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Effects of burning on the mortality and vigor of shrubby cinquefoil (Potentilla fruticosa) in central Montana

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THE EFFECTS OF BURNING ON THE MORTALITY AND VIGOR

OF SHRUBBY CINQUEFOIL (*POTENTILLA FRUTICOSA*)

IN CENTRAL MONTANA

By

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The increase of shrubby cinquefoil on productive rangelands has become a concern for land managers in central Montana. Prescribed burning of these rangelands was investigated to determine if burning at various seasons could be an effective control of shrubby cinquefoil. Two sites were chosen for the study. Different plots at each site were burned during the summer and fall of 1983 and during the spring of 1984. No mortality resulted from any of the burning treatments. Further investigation revealed that there were no significant differences ($P \leq 0.05$) in vigor of the regrowth between the summer, fall and spring. It is concluded that no control can be expected from burning shrubby cinquefoil and that the season of burning does not affect the vigor of resprouting plants.

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INTRODUCTION

Shrubby cinquefoil (Potentilla fruticosa) has greatly increased in density throughout its range in central Montana, so that it has become established in large continuous stands. In many areas the increased density of shrubby cinquefoil has become a problem by limiting production and availiblity of herbaceous forage. The Forest Service (1937) did not consider shrubby cinquefoil to be a problem plant species at that time. However, Scotter (1975) reported that the species was increasing in Alberta and that such spread was probably associated with poor grazing practices. Stelfox (1976) also reported the species to be abundant on poor, heavily grazed ranges in Alberta.

Shrubby cinquefoil is widely distributed throughout the Northern Hemisphere. It is found in Europe, Asia and North America where it ranges from Greenland and Labrador, west to Alaska and south to California, New Mexico, Minnesota, Illinois and New Jersey (Forest Service, 1937). In Montana it is found on both sides of the Continental Divide. On the west side of the state it is found mostly in mountain stream bottoms and is not looked upon as a problem.

On the east side of the Continental Divide it is more widespread and prolific, especially along the Rocky Mountain Front area and in the central mountain ranges. It has a wide elevation range from the prairie foothills to above timberline. Characteristically it is found in open areas, particularly in subalpine meadows. It is in these productive meadows that it has become a problem.

Shrubby cinquefoil is a low-growing, multi-stemmed shrub. Reproduction is from seed, although vegetative reproduction by means of adventitious rooting of prostrate stems has been reported (Scotter, 1975). Its dark brown bark is a shaggy, papery fiber which is probably the most flammable part of the plant. It has a deep spreading root system (Fig. 1).

In Central Montana grazing and browsing animals, both domestic and wild, normally do not browse this shrub. Lovaas (1958) in a study of wintering deer noted the presence of shrubby cinquefoil on all his study sites yet found no browsing of the plants. Scotter (1975) noted that it is not used by grazing animals in Alberta. However, in some areas it has been observed to be fair to good forage for sheep, cattle, deer and elk (Forest Service, 1937; Kearney and Peebles, 1951).

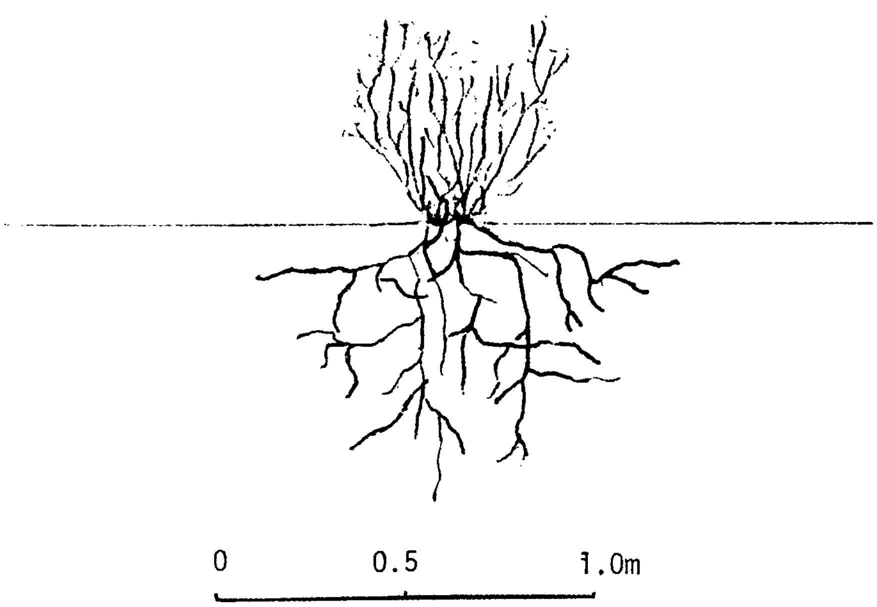

Figure 1. Shrubby cinquefoil root system.

Reports on the control of shrubby cinquefoil are scanty. Scotter (1975) has done the only specific study on shrubby cinquefoil. He investigated the effect of applying various levels of picloram, as a herbicide, on the plant and found he could obtain a 90 percent kill using 1.75kg acid equivalent per hectare.

The use of herbicides has become more controversial and more expensive in recent years. Thus, a need exists to find other control methods.

Fire has been recognized as a major factor in the ecology of forest and grassland ecosystems (Alhgren and Alhgren, 1960) and the use of fire as a range management tool and its effects on various plant species and communities has been well documented (Daubenmire, 1968; Valentine, 1971; Wright, 1974; Biswell, 1974; Mueggler, 1976).

The effects of fire on shrubby cinquefoil have not been well documented. Wright et al. (1975) noted the effects of fire on several members of the rose family, Rosaceae, of which shrubby cinquefoil is a member. They found that these species responded to fire by resprouting from a rootcrown. Keown (1982) reported an increase in the palatability of resprouting shrubby cinquefoil following burning but did not mention any fire damage. Nimir and Payne (1978) studied spring burning of sagebrush (_Artemisia_ spp.) and stated that shrubby cinquefoil was susceptable to fire damage. This susceptablity may have been influenced by the high intensity fire developed by the burning sagebrush.

Shrubby cinquefoil is known to resprout but the vigor by which this resprouting occurs has not been studied. Sprouting, as influenced by crown removal either by fire or other means, has been related to the season of crown removal (Aldous, 1929; Brown, 1930; Buell, 1940; Wenger, 1953). Crown removal during periods of low carbohydrate reserves, such as mid to late summer during flowering and seed production, can cause less vigorous sprouting than removal during periods of high carbohydrate reserve (Aldous, 1935; Jones and Laude, 1960; Laude et al., 1961; Tew, 1970; Willard and McKell, 1973; Young and Bailey, 1975).

The basic purpose of this study was to obtain management information on the prescribed burning of shrubby cinquefoil. Specifically, this study was designed to determine the mortality of shrubby cinquefoil as caused by burning, to determine whether season of burning influenced the mortality or the recovery of the plant, and to assess the influence of burning treatments on the vigor of respouting plants.

STUDY AREA

The study area was located on the Lewis and Clark National Forest 26km south of the town of Stanford, Montana, in the foothills of the Little Belt Mountains (Fig.2). The area is part of the Blacktail Grazing Allotment.

Two experimental sites were established in the early summer of 1983. The Dry Wolf site (DW) has a northwest exposure and drains toward Dry Wolf Creek. The Running Wolf site (RW) is 1.5km east of the DW site and has a northeast exposure and drains toward Running Wolf Creek. Elevation for the sites is approximately the same at 1650 meters. Both sites have been described as a Pinus flexus/Festuca idahoensis habitat type, Festuca scabrella phase (Pfister et al. 1977) and fall in Fire Group One as described by Fischer and Clayton (1983).

The DW site has a slope of about 5 percent and average canopy cover of shrubby cinquefoil of 39 percent. The RW site slopes are 10 percent and the average shrub cover is 44 percent. Shrubby cinquefoil dominates both sites. Common grasses are Kentucky bluegrass (Poa pratense), Idaho fescue (Festuca idahoensis), rough fescue (Festuca scabrella), and timber oatgrass (Danthonia intermedia). Forbs include pussytoes (Antennaria spp.), yarrow (Achillea millefolium), old man's whiskers (Geum triflorum), and chickweed (Cerastium arvense).

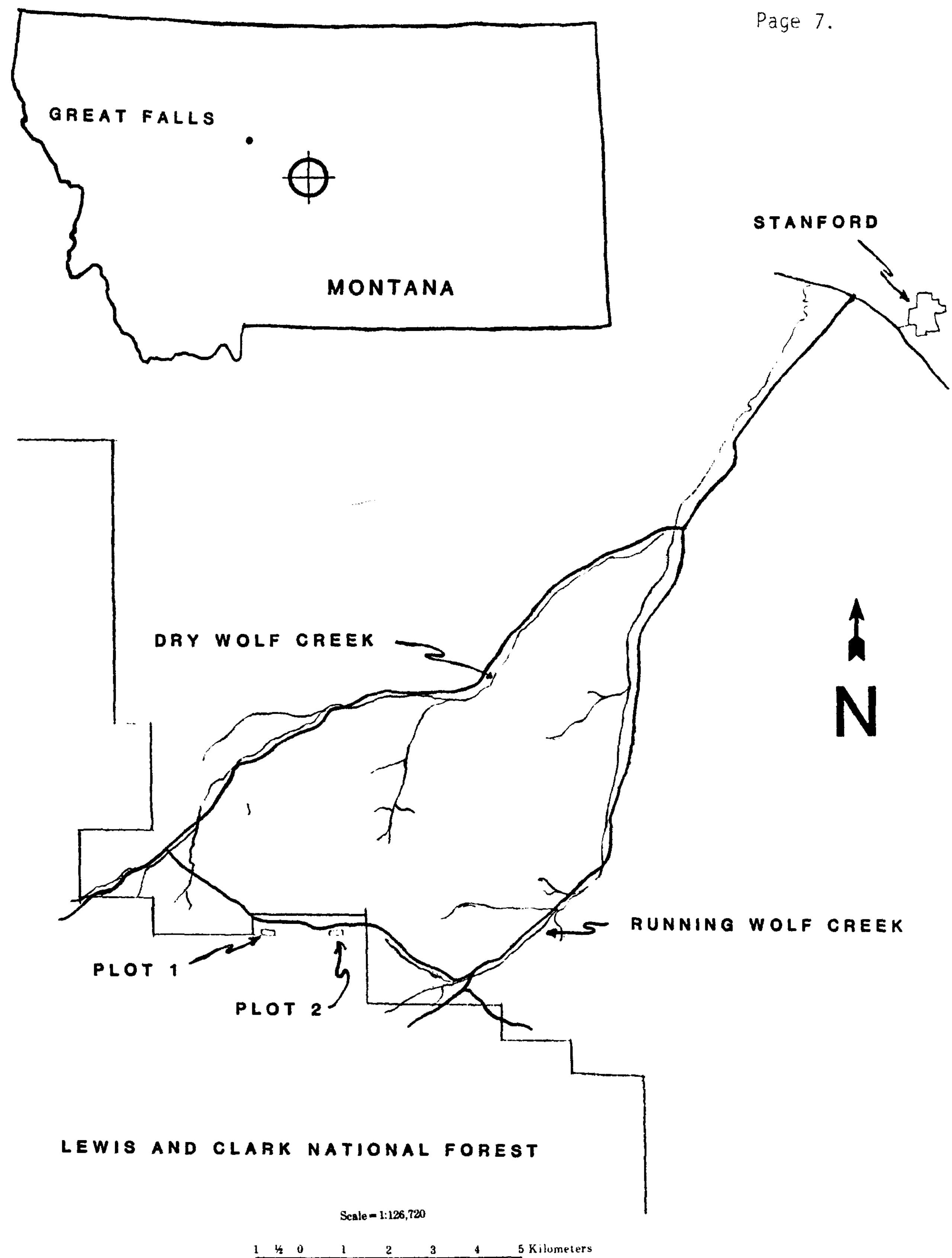

Figure 2. Study area map.

Annual precipitation for the area averages 52cm per year. Soils for the area are of the Skaggs series and are described as a stony clay loam with a dark-colored surface layer and a light-colored, strongly calcareous subsoil. The soil absorbs water readily, is well drained and has fair to good moisture- holding capacity.

Both sites had been previously burned in 1976 as part of Keown's (1982) work. Livestock grazing has been the only other disturbance.

METHODS

On each site one large plot, approximately 30m x 85m, was delineated and fenced. Each of these large plots was then subdivided into 12 equal subplots measuring 6m x 30m. Each subplot was separated by a 1m buffer strip used for fireline construction. The subplots for each main plot were randomly assigned 1 of 4 treatments so that each treatment was repeated 3 times in each main plot for a total of 6 repetitions (Fig. 3). Treatments were seasonal burns during summer, fall and spring. A set of control plots was also established.

Before burning 50 plants were selected from each subplot and were marked with wire flags for post-fire observation. There were a total of 300 observations for

2	2	4	1	4	3	1	1	3	4	3	2

Plot 1. Dry Wolf site.

3	1	3	4	3	2	2	1	4	4	2	1

Plot 2. Running Wolf site

Subplots: 1-Summer treatment

2-Fall treatment

3-Spring treatment

4-Control

Figure 3. Plot diagram.

each treatment. In order to be selected, a plant had to appear alive and healthy and be situated within the plot so as to be unaffected by fire line construction and be burned after the fire had reached a steady state. This places the marked plants in the center of the upper two- thirds of the subplots.

A fire prescription was written during the summer of 1983. The prescription called for the burning of a reasonably hot fire through each of the 6 subplots during each of the seasons of treatment. A minimum consumption of 75 percent of the shrubby cinquefoil to a stub height of 8-11cm was prescribed. In order to accomplish these objectives it was believed that flame lengths must be between 60-180cm and fireline intensity must between 14-240 Kcal/m-sec. These parameters were computed using a TI-59 calculator (Bergan, 1979).Indices for these calculations were a 10 percent average slope and a live fuel moisture of 100 percent. Fuel model 5 was used as the most appropriate model for this vegetation. Although a more intense fire was desired, a less intense fire was acceptable as long as the plants were burned during the specific season.

Firelines were constructed by applying liquid, aerial fire retardent with ground tankers. Immediately prior to each burning treatment, measurements were taken of soil moisture, vegetative moisture, relative humidity and wind speed. Estimates of flame lengths and rates of spread were recorded during the burning treatments.

Fuel loadings were also obtained by clipping random plots and weighing the oven-dried material. These measurements are shown in Table 1.

Phenology of the vegetation at the time of burning was also noted (Table 2).

Burns took place on August 16, 1983, for the summer burn, October 8, 1983, for the fall burn and April 16, 1984, for the spring burn. Conditions on the day of the burns are listed in Table 3. The summer burn was not intense because fine fuel moistures were high, resulting in flame lengths less than 60cm, low rates of spread and patchy burning. Burning conditions improved for the fall burn but fire intensity was still not as high as desired but was within the prescription. The spring burn was the most intense based upon flame lengths up to 150cm. Very dry conditions contributed to high fire spreads and good fuel consumptionsbecause of low fine fuel moisture.

In the late summer of 1984 the marked plants were evaluated for mortality and noted as being either alive or dead.

Table 1. Average fuel loadings of the sites (kg/ha).

	Dry Wolf	Running Wolf
Fine fuels (grasses)	700	800
Shrubby cinquefoil	2150	2300

Table 2. Phenology of vegetation on day of burn treatment.

	Summer	Fall	Spring
Shrubby cinquefoil	Flowering complete, few flowers remain, seeds not yet formed.	Leaves shed, plants dormant.	Buds unbroken, no swelling yet occuring.
Other veg.	Grasses mostly cured, seed shatter occuring.	Grasses cured, forbs cured and dry.	Bases of grass just begining to green. Forbs starting to emerge.

Table 3. Average burning conditions.

	Summer	Fall	Spring
Soil moisture (%)-	17	10	15
Veg. moisture (%)			
grass-	76	9	2
shrubby cinquefoil-	40	9	21
10hr fuel sticks-	6	12	6
Relative humidity (%)-	25	19	30
Wind speed (km/hr)-	8-11	8-11	14
Time of day (pm)-	5-6	1-2	2-4
Est. ave. flamelength (m)-	-	0.6	1-1.5
Est. ave. rate of spread (m/min)-	-	4	13

Vigor of the burned plants was evaluated 5 months after the spring burn. Four plants from each subplot were randomly collected by pacing a direct line three meters from the start of the distribution of the marked plants. From this point, one meter was paced along the transect, a random compass direction was selected, and the nearest plant in that direction was selected. Additional plants were selected along the transect in the same manner. Basal sprouts were then clipped from the plant and bagged for future measurement. The sprouts from each plant were counted, the total length of these sprouts was measured to the nearest centimeter, and their total oven-dried weight was recorded.

A factorial analysis of variance (ANOVA) was used to determine significant differences ($P \leq .05$) in mortality between treatments (SPSSX, 1983) . ANOVA was also used to determine if there were any significant differences ($P \leq .05$) in vigor, as measured by sprout number, length, and weight, between site and treatment. Duncan's multiple range test was used to test for differences ($P \leq .05$) between treatments.

RESULTS AND DISCUSSION

MORTALITY

Twelve hundred marked shrubby cinquefoil plant specimens, 300 from each treatment, were observed for mortality. Data for numbers of live and dead plants following treatments are presented in Table 4. The almost complete absence of mortality of shrubby cinquefoil following burning clearly indicates a tolerance to fire. Essentialy all burned plants studied regardless of the season of burning or the amount of plant consumed by the fire, were observed to be sprouting from their rootcrowns after burning.

These observations are confirmed from other burns outside my study. An area 50 ha in size, approximately 20 km from the study area, was burned in the fall of 1983 for conifer control. This area had a substantial amount of shrubby cinquefoil as a component of the vegetation. Fuels were heavier at this site than on my study plots, and both head and backing fires occurred. Observations in the late summer of 1984 indicated an almost total resprouting of the shrubby cinquefoil. Also, an on-going study of the effects of fire along the Rocky Mountain Front (Jourdonnais, personnel communication), approximately 200 km west of my study area, had shrubby cinquefoil as a minor component of the vegetation. Prescribed burns involving both head and back fires were applied in the fall of 1983 and in the

Table 4. Mortality results of observed plants.

Treatment	Alive (No.)	Dead (No.)
Summer	299	1
Fall	300	0
Spring	300	0
Control	300	0
Total	1199	1

spring of 1984. Regardless of the treatment, shrubby cinquefoil was observed resprouting in the fall of 1984.

All respouting occurred at the rootcrown. There was no evidence of any sprouts arising from roots or of any sprouting from the aerial stems.

VIGOR

A total of 96 plants were collected, 4 from each subplot, to observe the vigor of the respouting plants. Vigor was measured as a function of the number, length, and weight of sprouts on a plant.

Site Variation

The effect of the sites on shrubby cinquefoil vigor was analyzed using ANOVA (Table 5). There were no significant differences ($P \leq .05$) between the two sites for the mean number of sprouts per subplot and the mean total length of the sprouts per subplot. However, there was a difference for the mean total weight of the sprouts per subplot. Mean total weights were greater in the RW site than in the DW site. This difference can best be explained due to the difference in the natural productivity of the two sites. The RW site, with a northeast exposure, was a slightly more moist site than the DW site, and thus a slightly more productive site

Table 5. ANOVA results for vigor measurements.

Source of Variation	df	F-test Statistic Numbers	Length (cm)	Weight (g)
Site	1	*0.9a	2.43a	5.77a
Treatment	3	49.14b	28.91b	17.88a
SxT	3	6.22b	3.6b	3.02a
Residual	16			

* Means within the same column followed by a similar letter are not significantly different at the 0.05 level of probablity.

Treatment Variation

Vigor measurements due to treatments were significantly different ($P \leq .05$) as shown in Table 5. Further testing using Duncan's multiple range test indicates that in all parameters of the vigor measurements (numbers, length and weight), the control subplots were significantly lower than the other treatments (Table 6). Also, there was no significant difference in the vigor parameters between the summer, fall and spring burning treatments.

Shrubby cinquefoil plants within the control subplots, lacking any crown removal or disturbance, obviously did not actively resprout although some plants did have an occasional new sprout. Plants within the burned plots respouted with equal vigor regardless of the season of burning.

Although the vigor between treatments was not statisticaly different, a nonsignificent trend in the data does point toward the summer-treated plants as being the least vigorous of the treated plants (Table 6). This agrees with earlier findings of other shrubs and trees producing less srouts following disturbance during the active growing season than during the dormant season(Brown, 1930; Buell, 1935; Tew, 1970;Wright and Stinson, 1970).

Table 6. Plot means of vigor measurements.

	Numbers	Length(cm)	Weight(g)
Summer	*200a	1765a	16.36a
Fall	225a	1969a	18.25a
Spring	242a	2265a	22.31a
Control	4b	24b	0.17b

* Means within the same column followed by a similar letter are not significantly different at the 0.05 level of probability.

Data analysis also indicated an interaction between sites and treatments for all parameters of vigor (Table 5.). This was investigated further by constructing a 95% confidence interval of the treatments by site and comparing the sites. Only one parameter of one treatment , the number of sprouts produced on the summer burn, showed a difference between sites. Samples indicate that the DW site produced more sprouts per plant than the RW site. This could be explained by sampling error or by the fact that because the RW site was more moist the burning was less intense and thus less top damage occurred, stimulating less sprouting.

Vigor of the resprouting shrubby cinquefoil, following the burning treatments, indicates shrubby cinquefoil is a species suited to surviving fire. Scotter (1984) believes shrubby cinquefoil is actually stimulated by fire. Reports of its increase over time in areas being disturbed by heavy grazing (Scotter 1975, Stelfox 1975) indicates an ability to respond positively to disturbance.

CONCLUSION

Shrubby cinquefoil has demonstrated an ability to survive fire. Regardless of the season of burning it still resprouted vigorously. Burning may not be a viable improvement practice for the control of shrubby cinquefoil because of this response. However, White and Currie (1983) in studing silver sage (Artemisia cana) have shown that burning can significantly control a resprouting shrub. This may be the case for shrubby cinquefoil, although this did not occur with my treatments.

Further studies into repetitious burning of the newly resprouted plants should be investigated. Experiments using intense burns, during the critical low carbohydrate period of the summer, should be attempted. The effects such burns would have on associated plant species should also be studied.

The only method known to satisfactorly control shrubby cinquefoil has been herbicide application (Scotter, 1975). This method, combined with a well managed grazing system, may be the best answer to improving those rangelands in which shrubby cinquefoil is a problem.

LITERATURE CITED

Aldous, A.E. 1929. The eradication of brush and weeds from pasture lands. J. Amer. Soc. Agron. 21:660-666.

Aldous, A.E. 1935. Management of Kansas permanent pastures. Kansas Agr. Exp. Sta. Bull. 272. 44p.

Ahlgren, I.F. and C.E. Ahlgren. 1960. Ecological effect of forest fires. Bot. Rev. 26:483-535.

Baker, F.S. 1918. Aspen reproduction in relation to management. J. Forestry 16:389-398.

Bergan R. E. 1979. Fire danger / fire behavior computations with the Texas Instruments TI-59 calculator: users manual. Gen. Tech. Rep. INT-61. 25p.

Biswell, H.H. 1974. Effects of fire on chapparal. p. 321-360. In: T.T. Kozlowski and C.E. Ahlgren (Eds) Fire and Ecosystems. Academic Press Inc. N.Y.

Brown, B.A. 1930. Effect of time of cutting on the elimination of bushes in pastures. J. Amer. Soc. Agron. 22:603-605.

Buell, J.H. 1940. Effect of season of cutting on sprouting of dogwood. J. Forestry 38:649-650.

Daubenmire, R.F. 1968. Ecology of fires in grasslands. Advan. in Ecol. Research 5:209-266.

Forest Service. 1937. Range plant handbook. U.S. Dept. Agr., Washington D.C.

Fischer, W.C. and B.D. Clayton. 1983. Fire ecology of Montana forest habitat types east of the Continental Divide. Gen. Tech. Rep. INT-141. 73p.

Jones, M.B. and H. M. Laude. 1960. Relationships between sprouting in chamise and the physiological condition of the plant. J. Range Manage. 13:210-214.

Jourdonnais C. 1984. Personnel communications.

Kearney, T.J. and R.H. Peebles. 1951. Arizona flora. University of California Press. 456p.

Keown, L.D. 1982. An evaluation of qualitative plant responses to prescribed burning on a central Montana ecosystem. Unpubl. On file, Lewis and Clark National Forest, Judith Ranger District, Stanford Montana. 16p.

Laude, H.M., M.B. Jones and W.E, Moon. 1961. Annual variability in indicators of sprouting potential in chamise. J. Range Manage. 14:323-326.

Lovaas, A.L. 1958. Mule deer food habits and range use, Little Belt Mountains, Montana. J. Wildl. Manage. 22:275-283.

Mueggler, W. F. 1976. Ecological role of fire in western woodland and range ecosystems. p.1-9. In: Use of Prescribed Burning in Western Woodland and Range Ecosytems, a Symposium. Utah State Univ., Logan.

Nimir, M.B. and G.F. Payne. 1978. Effects of spring burning on mountain range. J. Range Manage. 31:611-613.

Pfister, F.D., B.L. Kovalchik, S.F. Arno and F. Presby. 1977. Forest habitat types of Montana. Gen. Tech. Rep. INT-34. 174p.

Scotter, G.W. 1975. Effects of picloram on cinquefoil and forage production at the Ya-Ha-Tinda Ranch, Alberta. J. Range Manage. 28:132-138.

Scotter, G.W. 1984. Personal communication.

SPSSX Inc. 1983. SPSSX user's guide. McGraw-Hill Book Company. Chicago, Ill. 802p.

Stelfox, J.G. 1976. Range ecology of Rocky Mountain bighorn sheep in Canadian national parks. Can. Wildl. Serv. Rep. Ser. 39:1-50.

Tew, R.K. 1970. Root carbohydrate reserves in vegetative reproduction of aspen. Forest Sci. 16:318-320.

Valentine, J. F. 1971. Range developement and improvement. Brigham Young Univ. Press, Provo, Utah. 516p.

Wenger, K.F. 1953. The sprouting of sweetgum in relation to season of cutting and carbohydrate content. Plant Physiol. 28:35-49.

White, R.S. and P.O. Currie. 1983. The effects of prescribed burning on silver sagebrush. J. Range Manage. 31:611-613.

Willard, E.E. and C.M. McKell. 1973. Simulated grazing management systems in relation to shrub growth responses. J. Range Manage. 26:171-174.

Wright, H.A. 1974. Range burning. J. Range Manage. 27:5-11.

Wright, H.A. and K.J. Stinson. 1970. Response of mesquite to season of top removal. J. Range Manage. 23:127-128.

Wright H.A., Neuenshwander, L.F. and C.M. Britton. 1979. The role and use of fire in sagebrush-grass and pinyon juniper plant communities; a state-of-the-art review. Gen. Tech. Rep. INT-58. 48p.

Young, D.L. and J.A. Bailey. 1975. Effects of fire and mechanical treatment on Cercocarpus montanus and Ribes cercum. J. Range Manage. 28:495-497.

APPENDIX

APPENDIX I

Summary of vigor measurements.

Subplot*	Number**	Length (cm)	Weight (g)
IS1	49	411	4.1
IS2	64	410	2.5
IS3	84	691	6.2
IF1	50	440	4.0
IF2	65	471	3.9
IF3	53	380	2.9
IV1	54	331	2.1
IV2	54	409	4.7
IV3	50	426	4.0
IC1	1	5	0.03
IC2	2	13	0.1
IC3	1	2	0.02
IIS1	41	470	4.3
IIS2	36	410	4.7
IIS3	27	255	2.8
IIF1	55	468	4.2
IIF2	61	647	6.4
IIF3	54	522	5.9
IIV1	69	746	8.3
IIV2	85	920	10.0
IIV3	51	477	4.5
IIC1	1	2	0.02
IIC2	1	5	0.03
IIC3	1	9	0.08

*I-Main plot DW site. II-Main plot RW site. S-Summer treatment. F-Fall treatment. V-Spring treatment. C-Control. 1-Subplot 1. 2-Subplot 2. 3-Subplot 3.

**Parameters are the average of 4 plants collected in each subplot.