject to a wide range in variation in terms of species composition (Magee and Meinke 1984).

Following the body of the report are three Appendices. Appendix A is the most current species list for the McCall Preserve. During floristic inventories 29 taxa previously unlisted were sighted. Appendix B is composed of the raw data forms for all transects and plots. Appendix C is a collection of 35 mm slides illustrating the sampling transects or general characteristics of communities under consideration.

Permanent Transects. Permanent transects were installed for sampling vegetation on mounds, transitional mounds, swales, transitional swales, and the vegetation on the more homogeneous landscape of the Toule addition. The deeper soiled nature of the latter make it similar in physiognomy to the mounds. Map locations for all transects are presented in Figure 1.

a. Swales. The swale disturbance community (Magee and Meinke 1984) is represented by one transect, plot number 4-1 (See Appendix C for photo). Due to dry spring conditions in 1984 most of the shallow soiled swales were past sampling condition during late April when the project began. As a result, an unusually wet swale site, near an ephemeral

stream, was selected for monitoring. This site should be consistently available for sampling from year to year.

Swales are characterized by common exotic taxa outranking native dominants in cover. The vegetation of these sites is predominantly composed of species falling into annual or ephemeral perennial growth form. Species composition varies substantially from site to site. Percent total vascular plant cover is low (23-53%) with relative cover exotic species quite high (53-62%) (Magee and Meinke 1984). Total vascular plant cover in this wetter site swale was slightly higher at 62% (Table 1). Relative cover of exotics at 70% was also more pronounced. Swales often have an extensive mat of dessication tolerant mosses. The site sampled in 1984 lacked this characteristic. Also the permanent swale transect averaged only 3% exposed mineral soil whereas in the drier swale sites bare ground is quite common. There is also a shift in exotic species on the 1984 site compared to swales sampled in the previous year. The major invaders of drier swales, Bromus tectorum and Bromus rigidus are replaced in the wetter site by Bromus mollis and Hordeum jubatum. Among the native species present in the wet site there are fewer ephemerals than at swales with a less persistent water source.

b. Transitional Swales. Transitional swales are broad, slightly sloping intermounds that grade into deep-soiled mounds. Compositionally they possess vegetation elements of

both swales and mounds (Magee and Meinke 1984). Four permanent transects were established in this vegetation unit (numbers 2-1 through 2-4 , Appendix C for photos). The percent total vascular plant cover was much reduced in the 4 permanent transect sites (59%) compared to sites sampled in 1983 (133%). This may be related to differences in growing season weather conditions. However, it is certainly related to a compositional change. Several native annual Trifolium species dominated this landform in 1983. Among these are Trifolium microcephalum, Trifolium tridentatum, Trifolium microdon, Trifolium variegatum, and Trifolium oliganthum. The abundance of these five taxa shifted from site to site but were always present in some combination. During the 1984 field season these species were absent. We spent considerable time looking for patches of these species without success. Trifolium microcephalum and Trifolium tridentatum were most abundant in 1983 with 20% and 35% cover, respectively. The other three Trifolium species occurred in low abundances It is possible that in our search these less common species were overlooked and did not suffer a substantial change in abundance. However, the two dominants which formerly carpeted the slopes of the transitional swales were absent or at least diminished in cover such that they were not found. This suggests 1) specific germination requirements which were not met in 1984 or 2) the seed germinated and were killed by late frost or dessication because of low vernal precipitation. This

phenomenon presents several interesting questions. Do the annual Trifolium species represented in this case have a seed bank? What is the longevity of their seeds? What are the specific requirements for germination? How often do such population fluxes occur and to what environmental characteristics are they related? Finally, what affect do these fluxes in abundance have on the abundance and vigor of associated native and exotic species?

Another reason for the decline in cover in 1984 vs. 1983 is the reduction in abundance of the introduced grass, Festuca bromoides (40% in 1983 vs. 1% in 1984). This species occurs mostly in depressions or lower sections of the transitional swales and requires vernal moisture. The more dessication tolerant bromes (e.g. Bromus mollis and Bromus rigidus) increased in cover during 1984. Festuca microstachys (7% cover) was the most common native species found in the 1984 growing season. During 1983, among native taxa, it followed the native Trifoliums in abundance. The low abundance, showy forbs present in 1983 were also present in 1984 (Table 2).

c. Mounds. The mounds of Rowena Plateau are deep-soiled landforms elevated 1-3 m above the surrounding swales. They are characterized by dense graminoid and large forb dominated vegetation. The four permanent transects established on mound vegetation are numbered 3-1 through 3-4 (Appendix C for photos). Total vascular plant cover is

reduced in 1984 (83%) (Table 3) compared to 1983 (125%) consistent with 1984 growing season conditions. With the reduction in total cover comes an increase in relative cover exotic species, 36% in 1983 and 67% in 1984. This may be a response of 1) greater resistance of weeds to drought, or 2) a decline in competitive interference against exotics by native perennials.

Species composition is variable from mound to mound. For example, Balsamorhiza careyana and Festuca idahoensis may occur in high abundance or be absent. The latter species, Festuca idahoensis is locally present at cover levels up to 50% on the lower plateau but is not common on the upper plateau which has suffered greater disturbance than the lower plateau (Magee and Meinke 1984). All of the permanent transects were located on the more disturbed upper plateau both for the purpose of monitoring improvement in vegetation with time since disturbance and for easier access to the sampling transects. Festuca idahoensis did not occur in the sampled transects in 1984. Balsamorhiza careyana was locally abundant ranging form 0 to 19% cover (Table 3). On the sites sampled in 1983 cover for this species ranged from 20 to 60%. These large shifts in abundance are more likely related to site difference rather than growing season fluctuations. This statement is probably appropriately applied to most apparent shifts in species abundance of deep rooted forbs between the two years on the mound landforms. Trifolium microcephalum which was found at 5% cover on the

1983 sites was absent from the 1984 transects. Marah oreganus occurred at an average of 6% cover in 1984 but was not found in the 1983 sampled sites. Lupinus sericeus and Lupinus latifolius were both encountered at approximately 2 % cover in 1984 an increase compared to the 1983 sites. Many of the low cover native grasses and showy forbs occur at similar abundances.

There is a general increase in the cover of the common exotic grass species Bromus rigidus which shifts from 23% in 1983 to 36% in 1984. Bromus mollis goes from 3% to 10 % in the same period. Both taxa are mesic site organisms and tend to grow on deeper soils of the mound tops. Bromus tectorum which generally is found on the drier sloping sides of mounds exhibits < 1% cover on 1984 sites compared to 10% cover on 1983 locations.

d. Transitional Mounds. The vegetation of shallow-soiled transitional mounds is most closely aligned with that occurring in swales. Transitional mound vegetation is characterized by short-statured taxa and a substantial underlying dessication tolerant moss mat (See Magee and Meinke 1984). The permanent transects located on transitional mounds are illustrated in Appendix C, transect numbers 1-1 through 1-4. Few differences exist between data collected from this landform type in 1983 and 1984. There is an increase in total vascular plant cover from 58% in 1983 to 76% in 1984 (Table 4). While, this contrasts to

declines in cover on other landform types it is not unexpected. Most of the plant cover is composed of annual and ephemeral perennial taxa which are adapted to a xeric moisture regime. The relative cover of exotic species is similar in 1984 vs. 1983, 80% and 88% respectively. The greater number of sampling microplots along the permanent transects allowed detection of more low cover native species in 1984. The three most abundant exotic species occurred with moderate cover differences between 1983 and 1984 sites. Festuca bromoides had 25% cover in 1983 and 17% in 1984. Bromus tectorum occurred at 25% cover in 1983 vs. 36% in 1984. Bromus mollis was present with 1% cover in 1983 and 5% in 1984. The showy forbs such as Sisyrinchium douglassii remained relatively constant at low cover values, 1% or less. Poa sandbergii which occurred at < 1% the first year was found at 3% cover on the permanent transects.

Toule Addition. The landscape of the Toule Addition to Gov. Tom McCall Preserve is a large rolling grassland, more homogeneous than the swale-mound mosaic occupying the initial purchase property. Physiognomy resembles the mounds of the lower plateau. However, the number and cover of exotic species are reduced. Overall, the vegetation of the Toule Addition is in much better condition. Two 30 m transects (numbers 1 and 2) were placed on the Addition. Only 11 out of the 42 species encountered during sampling

were introduced (Table 5). Total vascular plant cover was 79% with 26% relative cover alien species.

The most common native species were Balsamorhiza careyana (16% cover), Festuca idahoensis (11% cover), Agropyron spicatum (9% cover), and Lupinus latifolius (8% cover). Several other native taxa occur with moderate frequency but low cover. Among these are Haplopappus carthamoides (3% cover), Festuca myuros (1.8% cover), Achillea millifolium (2% cover), Lomatium nudicale (1% cover), and Astragalus hoodianus (1% cover). Many less common native species are also present (Table 5).

The two most prevalent weed species are both members of the genus Bromus. Both are quite ubiquitous with over 93% frequency. Bromus mollis has greatest abundance with 12% cover and Bromus tectorum follows with 7% cover. A third alien which is visually quite noticeable is Tragapogon dubius. It however, occurs at only 1% cover.

Astragalus hoodianus permanent plots. Four permanent plots (2 X 2 m) were established to follow population changes in Astragalus hoodianus. The plots were located in areas with varying numbers of Astragalus hoodianus individuals and with different groups of associated species. The percent cover of each species occurring within these plots is given in Table 6. Diagrams of the plots with map locations of Astragalus hoodianus individuals, either reproductive or

non-reproductive, are present in Figure 2. Locations of each plot on the Toule Addition are given in Figure 1.

Little can be said from first year sampling regarding directional trends in the population development of Astragalus hoodianus. However, it can be observed that larger numbers of Astragalus hoodianus are associated with high levels of total vascular plant cover and lower relative covers of exotic species.

Vernal Pools. The two large vernal pools sampled in 1983 were resampled in 1984. Transects were relocated as precisely as possible. End markers placed in 1983 were largely intact so relocation along compass lines was relatively accurate. Pool size was different between sampling years with boundaries migrating inward in 1984. This is apparent in reduced transect lengths which are indicated on the raw data forms. Vernal pool maps (see Magee and Meinke 1984) were not redrawn as the shape of the pools appeared constant.

Compositional and abundance information for the sampled vernal pool is presented in Table 7. There was a general reduction in abundance of exotic species in 1984 compared to 1983. Particularly important was the absence of Festuca bromoides in pool 1 and Hordeum jubatum in pool 2. Reduced abundance was also observed for several native species including Veronica peregrina and Montia linearis in both pools, Mimulus breviflorus and Gnaphalium palustris in pool

1, and Eremocarpus setigerus and Deschampsia danthanioides in pool 2.

Several native species exhibited increased cover and frequency. A large upswing in the abundance of Deschampsia danthanioides occurred in pool 1. Gratiola ebracteata increased slightly in pool 2 and Myosurus minimus was more common in both pools. Abundance of the Plagiobothrys spp. in both pools was elevated from 1983. Plagiobothrys leptocladus and P. scouleri var. penicillatus occur in a an apparent hybrid swarm. In pool 1 where the moisture gradient is more pronounced the two species are identifiable at gradient extremes. However, plants occurring at intermediate moisture levels exhibit morphological characteristics of both taxa. In pool 2 all Plagiobothrys plants exhibit intermediate morphology so are referred to without a species epithet.

Some species present in 1983 were not encountered in 1984. These were generally edge species often found in adjacent communities and included Lotus purshiana, Saxifraga integrifolia, Achillea millefolium, Lithophragma sp., and Festuca sp. There was one important absence, Isoetes nuttallii, a vernal pool plant that had rare occurrence in 1983.

Table 1. Swale permanent plot summary data. C = % cover, F = % frequency, T = % cover < 0.1 %. Transect 20 m with 20 0.1 m2 micropolts.

	Transect 1	
Native Species	C	F
Mimulus guttatus	8.7	55
Navarretia divaricata	2.6	25
Alopecurus saccatus	2.1	25
Rorippa islandica	1.5	5
Montia linearis	0.8	55
Boisduvalia densiflora	0.5	35
Dodecatheon poeticum	0.4	5
Plagiobothrys figuratus	0.3	10
Festuca myuros	0.2	10
Brodiaea hyacinthina	0.1	5
Achillea millefloium	T	5
Cerastium arvense	0.3	50
Nemophila pedunculata	T	10
Exotic species		
Hordeum jubatum	41.3	95
Myosotis discolor	1.3	10
Aira caryophyllea	0.9	15
Plantago lanceolata	0.4	5
Bromus mollis	0.2	10

Table 1. Swale permanent plot summary data. (Cont.) 17

	Transect 1	
Exotic species	C	F
Poa bulbosa	0.1	10
Bromus tectorum	T	5
Vicia sativa	T	10
Lactuca serriola	T	5
Rumex acetosella	T	5

Total Number Vascular Plant Species	23
Number Exotic Plant Species	12
% Number Exotic Plant Species	52
% Cover Total Vascular Pant Cover	62.3
% Cover Exotic Plant Species	44.2
% Relative Cover Exotic Plant Species	70.9

Species occurring on site but outside plots

Veronica perigrina

Trifolium sp.

Lithophragma tenella

Plectritis macrocera

Veronica arvensis

Galium aparine

Table 2. Transitional Swale permanent plot summary data. C = % cover, F = % frequency, T = % cover < 0.1%.

	Transect 1		Transect 2		Transect 3		Transect 4		Overall	
Native Species	C	F	C	F	C	F	C	F	C	F
Achillea millefolium	0.2	20	4.4	15	5.5	20	0.1	10	2.8	16
Brodiaea howellii	0.1	10	0.3	5	0	0	0.1	5	T	5
Eriogonum strictum	T	5	0	0	0	0	0.1	5	T	3
Lagophylla ramosissima	0.2	50	0	0	0	0	0	0	T	13
Lomatium macrocarpum	0.4	5	0.8	5	0	0	2.7	10	1.0	5
Festuca microstachys	6.4	100	13.7	70	0	0	8.3	90	7.1	65
Eriogonum spherocephalum	0.3	5	0.5	5	1.0	5	0.5	5	0.6	5
Frittilaria pudica	T	5	0	0	0	0	0	0	T	1
Collinsia parviflora	T	15	0	0	0.3	30	0	0	T	11
Collinsia rattanii	T	20	0	0	0.1	10	0	0	T	8
Madia minima	T	25	0	0	0	0	0	0	T	6
Epilobium paniculatum	T	15	0	0	0	0	0.2	5	T	5
Sisymbrium altissimum	0.3	10	0	0	0	0	0	0	T	3
Amsinckia intermedia	0.2	15	0	0	0	0	0.3	10	0.1	6
Phacelia heterophylla	T	5	0	0	0	0	0	0	T	1
Eriogonum compositum	0	0	0.3	5	0	0	10.3	35	2.6	10

Table 2. Tansitional Swale permanent plot summary data. (Cont) 19

	Transect 1		Transect 2		Transect 3		Transect 4		Overall	
Native Species	C	F	C	F	C	F	C	F	C	F
Plectitis macrocera	0	0	0.2	15	0	0	0	0	T	4
Nemophilla pedunculata	0	0	0.2	5	0	0	0	0	T	1
Navarretia sp.	0	0	T	5	0	0	0	0	T	1
Pectocarya pusilla	0	0	T	5	0	0	0	0	T	1
Dodecatheon poeticum	0	0	0	0	3.5	10	0	0	0.9	3
Orthocarpus attenuatus	0	0	0	0	T	10	0	0	T	3
Draba verna	0	0	0	0	T	15	0	0	T	4
Lupinus bicolor	0	0	0	0	T	5	0	0	T	1
Veronica peregrina	0	0	0	0	T	25	0	0	T	6
Cerastium arvense	0	0	1.0	5	0	0	0	0	T	1
Exotic species										
Bromus mollis	19.6	100	10.0	20	0	0	14.4	90	10.9	40
Bromus rigidus	33.9	100	8.1	40	3.0	5	28.0	100	18.5	61
Bromus tectorum	0.3	65	0.7	30	0	0	0.1	30	0.3	31
Tragapogon dubius	0.7	10	0	0	0	0	T	5	0.6	5
Erodium cicutarium	0.5	95	0	0	0.3	25	T	5	0.2	31
Aira caryophyllea	0.8	90	0	0	2.3	20	0	0	0.8	28
Lactuca serriola	T	20	0.3	25	0	0	0.8	45	0.3	23
Festuca bromoides	4.6	100	T	5	0	0	0.3	30	1.3	34
Poa bulbosa	0.5	70	T	5	T	15	2.0	40	0.7	33
Geranium molle	0	0	3.5	15	0.3	35	T	5	1.0	14

Table 2. Tansitional Swale permanent plot summary data. (Cont) 20

	Transect 1		Transect 2		Transect 3		Transect 4		Overall	
Exotic Species	C	F	C	F	C	F	C	F	C	F
Vicia sativa	0	0	4.8	15	0	0	0.4	5	1.3	5
Rumex acetosella	0	0	0	0	0	0	0.2	5	T	1
Galium aparine	0	0	0	0	2.5	30	0	0	0.6	8
Hordeum jubatum	0	0	0	0	1.9	20	0.4	15	0.6	9
Veronica arvensis	0	0	0	0	T	15	0	0	T	4
Centaurea cyanus	25.7	100	0	0	0	0	0	0	6.4	25

Total Number Species	25	19	17	21	48
Number Exotic Species	10	9	7	12	18
Percent Number Exotic Species	40.0	47.4	41.2	57.1	37.5
Percent Total Vascular Plant Cover	95.6	49.2	21.3	70.4	58.8
Percent Cover Exotic Species	86.7	28.6	10.5	47.8	40.9
Percent Relative Cover Exotic Species	90.7	58.1	49.3	67.9	69.6

Table 3. Mound permanent plot summary data. C = % cover, F = frequency, T = % cover < 0.1%.

	Transect 1		Transect 2		Transet 3		Overall	
Native Species	C	F	C	F	C	F	C	F
Balsamorhiza careyana	18.5	30	0	0	0	0	6.1	10
Brodiaea howellii	0.2	20	T	5	0	0	T	8
Plectritis macrocera	0.4	70	0	0	0	0	0.1	23
Eriogonum compositum	4.6	20	0	0	8.5	30	4.4	17
Amsinckia intermedia	1.6	25	11.3	25	0	0	4.3	17
Eriogonum strictum	1.3	5	0	0	0	0	0.4	2
Lomatium triternatum	0	0	T	5	0	0	T	2
Achillea millefolium	3.0	45	0	0	2.0	25	1.9	23
Bromus carinatus	0	0	1.5	5	0	0	0.5	2
Eriogonum elatum	3.2	25	T	10	0	0	1.1	12
Epilobium paniculatum	0.4	20	2.9	25	0.1	5	1.1	17
Collomia grandiflora	0.1	30	0	0	0.3	25	0.1	18
Lupinus sericeus	6.0	30	0	0	0	0	2.0	10
Stipa lemmonii	0.3	15	0	0	0	0	T	5
Lagophylla ramosissima	T	20	0	0	0	0	T	7
Lupinus latifolius	0	0	5.8	20	0	0	1.5	8
Microseris troximoides	0	0	1.0	5	1.5	5	0.8	3

Table 3. Mound permanent plot summary data. (Cont.)

	Transect 1		Transect 2		Transet 3		Overall	
Native Species	C	F	C	F	C	F	C	F
Marah oreganus	0	0	7.8	10	11.0	15	6.3	8
Collomia sp.	0	0	1.0	15	0	0	T	5
Eriogonum spherocephalum	0	0	0.4	10	0	0	0.1	3
Festuca microstachys	1.1	75	0	0	0	0	0.4	25
Sisymbrium altissimum	0	0	5.5	10	0	0	1.8	3
Thysanocarpus curvipes	0.2	20	0	0	0	0	T	7
Exotic Species								
Bromus rigidus	13.2	80	62.3	95	32.8	75	36.1	82
Bromus mollis	0	0	28.9	100	1.0	10	10.0	37
Anthriscus scandicina	0.4	20	3.6	5	0.3	5	1.4	10
Bromus tectorum	T	5	T	10	0.3	35	0.2	17
Centaurea cyannus	1.6	55	2.0	10	0	0	1.2	20
Lactuca serriola	0	0	9.5	15	0	0	3.2	5
Poa bulbosa	0.8	60	0	0	0	0	0.3	20
Erodium cicutarium	5.4	70	0	0	0.3	25	1.9	32
Plantago lanceolata	T	10	0.1	10	0	0	T	7
Vicia sativa	0.1	15	T	5	1.0	5	0.4	8
Tragapogon dubius	T	5	0.1	10	0	0	T	5

Table 3. Mound permanent plot summary data. (Cont.)

	Transect 1		Transect 2		Transet 3		Overall	
Exotic Species	C	F	C	F	C	F	C	F
Geranium molle	0	0	1.4	15	0	0	0.4	5
Rumex acetosella	0	0	0	0	0.2	20	T	6
Festuca bromoides	0.9	40	0	0	0	0	0.3	13
Total Number Species	27		21		17		40	
Number Exotic Species	8		8		8		13	
Percent Number Exotic Species	29.6		38.1		47.1		32.5	
Percent Total Vascular Plant Cover	68.6		144.3		61.3		83.0	
Percent Cover Exotic Species	22.3		106.6		37.3		55.6	
Percent Relative Cover Exotic Specis	32.5		74.0		60.8		67.0	

Table 4. Transitional mound permanent plot summary data. C = % cover, F = % frequency, T = % cover < 0.1 %.

	Transect 1		Transect 2		Transect 3		Transect 4		Overall	
Native Species	C	F	C	F	C	F	C	F	C	F
Plectritis macrocera	3.4	70	0	0	0	0	0.2	40	0.9	28
Microseris troximoides	0.5	55	0.2	65	0.2	45	0	0	0.3	42
Collinsia parviflora	1.3	85	0.5	50	T	10	T	10	0.5	39
Sisyrinchium douglasii	1.0	55	1.2	50	1.3	70	0.6	40	1.0	54
Selaginella wallacii	0.8	5	0	0	0.8	25	0.9	30	0.6	15
Allium accuminatum	T	5	T	5	T	5	T	5	T	5
Lomatium sp.	2.0	65	0	0	0	0	0	0	0.5	16
Achillea millefolium	0.4	10	0.2	5	0.2	10	0.1	5	0.3	8
Cerastium arvense	0.3	80	3.1	85	0	0	0	0	0.9	41
Lupinus bicolor	T	10	T	10	T	5	0	0	T	6
Idahoa scapigera	0.1	60	T	45	T	30	0.1	45	0.1	45
Poa sandbergii	2.3	45	0.2	10	3.8	50	5.2	85	2.9	48
Orabanche uniflora	T	20	T	15	0	0	0	0	T	9
Eriogonum strictum	0.8	10	T	5	1.3	35	0.2	10	0.6	20
Vulpia sp.	T	5	1.3	45	0	0	0.5	30	0.5	20
Nemophila pedunculata	T	5	0	0	0	0	0	0	T	1

Table 4. Transitional mound permanent plot summary data. (Cont.) 25

	Transect 1		Transect 2		Transect 3		Transect 4		Overall	
Native Species	C	F	C	F	C	F	C	F	C	F
Microsteris gracilis	0.1	15	0.3	55	T	5	0.6	65	0.3	35
Poa sp.	1.1	15	T	5	0	0	0	0	0.3	5
Lagophylla ramosissima	T	10	T	5	T	15	T	30	T	15
Pectocarya pusilla	T	5	0	0	0	0	0	0	T	1
Collinsia rattanii	0.3	25	0.2	35	T	5	0.3	75	0.2	35
Plagiobothrys nothofulvus	T	20	T	5	T	20	T	5	T	13
Epilobium paniculatum	0.1	10	0.4	25	T	15	T	5	0.2	14
Draba verna	0.2	30	T	20	T	35	T	30	0.1	29
Saxifraga integrifolia	0.3	5	T	5	0	0	T	5	0.1	4
Linanthus bicolor	0	0	1.2	55	0	0	0	0	0.3	14
Lithophragma bulbifera	0	0	T	10	0	0	0	0	T	3
Lomatium macrocarpum	0	0	1.8	70	0.8	10	2.3	80	1.2	40
Veronica sp.	0	0	0.8	5	T	5	T	5	0.3	4
Eriogonum compositum	1.0	10	1.4	15	2.8	40	1.0	20	1.6	21
Cardamine oligosperma	0	0	T	10	T	5	0	0	T	4
Eriogonum sphaerocephalum	0	0	0	0	1.9	25	T	5	0.5	8
Stipa lemmonii	0	0	0	0	1.9	15	0.4	10	0.6	6

Table 4. Transitional mound permanent plot summary data. (Cont.) 26

	Transect 1		Transect 2		Transect 3		Transect 4		Overall	
Native Species	C	F	C	F	C	F	C	F	C	F
Agoseris heterophylla	0	0	0	0	0	0	1.1	90	0.3	23
Trifolium macrocephalum	0	0	0	0	0	0	T	5	T	1
Polygonum aviculare	0	0	0	0	0	0	T	5	T	1
Crocidium multicaule	0	0	0	0	0	0	T	5	T	1
Epilobium minutum	0	0	0	0	0	0	T	15	T	3
Exotic Species										
Bromus tectorum	48.3	100	38.2	100	47.5	100	9.4	100	35.9	100
Erodium cicutarium	1.1	90	0.8	95	0.5	100	0.2	65	0.7	88
Bromus rigidus	0.6	20	0.3	10	0.3	20	0	0	0.3	13
Festuca bromoides	9.1	85	29.8	95	20.7	100	7.1	95	16.7	73
Holosteum umbellatum	T	5	0	0	T	5	0	0	T	3
Polygonum lapathifolium	0.2	5	0	0	0	0	0	0	T	1
Bromus mollis	0	0	9.5	100	3.2	100	7.1	100	5.0	75
Poa bulbosa	0	0	1.8	70	0.8	10	2.3	80	1.2	40
Lactuca serriola	0	0	0	0	0.2	30	0	0	0.5	8
Cerastium viscosum	0	0	0	0	1.9	15	0.4	10	0.6	7
Aira caryophyllea	0	0	0	0	T	10	T	10	T	5

Table 4. Transitional mound permanent plot summary data. (Cont.) 27

	Transect 1	Transect 2	Transect 3	Transect 4	Overall
Total Number Species	32	32	31	34	49
Number Exotic Species	6	5	10	7	11
Percent Number Exotic Species	18.8	15.6	32.3	20.6	22.4
Percent Total Vascular Plant Cover	71.2	92.7	89.0	38.8	75.6
Percent Cover Exotic Species	54.4	69.9	72.8	26.3	60.3
Percent Relative Cover Exotics	76.4	75.4	81.8	67.8	79.8

Table 5. Toule Addition Summary Data. C = % cover, F = frequency, T = % cover < 0.1%. 30 microplots per transect.

	Transect 1		Transect 2		Overall	
Native Species	C	F	C	F	C	F
Balsamorhiza careyana	21.9	63.3	10.8	40.0	16.4	51.7
Astragulus hoodianus	2.2	23.3	0.2	6.7	1.2	15.0
Agropyron spicatum	5.1	30.0	13.2	56.7	9.2	43.3
Achillea millefolium	1.8	33.3	1.7	53.7	1.8	43.3
Lomatium nudicale	1.0	46.7	1.8	50.0	1.4	48.3
Festuca myuros	2.6	70.0	0.9	36.7	1.8	53.3
Epilobium paniculatum	T	3.3	T	6.7	T	5.0
Madia minima	T	3.3	0	0	T	1.6
Festuca idahoensis	8.6	33.3	13.3	56.7	11.0	45.0
Lagophylla ramosissima	T	10.0	T	6.7	T	8.3
Agoseris heterophylla	0.1	10.0	0.1	30.0	0.1	20.0
Lupinus latifolius	13.1	60.0	3.2	26.7	8.2	43.3
Orthocarpus attenuatus	T	3.3	0	0	T	1.7
Haplopappus carthamoides	2.4	10.0	2.6	26.7	2.5	18.3
Lupinus micranthus	T	3.3	0	0	T	1.7
Allium acuminatum	T	6.7	0	0	T	3.3
Poa sandbergii	T	3.3	0	0	T	1.7
Plectritis macrocera	T	3.3	T	6.7	T	5.0
Collomia sp.	T	16.7	T	10.0	T	13.3
Festuca microstachys	0.7	30.0	0.4	36.7	0.5	33.3
Madia citriodora	0.4	30.0	0.4	46.7	0.4	38.3

Table 5. Toule Addition Summary Data. (Cont.)

	Transect 1		Transect 2		Overall	
Native Species	C	F	C	F	C	F
Amsinckia intermedia	1.3	20.0	T	13.3	0.7	16.7
Microseris troximoides	0.1	10.0	0.4	36.7	0.3	23.3
Eriophyllum lanatum	0	0	1.7	20.0	0.9	10.0
Sisyrinchium douglasii	0	0	T	3.3	T	1.7
Sitanion hystrix	0	0	0.2	16.7	0.1	8.3
Linathus bicolor	0	0	T	6.7	T	5.0
Lomatium macrocarpum	0	0	T	3.3	T	1.7
Brodiaea howellii	0	0	T	3.3	T	1.7
Stipa lemmonii	0	0	0.2	3.3	0.1	1.7
Exotic Species						
Bromus mollis	7.2	86.7	16.7	100	11.9	93.3
Bromus tectorum	9.1	96.7	4.3	86.7	6.7	91.7
Galium aparine	T	26.7	T	13.3	T	20.0
Cerastium viscosum	T	10.0	T	6.7	T	8.3
Tragapogon dubius	1.7	56.7	0.4	26.7	1.1	41.7
Aira caryophyllea	T	33.3	T	16.7	T	25.0
Poa bulbosa	0.1	13.3	T	16.7	T	15.0
Erodium cicutarium	T	26.7	0.1	26.7	T	26.7
Myosotis discolor	T	3.3	T	6.7	T	5.0
Anthriscus scandicina	0.2	26.7	T	6.7	0.1	16.7
Fesutca bromoides	0.1	20.0	0.3	33.3	0.2	26.7

Table 5. Toule Addition Summary Data. (Cont.) 30

	Transect 1	Transect 2	Overall
Total Number Species	34	36	42
Number Exotic Species	11	11	11
Percent Number Exotic Species	32.4	30.6	26.2
Percent Total Vascular Plant Cover	80.7	74.2	78.7
Percent Cover Exotic Species	18.7	22.3	20.5
Percent Relative Cover Exotic Species	23.2	30.1	26.0

Table 6. Percent cover of associated species in *Astragulus hoodianus* plots and number of *A. hoodianus* plants in plots.

	Plot 1	Plot 2	Plot 3	Plot 4
Number *Astragulus hoodinanus* plants	16	12	10	47

	Percent Cover			
Native Species	Plot 1	Plot 2	Plot 3	Plot4
Astragulus hoodianus	23	15	9	40
Lagophylla ramosissima	11	0	T	T
Balsamorhiza careyana	3	25	0	24
Epilobium paniculatum	T	3	0	1
Achillea millefolium	3	T	0	4
Collomia sp.	T	T	0	0
Allium accuminatum	T	0	T	T
Agropyron spicatum	15	21	0	10
Amsinckia intermedia	T	0	T	0
Frittilaria pudica	T	0	0	T
Calochortus macrocarpus	T	T	0	0
Microseris troximoides	T	T	0	T
Sitantion hystrix	40	0	45	17
Haplopappus carthamoides	0	15	0	2
Lupinus laxiflorus	0	3	0	0
Festuca idahoensis	0	5	0	18
Lomatium nudicale	0	12	7	2

Table 6. Percent cover of associated species in *A.hoodianus* plots 32

	Percent Cover			
Native Species	Plot 1	Plot 2	Plot 3	Plot4
Festuca microstachys	0	1	T	1
Lupinus sericeus	0	T	0	0
Lomatium triternatum	0	0	2	0
Stipa lemmonii	0	0	3	0
Plagiobothrys nothofulvus	0	0	T	0
Fraseria albicaulis	0	0	0	18
Linanthus bicolor	0	0	0	T
Eriophyllum lanatum	0	0	0	T
Exotic Species				
Bromus tectorum	17	30	2	10
Bromus mollis	13	25	T	T
Myosotis discolor	T	T	0	0
Erodium cicutarium	T	T	0	0
Tragapogon dubius	1	4	2	T
Aira caryophyllea	2	0	13	20
Madia citriodora	T	1	T	T
Poa bulbosa	T	T	0	T
Festuca bromoides	0	T	0	T
Galium aparine	0	T	0	T
Holosteum umbellatum	0	T	0	T
Cerastium viscosum	0	T	0	0
Geranium molle	0	T	0	0
Rumex acetosella	0	0	1	0

Table 6. Percent cover of associated species in A.hoodianus plots 33

	Percent			
	Plot 1	Plot 2	Plot 3	Plot4
% Cover Exotic Species	34	57	18	30
% Total Vascualar Plant Cover	129	161	80	168
% Relative Cover Exotic Species	26	34	30	18

Table 7. Vernal Pool Summary Data for 1984. C = % cover, F = % frequency, T = % cover < 0.1 %.

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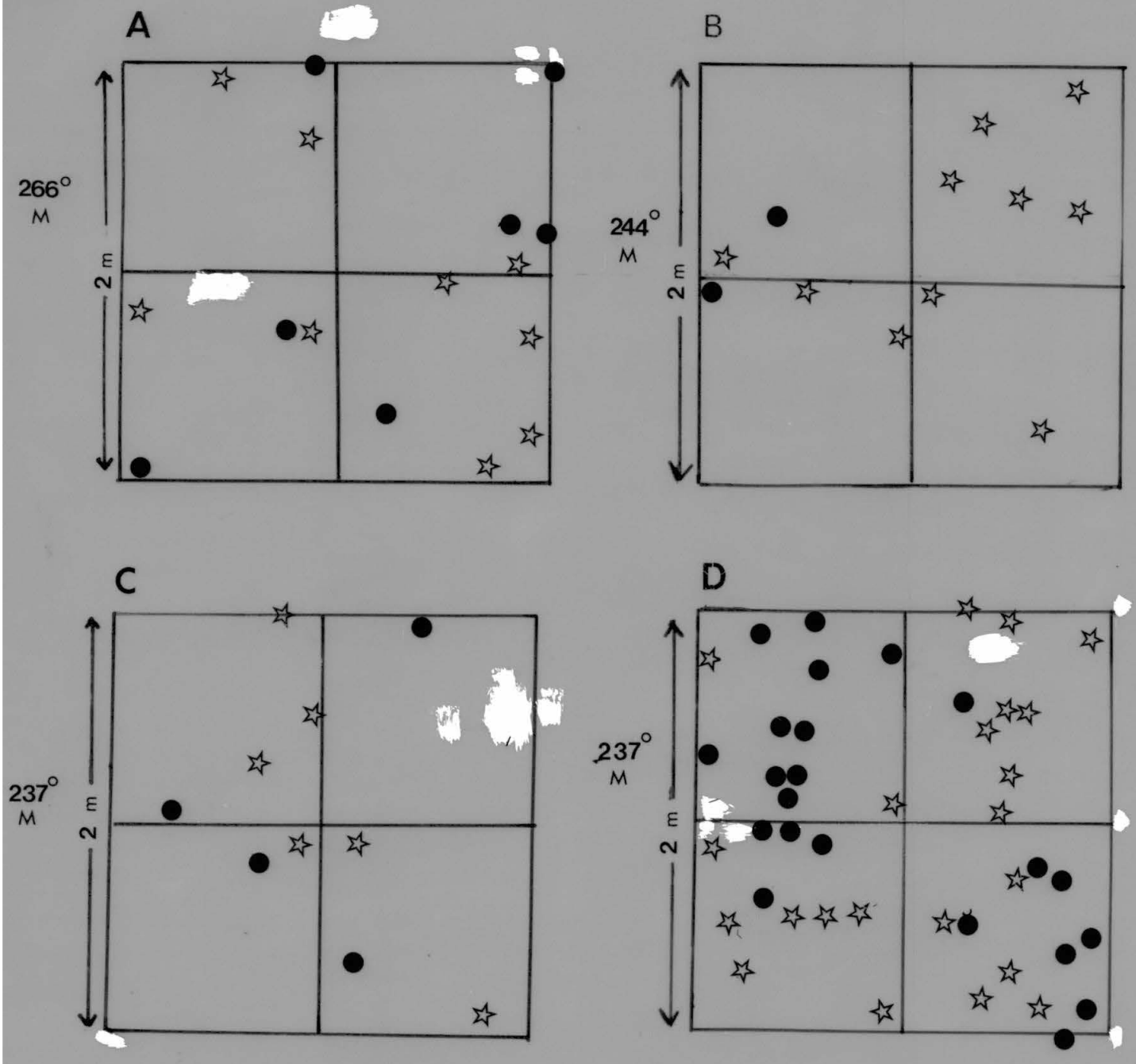
	Plot 1		Plot 2	
Native Species	C	F	C	F
Plagiobothrys leptocladus	19.8	25.3	0	0
Plagiobothrys scouleri var. penicillatus	10.0	50.7	0	0
Plagiobothrys sp.	0	0	32.0	72.0
Mimulus breviflorus	0.2	0.1	0	0
Gnaphalium palustre	0.5	0.1	0	0
Myosurus minimus	1.5	22.7	2.2	22.0
Veronica peregrina	2.1	28.0	3.5	37.0
Montia linearis	T	0.1	3.2	41.0
Collinsia parviflora	T	0.1	0	0
Navaretia divaricata	0.2	0.1	0	0
Linanthus bicolor	0.7	0.1	T	0.1
Deschampsia danthanoides	30.0	80.0	18.5	38.0
Idahoa scapigera	T	0.1	T	0.1
Draba verna	T	0.1	0	0
Lagophylla ramosissima	T	0.1	0	0
Alopecurus saccatus	0	0	1.2	13.5
Gratiola ebracteata	0	0	2.1	11.0
Eremocarpus setigerus	0	0	T	0.1
Sisyrinchium douglassii	0.4	0.1	0	0
Marchantia sp.	0.7	0.1		

Table 7. Vernal Pool Summary Data. (Cont.) 35

	Plot 1		Plot 2	
Exotic Species	C	F	C	F
Bromus rigidus	1.7	0.1	1.6	0.1
Rumex acetosella	0.7	0.1	T	0.1
Bromus mollis	1.4	1.3	0.1	0.3
Cerastium viscosum	T	0.1	0	0
Erodium cicutarium	0.2	0.1	T	0.1
Total Number Species	22		15	
Loose Rock	25.5	53.3	10.5	25.8
Mineral Soil	39.1	78.7	42.2	86.4
Moss	2.0	0.1	0.2	0.1
Litter	11.8	33.3	24.7	21.3

Figure 1. Map of permanent transect and plot locations on the Gov. Tom McCall Preserve at Rowena Plateau, Oregon.

Figure 2. Astragulus hoodianus permanent plots. A = plot1, B = plot2, C = plot 3, D = plot 4. Stars = reproductive individuals of A. hoodianus, circles = non-reproductive individuals (generally juveniles) of A. hoodianus. Compass directions are magnetic.


A
266°
M
2 m
B
244°
M
2 m
C
237°
M
2 m
D
237°
M
2 m

References

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