Wyethia mollis: Good Neighbor or Bad? The Presence and Abundance of *Wyethia mollis* and Non-*Wyethia* Herbs in a Forest Clearing

Abstract

Persistent, large, dense patches of *Wyethia mollis* often occur in openings in forests in the Sierra Nevada mountains. To design an experiment that would test for a negative association between *Wyethia* and non-*Wyethia* herbs we collected preliminary data using three sampling methods; quadrat, focal plant and transect. We then determined which sampling method would require the least effort to detect a negative association with 80% power. In two of the three methods we found a negative association, but concluded that because of differences in the methods used to estimate percent cover, it would be useful toward repeat the sampling process; ensuring that all three techniques used the same procedures to estimate percent cover.

Introduction

Wyethia mollis is a long-lived perennial under story plant that grows in large, dense patches often associated with openings in pine forests. *Wyethia* colonizes and persists in areas where fire, logging, and grazing have disturbed pine forests. The fact that *Wyethia* forms and persists in dense patches may stem from its ability to out compete other herbaceous and woody plant species. Such competitive superiority could arise because *Wyethia* is more efficient in using resources such as water and minerals, and/or because *Wyethia* has allelopathic affects on other plants (Parker, 1989; Riegel, 1997). To determine which of three sampling methods would require the smallest effort to detect a negative association between the percent cover of *Wyethia* and other non-*Wyethia* herbs, we chose a site that appeared to be typical of a large, *Wyethia*

dominated forest opening, and we estimated the percent cover of *Wyethia* and of non-*Wyethia* herbs. We used three sampling approaches: quadrat, transect and the focal plant approaches. We used data on the variances in percent cover among replicates and the time required to complete a replicate to determine which method would be most efficient for estimating the relationship between the percent cover of *Wyethia* and non-*Wyethia* herbs.

Methods

We used three sampling methods to estimate the percent cover of *W. mollis* and the percent cover of non-*Wyethia herbs*. Our goals were two-fold: 1) to determine if *W. mollis* inhibits the growth and establishment of other herbs, and 2) to determine the most efficient means of estimating percent cover for *Wyethia* and non-*Wyethia* herbs. To find the most efficient sampling method, we used three approaches, a quadrat, a transect, and a focal plant method. For each method we estimated the percent cover of *Wyethia*, non-*Wyethia* forbs, bare ground, and rock. Given that plants cannot grow where rocks are present, the area of each sample was adjusted by removing the percentage of rock. The remaining sample area was assigned the cover value of one hundred percent.

The criterion we used to determine the most efficient method was the number of person-hours necessary to achieve 80% power to detect a negative association between the percent cover of *Wyethia* and non-*Wyethia* herbs. To achieve 80% power we calculated the number of samples necessary for each sampling method using the preliminary data. Combined with an estimate of the number of person-hours required per sample, we estimated the total number of person-hours needed to achieve the desired power for each sampling method. The most efficient sampling method required the smallest effort to achieve the desired power.

To determine the nature and magnitude of the association between percent over of non-*Wyethia* herbs and *Wyethia*, we fit a linear least-squares regression to the percent cover data with percent cover of non-*Wyethia* herbs as the response variable and percent cover of *Wyethia* serving as the explanatory variable.

Quadrat - Quadrat locations were chosen at random by blindly throwing a hat. A corner of a 1 m^2 square quadrat, constructed from ¼" PVC pipe, was lined up with the hat and allowed to fall in any direction. Percent cover was estimated by each observer and averaged. To account for a possible canopy effect, total estimates of cover were allowed to exceed one hundred percent. Any plants or parts of plants within the quadrat were included in the estimates of percent cover.

Transect - The locations of transects were chosen using a random number generator to determine number of steps from the edge of the *Wyethia* population. Once a starting point was selected, a transect 20 m in length was established by marking each end of a measuring tape with tent stakes. The actual cover of *Wyethia*, non-*Wyethia* herbs, rock, and bare ground lying below the tape was measured in meters. The percent cover of each category was calculated as a percentage of the total length of the transect. Percentages were calculated to sum to one hundred percent.

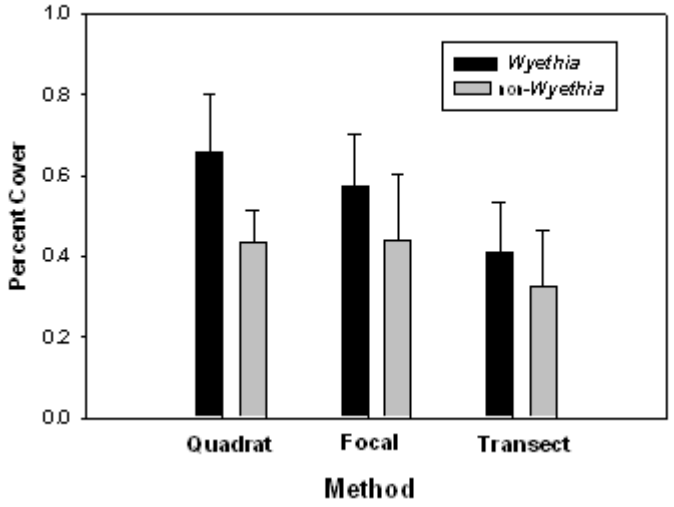
Focal Plant - Each focal plant was chosen by randomly tossing a tube of suntan lotion. The plant nearest to the cap was selected. The focal plant could include both single individuals and clumps of *Wyethia* when it was difficult to distinguish individual plants. Centered on the focal plant, a circle with a .5 m radius was traced with measuring tape, and marked by four tent stakes. Observers individually estimated percent cover, but the average results were reported. The percent cover in each category was scaled to sum to one hundred percent. Only plants

rooted in the sample plot were included in estimates of percent cover. The distance from the center of the focal plant to the crown of the nearest *Wyethia* was also estimated.

Results

Estimates of the percent cover of *Wyethia* and non-*Wyethia* herbs were made for 6, 3, and 2 subjects each for the quadrat, focal, and transect methods respectively. For each sampling method *Wyethia* consistently had higher percent cover than did non-*Wyethia* herbs (Figure 1). While the quadrat and focal plant methods yielded similar estimates of percent cover, estimates derived from the transect method were considerably lower than the other two methods.

Figure 1. Estimates of percent cover of *Wyethia* and non-*Wyethia* herbs generated by each sampling method. Vertical bars represent means and lines represent one standard error.



The time required to sample a single subject using each sampling method was similar at 5-10 minutes per subject. Estimates of the sample sizes necessary to detect specific effect sizes at fixed α and β indicate that among the three sampling methods examined the focal plant method would require the least effort to detect a specific treatment effect (Table 1).

Table 1. Estimates of variability, effect size, and the sample size necessary to detect specific effect sizes with $\alpha = 0.05$ and $\beta = 0.2$.

Method	SD_x	SD_y	$SD_{estimate}$	Estimated Sample Sizes with $\alpha = 0.05$ and $\beta = 0.2$		
				Observed Effect Size (Slope)	Conjectured Effect Size (Slope = -0.5)	Conjectured Effect Size (Slope = -1.0)
Quadrat	0.19553	0.35096	0.37740	0.491	119	31
Focal	0.21388	0.23894	0.11674	-1.048	12	5
Transect	0.17981	0.23649	0.15466	-1.322	25	8

Discussion

Based on the observed estimates of percent cover, the focal plant method would be the most efficient technique to test the hypothesis that there is a negative association between the cover of *Wyethia* and non-*Wyethia* herbs. However, since the focal plant method involves selecting a focal *Wyethia* plant as the center of the sample unit, it might overestimate the percent cover of *Wyethia* within the region. Such a bias may or may not be important to testing the hypothesis that the cover of *Wyethia* and non-*Wyethia* herbs is negatively associated. Furthermore, the observed estimate of the percent cover of *Wyethia* is similar to that derived by the quadrat technique, suggesting that whatever bias exists may be small.

When planning this sampling program, we were expecting to find a negative association between the abundance of *Wyethia* and non-*Wyethia* plants. It is interesting to note that the quadrat sampling technique showed a positive association between the percent covers of *Wyethia* and non-*Wyethia* herbs, while the other two sampling methods showed a negative association. The differences in these patterns among sampling techniques likely due to the way percent cover was estimated by the observers applying each sampling method. The quadrat group allowed for a layering of the plants to occur, so the total percent cover in each quadrat could be more than 100 percent. The transect and focal plant groups did not allow for layering within the sample area by requiring the total percent cover to add up to 100 percent. By doing so, the transect and focal methods the two estimates of percent cover were not truly independent of one another since they must sum to 100 percent. Therefore, it is more likely that a negative association would be found. However, it is interesting to note that the sum of the percent cover of *Wyethia* and non-*Wyethia* herbs for the transect method was not 100 percent (Figure 1), so perhaps the variability between sampling methods in how percent cover was estimated was even greater than initially thought.

It would be useful to collect preliminary data again using these three sampling methods insuring that all three techniques used the same procedures to estimate percent cover, and that cover was allowed to sum to more than 100 percent. With this information, the three sampling methods could be compared and the method requiring the least effort could be chosen and used to perform the full study.

Literature cited

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