# Edge Effects on Forest Composition and Structure

XXXX XXXX
Lab 5, 5.16.07

## Abstract

Forest fragmentation arising from modern forestry practices has dramatically increased the amount of edge habitat relative to interior habitat. Edge habitats have unique microenvironments that have the potential to profoundly impact forest communities. In this study, we characterized the forest composition and structure of edge and interior plots within a second growth big leaf maple-Douglas fir stand on Blanchard Mountain, Washington from 2001 to 2007. We found the edge environment was characterized by high stem densities and basal areas of young, early seral stage species like big leaf maple. Interior sites were characterized by greater tree diameter and favored an overstory of Douglas fir and an understory of sword fern. We discuss the mechanisms that likely contribute to the edge effects we describe, and suggest future studies to determine if these effects are unique to the age of this forest stand or may be more universal among big leaf maple-Douglas fir forests.

## Methods

***Study Area***

Data were collected from interior second growth stands or adjacent edge sites located along the southern slope of Blanchard Mountain, Washington from 2001 to 2007. The interior area was last logged in 1920. Edge sites were located along the forest margin adjacent to a 10 - 15 years old clearcut, while the interior sites were located perpendicular to this edge and approximately 100 M uphill.

***Data Collection***

Several vegetation parameters were collected within a circular 0.2 ha sampling plot for each site according to the methods of Wallin (2007). Briefly, the perimeter of the sampling plot was flagged, and the species and diameter at breast height (dbh) was recorded for all trees within the plot. Coarse woody debris was surveyed for one quarter of the plot. Additionally, the species and quantity of saplings was recorded along four 2M wide transects within the sample plot. Estimates of percent ground cover and seedling counts were performed within four $1m^2$ quadrats.

## Results

### *Tree size class distribution*

Edge sites exhibited significantly higher stem densities than interior sites (Figure 1). This difference was highest among saplings, which were present at over four times the density in edge plots compared to interior plots. When considering the size class of stems between the two site types, edge areas exhibited significantly higher stem densities for all tree size classes with dbh values less than 40 cm, while trees above 40 cm dbh had a higher density in the interior plots.

### *Mean stem density and basal area of tree species*

The mean stem density for all tree species combined was significantly higher in the edge environment than in the interior sites (Table 1). Hardwood trees appeared to be the main contributor to this difference. In particular, big leaf maples grew at significantly higher densities in the edge sites.

Hardwood trees, and big leaf maples in particular, also show significantly greater basal areas in edge sites versus interior sites (Table 2). In the interior plots, conifers exhibited a significantly higher basal area compared to the edge plots, and this difference appears to be driven by a significant difference in the basal areas of Douglas fir trees. Other tree species evaluated did not show a significant difference in stem density or basal area between sites.

### *Understory composition*

While percent cover by shrubs, mosses, and herbs was not statistically different between edge and interior sites, there were significantly more ferns at interior sites (Table 3). The total vegetation cover between the two site types was not significantly different.

### *Snag density/basal area and coarse woody debris*

Edge sites exhibited lower mean snag density, snag basal area, and CWD volume compared to interior sites, however, the difference was not statistically significant (Table 4).

## Discussion

This study highlights the influence of edge effects on forest structure and composition. In our study area, an important edge effect was the favoring of high stem densities and large basal areas of big leaf maple trees, mostly of small diameter. These young hardwoods are an early seral stage species well adapted to growth in disturbed sites with an open canopy. Their prevalence in edge environments, as in our study, highlights the differences in canopy structure between the edge and interior, and the effect this has on species composition. Though big leaf maples are shade tolerant, they lack the ability to dominate under a closed conifer canopy, resulting in reduced basal area and tree density. Instead, interior sites were distinguished by higher basal area of Douglas fir. Interior trees also exhibited a larger mean diameter, indicative of their greater age since last disturbance compared to the recently logged edge plots.

Another edge effect apparent in our study was the impact on understory composition. The open canopy edge microclimate is characterized by higher solar radiation levels reaching the forest floor and greater variation in temperature and moisture in comparison to closed canopy interior plots (Chen 1992). Plants adapted to low light levels or poorly adapted to extremes of temperature and moisture would be expected to be favored in interior plots while being excluded from edge areas. In this study, for example, the shade adapted, drought intolerant sword fern predominates only in the interior plots, which offer better habitat for this species.

In addition to impacts on the forest understory, the greater availability of sunlight reaching the forest floor and the space available for new plants to colonize after disturbance in edge environments would also be predicted to result in greater reproductive rates along the edge. This prediction was supported by our observations of higher numbers of saplings and seedlings in the edge plots compared to interior areas (data not shown). Future studies to directly compare the growth rates of trees in edge and interior plots would be predicted to reveal higher growth rates in edge sites due to the same factors that promote increased reproduction in this microenvironment.

While the availability of light and space along the edge can favor colonization and reproduction for species adapted to that environment, the edge also has the potential to lead to greater mortality due to its exposure to high winds and other forms of disturbance such as insect outbreaks and disease (Chen 1992). Increased mortality of edge trees would be predicted to result in greater volumes of coarse woody debris on the forest floor, higher snag densities, and higher snag basal area (Maser 1988). In our study, however, there was no significant difference among these three factors between edge and interior plots. A potentially confounding factor may be the forest management practices in the study area. This area is managed for both recreation and timber harvest, and as part of those efforts, snags and coarse woody debris may have been removed from the edge area, potentially obscuring differences between the edge and interior environments.

In this study, we observed several differences between the edge and interior environments of a second growth forest stand comprised of trees that have regrown since the area was clearcut in 1920. These differences may not be applicable to stands that differ in age, composition, or structure substantially from the one we studied. Future studies will be necessary to determine if similar edge effects apply to forests of other types. Additionally, studies utilizing a multivariate statistical approach may reveal edge effects not possible with univariate methods.

## Literature Cited

Chen, J., J.F. Franklin and T.A. Spies. 1992. Vegetation responses to edge environments in old-growth Douglas-fir forests. *Ecological* Applications 2(4): 387-396

Maser, C., R.F. Tarrant, J.M. Trappe, and J.F. Franklin. 1988. From the forest to the sea: a story of fallen trees. PNW Research Station, USDA Forest Service; General Technical Report PNW-GTR-229, Portland, Oregon, 153 pages

Wallin, David O. 2007. ESCI 407/507 Forest Ecology Course Website: http://www.ac.wwu.edu/~wallin/envr407/407_edgelab.html. Western Washington Univeristy, Huxley College of the Environment, Bellingham, Washington.

**Figure 1: Tree size class distribution for edge and interior sites in a second-growth stand on Blanchard Mountain (2001-2007 data)**

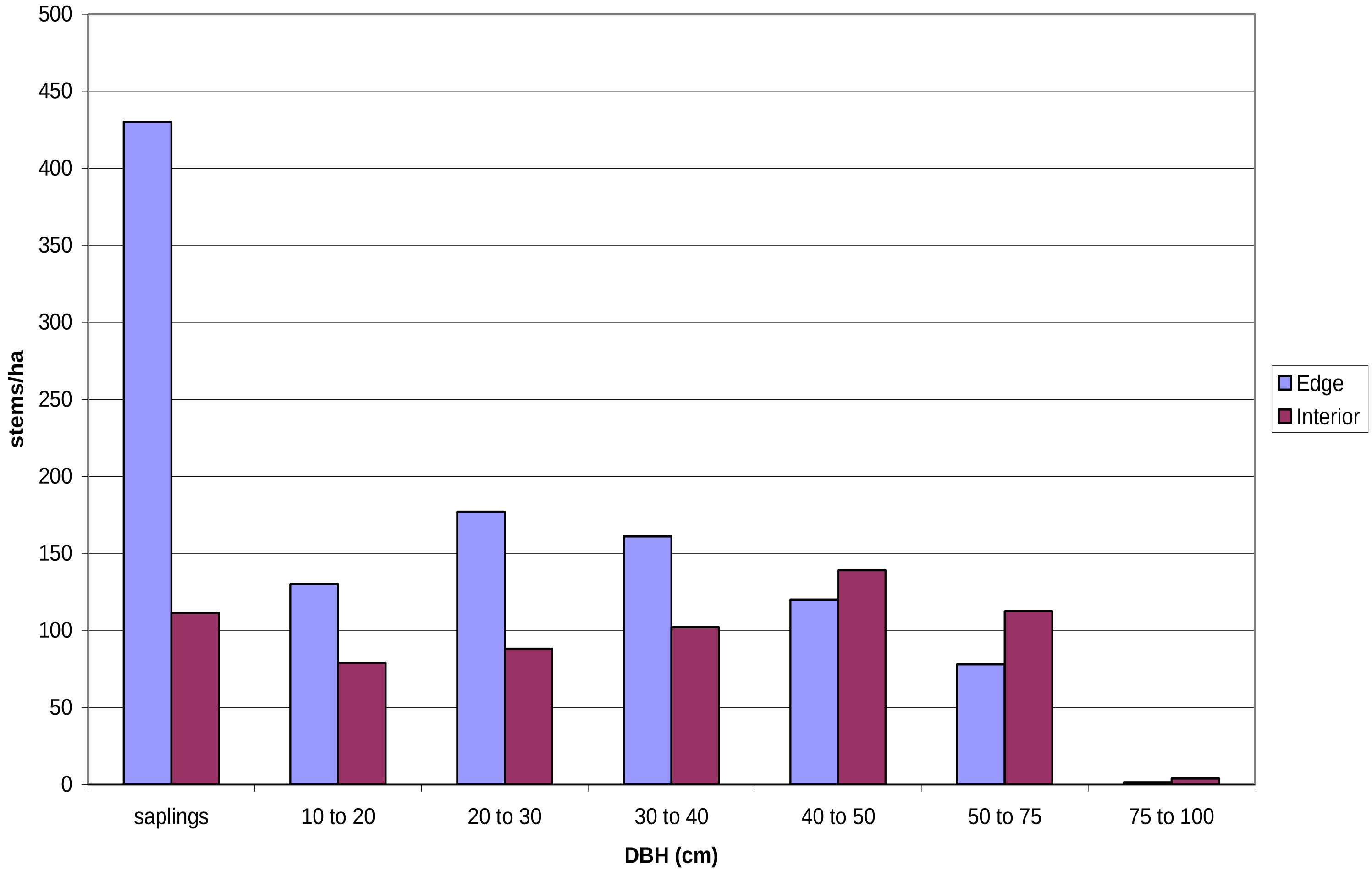

Table 1: Mean Stem density (stems/ha) +- standard deviation for edge and interior plots in a second growth stand on Blanchard Hill. Mean values were compared using a one-way ANOVA

| | Interior mean | stan. Dev. | Edge mean | stan. Dev. | F-statistic | P value |
|---|---|---|---|---|---|---|
| Douglas Fir | 429.5 | 115.1 | 480.0 | 116.6 | 0.949333 | 0.342802 |
| Western Hemlock | 39.0 | 28.8 | 43.5 | 42.6 | 0.0766 | 0.785112 |
| Western Red Cedar | 35.0 | 25.5 | 40.0 | 29.8 | 0.162455 | 0.691654 |
| Big Leaf Maple | 10.0 | 13.3 | 94.0 | 45.9 | 30.84216 | 2.85E-05 |
| Red Alder | 0.0 | 0.0 | 3.0 | 6.7 | 1.97561 | 0.17688 |
| All Conifers | 503.5 | 93.2 | 563.5 | 98.9 | 1.949986 | 0.179572 |
| All Hardwoods | 10.0 | 13.3 | 97.3 | 46.1 | 33.03693 | 1.9E-05 |
| All Tree Species | 513.5 | 96.3 | 660.8 | 90.9 | 12.37127 | 0.00246 |

Table 2: Mean Basal Area (m^2/ha) +- standard deviation for edge and interior plots in a second growth stand on Blanchard Hill. Mean values were compared using a one-way ANOVA

| | Interior mean | stan. Dev. | Edge mean | stan. Dev. | F-statistic | P value |
|---|---|---|---|---|---|---|
| Douglas Fir | 69.8 | 9.8 | 59.3 | 6.3 | 8.128397 | 0.010608 |
| Western Hemlock | 1.1 | 1.1 | 1.5 | 1.4 | 0.538915 | 0.472338 |
| Western Red Cedar | 0.9 | 1.0 | 1.3 | 1.2 | 0.843753 | 0.370471 |
| Big Leaf Maple | 0.7 | 1.3 | 4.7 | 2.1 | 27.22177 | 5.81E-05 |
| Red Alder | 0.0 | 0.0 | 0.1 | 0.2 | 1.581694 | 0.224589 |
| All Conifers | 71.8 | 10.6 | 62.1 | 7.6 | 5.518971 | 0.030427 |
| All Hardwoods | 0.7 | 1.3 | 4.8 | 2.0 | 29.18982 | 3.92E-05 |
| All Tree Species | 72.5 | 10.8 | 67.0 | 8.6 | 1.601593 | 0.221814 |

Table 3: Mean and standard deviation of % understory composition for the edge and interior of a second-growth stand on Blanchard Mt. Mean values were compared using a one-way ANOVA.

| | Int Mean | Std Dev | Edge Mean | Std Dev | F-Statistic | P-Value |
|---|---|---|---|---|---|---|
| fern | 38.0 | 19.84 | 13.5 | 8.72 | 12.759762 | 0.002178 |
| red huckleberry | 4.4 | 9.23 | 7.0 | 7.05 | 0.5108766 | 0.483927 |
| oregon grape | 24.0 | 18.47 | 20.6 | 12.45 | 0.2331056 | 0.63505 |
| moss | 6.5 | 7.75 | 9.8 | 8.64 | 0.7848297 | 0.387351 |
| herbs | 2.0 | 2.71 | 1.9 | 3.88 | 0.0069822 | 0.934329 |
| shrubs | 29.0 | 18.89 | 36.4 | 12.04 | 1.0838189 | 0.311627 |
| total veg cover | 77.5 | 9.14 | 71.4 | 22.68 | 0.6221035 | 0.440532 |

Table 4: Mean and standard deviation of snag density (stems/ha), snag basal area (m^2/ha) and coarse woody debris volume (m^3/ha) for the edge and interior of a second-growth stand on Blanchard Mt.. Mean values were compared using a one-way ANOVA.

| | Interior Mean | Std Dev | Edge Mean | Std Dev | F-Statistic | P value |
|---|---|---|---|---|---|---|
| snag density | 271.000 | 101.975 | 233.500 | 102.877 | 0.6702014 | 0.423688 |
| snag basal area | 46.254 | 40.591 | 27.109 | 26.358 | 1.5647667 | 0.226984 |
| CWD volume | 176.6713 | 137.5961 | 121.3194 | 81.47225 | 1.1981948 | 0.288115 |