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Plant Succession at the Edges of Two Abandoned Cultivated Fields on the Arid Lands Ecology Reserve

Abstract

How vegetation recovers from disturbances is an important question for land managers. We examined 500 m² plots to determine the progress made by native herbaceous plant species in colonizing the edges of abandoned cultivated fields at different elevations and microclimates, but with similar soils in a big sagebrush/bluebunch wheatgrass steppe. Alien species, especially cheatgrass and cereal rye, were the major competitors to the natives. The native species with best potential for restoring steppe habitats were sulphur lupine, hawksbeard, bottlebrush squirreltail, needle-and-thread grass, Sandberg's bluegrass, and several lomatiums.

Introduction

Plant succession on abandoned cultivated fields in the semi-arid interior Columbia River Basin of eastern Washington is a chronologically slow process (Daubenmire 1975, Rickard and Sauer 1982). Recolonization by native plants is slowed by the aggressive seedlings of alien annual plants, especially cheatgrass (*Bromus tectorum*), because alien seedlings compete with native seedlings for scarce soil water and nutrients (Harris 1967).

The Fitzner-Eberhardt Arid Lands Ecology (ALE) Reserve is a 30,000 ha tract of land located 25 km northwest of Richland in Benton County, Washington. Since the 1960s, the ALE Reserve has been free of grazing and managed as a research natural area (Franklin et al. 1972, Soll et al. 1999). Two abandoned cultivated fields well inside the boundaries of the ALE Reserve were selected as study sites. The lower field was located at 323 m elevation on a gently sloping, linear tract of land closely bounded on the long sides by ravines. In all, the field occupied about 10 ha. The entire field was cultivated between 1900 and 1943, and it was irrigated at least for a time with water taken from a nearby permanent spring.

The upper field (533 m elevation) was >100 ha. The edges of the cultivated ground in most places is limited by ravines and in one place by a change in past land ownership as marked by the remnants of a fenceline. This field was used to raise dryland wheat between 1900 and 1943. Slope

and soil properties were similar on both sides of the fenceline.

The general habitat-type of both fields is big sagebrush/bluebunch wheatgrass (*Artemisia tridentata/Pseudoroegneria spicata*) as described by Daubenmire (1970). The microclimate of the upper field is slightly cooler and wetter than the lower field. Precipitation at the upper field averages 22.5 cm compared to 19.5 cm at the lower field. Average maximum January air temperature was 11.5°C at the upper field and 12.5°C at the lower field. Average maximum July air temperature at the upper field was 41.0°C compared to 44.5°C at the lower field. Average minimum January air temperature was -17.0°C at the upper field and -15.5°C at the lower field. Average minimum July air temperature at the upper field was 6.0°C compared to 8.5°C at the lower field. The soil texture at both fields is mapped as silt loam (Thorpe and Hinds 1977).

Our work had three objectives: 1) analyze the vegetation on the edges of 57-yr-old abandoned fields to determine those native perennial species with the greatest propensity to recolonize the fields; 2) obtain information on species composition and abundance of native perennials on nearby unplowed ground; and 3) mark the locations of the study plots to facilitate monitoring the future progress of succession.

Methods

We elected to place study plots near the edge of the fields because the edges were closest to sources of native seeds. Two adjacent 20- by 25-m

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macroplots were located 10 m inside the downslope boundary of the lower field and were labeled A and B. In the upper field, we placed one 20- by 25-m macroplot on cultivated ground and the adjacent macroplot on ground that had never been cultivated. The macroplots were separated only by the remnants of a fence line. The uncultivated macroplot was included to show species richness and abundance of native perennial plants at a place with closely similar soil and topography near the edge of the field. It was necessary to do this to make an assessment of the progress of plant succession based on the plant community on the adjacent uncultivated ground. The cultivated macroplot was labeled C and the uncultivated macroplot was labeled D. On both fields, each macroplot was subdivided into twenty 5- by 5-m (25 m²) microplots marked by a grid of strings. Each macroplot was permanently marked at the corners with short lengths of half inch steel rod. Each microplot was visually searched for the pres-

ence of plant species in May 2000 when most vascular plants were in flower. The most conspicuous perennial species were counted. The number of clumps of needle-and-thread grass (*Hesperostipa comata*) and bluebunch wheatgrass in each microplot were too numerous and cumbersome to count on macroplot D on the upper field. A single microplot was randomly selected for counting. This value was used to estimate the total number of grass clumps on the entire macroplot. Sandberg's bluegrass (*Poa secunda*) was not counted because of its small stature and indistinct clumps compared to the larger perennial grasses.

Results

Lower field

Twenty-two species were recorded at the lower field (Table 1). Of these, 16 were natives and six were alien species. Nine species occurred in 90

TABLE 1. Frequency distribution (%) and density per 500 m² of plant species recorded on two adjacent study plots in an abandoned field at 323 m elevation in May 2000. + = Species present in the plot, but density not counted.

	Macroplot A		Macroplot B	
	Frequency	Density	Frequency	Density
Perennials				
<i>Lupinus sulphureus</i>	100	1205	100	1067
<i>Crepis atrabarba</i>	100	211	100	326
<i>Elymus elymoides</i>	100	200	100	358
<i>Poa secunda</i>	100	+	100	+
<i>Lomatium grayi</i>	55	20	40	10
<i>Lomatium macrocarpum</i>	30	17	15	6
<i>Stipa thurberiana</i>	25	10	15	3
<i>Lomatium tritermatum</i>	15	5	5	2
<i>Pseudoroegneria spicata</i>	15	11	5	2
<i>Agoseris grandiflora</i>	5	1	10	3
<i>Ericameria nauseosa</i>	5	2	5	1
<i>Phlox longifolia</i>	+	+	25	23
<i>Achillea millefolium</i>	+	+	5	7
<i>Erigeron filifolius</i>	+	+	5	8
Annuals				
<i>Draba verna</i>	100	+	100	+
<i>Amsinckia</i> spp.	77	+	45	+
Perennials				
<i>Poa bulbosa</i>	60	+	45	+
Annuals				
<i>Bromus tectorum</i>	100	+	100	+
<i>Holosteum umbellatum</i>	100	+	100	+
<i>Sisymbrium altissimum</i>	100	+	100	+
<i>Tragopogon dubius</i>	95	+	100	+
<i>Lactuca serriola</i>	10	+	5	+
Total Number of Species	11.9		22	
Mean species/25 m ² ± SE	11.9 ± 0.3		11.3 ± 0.3	

percent or more of the microplots. Of these, five were natives: hawksbeard (*Crepis atrabarba*), sulphur lupine (*Lupinus sulphureus*), bottlebrush squirreltail (*Elymus elymoides*), spring draba (*Draba verna*), and Sandberg's bluegrass. Four were alien species: cheatgrass, jagged chickweed (*Holosteum umbellatum*), tumble mustard (*Sisymbrium altissimum*), and yellow salsify (*Tragopogon dubius*). Longleaf phlox (*Phlox longifolia*), yarrow (*Achillea millefolium*), and threadleaf fleabane (*Erigeron filifolius*) were found only on macroplot B (Table 1). The mean number of species per microplot were similar on

macroplots A and B (Table 1). Of the native species, Sandberg's bluegrass, sulphur lupine, hawksbeard, and bottlebrush squirreltail had the highest frequency of occurrence and were the most abundant perennial native species on the macroplots.

Upper Field

Twenty three species were found on macroplot C (Table 2). Here the vegetation was visually dominated by one-meter-tall culms of cereal rye (*Secale cereale*). The mean number of species per microplot

TABLE 2. Frequency distribution (%) and density per 500 m² of plant species recorded on two adjacent study plots in an abandoned field at 533 m elevation in May 2000. + = Species present in the plot, but density not counted. () = estimated values.

	Macroplot C		Macroplot D	
	%Freq	Density	%Freq	Density
Perennials			Native Species	
<i>Erigeron filifolius</i>	5	8	100	376
<i>Crepis atrabarba</i>	5	6	100	220
<i>Lupinus sulphureus</i>	100	161	100	149
<i>Pseudoroegneria spicata</i>	30	15	100	(1120)
<i>Hesperostipa comata</i>	65	494	100	(1060)
<i>Poa secunda</i>	35	+	100	+
<i>Achillea millefolium</i>	15	7	95	132
<i>Chrysothamnus viscidiflorus</i>	5	1	80	37
<i>Astragalus spaldingii</i>	5	3	85	102
<i>Calochortus macrocarpus</i>	15	3	75	37
<i>Lomatium triternatum</i>	20	6	70	103
<i>Antennaria dimorpha</i>	0	+	55	71
<i>Stipa thurberiana</i>	0	+	20	4
<i>Agoseris grandiflora</i>	30	11	20	+
<i>Phlox longifolia</i>	0	+	10	6
<i>Maceranthera canescens</i>	0	+	10	2
<i>Ericameria nauseosa</i>	0	+	5	1
Annuals				
<i>Draba verna</i>	40	+	100	+
<i>Epilobium paniculatum</i>	55	+	80	+
<i>Festuca microstachys</i>	0	+	50	+
<i>Lagophylla ramosissima</i>	5	+	30	+
<i>Amsinckia</i> spp.	10	+	10	+
<i>Plectritis macrocera</i>	0	+	5	+
Perennials			Alien Species	
<i>Poa bulbosa</i>	60	+	0	+
Annuals				
<i>Bromus tectorum</i>	100	+	100	+
<i>Holosteum umbellatum</i>	100	+	100	+
<i>Sisymbrium altissimum</i>	100	+	80	+
<i>Lactuca serriola</i>	80	+	35	+
<i>Tragopogon dubius</i>	40	+	35	+
<i>Secale cereale</i>	95	+	20	+
Total Species	23		29	
mean species/25m ² ± SE	11.2 ± 0.7		18.0 ± 0.4	

was less on macroplot C than on macroplot D (Table 2). The number of species per microplot decreased with increasing distance from the fence on macroplot C, but there was little change with increasing distance on macroplot D (Figure 1). Sulphur lupine occurred in 100% of the microplots on the cultivated ground and was the only native species with such high frequency (Table 2). The alien perennial, bulbous bluegrass (*Poa bulbosa*), was found only in macroplot C.

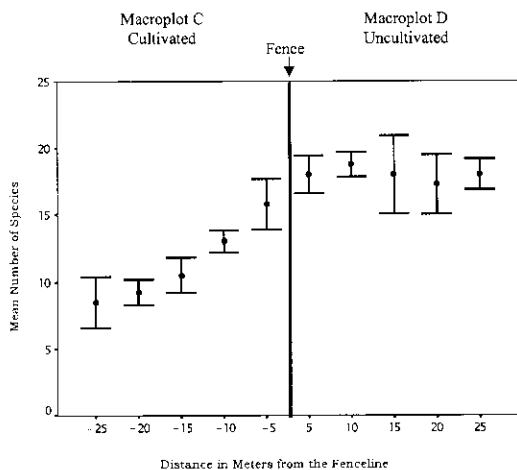


Figure 1. Mean number of species per 25 m² microplot and standard error (n=4 at each 5-m increment) recorded on the upper field at 5-m incremental distances on both sides of a fence.

The uncultivated macroplot D was visually dominated by clumps of native perennial bunch grasses: needle-and-thread grass, bluebunch wheatgrass, and Sandberg's bluegrass. In all, 29 species were recorded (Table 2). Thirteen species occurred in 90% or more of the microplots, of these 11 were natives: sulphur lupine, needle-and-thread grass, spring draba, Sandberg's bluegrass, bluebunch wheatgrass, hawksbeard, threadleaf fleabane, tall willowherb (*Epilobium paniculatum*), yarrow, green rabbitbrush (*Chrysothamnus viscidiflorus*), and fiddleneck tarweed (*Amsinckia* spp.). Only two were alien species: cheatgrass and jagged chickweed.

Discussion

Most of the habitat restoration work on ALE has focused on planting sagebrush shrubs in areas where it had been destroyed by recent wildfires

(Durham 2000). Sagebrush provides important habitat for nesting populations of sage sparrows (*Amphispiza belli*) and loggerhead shrikes (*Lanius ludovicianus*) which are listed as species of concern by the Washington Department of Wildlife (Poole 1992, Fitzner 2000, Vander Haegen et al. 2000).

Native grasses, especially bluebunch wheatgrass, have been planted on dryland wheat fields accepted into the USDA Conservation Reserve Program in eastern Washington. However, other native species commonly associated with native stands of sagebrush and bluebunch wheatgrass habitat have seldom been used. Our data indicate that sulphur lupine, hawksbeard, Gray's lomatium (*Lomatium grayii*), nine-leaf lomatium (*L. triternatum*), bottlebrush squirreltail and Sandberg's bluegrass were the more successful native perennial species to colonize the lower field. At the upper field, the most successful species were sulphur lupine and needle-and-thread grass. Colonization by natives in the cultivated portion of the upper field may be slowed by the dominance of cereal rye, an alien species not found at the lower field. For the most part, bluebunch wheatgrass, the characteristic perennial grass of the steppe region, appears to be a poor competitor on abandoned cultivated fields even in the long-time absence of livestock grazing.

The ALE Reserve is a good place to conduct studies of plant succession because the site has a long history of freedom from livestock grazing and it is likely to be free from grazing into the future. At the present time, the major kinds of disturbances to the ALE Reserve are wildfire and grazing by a resident herd of elk (*Cervus elaphus*) (Dirkes et al. 1999). The abandoned fields provide opportunities to monitor the progress of plant succession by establishing more study plots across both fields.

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