Ecological Restoration Institute

Fact Sheet: *Post-Wildfire Restoration of Structure, Composition, and Function in Southwestern Ponderosa Pine and Warm/Dry Mixed-Conifer Forests*

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Introduction

Post-fire rehabilitation is separated into short-term, emergency stabilization and long-term restoration measures. The Burned Area Emergency Response (BAER) program includes emergency treatments to stabilize the burned area, protect public health and safety, and reduce the risk of additional damage to valued resources. As opposed to emergency rehabilitation, ecological restoration focuses on assisting the recovery of characteristic ecological structure, process, and function, which requires an understanding of natural range of variability for these key attributes as well as development of reference conditions to guide management activities. In addition, restoration activities demand long-term commitment and evaluation. Given the altered conditions that can follow high-severity fires, successful restoration to a desired state may be difficult and costly. Areas experiencing high-severity fire often exhibit accelerated soil erosion and subsequent loss of soil productivity; expansions or invasions of non-native plant populations; loss of wildlife habitat; damaged watersheds and degraded water quality to connected streams; and/or vegetation type conversion. Attributes of a restored ecosystem include the reestablishment of resilience, forest structure, composition, function, physical environment, and landscape context and integrity.

Resilience

Stability is the natural ability of a system to return to equilibrium after a temporary disturbance. The more rapidly it returns and the less it fluctuates, the more stable it is. Resilience is the capacity of a system to experience shocks while retaining essentially the same function, structure, feedbacks, and identity. A restored ecosystem is sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain the integrity of the ecosystem (SER 2004). When certain thresholds are exceeded (fire severity, for example), system feedbacks may lead to changes in function and structure and to irreversible regime shifts. The more resilient a system is, the larger a disturbance it will be able to absorb without shifting into an alternate regime.

Forest Structure

Given the key role that forest overstory structural patterns play in regulating many ecosystem processes and functions, long-term restoration planning designed to reestablish characteristic structural attributes is critical after a wildfire. Returning structural attributes to a forest burned at high severity may involve planting trees, managing natural regeneration, and manipulating levels and types of dead wood. Species composition, density, and spatial arrangement of tree regeneration should follow natural ranges of variability appropriate for the disturbed ecosystem. Restoring reference structure also requires consideration of the spatial pattern of planted trees. In some cases, evidence of reference patterns (e.g., large stumps, snags, and logs) may remain on the site and can be used to guide planting to achieve reference spatial patterns. However, loss of field evidence often increases with fire severity. In such cases, other sources of information, such as pre-fire inventories, written reports, and photos, may be needed to develop spatial pattern planting prescriptions.

The Ecological Restoration Institute is dedicated to the restoration of fire-adapted forests and woodlands. ERI provides services that support the social and economic vitality of communities that depend on forests and the natural resources and ecosystem services they provide. Our efforts focus on science-based research of ecological and socio-economic issues related to restoration as well as support for on-the-ground treatments, outreach and education.

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Composition

A restored ecosystem contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure (SER 2004). Post-fire environments have an abundance of nutrients, sunlight and bare soil — conditions that can be favorable to the establishment of aggressive and invasive non-native plant species. Ecological impacts of invasion by these species vary along a gradient, depending on whether they affect a single native species or the ecosystem as a whole, with "strong" invaders (transformer species) having the most negative impacts. Transformers are a subset of invasive plants that can change the form of ecosystems over substantial areas. They include species such as knapweeds and annual bromes, including cheatgrass (*Bromus tectorum*), which are of particular concern because they are capable of reducing species diversity and/or changing fire regimes. Control efforts using herbicides, grazing livestock or biological controls can be quite effective for some species. However, others are extremely difficult to eradicate once established, and competing native vegetation is necessary to colonize bare soil in order to prevent further invasion and colonization by invading species.

Function

Ecosystem functions are the ecological processes that control the fluxes of energy, nutrients, and organic matter, including primary production, decomposition of dead matter, and nutrient cycling. High-severity fire can lead to dramatic species losses and changes in species composition and structure, which in turn will affect nutrient composition and turnover rates. A restored ecosystem apparently functions normally for its ecological stage of development, and signs of dysfunction are absent (SER 2004).

Conifer seedlings surrounded by tree shelters on a high-severity burn patch. *Photo courtesy of Elwood Rokala, Kaibab NF*

Physical Environment

The success of early BAER treatments varies by type of treatment, treatment combinations, and environmental conditions, and carries implications for long-term health and restoration of an ecosystem. Long-term monitoring can allow for information to be accessible to BAER teams to further refine future treatments. Preventing accelerated soil erosion is a primary BAER activity, but erosion can continue to occur for several years following a severe wildfire. In-channel erosional processes may last much longer than those occurring in upland systems. Some of the dynamics associated with erosion may be desirable for rejuvenating aquatic systems, but over large areas and where species are vulnerable, such impacts may be a real concern.

Landscape Context and Integrity

Some important and common threats to severely burned forest sites from surrounding landscapes include domestic and wild grazers, which may feed on newly seeded or planted areas, and the introduction of invasive plants that may disperse or be inadvertently transported into burned areas. The effect of subsequent wildfires (reburns) on areas that have already burned is another landscape context issue. Both shrubfields and hyper-dense forests are subject to high-severity reburns in the Southwest. Determining when and where it makes sense to intervene and where natural recovery processes may be deemed sufficient within high-severity burn patches requires careful consideration of a number of site-specific interactive factors, and decisions should be made within a broad landscape context. Long-term monitoring is crucial in order to determine if ecosystem changes are occurring and how to best respond to them.

SUMMARY

The Society for Ecological Restoration has developed nine attributes that provide a basis for determining when restoration of an ecosystem has been accomplished (SER 2004):

1. The restored ecosystem contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure.
2. The restored ecosystem consists of indigenous species to the greatest practicable extent.
3. All functional groups necessary for the continued development and/or stability of the restored ecosystem are represented or, if they are not, the missing groups have the potential to colonize by natural means.
4. The physical environment of the restored ecosystem is capable of sustaining reproducing populations of the species necessary for its continued stability or development along the desired trajectory.
5. The restored ecosystem apparently functions normally for its ecological stage of development, and signs of dysfunction are absent.
6. The restored ecosystem is suitably integrated into a larger ecological matrix or landscape, with which it interacts through abiotic and biotic flows and exchanges.
7. Potential threats to the health and integrity of the restored ecosystem from the surrounding landscape have been eliminated or reduced as much as possible.
8. The restored ecosystem is sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain the integrity of the ecosystem.
9. The restored ecosystem is self-sustaining to the same degree as its reference ecosystem, and has the potential to persist indefinitely under existing environmental conditions. Nevertheless, aspects of its biodiversity, structure and functioning may change as part of normal ecosystem development, and may fluctuate in response to normal periodic stress and occasional disturbance events of greater consequence. As in any intact ecosystem, the species composition and other attributes of a restored ecosystem may evolve as environmental conditions change.

Emergency stabilization activities have been well-researched. However, longer-term post-fire restoration efforts require commitment, research and monitoring, but have generally received much less attention. The increasing occurrence of very large wildfires has prompted more attempts to articulate and evaluate long-term restoration strategies. Monitoring is crucial in order to determine if ecosystem changes are occurring and how best to respond to them in both the short- and long-term.

REFERENCE

Society for Ecological Restoration. 2004. SER International Primer on Ecological Restoration. Society for Ecological Restoration International Science & Policy Working Group. Version 2, October, 2004. http://www.ser.org/resources/resources-detail-view/ser-international-primer-on-ecological-restoration

This Fact Sheet summarizes information from the following publication:

Springer, J.D. 2013. Post-wildfire restoration of structure, composition, and function in southwestern ponderosa pine and warm/dry mixed-conifer forests. ERI Working Paper 29. Ecological Restoration Institute, Northern Arizona University. http://library.eri.nau.edu/gsdl/collect/erilibra/index/assoc/D2014003.dir/doc.pdf

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