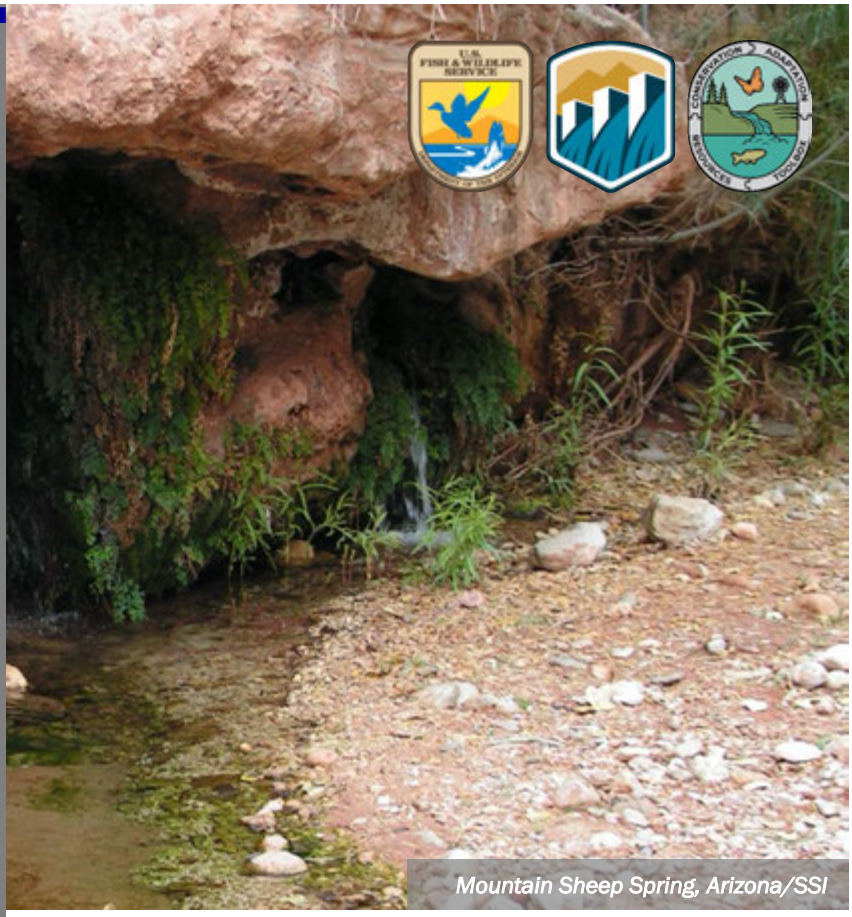
ACTIONABLE SCIENCE

Spring Ecosystems Monitoring for the Four Forest Restoration Initiative

The Four Forest Restoration Initiative (4FRI) aims to restore stand structure and integrity on four national forests in northern Arizona. Thinning and controlled burn treatments are anticipated to reduce risk of catastrophic wildfire, improve forest resilience to climate change, and enhance groundwater infiltration in the project area. However, precise effects of such treatments are difficult to predict due to limited monitoring of Arizona's springs. With administrative support from the Museum of Northern Arizona, the Springs Stewardship Institute (SSI) has been monitoring 56 spring ecosystems in northern Arizona since 2019 to test whether 4FRI treatments improve aquifer infiltration, spring flow, and habitat conditions. The results will improve knowledge of spring ecosystems and inform future management.



Mountain Sheep Spring, Arizona/SSI

KEY ISSUES ADDRESSED

Scientists are uncertain how 4FRI treatments and climate change may impact springs, which are ecologically important but highly threatened ecosystems. Climate change is causing new precipitation patterns that can decrease infiltration of groundwater into aquifers and out through springs. However, the multiple influences of climate and land use changes, coupled with a lack of prior monitoring data, limit prediction of such impacts on springs. Arizona has almost 11,000 springs, but only about 1,200 have been visited and assessed as ecosystems. Springs have to be carefully monitored to relate changes to environmental conditions and better inform future management strategies.

PROJECT GOALS

- Monitor how spring discharge and habitat quality have been affected by 4FRI prescribed burn and mechanical thinning treatments
- Use monitoring results to inform future management of spring ecosystems
- Gather data about spring ecosystem variability and underlying features in northern Arizona

Collecting Data at a Spring Site/SSI

PRESERVATION THROUGH ISOLATION

The isolated nature of spring ecosystems often protects them from invasive species like bullfrogs because they do not share surface water with other water sources.

PROJECT HIGHLIGHTS

Monitoring Process: The project team collected data during the spring and late summer of the past four years on 56 springs, half in 4FRI treatment areas and half outside the treatment areas. Similarly, spring sites were split equally between springs sourced from basalt and sedimentary aquifers, and springs were in both forested and wet meadow environments. Discharge and habitat area have been monitored annually, and a sensor in each spring provides flow information.

Integrative Data Collection: Experts in hydrology, biology, zoology, and geography documented the ecosystem status and collected assessment data on habitat quality at the start of the project period and again at the end.

Springs Online: The team reported data in SSI's Springs Online database. Users of the database can quickly and freely generate summary reports of any monitored spring, making consistent monitoring data of the 56 springs readily accessible to managers and interested groups.

4FRI Treatment Effects: Based on limited data, it is unclear if forest treatments have led to hydrological changes. One burned site has not yet shown any change in discharge. However, it may take more than the five-year duration of this project for water table responses to occur.

LESSONS LEARNED

The 4FRI treatment implementation was delayed, which has allowed researchers to learn more about spring responses to different climate patterns. Winter precipitation, and associated snowmelt, is more influential on spring discharge than summer precipitation, which evaporates faster and reduces infiltration and spring discharge. However, low summer precipitation leads to greater reduction in spring habitat area. Aquifer bedrock type was also found to correlate with spring quality; igneous basalt springs were more often degraded and were more likely to go dry than springs sourced from sedimentary (limestone) aquifers. The Kaibab Limestone formation was not previously recognized as an important aquifer, but produces reliable, high-quality water along the southern edge of the Colorado Plateau. Researchers also improved methods for monitoring and managing springs. SSI research found that feeding guilds of aquatic invertebrates are likely better indicators of spring health than individual species, and thinning up to the edge of the spring, instead of leaving a buffer around it, will increase wetland vegetation productivity and diversity, improving wildlife access.

NEXT STEPS

- Compile the data gathered from the five-year study to develop habitat and climate assessments, models, and recommendations.
- Compare study results with data collected from three long-term study sites in the Southwest to investigate patterns between climate and spring ecosystem habitat responses.

Collaborators

- Grand Canyon Trust
- Northern Arizona University
- Salt River Project
- Coconino National Forest

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Assessing Sites in the 4FRI Restoration Area/4FRI