USDA Climate Hubs: Northern Forests

Effects of Drought on Forests and Rangelands in the United States: A Comprehensive Science Synthesis

Drought Impacts on Forests in the Northern Forests

Overview:

The Northern Forests of the Midwest and Northeast regions are home to a diversity of ecosystems and tree species. Anticipated climate change effects, such as increased temperatures, extended growing season, variable precipitation, reduced snowpack and earlier melt, and episodic precipitation events, can interact to increase drought risk and put stress on forest ecosystems[2]. Droughts may impact the unique characteristics of these ecosystems, affecting forest vigor and productivity, carbon storage, and water yield and quality[1].

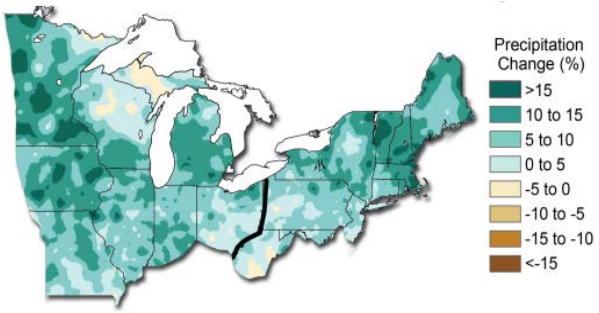

***Figure 1**: Observed change in annual precipitation (1991-2002, compared to 1901-1960)[3]. (Map was modified from source to show region).*

The Midwest and Northeast regions are expected to receive increased annual precipitation (*Figure 1*)[3], but moisture stress may still be a concern for regional forests under a changing climate. Current observations indicate more precipitation is already falling in the form of very heavy events[3], often with lower seasonal rainfall between events. The Midwest and Northeast regions have actually experienced a slight decrease in drought frequency over the 20th century[1,2,3], though this trend may reverse as temperatures increase.

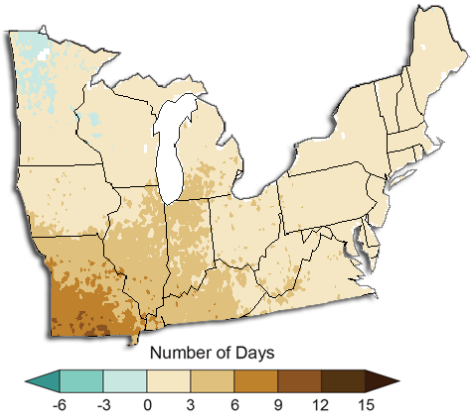

***Figure 2:** Projected change in the number of consecutive dry days[3] (Map was modified from source to show region)*

Higher temperatures combined with altered seasonal precipitation and increased frequency of high-intensity heavy precipitation events may ultimately result in less available moisture during the growing season as climate change continues[3]. The combination of high temperatures and lower recharge of water tables are projected to result in an increase of consecutive "dry" days by mid-century (*Figure 2*)[3]. Seasonally, drought is projected to occur late in the summer at the end of the growing season, and in early fall, due to limited moisture availability[2]. Further, as high-intensity heavy precipitation events occur in the form of rain, and rain-on-snow, forest ecosystems may be less able to absorb and utilize the robust water inputs, which may result in greater runoff and less available moisture available for the growing season[2]. As soils become drier and available moisture for vegetation growth decreases; sites may experience increased rates of plant mortality and habitat degradation.

Drought Impacts on Forests:

- **Increased temperatures and altered precipitation may increase moisture stress.** Warmer temperatures will increase water loss from plants and forest soils, requiring more precipitation to maintain water balance. Reduced winter snow, earlier spring flows, and a greater concentration of precipitation in heavy precipitation events may increase moisture stress during the growing season.
- **Conditions may favor drought tolerant species,** with frequent low severity drought. Species that are able to tolerate hotter and drier conditions may be better adapted in areas where drought increases, making them more competitive.

- **Habitats may shift,** as an effect of competition and drought. Drought tolerant species, such as pines and oaks, may have increased habitat in the future. Habitat for northern species in some areas will shift, presenting opportunities for southern tree species.
- **Low diversity forest systems are at a greater risk**. Diverse ecosystems are generally more resilient to disturbance because there are many more options to respond to change.
- **Many invasive species, insect pests and pathogens will increase or become more severe and damaging**. Warmer temperatures may help invasive species and pests expand into new areas. Drought and other stressors can create opportunities for non-native species and pests to invade.
- **Climate conditions will increase the risk of wildfire** in parts of the Midwest by the end of the century. Risk is likely to be greater in forests that are under stress from other climate impacts or have fuel loads from pest-induced mortality, blowdown events, or other disturbances.
- **Aquatic organisms could face increased stress from heat and reduced water quality.** Reduced streamflow can concentrate nutrients and sediments, warming waters more quickly. Some type of organisms, such as cold-water fish species, may be at greater risk.
- **Some forests will be more vulnerable than others.** Drought will vary in duration and intensity across the Northern Forests, and forests will be affected differently based on degree of warming, changes to local precipitation patterns, local site conditions, and the sensitivity of the individual trees on site.

Adaptation Considerations of Drought in Forests:

Management options will need to vary based on the vulnerability of the site to drought. Management options to deal with this additional stress include:

- **Increase diversity.** Including a mix of drought-tolerant species and genotypes will help to reduce stand vulnerability to drought[1]. When planting sites, managers may consider both species and genetic populations within species to help select appropriate planting stock that will be better adapted to current and future conditions.
- **Manage stand density**. Managing tree age, size, and structure within forest stands can improve resistance and resilience to drought[1]. Thinning stands may result in positive near term drought resistance; however, as stands age and grow in size and complexity water demand and drought vulnerability can increase[1]. Uneven-aged management may also reduce stand-wide vulnerability to drought, spreading risk across ages and size classes[1].
- **Control competition, including invasive species.** Management to favor desired species will become important, especially if managing during a drought.
- **Maintain harvest residues.** Woody material from harvest can be left on-site to increase moisture availability, resulting in a mulching effect[1].
- **Consider containerized seedlings.** If planting during drought, consider containerized nursing stock which has been observed to have increased survival and growth rates compared to bare-root seedlings on dry sites[1].

Conclusions:

- Drought has not been a major disturbance in many regional forests in recent decades, although localized areas have been affected.
- There is increased potential for drought as a result of climate change.
- Land managers can be aware of the potential for drought and use appropriate management to help alleviate drought stress.

Citations

1. Vose et al, 2016. Drought Impacts on US Forests and Rangelands: A Comprehensive Science Synthesis.

2. Handler, S.D., C.W. Swanston, P.R. Butler, L.A. Brandt, M.K. Janowiak, M.D. Powers, and P.D. Shannon, 2014. Climate change vulnerabilities within the forestry sector for the Midwestern United States. In: Climate Change in the Midwest: A Synthesis Report for the National Climate Assessment, J.A. Winkler, J.A. Andresen, J.L. Hatfield, D. Bidwell, and D. Brown, eds., Island Press, 114-151, available online: www.treesearch.fs.fed.us/pubs/47125.

3. Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2, available online: nca2014.globalchange.gov.

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