Power is the long-run probability of detecting a specific effect given that this effect really exists. A power analysis can be used to estimate power for a given alpha level (here 0.05), sample size per group, and defined effect sizes and variances. In a simulation-based power analysis, true effects are defined based on subject matter expertise and then assumptions from the model used for analysis are assumed to be true.

For example, in an unequal variances ANOVA we would assume that the observed values in a sample taken will follow a normal distribution with some defined mean and variance for every group. Since there is variability around our defined true mean, any observed sample will contain different values; how different each sample is depends on the variability around the effects. To estimate power we draw some number of samples per group from our defined distribution, fit the model we expect to use, and record the p-value from the overall F test that tests against the null hypothesis that all means are the same. We do this many times, and estimate power is the proportion of times we reject the null hypothesis based on our defined alpha across all simulations. We can vary the number of samples per group to estimate power at different sample sizes.

Note that in actuality, in any given field experiment we will only take a single sample. Power is a theoretical construct about long-run behavior to help with study planning as long as 1., our guesses at effects and variances are reasonably what we expect and 2., model assumptions are met and so the distribution we draw samples from mirrors what can truly happen in the landscape.

In the ESRF power analysis, the Woodstock model runs gives us estimates of values for every subwatershed. There are no other subwatersheds to select. What does the power analysis do for us in this case? We still assume that if we actually take a sample on the group there will be variability in the outcome, based on the variability around the Woodstock-based estimates. Power still allows us to understand if we are likely to reject the overall null hypothesis for different sample sizes based on the modeled effect sizes and variances.

Code for power analysis is available on GitHub: https://github.com/aosmith16/elliott-power