CLIMATE CONSIDERATIONS FOR QUAKING ASPEN CONSERVATION

WAA Brief #10, June 2024

Douglas Shinneman, Research Fire Ecologist, US Geological Survey
Susan McIlroy, Biologist, US Geological Survey
Paul C. Rogers, Director Western Aspen Alliance, Utah State University

Overview

Human-caused climate change alters ecosystem processes ranging from local to global scales. As a consequence of climate change we should expect increased rates and intensities of disturbance events. Though we are only beginning to understand what those impacts might be to aspen forests and their diverse plant and animal assemblages, recent science suggests there may be unavoidable effects. In the face of anticipated climate-ecosystem challenges, contemporary managers are searching for guidance on preserving aspen resilience. We suggest crafting strategic yet cautious approaches to minimize effects and facilitate broad resilience. For instance, monitoring conditions in and near aspen forests will help land managers remain nimble in response to potentially abrupt changes. Although in its infancy, here we synthesize current research that focuses on climate adaptation strategies to improve aspen resilience.

Background

Quaking aspen (*Populus tremuloides*) is found throughout much of North America owing to its genetic diversity and broad climatic tolerance. However, despite its extensive distribution, aspen isn't adapted to locations where average annual temperatures are too warm or where evapotranspiration is greater than annual precipitation. Thus, as climate continues to warm and/or moisture availability declines, some currently occupied aspen locations may become unsuitable. Although some research has forecasted aspen habitat contraction for much of the western U.S. (Rehfeldt et al. 2009), other research suggests a diversity of responses contingent on ecoregion, elevation, aspect, and functional type (Fig 1; Yang et al. 2015; Andrus et al. 2021).

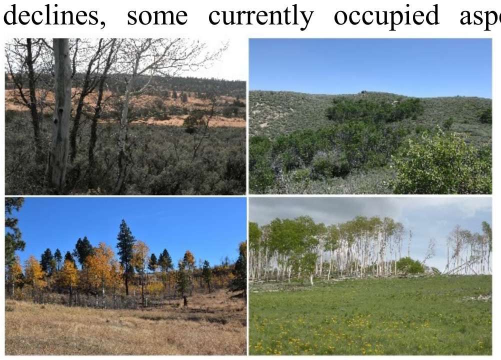

Fig. 1 *Aspen forest response to climate vary by elevation, drought exposure, cohort species, and browse intensity (Photos: P. Rogers).*

Aspen ecosystems are subject to multiple natural and human-caused disturbances, such as fire, insect and pathogen infestations, chronic ungulate herbivory, weather-related phenomena, and landscape alterations (development, logging, mining, etc.). As an early successional species, aspen carries a competitive advantage over other tree species after disturbance, via vegetative suckering or regeneration from seed (Landhäusser et al. 2019). In some environments, fire is particularly critical to ensuring aspen recruitment, especially where shade-tolerant conifers dominate in the absence of disturbance. In other locations, especially where few competitor species are present, aspen is capable of persisting through multiple generations without fire (Shinneman and McIlroy 2019; WAA Briefs #1, 3).

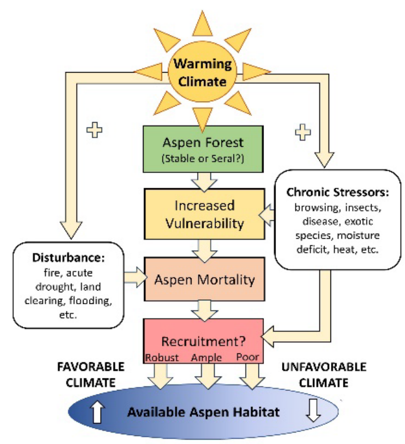

Fig. 2 *Conceptual model of aspen vulnerability to climate change*

Wildfire may become more prevalent in many regions due to climate change, as fire seasons lengthen, and fire-weather becomes more extreme. Some areas may see positive outcomes for aspen with expansion into post-fire environments (Andrus et al. 2021). However, changes in the frequency and intensity of fire, alongside post-disturbance herbivory, may create unsuitable habitat and reduce aspen regeneration, especially where stressors are amplified by warming, creating vulnerable stand conditions (Fig. 2).

Climate, Disturbance, Response

A critical question is how interactions between changing climate and altered disturbance regimes will affect future aspen habitat. We anticipate these interactions will accelerate its decline in some locations while increasing abundance elsewhere. For instance, modeling suggests that more wildfire under warming climates could result in a loss of aspen at lower elevations in mountainous regions of the western U.S. However, those same conditions may create more habitat at higher elevations, where temperatures and moisture availability (generally, snowpack) are likely to remain suitable for aspen, and where more fire creates early-successional conditions (Yang et al. 2015). Similarly, increasing fire activity may already be transitioning many northern boreal forests from spruce-dominated to aspen-birch dominated (Johnstone et al. 2010).

Research in the western U.S. has found that site, herbivory, disturbance, and climate conditions are important to aspen regeneration following fire, further suggesting interacting factors will influence aspen persistence and productivity as climate warms (McIlroy and Shinneman, 2020; Fig 3). Still, there remains considerable uncertainty regarding potential aspen loss, persistence, or expansion under climate change, due in part to uncertainty regarding future decreases in snowpack and enhanced drought conditions. Aspen may be buffered from more extreme climate where moisture is readily available at higher elevations and near riparian zones. Conversely, lower elevations—pointedly, those facing south and southwest—may experience more rapid aspen habitat loss. Such declines should be expected to accelerate where chronic browsing exacerbates elevated heat and limited water. Furthermore, even with potential upslope migration of aspen to cooler locations, the broadly conical shape of mountains means less land area at higher elevations, which could lead to greater isolation and decreased area of aspen cover. Another key element—where the science is currently somewhat limited—is the role of seed dispersal and subsequent natural aspen seedling establishment, and the extent to which these dynamics may align favorably with evolving climate-habitat conditions driven by periodic disturbance (Landhäusser et al. 2019).

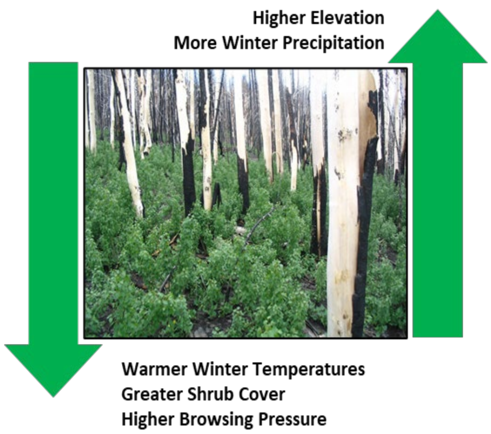

Fig. 3 *Key environmental factors that can positively or negatively influence aspen regeneration after fire* (Photo USGS.)

Management Implications

As we begin to understand aspen dynamics under future climate scenarios, prudence suggests limiting stressors (e.g., excessive browsing) to ecosystem processes, to ensure the greatest number of options for future stewardship. Monitoring aspen populations and their response to disturbances will help inform management priorities, including identifying opportunities to promote aspen persistence or expansion through treatments (i.e., burning, cutting, rest from grazing). Such information can also help to identify the most vulnerable aspen habitat, where eventual aspen loss is likely, and to prioritize mitigation efforts strategically.

Key Findings:

1. A warming climate is already affecting some aspen forests.
2. Warming will alter fire and other disturbance patterns, as well as available aspen habitat.
3. Though uncertainty remains, we expect both contraction and expansion of aspen with geographic variance.
4. Management actions taken now (e.g., browsing reduction, strategic burning) may enhance aspen forest resilience under ongoing climate change.

Sources

Andrus, R., S. Hart, N. Tutland, and T. Veblen. 2021. Future dominance by quaking aspen expected following short-interval, compounded disturbance interaction. Ecosphere 12:e03345.

Johnstone, J. F., T. N. Hollingsworth, F. S. Chapin, and M. C. Mack. 2010. Changes in fire regime break the legacy lock on successional trajectories in Alaskan boreal forest. Global Change Biology 16:1281–1295.

Landhäusser, S. M., B. D. Pinno, and K. Mock. 2019. Tamm Review: Seedling based ecology, management, and restoration in aspen (*Populus tremuloides*). Forest Ecology and Management 432:231-245.

McIlroy, S. K., and D. J. Shinneman. 2020. Post-fire aspen (*Populus tremuloides*) regeneration varies in response to winter precipitation across a regional climate gradient. Forest Ecology and Management 455:117681.

Rehfeldt, G. E., D. E. Ferguson, and N. L. Crookston. 2009. Aspen, climate, and sudden decline in western USA. Forest Ecology and Management 258:2353-2364.

Shinneman, D. J., and S. K. McIlroy. 2019. Climate and disturbance influence self-sustaining stand dynamics of aspen (Populus tremuloides) near its range margin. Ecological Applications 29:e01948.

Yang, J., P. J. Weisberg, D. J. Shinneman, T. E. Dilts, S. L. Earnst, and R. M. Scheller. 2015. Fire modulates climate change response of simulated aspen distribution across topoclimatic gradients in a semi-arid montane landscape. Landscape Ecology 30:1055–1073.