# The Effects of Fire on Scotch Broom

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## ABSTRACT

Scotch broom (*Cytisus scoparius*) is an invasive species on glacial outwash prairies of Western Washington, and ongoing attempts to restore prairies to their natural state are hindered by its rapid spreading habits. We studied the effects of fire on Scotch broom to determine if it was an effective means of elimination of the plant. A random number and walking process was used to determine which plants would be selected for recording variables. A similar random process was used to determine which shoots and leaf clusters were counted. We found that although some growth variables were unaffected by the burn, variables such as leaf count and new growth length showed a strong negative response to the burn. Since leaf count and new shoot length are key to a plant's overall health, our research indicates that fire negatively affects the Scotch broom. Our research revealed that a controlled burn treatment did effect on new shoot length and leaf count, though it did not appear to affect other variables measured and the burn did not eradicate the plant from the prairie.



KEY WORDS:

Scotch broom, Cytisus scoparius, prairie, restoration, burn, fire, exotic, non-native, shrub


## INTRODUCTION

Scotch broom (*Cytisus scoparius*) is an invasive species on Pacific Northwest prairies, which crowds out native species and accelerates succession. This European native first arrived in the Pacific Northwest in 1850 when Captain Walter Colquhoun Grant planted seeds that he had acquired in the Sandwich Islands. The shrub has since spread from this initial planting in Vancouver Island along the west coast and into central California (Pojar 1994, Parker 2000). As a legume, Scotch broom can fix nitrogen in the soil, changing the soil chemistry which encourages trees to grow sooner, converting

prairies into forests (Haubensak et al. 2004). Glacial Prairies are important to protect because they are a unique ecosystem that is very rare in Western Washington (Dunn, 1998).

Prairie restoration techniques include attempting to remove invasive plants through herbicide applications, mechanical cutting and pulling, and prescribed burns (Alexander and D'Antonio, 2003). One of the reasons that Scotch broom is difficult to eradicate is because its seeds remain viable for a very long time. Seeds can stay dormant in the soil for up to 70 years, which results in a very large seed bank. Burning scarifies the protective coating on the seeds encouraging them to germinate the next year (Boyd 1995).

We studied the effects of fire on Scotch broom. Studying the robustness, growth, and reproduction of Scotch broom in burned and unburned sections of an otherwise equal prairie could indicate the effectiveness of these treatments for future restoration efforts.

## METHODS

### *Site Description*

Our field site was the Black River-Mima Prairie Glacial Heritage Preserve, a 1,100 acre park in Thurston County, Washington. Glacial Heritage contains one of the best remaining examples of Mima Mounds, a unique geographical phenomenon comprised of mounds of soil several meters tall throughout the prairie. Glacial also contains a diverse prairie plant community, including camas (*Camassia quamash*), Scotch broom (*Cytisus scoparius*), lomatium (*Lomatium utriculatum*), and a variety of grasses, lichens, and mosses.

The Nature Conservancy has done extensive prairie restoration at Glacial Heritage, including controlled burns and herbicide applications, as well as tree and invasive plant removal. In order to examine the effect fire has on Scotch broom, we compared plants from a portion of the prairie that had

been treated with a burn two years ago in 2005, and an unburned area that served as a control. Though Scotch broom has been specifically targeted for eradication on other sections of the prairie, to our knowledge both sites had not been treated, though herbicides had been used nearby.

### *Field Methods*

We sampled 30 plants from the two-year old burn and 21 plants from a section of unburned prairie. Plants were chosen using a randomized walk and selecting the nearest plant. We measured growth characteristics, flowering intensity, and general robustness of the Scotch broom in both burned and unburned areas.

First, we measured the overall height of each plant and, when possible, plants were extracted from the soil and root length was measured. To assess the plant's reproductive activity we counted the number of flowers and buds on each Scotch broom. We measured the lengths of 10 haphazardly chosen shoots per plant and counted the number of leaf clusters per shoot on another 10 shoots as an index of overall plant performance. When there were insects, larvae or eggs present on the plant, we recorded it. We also measured the distance to the nearest Scotch broom from the base of the shrub being sampled, as well as the number of plants within a one meter radius in order to record the population's density.

## RESULTS

The influence of fire on scotch broom studied in a two-year-old burned and unburned environment had noticeable effect on both the plants' new growth length (i.e., new shoot length) and leaf production (Table 1). Plants in the two-year burn site had an average of 35 leaf clusters per shoot. In contrast, plants in the unburned site produced an average of 53 leaf clusters per shoot (Table 1), which is 56% greater than those on the two-year burn (Fig. 1). The presence of fire also had a marked

effect on the lengths of randomly selected new growth shoots from plants in both the burned and unburned sites. Shoots on plants in the unburned site had an average length of 32 cm, however, shoots on plants in the two-year burn site only had an average length of 21 cm (Table 1). This presents a difference of eleven shoots between the two populations with 50% more growth on the unburned site (Fig.2).

There was also a significant difference in the density of Scotch broom growing on the two different sites. On the burned prairie the nearest plant of the same species was much closer to the plant being sampled, on average, than the ones on the unburned site. Similarly, there were generally more plants within a meter radius of the selected plant on the burned side than the unburned side (Table 1, Fig. 3).

The effects of fire on other variables, however, were inconclusive. The data collected on both height of the plant and total number of flowers per plant were not significantly different between sites (Table 1). We recorded root lengths when possible, but on many occasions roots either broke off or the plant simply could not be extracted from the soil. We thus did not have enough data to make a solid comparison. Likewise, while we noted a variety of insects, our findings were not complete enough on this issue to make any inductions (Data not shown).

## DISCUSSION

In our research with Scotch broom, we noticed a few important trends. In the unburned site, the Scotch broom had more leaf clusters and longer shoot length in comparison to the burned site. Other variables observed (flower buds, root length, presence of insects) did not reveal conclusive patterns. Scotch broom in the unburned site were further apart from one another, and this may contribute to the increased growth and reproduction that we observed. The Scotch broom in the burned site may be more

abundant in comparison to the unburned site as a result of the effects of fire on the seed banks. Fire flushes the seeds out from the bank and provides an opportunity for them to germinate and sprout (Dunn, 1998).

Previous research has shown a trend that where there is an adequate water supply after a burn treatment, plant production typically increases for the next 3 years, and then sharply decreases (Risser, 1982; Hadley and Kickhefer, 1963). The pattern we observed may be a result of this trend. Although Scotch broom was more abundant in the burned site, plants in the unburned site showed more signs of healthy growth and reproduction.

Though our information gathered on root length was inconclusive, we did notice that many of the plants we examined on the burned site had woody bases and branches that could not have grown in only two years time. There were even some that still showed evidence of charring. Clearly, the fire was not successful in killing all of the plants.

This data has many uses in prairie restoration and application of burn treatments. The implications of our research suggest that while fire may temporarily increase production, burn treatments are useful in restoring native species in their respective ecosystems over a longer period of time.

We have several recommendations for further studies. First, a larger sample size might yield more significant data. Also, given the fact that Scotch broom can branch out in different patterns, plant height doesn't always give the best indication of the size of a plant. Branch number, length, and diameter could be measured in addition to height and shoot length. Shoots can also branch out, so recording the branches and the total number of shoots would also help get a more complete picture of the plant. Other studies identified this as a problem and have instead estimated the biomass of the plant rather than recording information on the height, branches, and shoots (Parker 1999, Parker 2000).

The method we used to select plants tends to favor isolated plants. Another method such as the variable-area transect method would avoid this problem and may give a more accurate picture of the density of Scotch broom (Myers and Bazely 2003).

Despite our inconclusive data, it is clear that a single burn was not effective in eradicating Scotch broom. After two years, some plants had grown back and many new seedlings took root and flourished. Other studies speculate that a series of burns would be required to eliminate Scotch broom. Cutting the plants down to just a couple of inches above the soil may help the plant matter burn better. It is also helpful to burn or at least cut the plants before their seeds are produced and added to the already plentiful seed bank (DiTomaso 2006). Planting annual grasses between burns also creates more fuel for fires and helps them to burn at hotter temperatures (Boyd 1995).

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TABLES

Table 1. Growth characteristics of Scotch Broom in burned and unburned areas. All variables are mean ± SE.

| | Two-Year Burn | Unburned | P-value |
|---|---|---|---|
| Leaf clusters per shoot | 34.9358 ± 3.83 | 52.8571 ± 4.58 | 0.004 |
| Shoot length (cm) | 21.3100 ± 0.96 | 32.2237 ± 1.21 | <0.001 |
| Height (cm) | 49.2667 ± 3.17 | 56.1 ± 3.88 | 0.180 |
| Flowers per plant | 308.933 ± 100.6 | 451.74 ± 120.2 | 0.367 |
| Nearest Scotch broom (cm) | 51.993 ± 18.524 | 132.048 ± 22.141 | 0.008 |
| Number of Scotch broom within a one meter radius | 10.4 ± 1.4899 | 2.2381 ± 1.7807 | 0.001 |

FIGURES

Fig.1 – Leaf clusters per shoot on Scotch broom plants in two-year burn (2yb) and unburned prairie (ub).

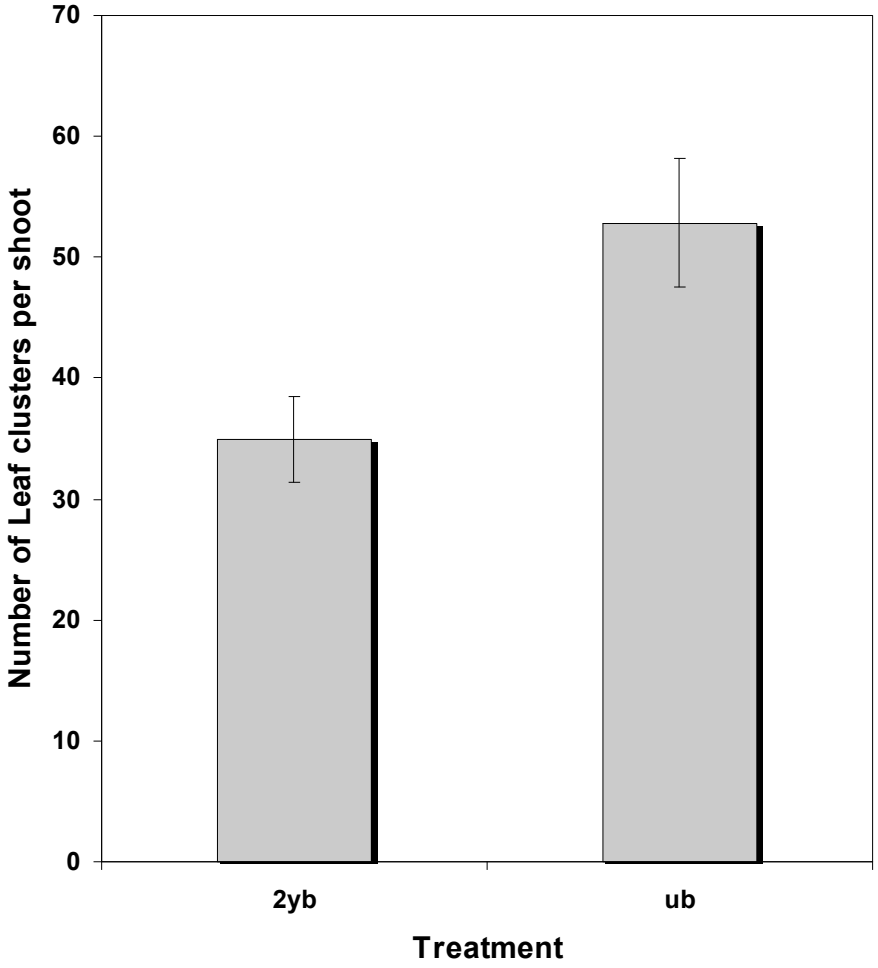

Fig. 2 – New growth on Scotch broom plants in two-year burn (2yb) and unburned prairie (ub).

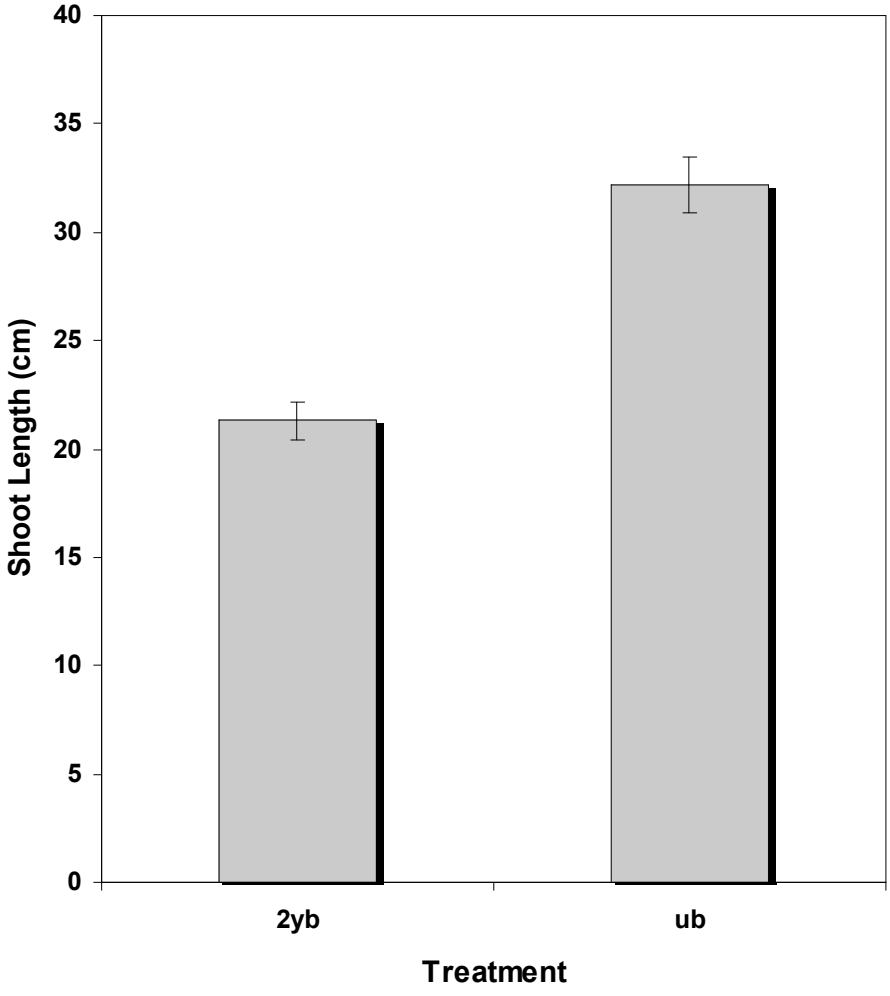

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Fig 3. – Proximity and Density of Scotch broom plants in two-year burn (2yb) and unburned prairie (ub).