Thomas A. Leege
Idaho Fish and Game Department
Kamiah, Idaho

and

William O. Hickey
Idaho Fish and Game Department
Salmon, Idaho

Growth and Dieback of Redstem (Ceanothus sanguineus) in Idaho

Abstract

Annual growth and dieback of redstem ceanothus was influenced by weather, aspect, elevation, and plant age. The length of annual twig growth was strongly correlated with the amount of precipitation during the period of May through August ($r = .90$). Substantial dieback occurred when minimum daily winter temperatures dropped rapidly to less than 0°F. Dieback was greatest on old redstem plants, especially those that were weakened from the stresses associated with advanced forest succession.

Introduction

Redstem ceanothus (*Ceanothus sanguineus*) constitutes about one-third of the winter diet of elk (*Cervus canadensis*) in the Lochsa River drainage (Trout and Leege, 1971). Undoubtedly, it is a very important winter browse for elk throughout northern Idaho and adjacent areas of Washington and Montana.

Twig growth on many shrub species varies significantly from year to year. Researchers have found a strong relationship between annual twig length and precipitation (Garrison, 1953; Shepherd, 1971; Halls and Alcaniz, 1972, and others), but the important period of precipitation has varied with the shrub species and weather patterns in the study area. No information about the growth-precipitation relationships for redstem has been reported.

The woody tissue of shrubs sometimes withers and dies, frequently in response to rapid fluctuations in air temperature. The twig growth that is lost in this manner is referred to as dieback and is commonly found on many species of *Ceanothus.* Young and Payne (1948) reported that about 15 percent of the new redstem growth in northern Idaho was killed by a severe frost in late May, 1942. Stickney (1965) documented a large dieback of snowbrush (*Ceanothus velutinus*) during the winter of 1962-63 in the Missoula, Montana, area and suggested that it was caused by a severe drop in temperature following a mild period. Williams (1963) reported substantial redstem dieback in northern Idaho during the same winter, but he did not suggest a cause.

In this paper we relate the annual growth and dieback of redstem to weather, site characteristics, and plant age. The word "significant," when used in reference to specific findings, indicates statistical probability at the 0.05 level.

Methods and Study Area

In the fall of 1966 and during the next four years, we tagged and measured redstem annual growth on east, south, and west aspects at 2000 ft, 3000 ft, and 4000 ft (610 m, 915 m and 1220 m, respectively) and on a north aspect at 4000 ft in the Pete King Creek drainage, a tributary of the Lochsa River in northern Idaho. At each site we selected 20 plants in a systematically random manner and measured the annual growth on one branch of each plant. Each branch was selected on the basis of having three to six unbrowsed twigs that did not exhibit any dieback and were less than 7 ft (2.1 m) above the ground, an arbitrary height related to browse availability. We returned to these transects each spring, usually in April, and measured the amount of the past year's stem growth on browsed and unbrowsed twigs that had died since the fall measurement. We measured to the nearest 0.5 in (1.27 cm) the growth and dieback of about one thousand twigs annually, for five years and four years respectively.

All study sites occurred within the *Abies grandis-Pachistima* or *Thuja plicata-Pachistima* habitat types as described by Daubenmire and Daubenmire (1968). Soils were of a granitic origin and slopes ranged from 40-90 percent. Annual precipitation averaged 38 in (96 cm) at 2000 ft and increased to about 45 in (114 cm) at 4000 ft. Nine of the study sites were burned by wildfire in 1934, and vegetation ranged from relatively open shrub stands on the xeric exposures to advanced conifer regeneration on moister aspects. Four other sites, all at 4000 ft, were clearcut-logged in 1961 and broadcast-burned in the fall of 1962. Since fire is the primary agent which stimulates germination of redstem seeds, we assumed that the plants we measured on the 1934 burn sites ranged from 32 to 36 years old during the five year study. Likewise, plants in the clearcuts ranged from four to eight years old. Throughout this paper we refer to these redstem as old and young plants, respectively. Whenever young and old plants are compared, we are referring only to the plants at 4000 ft, as all of the young plants occurred at that elevation in the clearcuts.

Results and Discussion

Annual Growth

The length of the average current annual growth twig for five growing seasons on old redstem plants varied from a low of 9.3 in (23.6 cm) in 1970 to a high of 12.0 in (30.5 cm) in 1968 (Fig. 1). We calculated correlation coefficients for precipitation and growth for all combinations of months, including those of the previous growing season, and found the May-through-August period to have the highest relationship ($r = .90$) with annual growth. A regression equation of: $5.77 + 0.633$ (total in ppt. for May through August) estimated average annual leader length in inches. May and June are typically wet months, whereas July and August are very dry. Annual growth began in May and usually terminated in July, unless adequate precipitation fell during July and August to prolong the growing period. This was the case in 1968 when both July and August precipitation was above average. The sample size was much smaller for young plants, so a correlation between twig length and precipitation was not computed.

On young plants, length of annual growth did not differ significantly among all

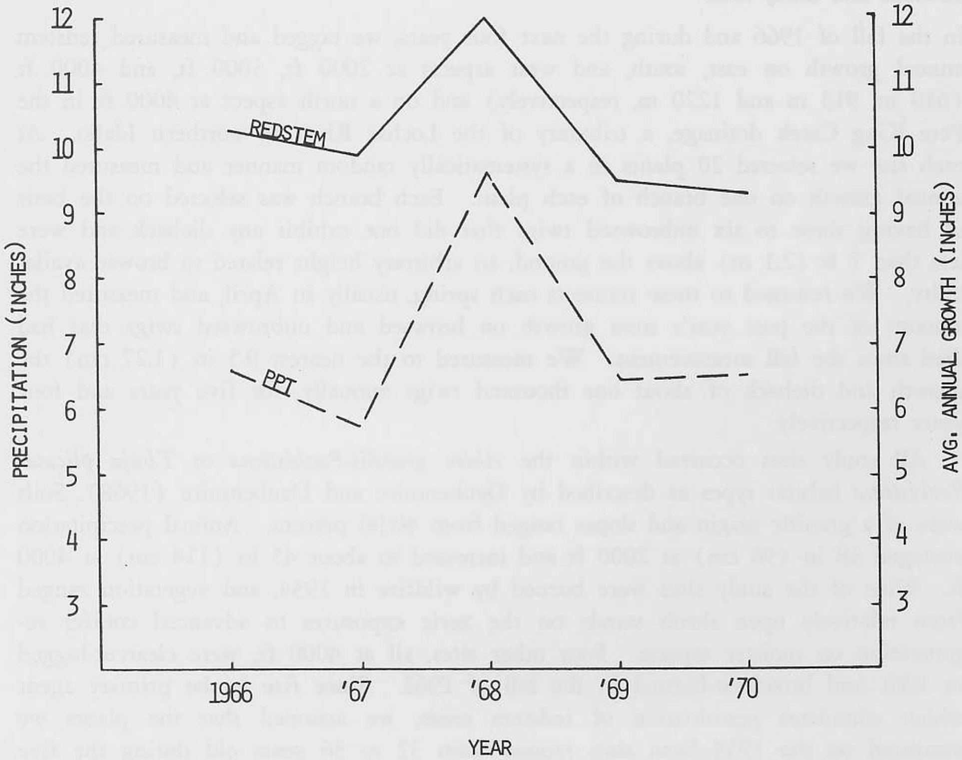

Figure 1. Relationship of redstem annual growth (old plants) to precipitation during the May-through-August period.

four aspects during the five year period. However, the length of the annual growth twigs on old plants was significantly greater on the south aspects (Table 1).

There was no apparent relationship between elevation and growth. Twigs were longest at 2000 ft for two years, at 3000 ft for one year, and at 4000 ft for two years.

Dieback

Dieback was divided into two types—that which occurred on a twig after it was browsed upon (browsed dieback), and that which occurred with no apparent twig injury (unbrowsed dieback). Browsed dieback on both young and old redstem plants averaged 3.5 percent of the linear annual growth and ranged from 2.9-4.6 percent

TABLE 1. Mean annual twig length in inches for old plants (32-36 years old), on three aspects.[1]

Year	South	East	West	Average
1966	10.9	10.6	9.5	10.3
1967	11.5	9.5	8.7	9.9
1968	12.2	11.9	11.9	12.0
1969	9.8	8.2	10.4	9.5
1970	12.6	8.7	6.7	9.3
Average	11.4[2]	9.8	9.4	10.2

[1] Each measurement is an average from 3 transects, 1 each at 2000 ft, 3000 ft, and 4000 ft.
[2] Significantly different from east and west aspects at 0.05 level.

during the four years. About 38 percent of the annual growth twigs were browsed upon during this period. We noted that as the percentage of browsed twigs increased, the percentage of browsed dieback also increased. Unbrowsed dieback averaged 5.9 percent annually, and deviated significantly from this mean during only one winter, 1968 to 1969, when almost two and one-half times as much unbrowsed dieback (12.9 percent) occurred as during the next highest year (5.2 percent).

Stickney (1965) suggested that a warm period of five to ten days with maximum temperatures 5-10° F above freezing and minimum temperatures not more than 5° F below freezing may change the winter hardiness of *Ceanothus velutinus.* He speculated that if such a period is followed by a sudden drop in temperature to 20-35° F below freezing in 24 to 48 hours, frost damage may occur. During the four years of our study, a temperature fluctuation similar to this occurred only during late December, 1968, the winter of greatest redstem dieback. The average maximum daily temperature for December 15 to December 28 was 36.6° F (2.6°C) and the daily minimum was 24.9° F (-3.9°C) at Fenn Ranger Station, about 1600 ft in elevation and eight air-miles (12.9 km) from the study plots. On December 29, the temperature dropped sharply, and for the following three days the average maximum temperature was 15° F (-9.4°C) and the average minimum was -4 F° (-20°C). The lowest temperature was -12° F (-24°C) on December 31.

Williams (1963) reported a large dieback for redstem during the winter of 1962 to 1963 on study areas within 25 mi (40 km) of ours. Weather records for that period from Fenn Ranger Station (U.S. Dept. of Commerce, 1962) indicate that a rapid decrease in temperature occurred in late December when the minimum daily temperature dropped from 28° F (-2°C) to -10° F (-23°C) in two days. Six days later it warmed to a minimum temperature of 31° F (-6°C) and then cooled to -4° F (-20°C) in the following two days. Therefore, similar temperature fluctuations in both 1962 and 1968 resulted in larger than normal amounts of dieback. During both years, when the cold temperatures occurred, there was less than one foot (30 cm) of snow on the ground below 4000 ft elevation. Additional quantities of snow may have reduced dieback by insulating portions of the plant from the severe temperature fluctuations.

It would seem that dieback caused by temperature fluctuations should have been more severe on south aspects because of greater insolation, and thus higher temperatures during the daytime, with night temperatures equally low as those on other aspects. In addition, snow depths were less on south exposures, and more of each plant was exposed to temperature extremes. This pattern of dieback did occur on the young plants as they had significantly more unbrowsed dieback on the south exposure than the other aspects. However, the unbrowsed dieback on old plants was significantly greater on the east aspect (Fig. 2).

There was significantly more unbrowsed dieback on old plants than on young plants during each winter (Fig. 3). Unbrowsed dieback on old redstem was usually greater (but not significantly so) at low elevations than at high elevations. However, Williams (1963) found the opposite to be true as dieback increased from about 27 percent at 2000 ft to 56 percent at 4000 ft during the winter of 1962 to 1963.

Although we recorded information regarding dieback only on annual growth twigs, we noted that in some instances branches and even entire plants were killed at ground level. Sometimes, the plant responded by sprouting from the root crown.

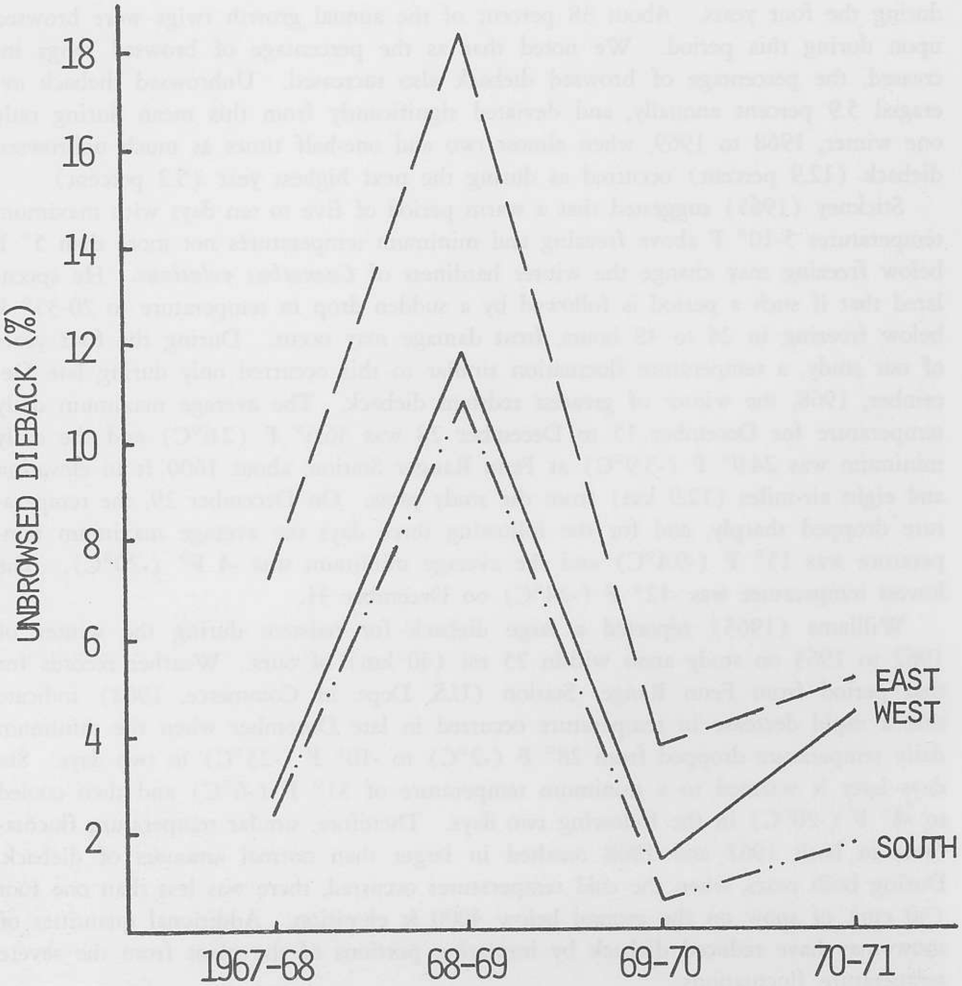

Figure 2. Relationship of unbrowsed dieback of annual growth (old plants) to aspect.

Effects of Plant Succession

Shading of the understory increases as plant succession advances toward the conifer climax. The rate of succession is affected by available moisture, which in turn is influenced greatly by exposure to the sun, especially where slopes are steep. Consequently, north aspects are the wettest and plant succession there is the most rapid (Fig. 4). Conversely, south aspects are the driest and their succession the slowest. East aspects are somewhat wetter than west aspects.

On our study area, redstem (young) germinated and grew very well on all four aspects at 4000 ft elevation after mature stands of *Abies grandis* and associated conifers were clearcut-logged and the slash broadcast-burned. However, at the same elevation on an adjacent area where mature timber was burned by wildfire in 1934, live redstem (old) plants were absent on north aspects, scattered on east and west aspects, and numerous on south aspects. Dead plant crowns indicated that redstem had been

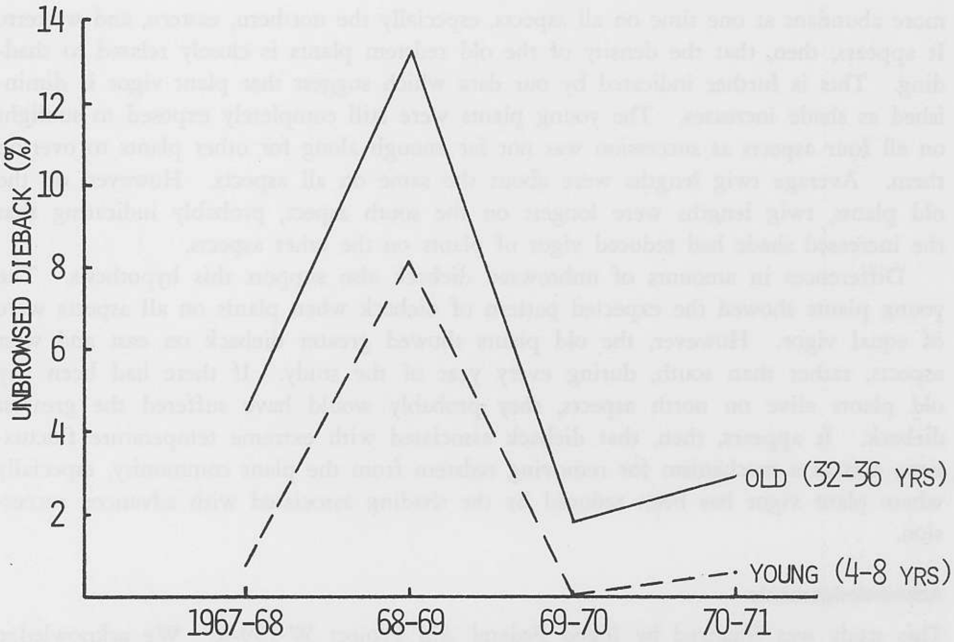

Figure 3. Relationship of unbrowsed dieback of annual growth to plant age, at an elevation of 4000 ft.

Figure 4. A small tributary of the Lochsa River that was burned by wildfire in 1919 and 1934, and photographed in 1969. Plant succession toward the conifer climax is occurring at a much faster rate on the northerly exposure.

more abundant at one time on all aspects, especially the northern, eastern, and western. It appears, then, that the density of the old redstem plants is closely related to shading. This is further indicated by our data which suggest that plant vigor is diminished as shade increases. The young plants were still completely exposed to sunlight on all four aspects as succession was not far enough along for other plants to overtop them. Average twig lengths were about the same on all aspects. However, on the old plants, twig lengths were longest on the south aspect, probably indicating that the increased shade had reduced vigor of plants on the other aspects.

Differences in amounts of unbrowsed dieback also support this hypothesis. The young plants showed the expected pattern of dieback when plants on all aspects were of equal vigor. However, the old plants showed greater dieback on east and west aspects, rather than south, during every year of the study. If there had been any old plants alive on north aspects, they probably would have suffered the greatest dieback. It appears, then, that dieback associated with extreme temperature fluctuations acts as a mechanism for removing redstem from the plant community, especially where plant vigor has been reduced by the shading associated with advanced succession.

Acknowledgements

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