Watershed-Scale Stream Restoration Experimental Design: Rigorous Tools to Obtain Definitive Results

Mark Rogers[1], John Selker[1], James Peterson[1], and Ivan Arismendi[1]

[1]Oregon State University

July 26, 2021

Abstract

Despite significant investments in watershed-scale restoration projects, evaluation and documentation of their impacts is often limited by inadequate experimental design. This project aimed to strengthen study designs by quantifying and elucidating sources of error in paired-watershed experiments and evaluating the statistical tools that detect and quantify population-level changes from watershed-scale restoration. Meta-analysis of 32 BACI experiments revealed that synchrony between paired-populations was both weak ($\rho = 0.18$) and unrelated to the primary experimental error (r = 0.01), the degree to which paired-populations vary independently in time (*independent variance*). Instead, it was found that the sum of the paired-population temporal variances (*total variance*), accounted for 91% of the variability that controls statistical power. These findings demonstrate that 1) synchrony in paired-populations does not influence the primary error in BACI field experiments and 2) the magnitude of temporal fluctuations is primarily responsible for this error. The second study component, hypothetical BACI simulations, mathematically relates spatial, temporal and sampling errors to the independent variance and power. Design guidance based on these findings are provided to ensure that future restoration experiments have maximum probability of detecting a present restoration impact. We recommend planners quantify error sources directly from pilot studies and apply the tools provided by this research to estimate statistical power in their monitoring designs. Lastly, we propose a paired-reach design which provides a powerful platform to conduct replicated local-scale restoration experiments, which can build understanding of restoration-ecological mechanisms.

Hosted file

`MainTextFile.docx` available at https://authorea.com/users/427342/articles/531523-watershed-scale-stream-restoration-experimental-design-rigorous-tools-to-obtain-definitive-results