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COMPARISON OF PRODUCTIVITY OF NATIVE AND ALIEN GRASS COMMUNITIES OF SOUTH-CENTRAL WASHINGTON

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W. H. Rickard Ecosystems Department

Battelle Memorial Institute

Pacific Northwest Laboratories, Richland, Washington

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DISCLAIMER

The study area is located in south-central Washington in the Northwestern corner of the contiguous United States on the United States Energy Research and Development Administrations Hanford Works Reservation in south-central Washington. The vegetation reflects the general climatic aridity of the region by not supporting trees, instead grasses and desert shrubs dominate the vegetation. Although a variety of plant communities exist on the Hanford Reservation attention is given here to the native sagebrush-bluebunch wheatgrass community which has the best developed grass layer and is regarded as the biologically most productive of the various plant communities and also the most valuable in terms of supporting livestock. This community type occurs on deep soil and has agricultural potential and dryland wheat can be successfully raised. For this reason once the land is plowed it is seldom allowed to revert back to a natural condition. However, such a condition exists on the Hanford Reservation where formerly productive wheatfields have been abandoned and not used for a period of 30 years. Initial invasion of the abandoned fields was by cheatgrass, Bromus tectorum an alien plant introduced to North America from Europe more than a century ago. During the past four years studies have been conducted to compare species composition and the aboveground productivity of these contrasting kinds of plant communities.

A list of plant species associated with the cheatgrass community and the amount of live biomass for each at various harvest periods during the spring growing season is shown in Figure 1. A list of plant species and the amount of live biomass for the herbaceous species in the sagebrush-bluebunch wheatgrass community is shown in Figure 2.

Clearly many more plant species are associated with the sagebrush-bluebunch wheatgrass community than with the cheatgrass community. It is also clear that the sagebrush-bluebunch wheatgrass community supports only trace amounts of the plants found in the cheatgrass community and that only one native perennial grass species (Poa secunda) is associated with the cheatgrass community and then only in trace amounts.

The data shown in Figure 3 show that cheatgrass communities are much more productive than sagebrush-bluebunch wheatgrass communities at least over the four years of available data. The data also show that cheatgrass responded to a year of greater than average precipitation by increasing productivity. At the same time the dominant grass in the sagebrush-bluebunch wheatgrass community failed to respond to the increased precipitation regime. The reasons for this are not known but observations made on communities subjected to wildfire during the year preceding the year of abundant rainfall indicate that burning released the constraints that suppress bluebunch wheatgrass yields.

Although aboveground productivity is greater in cheatgrass communities we have no data for below ground comparisons because of the difficulties in separating roots from soil and the inability to segregate living from dead tissues and distinguishing the root production of the current year from that of previous years.

Nitrogen is scarce in the soil profile of the steppe region and is present in chemical forms not available for plant uptake. One way to estimate the annual uptake of nitrogen from the soil is to measure the nitrogen in plant tissues produced during the year. Cheatgrass communities are especially amenable for the kind of analyses because almost all the plants are annuals. An average of 1.6 grams of nitrogen were assimulated by the cheatgrass community as compared to 1.2 grams in the sagebrush community.

Figure 1. Live aboveground biomass by species harvested during the spring growing seasons of 1971, 1972, 1973, 1974 in a cheatgrass community. The data are presented as grams dry weight per square meter.

FIGURE 1

TAXA	1971 MAR 8	APR 1	APR 19	MAY 7	MAY 28
ANNUAL GRASSES					
Bromus tectorum	35 ± 3	60 ± 6	127 ± 8	198 ± 12	125 ± 11
ANNUAL FORBS					
Sisymbrium altissimum	0.5 ± 1	1.0 ± 0.4	2.8 ± 0.9	10 ± 3	17 ± 4
Amsinckia lycopsoides	0	0.1 ± 0.1	0	2 ± 2	0
Holosteum umbellatum	0	0	0.1 ± 0.1	0	0
PERENNIAL GRASSES					
Poa secunda	1.1 ± 1.1	3.2 ± 2.8	0	1.1 ± 0.9	0.5 ± 0.3
TOTAL	37 ± 3	64 ± 5	130 ± 8	211 ± 11	142 ± 12

	1972 MAR 14	APR 3	APR 13	APR 25	MAY 15
ANNUAL GRASSES					
Bromus tectorum	56 ± 4	76 ± 3	132 ± 7	126 ± 5	112 ± 20
ANNUAL FORBS					
Sisymbrium altissimum	0	0.04 ± 0.04	0.3 ± 0.2	0.6 ± 0.4	1.7 ± 0.7
Amsinckia lycopsoides	0	0	0	0	0
Holosteum umbellatum	0	0.1 ± 0.1	0	0	0
Descurainia pinnata	0	0.2 ± 0.2	0	0	0
PERENNIAL GRASSES					
Poa secunda	0	0	0	0	0
TOTAL	56 ± 4	77 ± 3	132 ± 7	127 ± 5	114 ± 20

	1973 MAR 6	MAR 26	APR 6	APR 23	MAY 9	MAY 18	JUN 4
ANNUAL GRASSES							
Bromus tectorum	32 ± 3	36 ± 2	70 ± 5	115 ± 11	166 ± 12	62 ± 7	0
ANNUAL FORBS							
Sisymbrium altissimum	1.8 ± 0.5	2.8 ± 0.7	3.9 ± 0.9	9 ± 3	34 ± 10	44 ± 10	67 ± 15
Amsinckia lycopsoides	0	0	1.5 ± 1.4	0.2 ± 0.2	5.3 ± 3.7	0.3 ± 0.3	0
Holosteum umbellatum	0	0.3 ± 0.1	0.1 ± 0.1	0.1 ± 0.07	0.2 ± 0.2	0	0
Descurainia pinnata	0	Tr	Tr	0	0	0	0
PERENNIAL GRASSES							
Poa secunda	0	2.1 ± 2.1	0.8 ± 0.6	1.6 ± 0.9	0.1 ± 0.1	Tr	0
TOTAL	34 ± 3	42 ± 3	77 ± 5	126 ± 11	205 ± 14	106 ± 10	67 ± 15

	1974 MAR 13	APR 11	APR 28	MAY 22	JUL 2
ANNUAL GRASSES					
Bromus tectorum	78 ± 4.7	144 ± 7.5	253 ± 14	328 ± 16	0
ANNUAL FORBS					
Sisymbrium altissimum	2.0 ± 0.4	1.3 ± 0.3	5.4 ± 1.7	30 ± 7	68 ± 18
Amsinckia lycopsoides	0.2 ± 0.2	0.2 ± 0.2	1.4 ± 1.4	Tr	0
Holosteum umbellatum	0.1 ± 0.1	0.2 ± 0.1	0	0	0
Descurainia pinnata	Tr	0	0	Tr	0
Draba verna	Tr	0	0	0	0
Erodium cicutarium	0	0	Tr	0	0
PERENNIAL GRASSES					
Poa secunda	2.7 ± 2.7	8.4 ± 5.3	0.6 ± 0.4	0	0
TOTAL	83 ± 4.2	154 ± 7.0	260 ± 17	358 ± 25	68 ± 18

Figure 2. Live aboveground biomass by species harvested during the spring growing seasons of 1971, 1972 in a sagebrush-bluebunch wheatgrass community. The data are presented as grams dry weight per square meter.

TAXA	1973 MAR 19	APR 9	APR 30	MAY 21	JUN 11
PERENNIAL GRASSES					
Agropyron spicatum	7.1 ± 1.3	22 ± 3	35 ± 4.5	26 ± 5	40 ± 6
Stipa thurberiana	0.1 ± 0.1	0	0.3 ± 0.3	0.3 ± 0.3	0.5 ± 0.4
Poa secunda	3.6 ± 0.3	4.0 ± 0.4	0.4 ± 0.1	0.2 ± 0.1	0.2 ± 0.1
Poa cusickii	0.1 ± 0.1	1.0 ± 0.7	0.4 ± 0.4	2.0 ± 1.8	0.5 ± 0.3
TOTAL	11	27	36	28	41
PERENNIAL FORBS					
Astragalus purshii	0.5 ± 0.4	0.2 ± 0.2	2.9 ± 1.8	0	0
Calochortus macrocarpus	0.1 ± 0.1	0.2 ± 0.1	0.1 ± 0.1	0	0
Crepis atrabarba	0.1 ± 0.1	0.2 ± 0.1	0.1 ± 0.1	0.02 ± 0.02	0
Lupinus laxiflorus	0	0.2 ± 0.2	0.2 ± 0.2	0	0
Lomatium macrocarpum	0.3 ± 0.1	0.1 ± 0.1	0.6 ± 0.3	0.01 ± 0.01	0.01 ± 0.01
Brodiaea douglasii	0.1 ± 0.1	0	0.1 ± 0.1	0	0
TOTAL	1.1	0.9	4.0	0.03	0.01
ANNUAL GRASSES					
Bromus tectorum	0	0.01 ± 0.01	0.02 ± 0.02	0	0
Festuca octoflora	0	0.2 ± 0.1	0.3 ± 0.1	0	0
TOTAL	0	0.21	0.32	0	0
ANNUAL FORBS					
Draba verna	0	0.04 ± 0.02	0	0	0
Descurainia pinnata	0	0.03 ± 0.01	0.1 ± 0.1	0	0
Plantago patagonica	0	0	0.01 ± 0.01	0	0
TOTAL	0	0.07	0.11	0	0
HALF-SHRUBS					
Erigeron filifolius	2.2 ± 1.4	3.2 ± 0.8	7.6 ± 4.6	8.9 ± 4.1	7.7 ± 3.6
Phlox longifolia	0.6 ± 0.5	0.6 ± 0.6	0	0.1 ± 0.1	0
Antennaria dimorpha	3.4 ± 1.5	4.4 ± 3.2	3.1 ± 1.8	2.2 ± 1.7	0.9 ± 0.6
Townsendia florifer	0	0	0	0.2 ± 0.2	0
TOTAL	6.2	8.2	11	11	8.6
TOTAL LIVE	18	36	51	39	50

TAXA	1974 FEB 26	MAR 25	APR 15	MAY 8	JUN 6
PERENNIAL GRASSES					
Agropyron spicatum	7.50 ± 1.60	10 ± 1.20	52 ± 20	39 ± 7.20	44 ± 10
Stipa thurberiana	0.60 ± 0.50	0.40 ± 0.40	0	1.70 ± 1.20	2.1 ± 2.1
Poa secunda	5.6 ± 1.1	10 ± 1.5	11 ± 1.2	8.3 ± 1.4	0
Poa cusickii	0.9 ± 0.9	0	0.05 ± 0.05	1.1 ± 1.1	4.2 ± 3.8
TOTAL	15	20	63	50	50
PERENNIAL FORBS					
Astragalus purshii	0	0	1.00 ± 1.00	3.60 ± 3.60	
Calochortus macrocarpus	0.01 ± 0.01	0	0.20 ± 0.10	0.20 ± 0.10	0.5 ± 0.2
Crepis atrabarba	0.11 ± 0.08	0.08 ± 0.08	0.40 ± 0.30	0.70 ± 0.50	1.1 ± 1.1
Brodiaea douglasii	0.02 ± 0.01	0.11 ± 0.11			
Lomatium macrocarpum	0.01 ± 0.01	0.001 ± 0.001	0.06 ± 0.06	0.20 ± 0.20	
Lupinus laxiflorus	0	0	0	0	0
Castellya sp	0	0	0	0	0.6 ± 0.6
TOTAL	0.15	0.19	1.7	4.7	2.2
ANNUAL GRASSES					
Bromus tectorum	0.05 ± 0.05	0.08 ± 0.06	0.11 ± 0.05	0.40 ± 0.20	0
Festuca octoflora	0	0.01 ± 0.01	2.30 ± 0.40	4.30 ± 0.70	0
TOTAL	0.05	0.09	2.4	4.7	0
ANNUAL FORBS					
Draba verna	0.08 ± 0.07	0.60 ± 0.20	0.70 ± 0.30	0	-
Descurainia pinnata	0.20 ± 0.04	0.40 ± 0.10	1.10 ± 0.30	1.30 ± 0.30	-
Microsteris gracilis	0	0.003 ± 0.003	-	-	-
Amsinckia lycopsoides	0	0.015 ± 0.012	-	-	-
Plantago patagonica	0	0	0.005 ± 0.005	0.09 ± 0.06	0.9 ± 0.9
Cryptantha pterocarpa	0	0	0	0.001 ± 0.001	
TOTAL	0.3	1.0	1.8	1.4	0.9
HALF-SHRUBS					
Erigeron filifolius	0.90 ± 0.60	0	0.09 ± 0.06	1.00 ± 0.80	0.8 ± 0.5
Phlox longifolia	0.70 ± 0.60	0	1.00 ± 0.90	2.00 ± 1.50	3.1 ± 2.1
Antennaria dimorpha	0.10 ± 0.04	1.20 ± 1.10	1.40 ± 1.10	1.20 ± 1.10	0
TOTAL	1.7	1.2	2.3	4.2	3.9
TOTAL LIVE	17	22	71	65	57

Figure 3. Dry Weight living phytomass, average ± standard error expressed as g/m^2 at harvest peak in bluebunch wheatgrass and cheatgrass communities in relation to October to May, precipitation regimes.

	Bluebunch Wheatgrass Community (n=16)				
Agropyron spicatum	42 ± 6	44 ± 7	40 ± 6	40 ± 10	42
Total herbs	55 ± 6	65 ± 8	50 ± 6	57 ± 8	57
ppt cm	18	14	12	35	20
	Cheatgrass Community (n=20)				
Bromus tectorum	198 ± 12	126 ± 5	166 ± 12	328 ± 16	204
Total herbs	211 ± 11	127 ± 5	205 ± 14	358 ± 25	225
ppt cm	15	12	11	30	17