

## **Final project report for the Southwest Climate Adaptation Science Center**

Project Title: Understanding mechanisms of fire-caused vegetation type conversion in Southwestern conifer forests under current and future climate

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## **SECTION 1. ADMINISTRATIVE INFORMATION:**

### *Award recipients:*

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### *Project Cooperators:*

Rachel M. Gregg, Environmental Science Associates, 5309 Shilshole Avenue NW, Suite 200, Seattle, WA 98107.

Christopher H. Guiterman, Ecological Restoration Institute, Northern Arizona University, PO Box 15017 Flagstaff, AZ 86011.

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### *Project title:*

Understanding mechanisms of fire-caused vegetation type conversion in Southwestern conifer forests under current and future climate

*Date:* 4/16/2022

*Period of time covered:* 6/15/2018 to 4/16/2022

## **SECTION 2. PUBLIC SUMMARY:**

Fire has historically shaped much of the landscape across the U.S. Southwest. But today, the nature of fire in the Southwest is changing, owing to past land use practices and a warming climate. Wildfire trends point toward more frequent, larger, and in some cases more severe fire events now than in the past. The response of many natural areas in the Southwest to severe fires during a period of rapidly shifting climate has been the replacement of large areas of dominant vegetation with other vegetation types. Examples include the conversion of forest to shrublands, or shrublands to grasslands (often dominated by exotic species). This process, known as vegetation type conversion (or VTC), often viewed as a conservation failure, has negative impacts on native biodiversity and can disrupt services society relies on from these ecosystems (for example, soil stability, water purification, carbon sequestration, and wildlife habitat). Land management practitioners often ask, “What can be done to prevent or lessen the potential effects of VTC?”

The answer to this question is specific to a particular vegetation type, owing to different environments, biota, and histories. We synthesized the collective experiences of managers and practitioners across the region, using in-person meetings, and information about successes and failures of past management actions. We also convened groups of working scientists who have studied the conditions under which VTCs are most likely to occur. The project showed similarities in regional vegetation types prone to VTC. For example, across regions a common

observation was that following high severity fire, forests converted to shrublands. By bringing together managers and scientists from across the region, our project helped to further the understanding of VTC processes, as well as develop optional guidelines and decision tools that managers could use to protect vulnerable landscapes.

### **SECTION 3. PROJECT SUMMARY:**

This project synthesized the understanding of vegetation type conversion (VTC) in the Southwest, where fire catalyzes the change of forests to shrublands, or from shrublands to grasslands dominated by exotic species. These changes are often long-lasting. Our synthesis included input from panels of experts from the Southwest. These results appear in Falk et al. (2022) and Guiterman et al. (2022) (see section “Outreach and Products” below).

### **SECTION 4. REPORT BODY**

*Purpose and objectives:* The purpose of our project was to collect and interpret manager observations and current scientific understanding of VTC in southwestern conifer forests.

*Organization and approach:* We conducted a literature review and synthesis and convened expert panels on this topic. Our project engaged the land management and research communities to help define VTC in coniferous forests and describe potential management responses.

*Project Results, Analysis and Findings:* We hosted two-day workshops in Tucson, AZ and Sacramento, CA. These workshops brought together experts from management agencies, non-governmental organizations, and academia to discuss VTC. We documented known cases of VTCs, identified underlying mechanisms, and discussed potential management actions. These observations were collected and organized in maps (where we had location information) and tabular format. This allowed us to identify commonalities among observations, regions, and vegetation types. High-severity fire was repeatedly identified as a triggering mechanism for VTC. Less common mechanisms included drought and land-use changes. We developed a working definition of VTC and discussed challenges and opportunities for management of VTC. Practitioners reported that management choices were often constrained by societal and institutional values along with scientific considerations. Acceptance and even facilitation of VTCs were reported to represent valid management responses in some situations. A detailed summary of workshop findings appears in the peer-reviewed literature (Guiterman et al. 2022).

A subset of project participants also produced a synthesis of the scientific understanding of VTC (Falk et al. 2022). This manuscript explored ideas of ecological resilience, including a VTC which was considered a special case of resilience where responses to disturbance are persistent and feature reinforcing mechanisms. The resilience framework developed in this study could be used to create a basis for ecosystem management under rapidly changing conditions.

### **Outreach and Products**

#### Peer-reviewed publications

Keeley J.E., P. van Mantgem, and D.A. Falk. 2019. Fire, climate and changing forests. *Nature Plants* 5 (8): 774-775. <https://doi.org/10.1038/s41477-019-0485-x>.

Falk, D.A., P. van Mantgem, J.E. Keeley, R.M. Gregg, C.H. Guiterman, A.J. Tepley, D.A. Young and L.A.E. Marshall. 2022. Mechanisms of forest resilience. *Forest Ecology and Management* 512: 120129. <https://doi.org/10.1016/j.foreco.2022.120129>.

Guiterman, C.H., R.M. Gregg, L.A.E. Marshall, J.J. Beckmann, P.J. van Mantgem, D.A. Falk, J.E. Keeley, A.C. Caprio, J.D. Coop, P.J. Fornwalt, C. Haffey, R.K. Hagmann, S.T. Jackson, A.M. Lynch, E.Q. Margolis, C. Marks, M.D. Meyer, H. Safford, A.D. Syphard, A. Taylor, C. Wilcox, D. Carril, C.A.F. Enquist, D. Huffman, J. Iniguez, N.A. Molinari, C. Restaino, and J.T. Stevens. 2022. Type conversion in the US Southwest: Frontline observations and management responses. *Fire Ecology* 18: 1-16. <https://doi.org/10.1186/s42408-022-00131-w>.

#### Conference presentations

DA Falk (2018). “Climate, disturbance, resilience, evolution, restoration: Three principles for restoring the future of life on Earth.” Invited plenary address, Society for Ecological Restoration Europe, Reykjavik, Iceland.

DA Falk (2018). Panelist, Translational Ecology panel, Center for Climate Adaptation Science and Solutions (CCASS).

DA Falk (2019). “(How) can we map ecological restoration onto a rapidly changing world?” Society for Ecological Restoration national webinar.

DA Falk (2019), “Fire, climate change, and adapting restoration ecology to a changing world.” Society for Ecological Restoration-High Altitude Revegetation Committee. Ft Collins CO.

DA Falk (2019). “Restoring adaptive capacity for an unknown future.” Symposium on Fire-Driven Forest Conversion. International Association for Landscape Ecology, Fort Collins, CO.

DA Falk (2019). “Restoring adaptive capacity for an unknown future.” USGS Climate Adaptation Science Center, National PI Meeting. Tucson, AZ.

DA Falk (2019). “Scaling ecological resilience”. Contributed presentation at the Association for Fire Ecology, Tucson, AZ.

#### Other presentations

DA Falk (2019). “Fire and forests in a changing world”. Harvard Club of Tucson, AZ.

DA Falk (2019). “Restoring ecosystems in the climate change era”. UA Science Café, Tucson Botanical Gardens.

DA Falk (2020). “Can forests survive the Anthropocene (and can science help save them)?” UA Science Café, Tucson AZ.

DA Falk (2020). “Can forests survive the Anthropocene (and can we help)?” Environmental Breakfast Club, UA School of Law.

Falk DA and JR Malusa (2021) “The future of the Santa Catalinas after the Bighorn Fire: Restoration, resilience, and change.” Institute for Learning in Retirement, Oro Valley, AZ.

Falk DA and L McGuire (2021) “The future of the Santa Catalinas after the Bighorn Fire: Restoration, resilience, and change.” Sustainable Tucson.

Falk DA (2021). Panelist for section on forest resilience: Fire and the Future, webinar produced by the Desert Laboratory, Arizona Public Media, and Arizona Institutes for Resilience.

**Literature cited**

Falk, D.A., P. van Mantgem, J.E. Keeley, R.M. Gregg, C.H. Guiterman, A.J. Tepley, D.A. Young and L.A.E. Marshall. 2022. Mechanisms of forest resilience. *Forest Ecology and Management* 512: 120129. <https://doi.org/10.1016/j.foreco.2022.120129>.

Guiterman, C.H., R.M. Gregg, L.A.E. Marshall, J.J. Beckmann, P.J. van Mantgem, D.A. Falk, J.E. Keeley, A.C. Caprio, J.D. Coop, P.J. Fornwalt, C. Haffey, R.K. Hagmann, S.T. Jackson, A.M. Lynch, E.Q. Margolis, C. Marks, M.D. Meyer, H. Safford, A.D. Syphard, A. Taylor, C. Wilcox, D. Carril, C.A.F. Enquist, D. Huffman, J. Iniguez, N.A. Molinari, C. Restaino, and J.T. Stevens. 2022. Type conversion in the US Southwest: Frontline observations and management responses. *Fire Ecology* 18: 1-16. <https://doi.org/10.1186/s42408-022-00131-w>.