Evidence-based Conservation Systematic Review

Fact Sheet: Restoration Treatments and their Impact on the Water Budget June 2013

NORTHERN ARIZONA UNIVERSITY
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How Restoration Thinning Treatments on Conifer-dominated Watersheds Affect the Water Budget

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Background

The Four Forest Restoration Initiative (4FRI) is a collaborative effort to restore unhealthy ponderosa pine forest ecosystems to increase forest resiliency and reduce the threat of catastrophic wildfires across four national forests along the Mogollon Rim, Arizona. A systematic review was conducted to synthesize the state of knowledge with respect to hydrological responses to forest restoration thinning and to evaluate the quality and type of references that exist within the literature. Two questions guided the systematic review: 1) How do restoration thinning treatments conducted in conifer-dominated watersheds affect the water budget (the relationship between the input and output of water) and, 2) How do restoration thinning treatments impact the groundwater system?

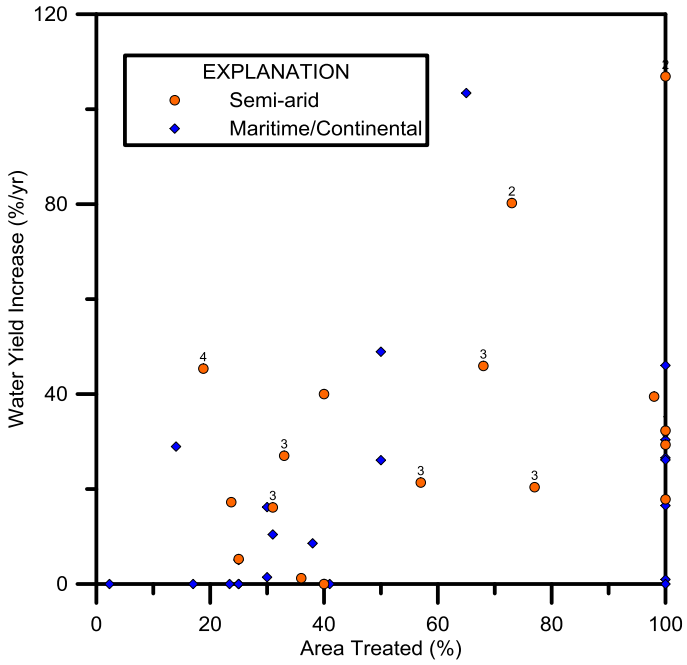

Figure 1. The distribution of mean water yield percent increase as a function of mean percent area treated. Water yield increase was determined by taking water yield increase divided by mean annual streamflow to arrive at percent increase. Therefore, only those studies that reported mean annual streamflow are included in the figure.

Methods

The systematic review was conducted following the Centre for Evidence-Based Conservation guidelines at: http://www.environmentalevidence.org/Authors.htm.

Results/Discussion

In this systematic review, 37 relevant experimental studies from around the world were identified. Results from 23 studies were used to answer question one and results from 15 studies were used to answer question two; one study was included in analyses for both questions. Of these 37 studies, 31 were peer-reviewed journal articles, five were project or technical reports from academic institutions or government agencies, and one was a dissertation. In addition, 43 review articles were identified that were useful for reference; however, no experiments were conducted in these articles.

The systematic review revealed that water yield can increase 10–35% percent when 20–100% of a conifer-dominated watershed is treated (Figure 1). Groundwater results were

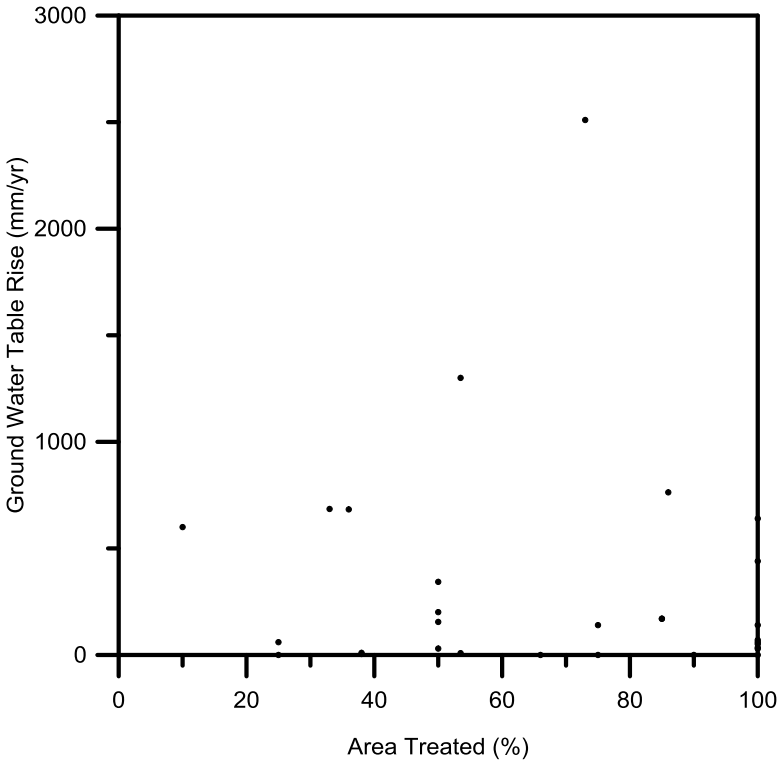

Figure 2. The distribution of groundwater table rise as a function of percent area of the forest treated. Only one of the 15 groundwater studies analyzed reported quantitative changes in groundwater recharge. The other 14 reported quantitative changes in the groundwater table elevation as a function of quantitative increase in groundwater recharge.

much less conclusive and no correlation was drawn between removing trees and groundwater recharge. Therefore, question two could not be answered (Figure 2).

Although all the studies reviewed showed a positive response of surface water yield to forest treatments, these responses appeared to vary across climatic types and seemed to be affected by other variables (such as topography, soils, aspect, elevation, etc.), so that there is no universal water yield response to change in forest cover. Without a universal relationship, regional studies in the same forest type are probably the best indicators of water balance response to 4FRI treatments. The restoration thinning treatments that will be used in 4FRI are different from those used in the studies reviewed. It is probable that an increase in water yield will accompany the proposed thinning treatments conducted on the 4FRI area. The responses are expected to be variable as the treatment types are diverse.

Management and Research Recommendations

Additional research and reviews may eliminate the uncertainties and variance found within studies of forest treatment effects on surface water yield and groundwater recharge. However, there may be an inherent structural limitation to how finely and conclusively results can be drawn from such studies. In a separate paper, the author has recommended future research approaches that may better determine any possible relationships between forest thinning and water budget to minimize uncertainty.

The development of a more systematic, structured, and standardized approach to developing controlled watershed experiments, measuring water budget variables, and reporting these variables will lead to more structured sets of data that will be useful to compare across studies. The methods used in measuring variables and collecting data appear to be appropriate, but a more rigorous application of testing against the null hypothesis as well as the transparency of results and description of methods would help future researchers and decision-makers draw useful conclusions. Many of the studies evaluated in this systematic review only reported mean annual results. Full disclosure of experimental data sets, while beyond the scope of most journal articles, would have facilitated the recognition of any actual relationships and the drawing of conclusions from these data.

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