Growth of Pteridium Aquilinum in Varying Habitats

Zack Davis*, Katy DeLong, Rebecca Hapke, Claire Hanson, Song Israel

*Zack Davis

1825 Lakehurst Dr. SE

Olympia, WA

(360)-402-9426

Theinfamouszackd@yahoo.com

ABSTRACT

Our study examined growth variations in *Pteridium aquilinum* in three different sites. *Pteridium aquilinum,* also known as the western bracken fern, exists naturally on six continents and is known to thrive following disturbance. The data we collected focused on plant size and number of blades. We measured forty random individuals in each of the three sites and concluded that *P. aquilinum* had different growth patterns in the varying habitats. Our data suggest that the *P. aquilinum* we observed limited vertical growth once access to sufficient sunlight was attained, and began to produce more horizontal blades to maximize photosynthesis. The fern blades tended to uncurl at an advanced rate in the sites with less sunlight. While many variables between the three sites prevented this study from finding any specific cause-effect relationships, we were able to conclude patterns in growth appeared different at the three sites.

KEYWORDS

Human disturbance, logging, forest fire, bracken fern, trample, growth patterns, rhizome, competition, deciduous, and Bear Gulch II.

INTRODUCTION

Pteridium aquilinum, commonly known as the western bracken fern, has proven itself to be a very resilient plant. It is found globally in a wide variety of climates and soil types, succeeding even in disturbed areas (Pojar, 1994). Its ability to thrive in challenging environments results in a dominantly invasive fern, causing substantial impact on the land it invades. Our study addressed the question how does growth of *P. aquilinum* differ between three distinctly different habitats.

Evidence from fossils suggests that the *P. aquilinum* has had over 55 million years to evolve and cultivate advanced anti-disease and anti-herbivore mechanisms (Page, 1986). *Pteridium aquilinum* competes for soil nutrients and water with other species effectively and often invades disturbed areas (Crane, 1990). As the *P. aquilinum* establishes itself, it impacts much of the plant life around it. The plant's rhizomes, horizontal underground stems, may spread underneath the roots of other vegetation and sprout fronds to prevent sunlight from reaching those plants. Fire is almost always a dominant factor in the biology of plant communities, and because of this we choose to include it as a factor in our own study (Dansereau 1957, Ahlgren and Ahlgren 1960, Spurr 1964, Daubenmire 1968, Mutch 1970) . When the fronds, the body of the plant visible above ground, die each year, they often crush the underlying plant life (Crouch, 1974). While hindering some, these fronds also protect and promote growth in certain species and seedlings (McCulloch, 1942). *Pteridium aquilinum* have interesting responses to natural disturbances. During a fire, dead fronds act as a thick blanket of dry fuel, but ironically, most vegetation are obliterated by fire except the fern rhizomes, which stay protected underground (McCulloch, 1942). This allows the bracken fern to dominate recently burned habitats, assisting in the reestablishment of the area by preventing erosion (Tiedemann, et. al., 1976).

These underground rhizomes not only allow *P. aquilinum* to survive fire, but also cold winters in which they shed their fronds early, leaving the rhizome intact until spring when they send up new immature, curled fronds (Crane, 1990). Mature fronds usually grow to in between two to six feet in length, but can grow up to ten feet in length depending on their environment (Hitchcock, 1969). Variations in frond size and the plant's deciduous nature, in combination, allow one to observe the yearly growth of ferns in significantly different habitats.

Pteridium aquilinum is a vital and active component in ecosystems around the world. Its adaptability and resilience to changing environments allow *P. aquilinum* to be studied in different habitats and disturbances. In fact, measurements of *P. aquilinum* growth may be an important indicator of changes within an ecosystem, particularly in areas recovering from disturbances. Our study investigated three different environments (a burn, a trampled area, and a clear-cut), each providing different microclimates, and each impacted by at least one human disturbance. We evaluated each site's impact on this year's growth and measured the success of *P. aquilinum* in the various sites. By investigating size differences occurring among *P. aquilinum* in these three sites, we were hoping to find distinct differences in growth patterns.

The sites were not standardized with respect to slope, aspect, site history, or vegetation type. Thus, our investigation focused exclusively on size variations of the plant among samples, and aimed at representation of the range of some variation found at sites, without specifically representing all burned, trampled, or logged areas.

METHODS1

Study Site Description

We selected three sites influenced by different disturbances; one a burn, one a trampled area, and the other a logged zone. We located site A within the area scarred by the Bear Gulch II fire at the base of Mt. Rose which occurred July 25, 2006. This fire was primarily a brush fire, causing little damage to the canopy. Located towards the bottom of a steep slope and near a stream, this area was dominated by Maple, *Acer macrophyllum,* and Douglas fir, *Pseudotsuga meuziesii,* trees with a sparse under story.

Site B, a few miles east of Sites A and C, was severely impacted by recent logging activity; specific dates of the logging could not be found and there was no evidence of replanting (i.e. saplings). As few as twenty trees were left standing in patches around the flat field, leaving most of the area completely exposed to sunlight. There was no visible stream and practically no under story aside from grasses. Site C was next to site A and on the same steep slope as A but it was outside the burned area. Site C was heavily impacted by two way-trails, most probably trampled by firemen fighting the Bear Gulch II fire. No stream was visible, and the area was populated again mostly by *P. menziesii* and *A. macrophyllum*, but with a dense under story of salal, *Gaultheria shallon,* and deer fern, *Blechnum spicant*. We gathered samples from between the trails, which were roughly seven yards apart, and up to five yards away from the trails on either side.

Field Studies

We conducted field studies on May 9th-11th, 2006. At each site we selected forty random samples. In order to document the growth patterns in each area, we assessed size of each plant by focusing on three measurements. First, we noted the distance between the stipe's protrusion from the ground and the tip of the frond. Second we counted the number of paired blades that had developed to a length of one inch or more, and measured the length of the longest blade. Third, we recorded whether the blades of the plant were still curled open or if they had already fully matured. The deciduous nature of the species also allowed us to study this years new growth exclusively. We assumed all green matter was current year's growth (since winter 2006-2007).

RESULTS

Height success

The deviation in average heights across the three sites were the most significant of the observations made. The *P. aquilinum* found in Site C grew the tallest, reaching an average height of 31.213 inches. In Site A we found ferns reaching an average of 23.694 inches, a substantial 7.5 inches shorter. In Site B we encounter another drop in height, an average of only 13.911 inches (Fig. 1).

Number of Blade Pairs

The difference in the number of frond pairs between the three sites was minimal, the means varying only from 3.84 to 4.75. However, these data are possibly due to chance (P = 0.059); Fig. 2).

Blade Length

The averages of the plants' longest blade lengths were very similar in Sites A and C, reaching 9.118 inches and 9.025 inches respectively. Site B, however, showed a much lower average of 5.792 inches (Fig. 3).

Percent Curled

We found the most curled ferns in Site B, with only 12% of its individuals having uncurled blades. Site A had less curling, with 27% of its population having uncurled blades. The greatest number of uncurled plants was found in Site C, with 30% of the plants having fully developed. However, like the number of blade pairs, these patterns are possibly due to chance (P = 0.093;Fig. 2).

Ratio of Height to # of Blade Pairs

The greatest ratio of plant height to number of frond pairs was seen in Site C, with eight inches of overall height per blade. This indicates that individuals in this area were growing more in height for each blade pair they produced than individuals in other sites.

In Site B, the ratio was only 3.6 inches, and only 4.9 inches in site A, showing much shorter heights for a comparable number of blades.

Ratio of Height to Longest Blade

The ratio of plant height to the plant's longest blade averages out very similarly among the three sites. Site A showed a ratio of 2.6, Site B a ratio of 2.4, and Site C a ratio of 3.4 (Fig. 2).

DISCUSSION

The average height of the *P. aquilinum* at the three sites was substantially different, while the average number of blades was fairly consistent. Although no tests were run to evaluate the amount of sunlight in each area, we noticed that average height was much shorter in areas that appeared to have more sun, specifically in the logged area, site B, where no real competition was present. *Pteridium aquilinum* appeared to grow much taller in areas with less light, like sites A and C, before producing blades. When the minimum height necessary to attain adequate sunlight is reached, *P. aquilinum* may concentrate energy on blade production to achieve more photosynthesizing blades earlier in the season. Other studies have drawn similar conclusions, reporting that the fronds of shaded ferns are often fewer and thinner, but also longer than those in open areas (Daniels, 1986).

Another possibility for the difference in height, and no substantial difference in blade pairs, may be the amount of undergrowth present in an area. In areas with greater undergrowth, the *P. aquilinum* tended to grow taller than they would in areas with minimal undergrowth. This may be due to the need for *P. aquilinum* to reach a height greater than that of its main competitor, in this case the salal, in order to effectively compete both for space and sun, before beginning to produce blades.

Another significant difference was seen between the average blade lengths of the three locations. Sites A and C were very similar, while site B's average was substantially less. This may suggest that in areas where constant sunlight is available, for example due to the logging in site B, ferns do not need to grow as long in order to guarantee enough sunlight, because there is no competition with other plant species, specifically the under story.

There were several other important factors that need to be considered in understanding the different growth patterns found. Slope may have played a large role. The fronds of *P. aquilinum* are frost sensitive, which is one reason they usually are found on the sides of hills (Watt, 1969). Site B had very little slope, which may be a reason why the ferns found there were smaller than in other locations; these fronds were not protected from early spring frosts, and may have had to restart after the frost.

In addition to the impact of different slopes, water may have been an influence on the growth of *P. aquilinum*. The water levels in the soil at the three locations were not tested, but may be different. The dramatic slopes of sites A and C increase water drainage, which has been seen to assist the growth of ferns (Brown, 1986). However, these areas were also protected from sunlight and heat by heavy canopies. Site A had the added impact of a nearby stream, which undoubtedly affected water levels in the surrounding soil. Site B was on flat ground, which meant no natural drainage, but this area was also exposed to direct sunlight and heat.

Although *P. aquilinum* rapidly recovers from trampling (Burden 1972), it is unclear weather the *P. aquilinum* at site C grew the tallest as a result of the way trails or a developed under story. A study relating trampling pressure to environmental effects could answer this question, and at the same time be influential in the formulation of management policies for recreational areas (Burden 1972).

Other unmeasured hidden factors may also be responsible for the patterns we observed. For example, soil types or nutrient levels of the different locations could affect plant growth. Additionally, fire could have affected the soil of site A, and altered plant growth. We also did not examine the rhizomes below ground, and therefore cannot know if one area had more established underground systems than others. The overall condition of the rhizomes may have impacted frond sizes in different locations. Similarly, other studies have shown that in shaded areas fronds can appear earlier than in sunny areas, which may also have affected our results (Hellum et al 1966). Beyond what we have listed, there are others variables that may have been key players in determining the success of *P. aquilinum.*

Our study explored how substantially variant fern growth can be, given different conditions. They demonstrate significant variation, even among relatively proximal disturbed localities. For our data to be fully interpreted in terms of what specific effects most impact the growth of *P. aquilinum,* much further study will be necessary, in which different variables are independently controlled.

ACKNOWLEDGEMENTS

Thank you to Dylan Fisher, Bill Ransom, and Duke Brady for helping formulate our research plan and work in the field. Thank you to Jill Wilkes, Olympic National Forest

Park Services, Zion National Park Services, and The Evergreen State College for use of facilities and accommodation. Thank you three groups of anonymous editors. Thank you to Writing on the Wild Side classmates for assistance, support, and encouragement. And finally, thank you to the bracken fern for abundance, strength and just being there.

REFERENCES

Ahlgren, I. F., and C. E. Ahlgren. **1960.** Ecological effects of forest fires. Bot. Rev. 26:483-533.

Brown, R. W. 1986. Bracken in the North York Moors: its ecological and amenity implications in national parks. In: Smith, R. T.; Taylor, J. A., eds. Bracken: Ecology, Land Use and Control Technology; 1985 July 1 - July 5; Leeds. Lancs: The Parthenon Publishing Group Limited: 77-86.

Burden, R. F., and Randerson, P. F. **1972**. Quantitative studies of the effects of human trampling on vegetation as an aid to the management of semi-natural areas. Journal of Applied Ecology, 19:439-457.

Crane, M. F. 1990. Pteridium aquilinum. http://www.fs.fed.us/database/feis/

Crouch, Glenn L. 1974. Interaction of deer and forest succession on clearcuttings in the Coast Range of Oregon, pp. 133-138. *In* Proceedings, Wildlife and forest management in the Pacific Northwest, 11-12 September 1973, Corvallis, OR. Oregon State University, Corvallis, OR.

Dansereau, P. **1957.** Biogeography-an ecological perspective. p. 394. Ronald Press Co, New York, NY.

Daubenmire, R. **1968.** Plant communities. p. 300. Harper and Row Publ., New York, NY.

Hellum, A. K.; Zahner, R. 1966. The frond size of bracken fern on forested outwash sand in northern, lower Michigan. Soil Science Society of American Proceedings. 30: 520-524.

Hitchcock, C. Leo; Cronquist, Arthur; Ownbey, Marion. 1969. Part 1: Vascular cryptograms, gymnosperms, and monocotyledons. p. 914. Vascular plants of the Pacific Northwest. University of Washington Press, Seattle, WA.

McCulloch, W. F. 1942. The role of bracken fern in Douglas-fir regeneration. Ecology. 23: 484-485.

Mutch, R. 1970. Wildland Fires and Ecosystems-A Hypothesis. Ecology. 51:1046-1051.

Page, C. N. 1986. The strategies of bracken as a permanent ecological opportunist. pp. 173-181. In

R. T. Smith and J. A. Taylor (eds.), Bracken: ecology, land use and control technology. The Parthenon Publishing Group Limited, Leeds, England.

Pojar, Jim, Mackinnon A, and Paul B. Alaback. 1994. Plants of the Pacific Northwest: Washington, Oregon, British Columbia & Alaska. Lone Pine, Redmond, WA.

Spurr, S. H. 1964. Forest Ecology. Ronald Press Co., New York, NY.

Tiedemann, A. R. and G. O. Klock. 1976. Development of vegetation after fire, seeding, and fertilization on the Entiat Experimental Forest, pp. 171-191. *In* Proceedings, No. 15 Annual Tall Timbers fire ecology conference. 16-17 October 1974, Portland, OR. Tall Timbers Research Station, Tallahassee, FL.

Watt, A. S. 1969. Contributions to the ecology of bracken (Pteridium aquilinum) VII. New Phytol. 68: 841-859.

White. R. A., 1963. Tracheary elements of the Ferns. II. Morphology of Tracheary Elements; Conclusions. American Journal of Botany 50:514-522.

LEGEND OF FIGURES

Table 1

Comparison of plant success (height, longest frond length, number of pairs) in sites A, B and C

Figure 1

Averages of measurements taken in sites A, B and C.

Percentages of uncurled P aquilinum.

Ratios of plant height to number of frond pairs and length of longest frond in sites A, B and C.

Figure 2

Correlation between height of P aquilinum and length of the plants longest frond in sites A, B and C. and Correlation between number of frond pairs of P. aquilinum and height in sites A, B and C

Table 1	Site A (Burn)	Site B (Logged)	Site C (Trail)	P value
Mean blade length	9.118 in.	5.792 in.	9.025 in.	0.0002
Mean height	23.694 in.	13.911 in.	31.213 in.	0.0001
Mean # of blade pairs	4.75	3.84	3.9	0.0585
% Un-curled	26%	12%	30%	0.0932
Height of plant (in) per pair of blades	4.9	3.6	8.0	
Height of plant (in) per inch of blade	2.6	2.4	3.4	

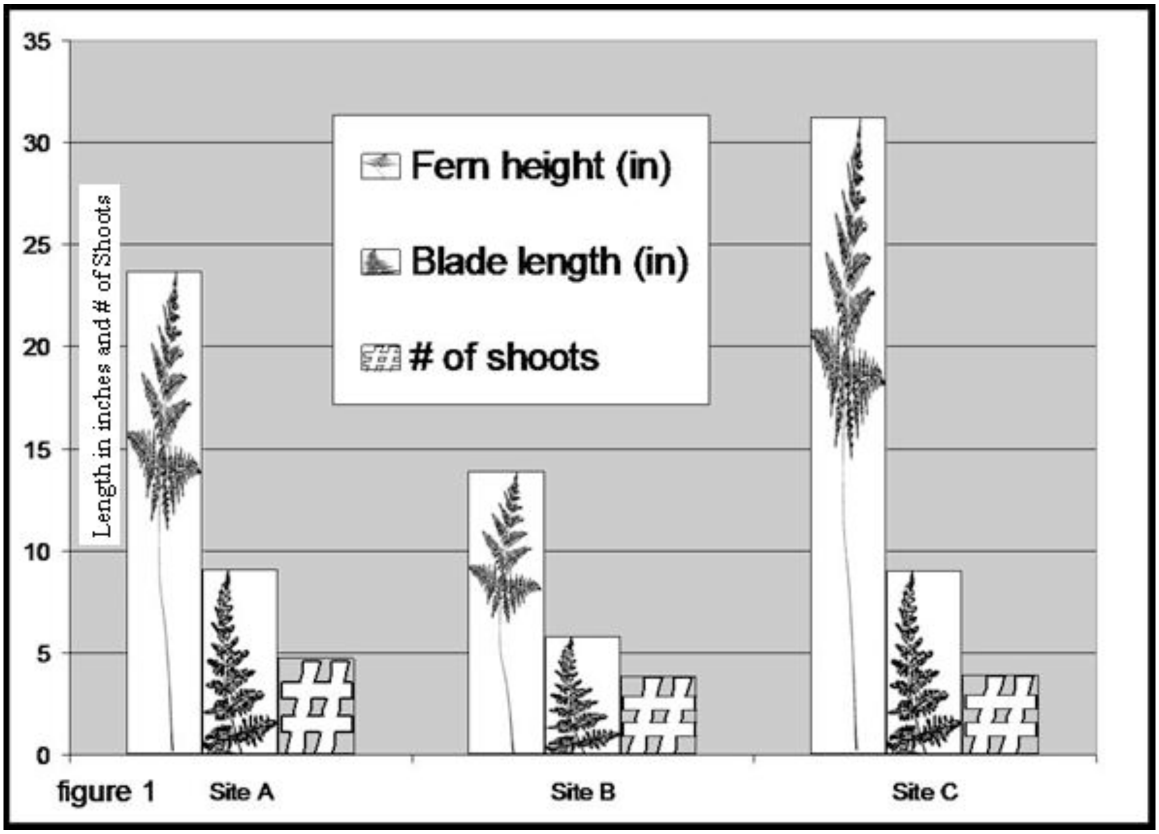
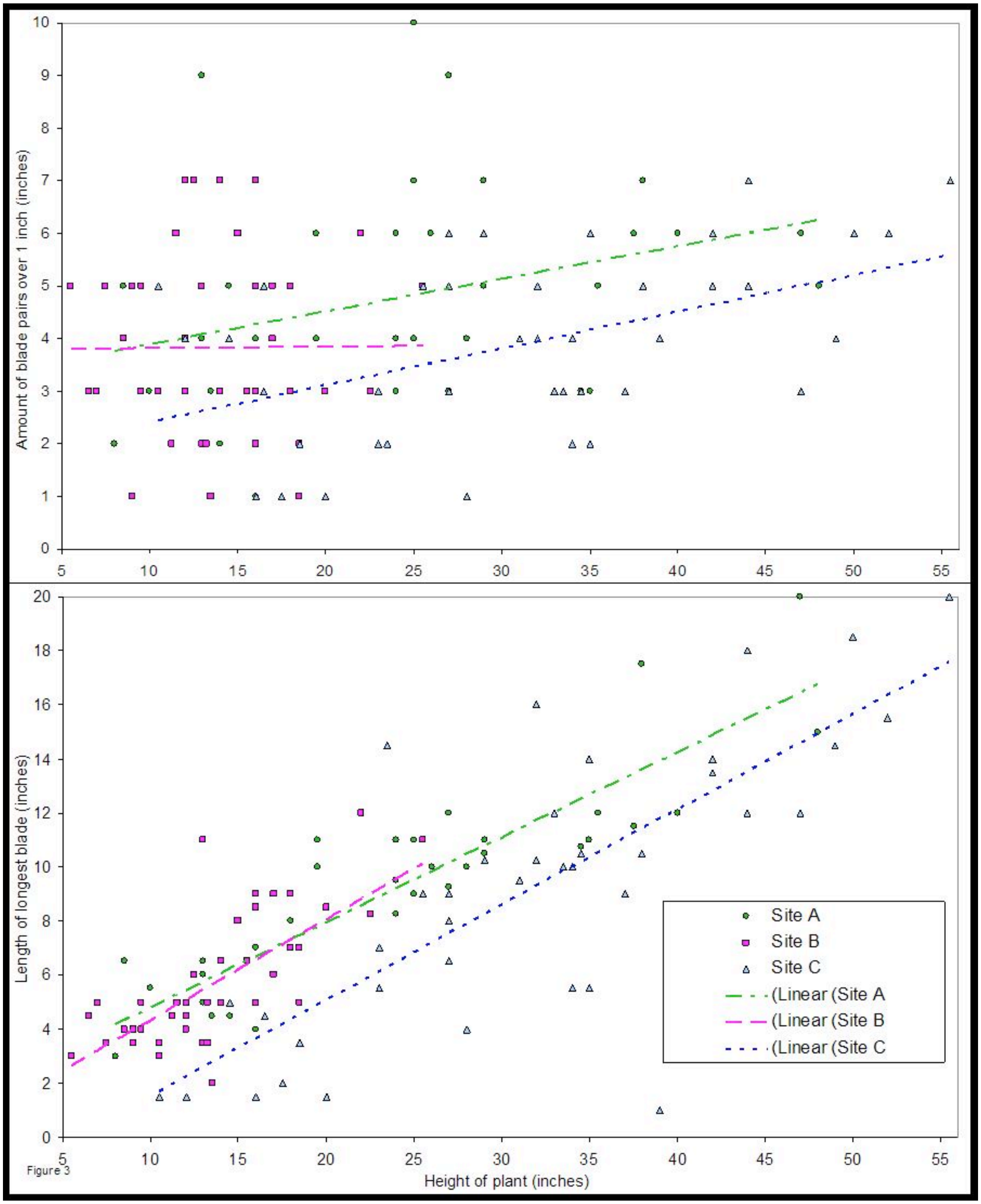

35
30
25
20
15
10
5
0
Length in inches and # of Shoots
Fern height (in)
Blade length (in)
# of shoots
Site A
Site B
Site C

figure 1


Amount of blade pairs over 1 inch (inches)
Length of longest blade (inches)
Height of plant (inches)
Site A
Site B
Site C
(Linear (Site A
(Linear (Site B
(Linear (Site C
Figure 3