NAU NORTHERN ARIZONA UNIVERSITY

School of Earth and Sustainability

January 16, 2020
4 FRI Team
1824 South Thompson Street Flagstaff, AZ 86001
Re: The Rim Country Draft Environmental Impact Statement

Dear Forest Supervisors and 4FRI Team,45645

The following comment letter is from the hydrogeology research group at Northern Arizona University. Our research group is comprised of undergraduate geology majors, graduate students in geology, and hydrologic research technicians. We reviewed the DEIS and supporting materials with respect to our education and experiences with water quality, water quantity, and watershed response. We appreciate the extensive time and attention the 4FRI team has invested in the document. We are providing comments and suggestions to enhance and improve the proposed actions and the monitoring and mitigation of the actions. NAU is poised to assist with monitoring, analyses and interpretations of the response to the proposed action. We have an existing master challenge cost share agreement with the forest service that can be used to help facilitate cooperation and collaboration for monitoring. Under this agreement, NAU is already monitoring Clover Springs. NAU is continuously monitoring discharge at Clover Springs to be complementary with the ecosystem level monitoring being conducted by the Springs Stewardship Institute. After reviewing the DEIS, we conclude that Alternative 2 would be the preferred action plan.

Water Quality

Further collection and analysis of water quality (both chemical and biological components) will provide a stronger pre-fire baseline and eliminate data gaps for future consideration. This is especially important for priority watersheds like the Upper Tonto Creek watershed, and for impaired bodies of water such as Black Canyon Lake. Once these additional baseline data are collected, a more robust study can be conducted to assess pre and post-fire water quality conditions.

Site-specific management techniques should be considered in conjunction with an ongoing monitoring program. Debris basins have shown success in catching sediment and mitigating potential post-fire contaminant transport (Meixner, 2004). Dredging of sediment as needed will allow for the basin to maintain its capacity and remain effective.

Several questions should be kept in mind when developing a monitoring program. **How does post-fire runoff affect contaminant transport?** A complete baseline study will offer a thorough characterization of the source and type of contaminants present in each subwatershed. **What is the likely effect of post-fire runoff on downstream receiving waters?** Continued monitoring of downstream waters will ensure long-term protection of both surface and groundwater resources. **What are the factors that influence how long post-fire runoff effects persist?** This will help to guide sampling procedures regarding duration of sampling plans (Stein and Brown, 2009).

Though the document predicted that there will be no changes to water quality, we do not believe this to be the case. In theory, prescribed fire would influence water quality because of the input of fire debris into water and subsequent dissolution of fire materials. Battle and Golladay (2003) found that pH, alkalinity, and dissolved inorganic carbon (DIC) were higher in burned wetlands than in reference sites. Field conditions also have an important effect on water quality. Water quality of wetlands were found to be most affected through fire's effect on soils rather than vegetation (Battle and Golladay, 2003). There may be measurable effects of fire on water quality. What is unknown is the time-scale on which changes in water quality would appear and how severe the changes will be?

Alternative 1 with no management could cause risk of more intense fires. How would these higher intensity fires impact water quality? A study by Douglass and Lear (1983) in South Carolina found no impact of prescribed burns to the downstream water quality. Another study by Smith et al. (2011) contradicted this showing that burned areas drastically increase suspended sediment in downstream water and an increase in trace elements. Further research within the 4FRI management area could help predict how it will respond to prescribed burns and high intensity wildfires and the water quality impacts. The table on page 107 of the DEIS states that none of the three alternatives will have a detectable impact on water quality. Each management alternative is likely to have a unique impact on surface water and groundwater quality.

Water Quantity

Alternatives 2 and 3 each will increase water yield throughout treated areas by reducing overstory vegetation and increasing grassland and meadow vegetation. We recommend Alternative 2 because it will produce the greatest increase in aquifer recharge rates and volumes and restoring stream and spring discharge to natural flow patterns. Decreasing understory vegetation and foliage cover throughout the watershed can reduce the likelihood of devastating fires which could increase erosion-causing overland flow. The use of prescribed burning could also temporarily increase overland flow. Therefore, we recommend the location and severity of prescribed burns should be monitored closely to avoid burning grassland/ meadow and riparian areas.

Have you considered the importance of groundwater recharge to spring and stream water quantity restoration? We would like to highlight that thinning and restoration could also increase groundwater recharge, which would help restore springs and streams to more traditional discharge patterns. We encourage you to cite Wyatt et al. (2015) for a recent study documenting the changes in groundwater recharge predicted in the 4FRI first analysis area. **Have you considered what spring and stream water quantity monitoring time period is appropriate for assessing restoration success?** We recommend that monitoring of spring and stream discharge should begin immediately, and should include historic measurements when applicable. Hydrograph data should be collected continuously during restoration, and continue for several years after project completion to monitor success, depending on your restoration goals. Research by O'Donnell et al. (2016) indicates that seven to nine years of pre-treatment data are necessary to observe a treatment response from mechanical thinning. Pressure transducers should be installed in stream channels and spring sites, and regular discharge measurements should be taken to develop depth-discharge relationships before and after restoration. These monitoring procedures will allow for quantitative analysis of the degree of success in returning water quantity to its post-treatment amounts. A priority for monitoring could be placed on sites with existing pre-treatment monitoring, such as perennial streams with USGS stream gages.

After thinning, the increased recharge rates will likely decline once understory begins to repopulate, which will increase water loss from evapotranspiration (Wyatt et al. 2015). Because of this, we recommend the restoration have an emphasis on increasing grassland/meadow cover. Additionally, we recommend soil response to thinning be monitored to understand the water yield response throughout the restoration process. Soil compaction, evapotranspiration rates, soil moisture, and overland flow patterns may all change due to the introduction of machinery and disturbance of ecosystems because of thinning. We recommend these factors be monitored throughout the restoration process in order to better understand how water quantity will be affected by forest thinning.

Riparian, Wet Meadow, Spring, and Stream Restoration

Alternatives 2 and 3 presented in this plan contain similar management of riparian, wet meadows, springs, and streams. These ecosystems are grouped into effects common to both alternatives and have the same proposed activities and treatment areas. Case studies have shown that prescribed burns have resulted in increased function of riparian zones, species diversity, and hydrologic connectivity of streams (Tucker, 2007). Treatment of riparian areas will initially have negative short-term effects but paired with proper management could see greater positive outcomes in the long-term treatment.

To properly ensure the greatest positive outcomes, greater monitoring efforts are needed. To see the effectiveness of treatments, more monitoring trips are needed than planned pre- and post-treatment, every two years following treatment for the first 6 years after treatment, then every 5 years for springs. Longer-term studies and more frequent monitoring visits are needed to obtain significant results. Monitoring needs to be done much longer in advance before the treatment and quarterly in frequency for both control and treated areas. Continuous instrumentation should be installed at major springs to obtain a better representation of the spatial and temporal hydrologic conditions. Development of a complete monitoring plan should be developed to obtain a full coverage of geologic units, elevation, topography, and other physical variations.

There appears to be a fair amount of concern about the removal of trees and burning of cleared areas in Riparian and wet meadows. The main concerns for the proposed thinning are due to increased flooding, increased stream velocities and higher rates in erosional processes from lack of debris in channels, and decreased water quality in the short-term due to lack of vegetation. However, these negative effects are temporary and the long-term benefits to the biome, stream health, and wet-meadow habitat, outlive the short-term water quality issues from disturbance.

We would also like to recommend that the Forest Service maintain oversight and timeliness in the removal and mitigation of temporary road impacts. All contractors should be managed to maintain a clear starting and ending date to temporary roads adjacent to springs, streams and wetlands not to exceed one year. All temporary roads should have very clear and obvious signage and barriers to prevent unauthorized road usage. Rehabilitation of roads should be an immediate priority after cessation of mechanical thinning. Clearing is not a quick process and a gentle reminder that roads need to be a mandated distance from streams, wet meadows and springs. Failure to keep to the published guidelines in CFR 36 22.5 could result in destruction of these environments exceeding the potential benefits from clearing.

Watershed Response

While Alternatives 2 and 3 both involve mechanical treatment of vegetation and prescribed fires, higher treatment acreage in Alternative 2 will ultimately result in increased soil stability, groundwater recharge, improved forest resiliency to high severity wildfires, and improved overall functioning of watersheds. However, the negative short-term effects of Alternative 2 will also be more significant than Alternative 3. The DEIS report states that these short-term negative effects may include 3-5 years of increased soil erosion, compaction, reduction in soil moisture and vegetative cover, changes in nutrient cycling, and changes in soil fauna. Watersheds in all four national forests in this project area, including highly visited areas like Wet Beaver Creek, Fossil Creek, and Oak Creek, are currently functioning at risk or have impaired function (USDA, 2011). Therefore, the long-term benefits of forest restoration outweigh the negative short-term effects.

We highlighted earlier the importance of water quantity and quality to proper watershed functioning. Sufficient groundwater recharge to springs and streams leads to water quantity restoration, and reduced erosion and sediment loading to streams increases water quality. Therefore, soil disturbances during the treatment period should be frequently monitored and minimized by implementing Best Management Practices (BMPs). To address how higher-angle streambank and hillslopes will be stabilized after treatment, the project should implement BMPs AQ103, AQ033, SI017, SW038, SW049, and SW055. It may also be helpful to refer to the treatments suggested in Robichaud et al. (2010). Additionally, the plan should address strategies for mitigating nutrient input to streams, particularly nitrogen and phosphorous, from increased runoff due to short-term soil instability. Collecting pre-fire samples to test soil for concentrations of nitrogen and phosphorous may help in forecasting nutrient loading to streams, which can also inform mitigation strategies. Lastly, implementers should utilize BMP SW060 for post-fire wetting treatment of soil to mitigate loss of moisture and improve soil stability.

For up to 5 (or more) years after treatment, soil erosion, soil nutrient and fauna composition, and vegetative growth should be monitored at least on a bi-annual basis (but preferably more frequently) to determine the magnitude and extent of short term impairment and to determine when beneficial effects of restoration begin to outweigh impairment. The results of these monitoring efforts on the first few treatment areas could inform the amount and type of mitigation strategies applied to other prescribed project areas.

Summary

We recommend the 4FRI team proceed with Alternative 2. We encourage the proposed action to include more monitoring of response to riparian, spring and wetland systems, changes in water quality and quantity, and physical response of treated watersheds. Again, NAU is poised to provide technical assistance to these monitoring, analysis and interpretation activities through our existing master challenge cost share agreement with the forest service. Please feel free to contact us for any questions about any of our comments or to discuss any of the recommendations we propose.

Sincerely,

Dr. Abraham Springer

Sara Burch
Riley Swanson
Lauren Magee
Hannah Chambless
Cecily Combs
Natalie Jones
Max Evans
Keegan Donovan

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