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Working Papers in Southwestern
Ponderosa Pine Forest Restoration

Butterflies as Indicators of Restoration Progress

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Working Papers in Southwestern Ponderosa Pine Forest Restoration

The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of southwestern ponderosa pine forests. These forests have been significantly altered through more than a century of fire suppression, livestock grazing, logging, and other ecosystem changes. As a result, ecological and recreational values of these forests have decreased, while the threat of large-scale fires has increased dramatically. The ERI is helping to restore these forests in collaboration with numerous public agencies. By allowing natural processes such as fire to resume self-sustaining patterns, we hope to reestablish healthy forests that provide ecosystem services, wildlife habitat, and recreational opportunities.

Every restoration project needs to be site-specific, but the detailed experience of field practitioners may help guide practitioners elsewhere. The Working Papers series presents findings and management recommendations from research and observations by the ERI and its partner organizations.

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1: Restoring the Uinkaret Mountains: Operational Lessons and Adaptive Management Practices

2: Understory Plant Community Restoration in the Uinkaret Mountains, Arizona

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Introduction

Ecological restoration treatments can significantly reduce the risk of unnaturally severe wildfire and increase the health of old-growth trees in southwestern ponderosa pine forests. Carefully planned thinning and prescribed burning treatments, sometimes followed by reseedling of native plant species or control of noxious species, can also promote the growth of understory plants. As a result, restoration work can have a great impact on the populations of animal species that rely on forest habitats.

This publication examines the effects of restoration treatments on butterflies. It also explains how monitoring butterflies—which either professionals or volunteers can do—can serve as a useful indicator of restoration progress.

Why Butterflies?

Many animals are affected by restoration treatments, but butterflies are particularly useful indicators of ecological changes for several reasons.

They are easy to watch. Although butterflies aren't as important to pollination in ecosystems as bees, wasps, or flies, they are easier to monitor (Taron 1996). Butterflies tend to be visible, and most are easily identified in the field.

They are sensitive to habitat changes brought on by restoration. Restoration of ponderosa pine forests can create localized habitat changes—including altered light intensity and air temperatures—that directly affect insects. Butterflies are sensitive to changes in these *microclimatic conditions*. Warmer temperatures and stronger light allow males of some species to fly longer in search of mates, and may also allow adult butterflies to forage longer (Meyer and Sisk 2001; Waltz 2001). In addition, increased understory growth can result in more flowering and nectar production, thereby increasing food supplies for adult butterflies and other pollinators (Short and Negrón 2003).

They can indicate what's happening with plants and other animals. Changes in butterfly populations can indicate important, yet less easily detected changes in populations of other organisms. Butterfly larvae—caterpillars—live exclusively on particular species of grasses, forbs, shrubs, or trees. Therefore, the *presence* of certain species of butterflies and moths indicates the presence of specific larval host plants in the area. Adult butterflies, on the other hand, generally utilize a variety of nectar-producing plants. For that reason, the *number* of adult butterflies can reflect the abundance and diversity of nectar-producing plants.



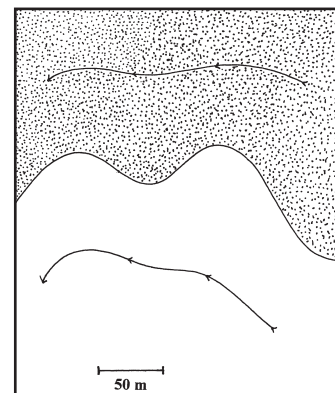
How Restoration Treatments Affect Butterfly Habitat

Butterflies react both to short-term and long-term habitat changes caused by restoration treatments. Short-term changes generally include increased light levels and temperatures due to lower tree densities; longer-term changes may include higher diversity and abundance in understory vegetation brought about by thinning and prescribed burning. Understory vegetation may continue to change with time as succession and future ground fires continue to shape habitat conditions.

Changes in microclimatic conditions and understory vegetation were quickly apparent in the wake of ponderosa pine forest restoration treatments conducted in the 1990s in the Fort Valley area, near Flagstaff, and near Mount Trumbull in far northern Arizona. Both areas were intensively thinned in an effort to return forest stands to a structure resembling that present prior to European-American settlement (Covington et al. 1997). These treatments removed most young trees. All trees old enough to have been standing prior to settlement were retained, along with enough younger trees to compensate for pre-settlement trees lost to earlier logging or to other mortality. The area near Mount Trumbull also experienced a prescribed burn before butterfly monitoring began.

These treatments dramatically increased sunlight and water available on the forest floor, and understory plant growth responded favorably. Near Mount Trumbull, treated areas had 26 times as many flowers available to nectar-feeders as untreated areas (Waltz and Covington 1999). As a result, Amy Waltz and W. Wallace Covington reported “at least twice as many [butterfly] species and up to eight times as many individuals” in sites two years after thinning and burning as in untreated sites. In a study conducted in Fort Valley, Cecilia Meyer and Thomas Sisk (2001) found that two butterfly species—orange sulphurs (*Colia eurytheme*) and pine whites (*Neophasia menapia*)—flew on sites earlier in the day at east-facing edges between forest that had been thinned several months earlier than they did in unthinned stands, indicating that increased light intensity resulting from restoration prescriptions influences butterfly behavior. This was especially noticeable on sunny days, when increased light penetrated openings in the treatment areas.

Figure 1. Sample transect routes through treated (speckled) and untreated (white) forest, with routes set at least 50 meters (164 feet) from habitat edges.



How to Monitor

Anyone willing to spend a bit of time to learn survey and identification details can survey butterflies and increase our understanding of restoration's effects on animals.

Butterflies are particularly well suited for monitoring by volunteers. Such groups as Audubon societies, garden clubs, Boy and Girl Scout troops, high school or university science students, and other youth and community groups may all be able to contribute time to volunteer monitoring projects. These simple steps can convert a small number of survey hours into meaningful data:

Establish transects. Butterflies are best surveyed along *transects*, or lines that pass through particular habitat types (Pollard 1977). There is no set length, but 100 meters (328 feet) is a good starting point. They do not have to be straight lines, but be sure to establish transects at least 50 meters (164 feet) away from habitat edges in order to ensure that the butterflies observed along it are utilizing vegetation typical of the survey area (Figure 1). Set up transects in treated and untreated areas so that comparisons can be made; mark them with colored flagging or other signs so that they can easily be relocated.

Walk the transects. Ideally, visit your transects between four and six times during late spring and summer months, when insects are most active. Butterflies limit their movements on cool, cloudy days, so sunny days are best for observations. Avoid windy days. The hours from 10 a.m. to 4 p.m., when temperatures and butterfly activity are at their highest, are best. Transects should be walked at a casual but consistent pace, about five minutes for every 100 meters (328 feet). Scan the area near the transect, and record whatever is flying within five to ten meters (16 to 33 feet). Don't be distracted by other things going on in the woods—such as birds or other animals—and survey transects alone each so that the effort that goes into each survey is the same.

Identify and count. With a pair of binoculars and a couple of guidebooks (listed below), identification doesn't have to be difficult. Many butterflies are distinct and can be identified in flight. For more difficult species, use a net for catch-and-release identification. Photographs can also be helpful, particularly sets of photos that feature both the tops and undersides of the wings. Species that are more difficult to identify from visible features, such as skippers, can be lumped together in surveys—for example, “brown skippers.” Do not kill or collect butterflies. Collecting can impact populations. In addition, several threatened and endangered butterfly species live in southwestern forests, and harming them is illegal.

Compile the data. It is helpful to have one person or organization in charge of collecting and interpreting survey data. This might be a land management agency, university, or nonprofit organization, or it could be a single person. For more details about butterfly monitoring, see Pollard (1977) or the Web sites listed below.



What to Monitor

Much remains to be learned about butterflies and how they respond to changing forest conditions. Butterfly monitors, whether professional or amateur, could make significant contributions to science and to forest restoration by pursuing the following directions.

Continued monitoring of restoration sites. Restored areas continue to evolve as understory plant composition and microclimatic conditions continue to change. In addition, year-to-year variability can be very high in the Southwest (for example, wet and dry years may support very different butterfly populations). For these reasons, butterfly monitoring should take into account not just short-term but also longer-term effects that show up over the years. As a starting point, consider monitoring one year following treatment and then two to three years later.

Establishing a baseline. Researchers don't have a clear picture of what butterfly communities once looked like in ponderosa pine forests. Surveys in forests that have continued to experience relatively natural fire regimes, such as in the Gila Wilderness or on parts of the North Rim of the Grand Canyon, could help establish a baseline for comparison with forest areas from which fires have been excluded for many years.

Monitor reproduction. Follow and watch adult butterflies for *ovipositing* (egg-laying) behavior. When laying eggs, a female butterfly curls her abdomen under and deposits one or several eggs on host plant stems or leaves, soil litter, tree trunks, or other surfaces. By flagging the site and returning in the following days and weeks, an observer can monitor hatching success, which is a direct indication of the abundance of the specific host plants on which butterflies feed.



Field Guides

Butterflies Through Binoculars, The West: A Field Guide to the Butterflies of Western North America by Jeffrey Glassberg (Oxford University Press, 2001).

National Audubon Society Field Guide to North American Butterflies by Robert Michael Pyle (Knopf, 1981).

The Butterflies of North America: A Natural History and Field Guide by James A. Scott (Stanford University Press, 1992).

A Field Guide to Western Butterflies by Paul A. Opler and Amy Bartlett Wright (Houghton Mifflin, 1999).

Butterflies of Arizona: A Photographic Guide by Bob Stewart, Hank Brodtkin, and Priscilla Brodtkin (West Coast Lady Press, 2001).

Web Sites

For free downloadable software that can help analyze counts of butterflies or other insects, visit www.urbanwildlands.org/INCA/.

For a good example of a volunteer monitoring protocol aimed at restoration sites, see *Butterfly monitoring guidelines for the Chicago region* at www.mchenry.cc.il.us/faculty_pgs/mgarriso/butterflyproject/aBMG.html#TableofContents.

The North American Butterfly Association (www.naba.org) serves as a resource for butterfly fans, and each year seeks volunteers for its NABA Butterfly Counts, usually held within a few weeks of July 4. The only NABA chapter in the Southwest is in southern Arizona; www.naba.org/chapters/nabasa/home.html.

For More Information

A number of different thinning prescriptions have been proposed for southwestern ponderosa pine forests. Read about some on the ERI website at www.eri.nau.edu, or call us at 928-523-7182.

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