Expressing the Competitive Relationship between Wyoming Big Sagebrush and Crested Wheatgrass

L. R. RITTENHOUSE AND F. A. SNEVA

Highlight: *Crested wheatgrass production was negatively correlated with Wyoming big sagebrush crown cover. Each 1% increase in sagebrush crown cover was associated with a decline in crested wheatgrass production equivalent to 3.3 to 5.2% of its potential within the range of cover measured. Expression of this relationship in the above manner may enable sounder economic analysis than conventional methods now used.*

Seeding of deteriorated ranges in the sagebrush-grass regions of the western United States to crested wheatgrass (*Agropyron desertorum*) has been a common practice over the past 3 decades. Historically, few seedings have remained free of big sagebrush (*Artemisia tridentata*) for an extended period of time.

Competition between big sagebrush and crested wheatgrass has been observed over a long period of time and is well documented (Robertson and Pearse, 1945; Blaisdell, 1949; Cook, 1958). An economic decision to control re-established big sagebrush in crested wheatgrass seedings must be based on its competitive influence. However, a technique for expressing the data in a form suitable for direct investment decisions has been lacking.

This study investigated the relationship between big sagebrush (subsp. *wyomingensis*) crown cover and production of crested wheatgrass. Implications for economic consideration are also presented.

Procedure

Crested wheatgrass seedings made in 1950–51 at the Squaw Butte Range Station 70 km west of Burns, Ore., at an elevation of 1,640 m were studied. The area had been grazed at a moderate stocking rate with biennial early spring deferrment. In years of data collection, use was deferred until after production estimates were made.

Records of the native species existing on the study area prior to plowing and seeding are lacking. Adjacent native stands are Wyoming big sagebrush with the dominant understory grass being Thurber needlegrass (*Stipa thurberiana*). Differences in sagebrush crown cover for the purpose of stratifying the area for locating transects were determined from 4X enlargements of 1:9600 aerial photography. A total of 30 transects approximately 60 m long were established. Sagebrush crown cover was determined directly from 1:600 scale IR 70-mm film in 1970 (using an eyepiece with a magnified reticle) and by line intercept in the field in 1971. Production of crested wheatgrass per ha was estimated from ten 1.5- and 2.2-m^2 plots clipped at ground level in 1970 and 1971, respectively, at predetermined points on the above-mentioned transects. Predetermined points were randomized each year. Clippings were made after plant maturity. Procedures used to estimate production in 1963 were similar to those used in 1971 except five .89-m^2 plots were clipped per 30.5-m line transect.

Simple linear regression analysis was made on data within each year. Crested wheatgrass yields were also adjusted for crop-year precipitation (Sneva and Hyder, 1962) and pooled over years. Homogeneity of regression coefficients of adjusted data was tested using analysis of covariance.

Results and Discussion

In this study, sagebrush crown cover ranged from 0 to 14% in 1970 and 1971. The 1963 data ranged from 5 to 22% crown cover.

Approximately 73% of the total variation in adjusted crested wheatgrass yield was accounted for by percentage of crown cover of Wyoming big sagebrush. The regression of adjusted crested wheatgrass production (P), kg/ha, on percentage of crown cover (CC) of the Wyoming big sagebrush was

$$P = 1156 - 46.6\,CC$$

The standard error of the estimate was 144 kg/ha. Each 1% increase in CC reduced P by 46.6 kg/ha (s_b = 3.3 kg/ha). The average potential production of the study location was 1,156 kg/ha, which was the regression value at zero crown cover of big sagebrush.

On a yearly basis, potential production ranged from 1,080 to 1,538 kg/ha, and each 1% increase in crown cover of sagebrush decreased crested wheatgrass production from 36.9 to 61.2 kg/ha (Table 1). Similar linear declines in crested wheatgrass have been calculated from data presented by other

Authors are associate professor, Rangeland Resources Program, Oregon Agricultural Experiment Station, Burns; range scientist, Agricultural Research Service, U.S. Department of Agriculture, Burns, Oregon 97720.

Rittenhouse's current address is: Chillicothe-Vernon Research and Extension Center, Texas Agricultural Experiment Station, Vernon, 76384.

The work is a contribution from the Squaw Butte Experiment Station, Burns, Oregon 97720. This Station is jointly operated by Oregon Agr. Exp. Sta., Oregon State University, and the Agr. Res. Serv., U.S. Dep. Agr.

Oregon Agricultural Experiment Station Technical Paper Number 3950.

The authors wish to acknowledge the helpfulness of Dr. A. Gene Nelson, Agricultural Economics Department, Oregon State Univ., in developing economic implications of this work.

Manuscript received June 14, 1975.

Table 1. Regression statistics relating crested wheatgrass production, kg/ha, and big sagebrush cover, percent, calculated from data obtained at various locations, including the study site.

Source	Location	Year	Statistic a	b	x	y
Hull & Klomp, 1974[a, b]	Twin Falls, Ida.	1967	933	39.2	5.4	722
Same[a]	Same	1968	637	31.1	5.6	463
Same[a]	Same	1969	964	37.5	5.8	746
Same[a]	Same	1970	1555	66.6	6.0	1157
Cook, 1958	Benmore, Utah	1956	548	25.0	10.0	298
Cook, personal communication	Benmore, Utah	1956	140	7.4	3.7	112
Same	Various, Utah		309	16.2	6.4	204
Current study	Burns, Ore.	1963	1537	61.2	11.2	851
Same	Same	1970	1080	55.9	2.7	926
Same	Same	1971	1119	36.9	5.0	937

[a]A factor of .90 was used to transform air dry weights to dry matter basis.
[b]A linear increase in canopy cover between 1965 and 1970 was assumed.

authors (Table 1). While evaluating various seedbed preparation methods, Cook (1958) found a decline of 25.0 kg/ha for each 1% increase in sagebrush cover at Benmore, Utah. Further analysis of that same data, including the data from Tintic Valley (Cook, personal communication) adjusted for treatment effects, showed a decline of 7.4 kg/ha. In another study on several seeded areas in the foothills of central Utah, he found an average decline of 16.2 kg/ha for each 1% increase in sagebrush cover (Cook, personal communication). Hull and Klomp (1974) measured the response of crested wheatgrass following control of Wyoming big sagebrush at Twin Falls, Idaho. Declines in crested wheatgrass production of 39.2, 31.1, 37.5, and 66.6 kg/ha for each 1% increase in sagebrush cover were calculated for 1967, 1968, 1969, and 1970, respectively.

Needed is a means of translating the quantitative competitive relationship between big sagebrush and crested wheatgrass yield to a form which could be used to describe the dynamic nature of the stand. We propose expressing the decline in crested wheatgrass production (per percentage increase in Wyoming big sagebrush cover) as a portion of crested wheatgrass production at zero crown cover (b/a). Ratios calculated from our data and that of others are given in Table 2. Even though the values do not represent an absolute constant, the relatively narrow range of the values suggest that the average ratio of approximately -.045 would be useful. The proposed relationship needs further testing over a wide geographic area under controlled conditions.

Research methodology has been presented by numerous authors for the economic evaluation of range improvement investments, e.g., Burt (1971); Cotner (1963); Kearl and Brannon (1967); Krenz (1962); Lloyd and Cook (1960). The decision of when to control establishing big sagebrush is important, since any sagebrush results in decreased crested wheatgrass yield. Present methods of economic evaluation are based on the assumption of average production increases with the investment amortized over an estimated life of the control. They also assume that the decision against controlling reestablishing sagebrush involves an indefinite period of time which tends to overstate the profitability of investing now.

Nelson and Rittenhouse (1972) have demonstrated the

Table 2. The ratio of the decline in creasted wheatgrass production per percentage increase in Wyoming big sagebrush cover (b) to the production at zero crown cover (a) at various locations, including the study site.[a]

Source	Ratio b/a
Hull & Clomp, 1974	-.042
Same	-.049
Same	-.039
Same	-.043
Cook, 1958	-.046
Cook, personal communication	-.053
Same	-.052
Current study	-.040
Same	-.052
Same	-.033

[a]From Table 1.

usefulness of the above ratio in economic decision making. In that study, discounted cash flows were related to a set of variable values affecting investments, using a "performance function" as proposed by Candler and Cartwright (1969). Of special interest was the decision to control now vs at some time in the future. In order to make this evaluation it was necessary to make an annual estimate of the influence of sagebrush on crested wheatgrass production. Associating forage production losses with increases in brush cover provided a means to make sounder economic evaluations for determining at what time rehabilitation would be most profitable.

Sagebrush cover is easily measured in the field or laboratory (from small scale photography). Within the range of cover values encountered its relationship with crested wheatgrass production was linear and appeared to be independent of plant numbers or size. The ratio of b/a exhibited a narrow range of values over a wide geographic area. Therefore, the above may have broad application in estimating productivity of brush infested seedings relative to potential productivity.

Literature Cited

Blaisdell, J. P. 1949. Competition between sagebrush seedlings and seeded grasses. Ecology. 30:512-519.

Burt, O. R. 1971. A dynamic model of pasture and range investments. Amer. J. Agr. Econ. 53:197-205.

Cook, C. W. 1958. Sagebrush eradication and broadcast seeding. Utah Agr. Exp. Sta. Bull. No. 404. 23 p.

Cotner, M. L. 1963. Optimum timing of long-term resource improvements. Amer. J. Agr. Econ. 45:732-748.

Hull, A. J., R., and G. J. Klomp. 1974. Yield of crested wheatgrass under four densities of big sagebrush in southern Idaho. U.S. Dep. Agr., Agr. Res. Serv. Tech. Bull. No. 1483. 38 p.

Kearl, W. G., and M. Brannon. 1967. Economics of mechanical control of sagebrush in Wyoming. Sci. Monogr. Wyo. Agr. Exp. Sta., Laramie, Wyo.

Krenz, R. D. 1962. Costs and returns from spraying sagebrush with 2,4-D. Wyo. Agr. Exp. Sta. Bull. No. 390.

Lloyd, R. D., and C. W. Cook. 1960. Seeding Utah's ranges—an economic guide. Utah Agr. Exp. Sta. Bull. No. 423. 19 p.

Nelson, A. G., and L. R. Rittenhouse. 1972. Estimation of a performance function for evaluating range improvement investments. *In:* Proc. W. Agr. Econ. Ass. Manage., Logan, Utah. July 23-25. 1972.

Robertson, J. H., and K. C. Pearse. 1945. Artificial reseeding and the closed community. Northwest Sci. 19:58-66.

Sneva, F. A., and D. N. Hyder. 1962. Forecasting range herbage production in eastern Oregon. Oregon State Agr. Exp. Sta. Bull. No. 588. 11 p.