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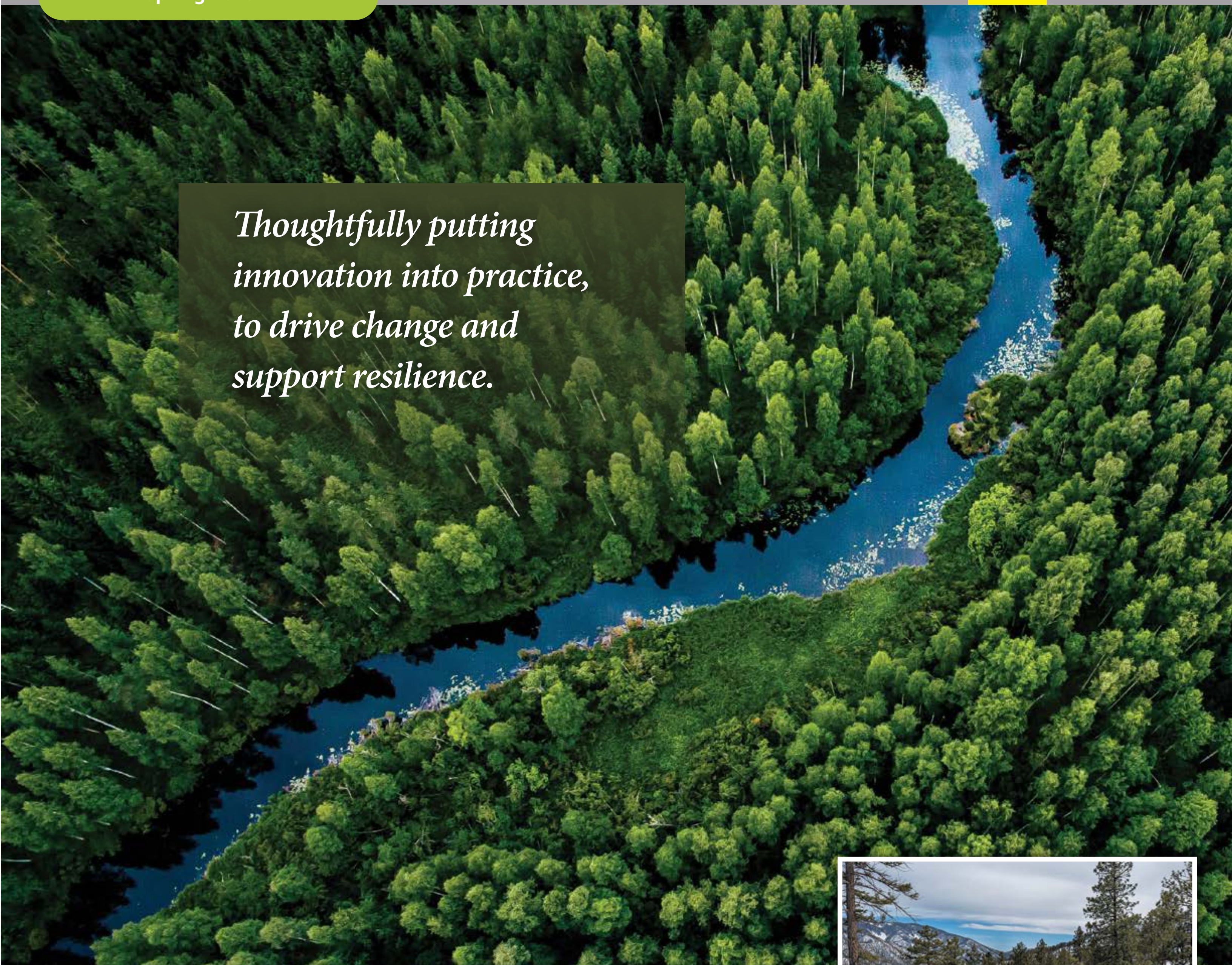

Thoughtfully putting innovation into practice, to drive change and support resilience.

Note: Full references for all articles in this edition are available in the online extra, found at foreststewardsguild.org/magazine

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INSIDE

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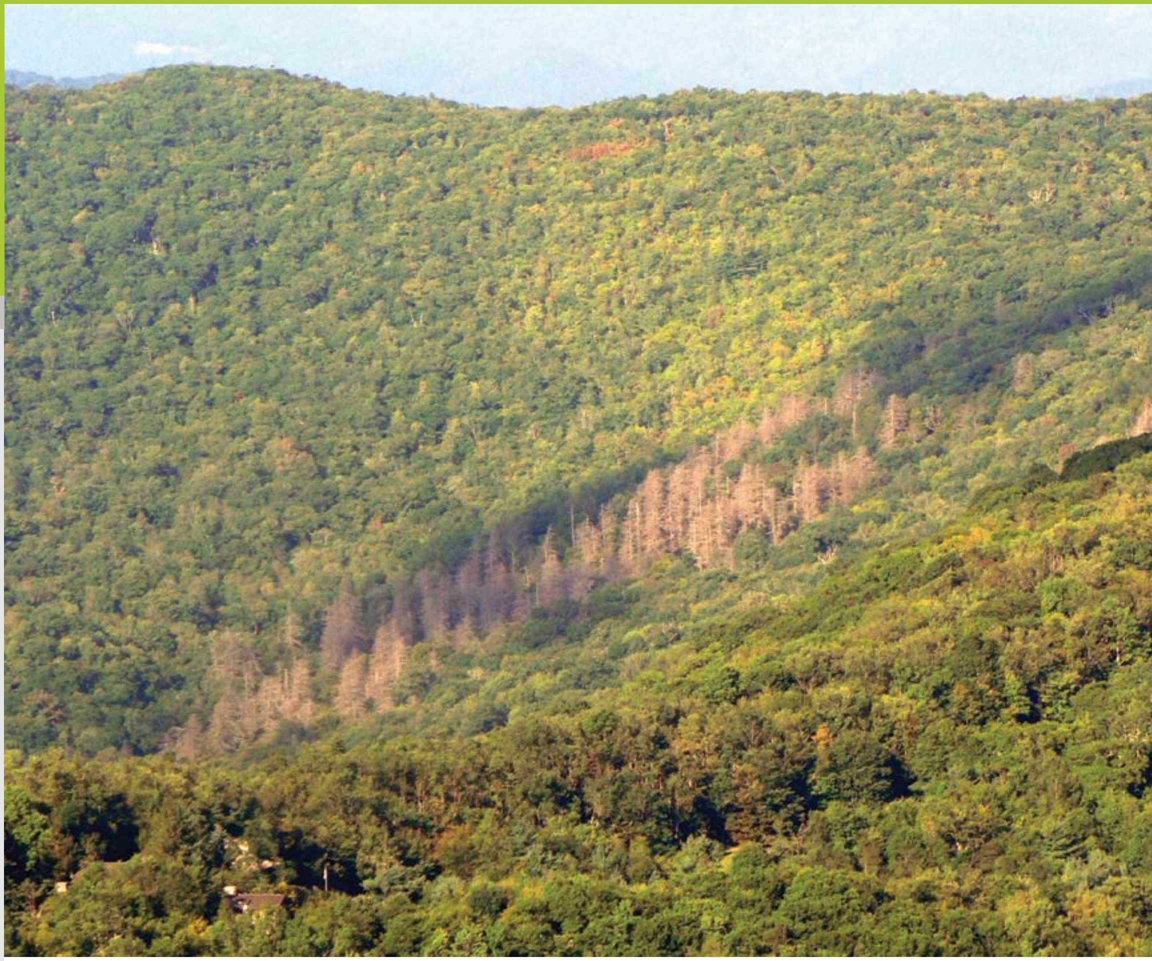
Innovation Driven by

Zander Evans, Executive Director, Forest Stewards Guild and project contributors



Hemlock mortality caused by hemlock wooly adelgid in the Great Smoky Mountains. Photo by Ignazio Graziosi, University of Kentucky, Bugwood.org

For nearly three decades, the Guild has supported and inspired stewards to put innovation into practice.

In the early years, innovations came from long-time practitioners sharing insights from working in the woods. Connections between foresters and across regions spur advances in practice. Today, as ecological forestry has become a more common approach to management, the threats facing our forests from climate change and invasive species require innovative responses.

Non-native insects and pathogens, often called invasive species, threaten the survival of our forests and all that forests provide. Invasive species cost the United States about $21 billion annually. Wood- and phloem-boring insects alone cost local governments $1.7 billion and reduce residential property values by $830 million. These dollar figures fail to fully account for the devasting impacts on biodiversity, cultural values and traditions, and other difficult-to-measure forest values. Of course, we need to invest in monitoring and preventing future introductions, but for many stewards the problem is already here and requires a creative response. A few examples of innovation driven by invasive species impact are highlighted here. Not all Guild members will agree with these approaches, and that is all the more reason to foster further investigation and an open discussion.

Invasive Species

The Hemlock Woolly Adelgid (HWA) has brought ecological, economic, and social damage to forests across the range of eastern hemlock. New research shows the potential for using hemlock's natural responsiveness to increased light availability and informed silviculture thinning to increase resistance to HWA. Mary Ann Fajvan and Andrea Hille at the USDA Forest Service studied pre-infestation silvicultural treatments to enhance hemlock vigor as part of integrated management to mitigate an invasive species' impacts.

A team from Sleeping Bear Dunes National Lakeshore and Michigan Technological University also wants to use a tree's natural attributes to reduce negative impacts. They worked for five years to identify individual trees that are resistant to beech bark disease. They planted saplings made from cuttings of resistant beech trees in November 2022. If the saplings continue to show resistance, the project will expand.

More extreme measures have been taken to increase resistance to the non-native chestnut blight. Last year, the USDA released a positive preliminary report on a genetic modification that could make future chestnut trees resistant to the blight that killed their ancestors. Spearheaded by scientists at the SUNY College of Environmental Science and Forestry in New York and supported locally by researchers at the University of New England and the Maine chapter of the American Chestnut Foundation, this modification inserts an extra gene into American chestnut DNA. The restoration of the American chestnut is a noble undertaking that deserves our serious consideration and thoughtful deliberation. If accomplished successfully, the tree would improve forest health, increase biodiversity, and provide important economic benefits for local communities.

Genetically altered trees are controversial and require serious assessment as highlighted by the Guild's Policy Statement on Transgenic Trees. USDA officials will seek to determine whether the tree could become a weed or otherwise threaten existing plants. The Food and Drug Administration will study whether the tree's fruit is safe to eat, and the Environmental Protection Agency will consider whether the trees' blight-blocking enzyme should be regulated as a fungicide. Equally important is a clear process for incorporating cultural and spiritual values into the decision-making. Chestnut is a culturally important tree and was an important food source. Neil Patterson, a member of the Tuscarora Nation and assistant director of the Center for Native Peoples and the Environment at SUNY ESF, notes some Native Americans are wary of genetically altering a species with which they have a long relationship.

Tetrastichus planipennisi is a gregarious larval endoparasitoid of emerald ash borer (EAB) in China, and is being released in the U.S. for biological control of EAB. Photo by David Cappaert via bugwood.org #5402604.

Another potentially controversial approach to protecting trees from non-native threats are biocontrols. Parasitoids have been released in over 360 counties in 31 states as biocontrols for Emerald Ash Borer (EAB). Three of the parasitoids, *T. planipennisi*, *S. galinae*, and *O. agrili*, have successfully established self-sustaining populations in release areas in the Northeast and Midwest. Jian Duan and colleagues from the USDA Agricultural Research Service have documented several areas where parasitoids have spread to nearby forests and resulted in significant suppression of EAB and survival of regenerating ash. The suppression of EAB is likely to expand geographically and thus contribute to ash recovery.

The development of a technologically innovative tool that can assist with invasive species damage detection was motivated by a derecho that destroyed thousands of forested acres in the Chequamegon-Nicolet National Forest in July 2019. Resources for mapping the extensive damage by plane were overwhelmed, and satellite-based mapping systems were insufficient. In response, Sarah Wegmueller at the University of Wisconsin-Madison created a system capable of mapping severe damage using satellite imagery at spatial resolution conducive to the needs of responding forest managers. This system, called Astrape, answers the need for better remote-based tools, and has since been used to map tornados, wildfires, hurricane damage, and defoliation by the invasive spongy moth. The tool, and others like it, will not replace professionals on the ground, but are force multipliers: greatly reducing mapping struggles and highlighting the areas where forestry professionals may want to focus their limited time as threats increase.

These challenges and opportunities only scratch the surface of what's in store for stewardship in an era of climate change. Read more in this edition, in our April 2023 *Across the Landscape* e-newsletter, and in future Guild communications about innovative approaches to unprecedented needs. The Guild is perfectly positioned as a thoughtful community of stewards who shed new light and look with a holistic lens across human and non-human communities.

Fantle-Lepczyk, J. E., Haubrock, P. J., Kramer, A. M., Cuthbert, R. N., Turbelin, A. J., Crystal-Ornelas, R., Diagne, C., & Courchamp, F. (2022). Economic costs of biological invasions in the United States. Science of The Total Environment, 806, 151318. https://doi.org/10.1016/J.SCITOTENV.2021.151318

Aukema, J.E., Leung, B., Kovacs, K., Chivers, C., Britton, K.O., Englin, J., Frankel, S.J., Haight, R.G., Holmes, T.P., Liebhold, A.M., McCullough, D.G., Von Holle, B., 2011. Economic impacts of non-native forest insects in the Continental United States. PLoS One 6, e24587. https://doi.org/10.1371/journal.pone.0024587

The Forest Restoration Movement in the Western U.S. Must Include Post-Fire Resilience

Brian Kittler | Vice President of Forest Restoration, American Forests

Introduction

For millennia, most western forest ecosystems not only survived fire disturbance but thrived with it. Yet, increasingly, wildfire effects and climate change are overwhelming the natural resilience and regenerative capacity of forests.[3, 4, 6, 7, 17]

Years of progressive tree mortality exacerbated by drought, heat, and insect and disease outbreaks are fueling large and severe wildfires. Recent examples include the 2020 Cameron Peak and East Troublesome Fires in Colorado, the 2021 Dixie Fire in California, and the Bootleg Fire in Oregon. Wildfire size has increased, and so too have the areas that burn so hot that virtually all trees are killed.[2, 10, 11, 14, 16] There has been an eight-fold increase in the areal extent of high severity wildfire in recent decades.[12]

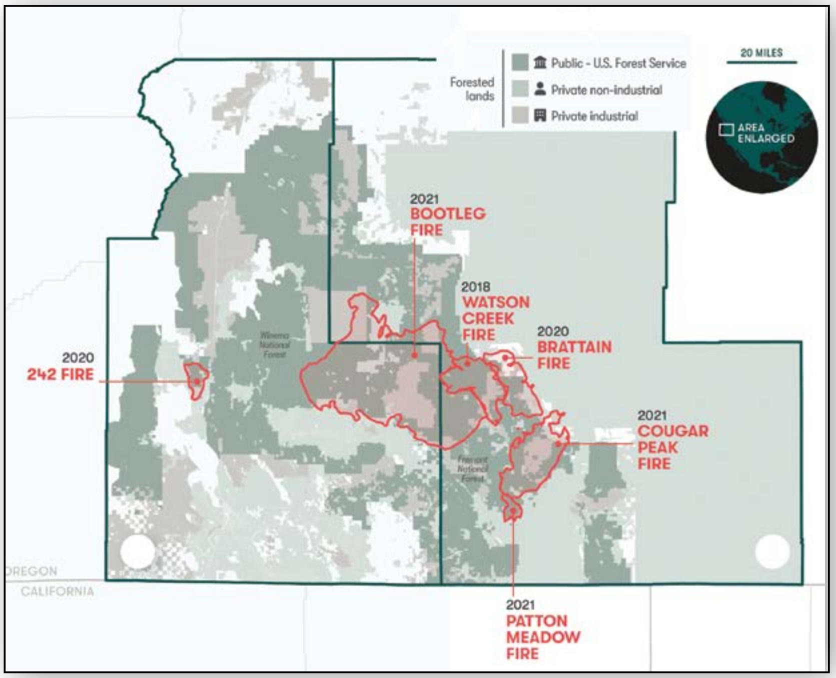
In large, high-severity patches, seedbanks can be lost, contributing to transitions away from forests to other vegetation types. Increases in forest regeneration failure are being driven by wildfire effects and increasingly hot and dry conditions.[3] In fact, American Forests found that since 2019 California has lost 5% of its forest cover in large, high-severity patches that are unlikely to regenerate naturally. These lands are on a trajectory toward shrubland ecosystems with potential for high severity reburns.

While efforts are under way to reduce risks of extreme wildfire behavior, anthropogenic climate change has made forest fuels about twice as dry as they would have otherwise been.[1] This makes forest vegetation, both alive and dead, more likely to ignite and burn. With the likely occurrence of 2°C of warming, the worldwide average wildfire risk is forecasted to increase by ~57% by 2100.[18] This risk is not evenly distributed. The western U.S. could see multiples of this increase by the end of the century.

Quite simply, there will be a lot more wildfire in our landscapes in the future. There is an increasing need for ecological forest management post-fire, especially in areas where the natural resilience and regeneration pathways have short circuited.

What can be done?

Knowledge and experience with ecological post-fire restoration is limited, but post-fire management frameworks are available.[8, 9, 11, 15]



Six fires in Klamath and Lake Counties included in the South-Central Oregon Post-Fire Resilience Strategy. Map by American Forests

There are working examples of how this science is being applied to the development of climate-smart post-fire restoration assessments and strategies. American Forests has partnered with the Bureau of Land Management in California to develop a climate-informed post-fire plan for lands affected by the 2018 Camp Fire[13], and more recently we partnered with the USDA Forest Service and others to develop the South-Central Oregon Post-Fire Resilience Strategy. The goal of the latter is to assess restoration needs, provide cost estimates and workforce capacity needs, and develop climate-smart restoration tactics that can be applied at the site or project scale.

Case Example—South-Central Oregon Post-Fire Resilience Strategy:

Since 2018, an area in south-central Oregon about the size of Rhode Island has burned, and much at high severity. This includes the massive 2021 Bootleg Fire. Its largest contiguous high severity patch covered an area more than four times the size of Manhattan.

Working with a "core team" of public land managers, industrial and non-industrial forest owners, non-profit conservation organizations, and the Natural Resources Department of the Klamath Tribes, American Forests honed a shared vision for establishing fire- and climate-resilient future forests with prescribed fire as the dominant management tool. Drawing from post-fire assessment and climate-informed restoration science, we completed a landscape-scale post-fire restoration strategy.

The spatial analysis maps eight categories of restoration action. The largest need is fuel reduction and reforestation planting across almost 224,000 acres, and another 200,000 acres where maintenance treatments, such as prescribed fire, are needed to maintain beneficial fire effects. This is a massive and expensive program. Across 577,000 priority acres, identified restoration actions tally as much as $650 million – for fuel management, reforestation, meadow restoration, prescribed fire, and fuel breaks.

On National Forest System lands, 100 "implementation units" are prioritized as future burn blocks, each about 3,000 – 5,000 acres. Prioritized implementation units across the landscape make implementation more manageable. The needed post-fire restoration actions are better sequenced, to regenerate forests to prepare the landscape for a large prescribed fire program. It's not just about restoration of forest cover but about bringing back associated ecological processes and addressing other concerns including invasive plants, wildfire resiliency and risk, and declines in seed production.

The strategy integrates a regional climate change vulnerability assessment,[5] which forecasts doubling of drought stress in plants by 2100, which along with increased heat, will limit reforestation success. Climate-smart reforestation techniques are incorporated at three scales. First, on the landscape scale, reforestation is focused on sites where trees are most likely to survive (productive soils, wetter areas). Second, on the site scale, forest geneticists and managers identify seed sources matched to the future climate, as in assisted migration efforts. Other site level techniques include prescribing lower stocking densities and "strategic spacing" to create spatial heterogeneity within regenerating forests to better accommodate future fires. Third, the strategy acknowledges the concept of "planting across time," whereby reforestation treatments will occur over several years if not decades, increasing diversity.

Lastly, the strategy assesses the adequacy of the "reforestation pipeline" to handle a dramatic scale up in reforestation activities. We identified two key bottlenecks in the pipeline. First, workforce capacity must grow significantly. The strategy calls for the equivalent of 47 new seasonal positions and 20 year-round positions on the Fremont-Winema National Forest. Second, the region is facing a severe seed shortage. The current seed bank for the national forest can only meet a maximum of 70,000 acres of reforestation need, which is half of the priority reforestation acres identified there. Unfortunately, like much of the west, the dry forests of south-central Oregon are producing less reliable cone crops due to heat and drought. The preponderance of high severity wildfire is also reducing the areas from which cones can be collected.

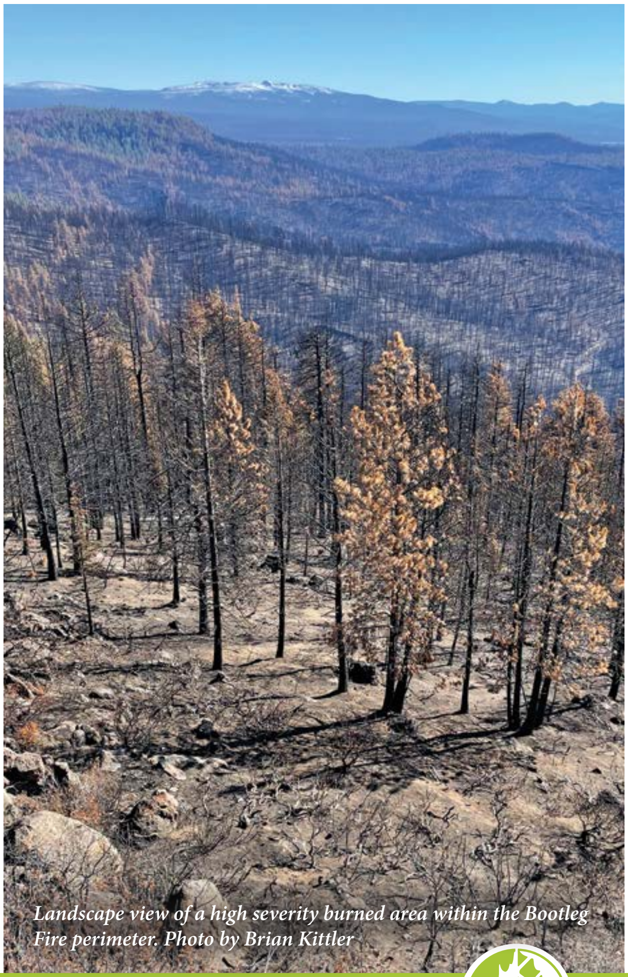
Conclusion

Reforestation and post-fire restoration actions aimed at countering large scale ecological transitions is a critical and complex forest management topic of increasing importance in the western U.S. While the need for pre-fire forest restoration overwhelms the current need for the post-fire work outlined here, the need for ecologically sound and climate-smart post-fire restoration work will grow substantially. This work is expensive and involves prioritization and analysis of tradeoffs.

This is not just about reforestation. Restoring watershed hydrology and the land's ability to collect and retain water is a complementary component of post-fire ecological restoration and climate readiness. Likewise, it will be increasingly important to protect remaining live trees and use burned areas as points of ecological leverage to anchor broader forest restoration efforts.

Thankfully, the Bipartisan Infrastructure Law and the Inflation Reduction Act included more than $14 billion for forestry, and 11% of these funds are in the space of post-fire ecosystem recovery. American Forests is also excited to advance the USDA Forest Service's recently released Reforestation Strategy, which focuses on reforestation following high-severity wildfires and making use of the REPLANT Act, a provision of the Infrastructure Law that expands the agency's reforestation funding. Moreover, the federal Wildland Fire Management and Mitigation Commission will issue a report to Congress later this year which will deliver among other things a raft of recommendations related to post-fire restoration. While the challenges in post-fire restoration are vast, so is the potential to advance innovation in forestry. The time is right for forest stewards to drive this change forward.

Ponderosa pine and shrub regeneration following the Barry Point Fire. Photo by Brian Kittler



Landscape view of a high severity burned area within the Bootleg Fire perimeter. Photo by Brian Kittler

Assisting Tree Migration To Adapt to Climate

Brian Palik | USDA Forest Service, Northern Research Station. Pete Clark | University of Vermont Rubenstein School of Environment and Natural Resources. Colleen Robinson | Forest Stewards Guild.

One of eight planted northern hardwood acre gap replicates at the Dartmouth College Second College Grant ASCC site. Each color coded pin flag is one of nine species from over 5000 seedlings tracked over (now 5) growing seasons. Photo by Pete Clark

Climate change adaptation and preparedness are becoming increasingly urgent. While extreme weather and other disturbances are expected to impact forests, warming temperatures are also changing tree habitat suitability. Currently, the pace of climate change far exceeds the rate of tree species to migrate, which may require deliberate movement of species across climatic zones to keep up. This is referred to as assisted migration, which is the deliberate movement of species or genotypes to locations climatically better suited to survival and growth in the future. Though unintended movement of species over long distances by humans have led to detrimental invasive species impacts, thoughtful assisted shifts in species range can better equip entire landscapes to endure the imminent challenges ahead.

Guild members embrace the reality that in ecological forestry, there is no "one size fits all" answer. Financial resources, overall support for strategies, and site characteristics all play in. Recent research has explored different strategies for climate adapted stewardship, focused on a spectrum from resistance, resilience, and transition options that may include assisted migration.

A resistance strategy may be as simple as stewarding in ways that make current species better able to handle climate-related threats. For example, thinning a red pine stand to lower stocking will help the stand be more drought resistant. This might include prescribed fire to reduce fuels and help a stand be better prepared to endure wildfire when it occurs. This is an example of "working with what you've got" and does not include assisted migration, making it low risk and straightforward for foresters to accomplish.

A resilience strategy focuses on working within the natural range of variation for a particular type of forest, though it still might be outside the norm of what foresters typically do. For instance, rather than favoring a single species like red pine, it might mean managing for a diverse suite of tree species and silvical traits that occur in this forest and more complex age structures than an even-aged stand. Additionally, some native species are likely adapted to climate change and may benefit from assisted migration. That is, planting genotypes of species that are native to the ecosystem, but from a seed-source from farther south or lower elevation. These are relatively short movements (less than 200 miles), and within the species' range.

A transition strategy is an approach that builds on this further to diversify structure and composition but may push the envelope and could involve more assisted migration, including range expansion or even species migration. With the former, the idea is to increase the proportion of better adapted species just outside the native range, say 100-200 miles away, that are not yet on site but are expected to have increases in future habitat under a warming climate. Migration under natural seed dispersal could take centuries to catch up to climate change. A forester might be pragmatic in the near-term by selecting sources of seeds as geographically near to the site as possible. A transition strategy may also include assisted species migration. This involves planting future-adapted species from well outside their current range, again while still sourcing as close to site as possible, but this distance may be beyond what would be considered range expansion, that is, over 200 miles. Transition strategies focus on climate predictions farther into the future, with a goal of creating variable, sustainable resource environments for future adapted species for the long-term.

Assisted migration is part of climate adaptation, and an area of focus in a recent publication in Ecosphere by Guild members Brian Palik and Tony D'Amato, along with Pete Clark, Linda Nagel, and Chris Swanston. They discuss varying levels of public tolerance for assisted migration techniques. Some public perception is related to risk assessment, and some is related to purpose. Overall, there is higher acceptance of assisted migration strategies when urgent solutions are needed to mitigate or reduce imminent threats by invasive species. The emerald ash borer (EAB) is one example.

Ash forests provide a tremendous amount of ecosystem services and cultural value and are at risk of completely disappearing from the landscape. There are few alternative tree species to take their place, particularly in black ash wetlands. In cases like this, public opinion leans toward the potential benefits of assisted migration of new species to replace black ash, outweighing the risks. On the other hand, when assisted migration is used to bolster an economy or forest product resource opportunistically for long-term, gradual benefit, there is less support for the silvicultural strategy.

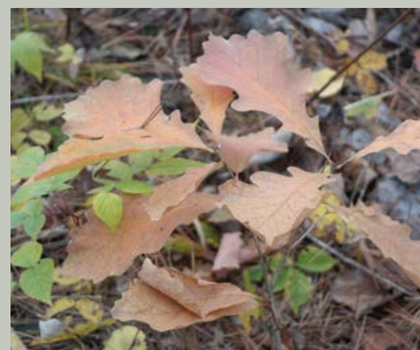
What is innovative about this research across the Lake States and Northeast United States, is that attention is given to the full context of the stewardship process. Site potential, species characteristics and behaviors, historical and future environmental context, and financial considerations are considered, as they typically are in holistic approaches to forest management. In addition, this research includes a deep dive into the motivations for adaptation strategies. What is possible across a spectrum of assisted migration options? How do motivations, options, and associated risks and benefits impact the level of buy-in and support from funders, landowners, land managers, policy makers, and other interests who ultimately determine the feasibility of a project? In the end, the case studies tell us about the things we have more "license" to try when invasive species urgency is involved, versus what we can still do when support for assisted migration/adaptation silviculture is limited.

A few things of note have come from the case studies. Results from the transition strategy show that there are aspects of southern climate present in northern forests already. This is especially apparent in the Minnesota red pine forest, where there is high survival of southern genotypes and species planted as part of range expansion and species migration efforts. Similarly, range expansion of species brought into black ash forests in anticipation of EAB shows that novel species have higher survival than native species already present in the ecosystems. Yet, assisted range expansion species planted in the northern hardwood site in New Hampshire showed a lagged response compared to more locally adapted species, and local vegetation outcompeted those seedlings planted farthest outside of their range limits.

For details on the full scientific information, see Palik, B, Clark, P, D'Amato, A, Swanston, C, Nagel, L. 2022. Operationalizing forest-assisted migration in the context of climate change adaptation: Examples from the eastern USA. Ecosphere 13.10: e4260.

American chestnut planted at the Second College Grant ASCC northern hardwood site. The inclusion of this species represented a unique effort to both restore this functionally extirpated cultural and ecological keystone species while also testing its performance under assisted range expansion.
Left and right photos by Pete Clark

Late spring frost damaged leaves from bitternut hickory, an assisted range expansion species tested at the Second College Grant ASCC northern hardwood site. Frost damaged leaves are an indication of phenological mismatch - such that the hickory seedlings originated in Illinois (cold hardiness zone 6a) but planted in northern New Hampshire (cold hardiness zone 3b).



White oak seedlings, planed in a northern Minnesota red pine forest. Photos by Brian Palik

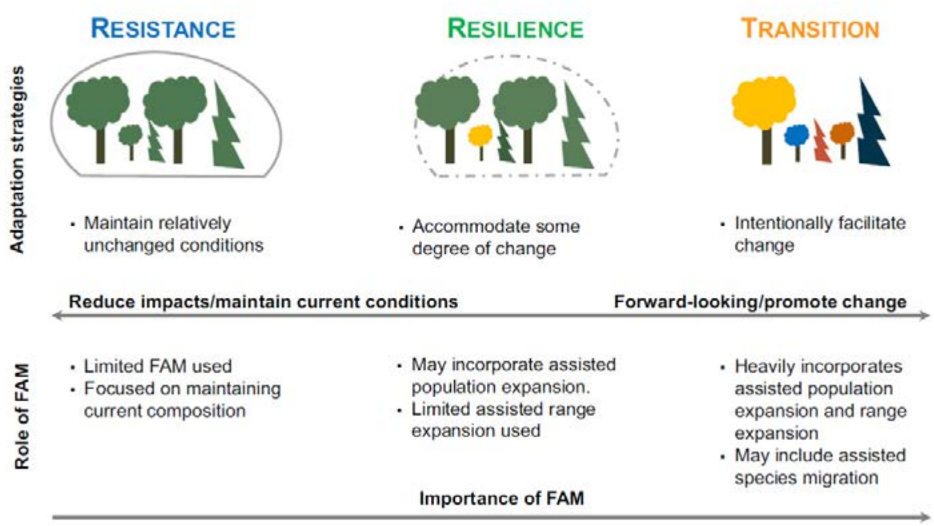


FIGURE 1 Forest-assisted migration (FAM) as part of climate adaptation strategies. The role of FAM increases with degree of change in forest conditions. Redrawn and adapted from Millar et al. (2007), Swanston et al. (2016), and Nagel et al. (2017).

References

1. Abatzoglou, J. T. (2016). Impact of anthropogenic climate change on wildfire across western US forests. *Proceedings of the National Academy of Sciences*, 113(42), 11770-11775.
2. Cansler, C. A. (2014). Climate, fire size, and biophysical setting control fire severity and spatial pattern in the northern Cascade Range, USA. *Ecological Applications*, 24(5), 1037-1056.
3. Davis, K. R. (2023). Reduced fire severity offers near-term buffer to climate-driven declines in conifer resilience across the western United States. *Proceedings of the National Academy of Sciences*, 120(11), e2208120120.
4. Davis, K. T. (2019). Wildfires and climate change push low-elevation forests across a critical climate threshold for tree regeneration. *Proceedings of the National Academy of Sciences,* 116(13), 6193-6198. Retrieved from **https://www.pnas.org/content/pnas/116/13/6193.full.pdf**
5. Halofsky, J. E., Peterson, D. L., & Ho, J. J. (2019). *Climate change vulnerability and adaptation in south-central Oregon. Gen. Tech. Rep. PNW-GTR-974.* Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research.
6. Kemp, K. B., Higuera, P. E., Morgan, P., & Abatzoglou, J. T. (2019). Data from: Climate will increasingly determine post-fire tree regeneration success in low-elevation forests, Northern Rockies, USA, Dryad, Dataset. Retrieved from **https://doi.org/10.5061/dryad.9g91451.**
7. Korb, J. E.-R. (2019). What drives ponderosa pine regeneration following wildfire in the western United States? *Forest Ecology and Management*, 454, 117663.
8. Larson, A. J. (2022). amm Review: Ecological principles to guide post-fire forest landscape management in the Inland Pacific and Northern Rocky Mountain regions. *Forest Ecology and Management*, 504, 119680.
9. Meyer, M. L. (2021). *Postfire restoration framework for national forests in California*. Albany, CA: US Department of Agriculture, Forest Service, Pacific Southwest Research Station.
10. Miller, J. D. (2015). Calibration and validation of immediate post-fire satellite-derived data to three severity metrics. *Fire Ecology*, 11(2), 12-30.
11. North, M. P. (2019). Tamm Review: Reforestation for resilience in dry western US forests. *Forest ecology and management*, 432, 209-224.
12. Parks, S. A. (2020). Warmer and drier fire seasons contribute to increases in area burned at high severity in western US forests from 1985 to 2017. *Geophysical Research Letters*, 47(22), e2020GL089858.
13. Rempel, A. D. (2018). *Camp Fire Reforestation Plan: A Climate-informed Restoration and Regeneration Plan for the Bureau of Land Management in Butte, County, California*. Washington, D.C.: American Forests.
14. Steel, Z. L. (2018). The changing landscape of wildfire: burn pattern trends and implications for California's yellow pine and mixed conifer forests. *Landscape Ecology*, 33(7), 1159-1176.
15. Stevens, J. H. (2021). Tamm Review: Postfire landscape management in frequent-fire conifer forests of the southwestern United States. *Forest Ecology and Management*, 119678.
16. Stevens-Rumann, C. S. (2018). Evidence for declining forest resilience to wildfires under climate change. *Ecology letters*, 21(2), 243-252.
17. Stevens-Rumann, C. S. (2019). Tree regeneration following wildfires in the western US: a review. *Fire Ecology*, 15(1), 15.
18. Sullivan, A. B. (2022). *Spreading like wildfire: The rising threat of extraordinary landscape fires*. Naiobi: United Nations Environment Program Rapid Response Assessment.
19. Tyukavina, A. P. (2022). *Global trends of forest loss due to fire from 2001 to 2019*. Frontiers in Remote Sensing.

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Guild and partner events

We put innovation into practice as an organization, as a community of members, in partnership, and through empowerment of land owners and new stewards. Your membership and donations are the fuel. Please join, stay current, give when you can, and invite others. We are humbled by this engaged community. Updated details at: http://www.foreststewardsguild.org/events.

- **Forestry for the Birds - Western Oregon**
  May 19, 20, or June 2 in Portland or Forest Grove, Oregon
  Explore the new Guide to managing with birds in mind. Local partner experts join sessions for urban forests, forest caretakers, and professionals.

- **Hemlock Treatment Demonstration**
  May 20 in Henderson County, North Carolina
  Hemlock Restoration Initiative and partners demonstrate chemical treatment methods to control hemlock wooly adelgid.

- **Second Annual Bird ID, Ecology, and Habitat Management Workshop**
  June 3 at Stone Fence Farm in Unity, New Hampshire
  Enjoy slow walking tours to learn tips for identification, the ecology and habitat needs of certain species, and how to help.

Check our event webpage often for new opportunities. We welcome your offers to host a Guild Gathering, highlighting good work and important topics in this community. Please email membership@forestguild.org with your ideas.