

One fell swoop

Discussing her latest collaborative project, **Dr Susan Loeb** reveals the importance of effective forest management to enhance biodiversity and conserve valuable early successional habitats



To set the context, how can early successional habitats be defined and what is their importance for plants and animals?

The term is generally used to refer to disturbed sites with few or no overstory trees that are dominated by grasses, forbs and shrubs. Removal of the tree canopy through natural or anthropogenic disturbance results in very open areas. The increased sunlight at ground level stimulates the growth of many herbs, grasses, shrubs and vines and promotes fruit production in these plants. Furthermore, many tree species such as pines, birch, willows and some oaks do not grow well in shade. Thus, plant species that require abundant sunlight may only be found in early successional patches.

Many animal species also use, or are dependent on, early successional habitats – particularly a number of bird species such as the grasshopper sparrow, chestnut-sided warbler, northern bobwhite quail and American woodcock, which rely on these habitats for nesting and foraging.

Although bats are not dependent on early successional habitats, they often use them for foraging. As these habitats decline, in turn the species that depend on them diminish.

Why is it that the importance of early successional habitats and their decline has only recently come to the attention of conservation biologists?

Historically, forestry in the US was focused on timber production. This resulted in concerns, in the latter part of the 20th Century, about the loss and sustainability of old-growth forests, with little focus on other successional stages. Conserving old-growth forests is still important, but over the past decade or so many researchers and managers have come to realise that early successional habitats are also declining due to factors such as regrowth of abandoned farm fields and pastures, urban development and suppression of natural disturbances such as fires, beaver activity and flooding. Consequently, there has been a rise in research on the abundance, distribution and condition of early successional habitats, as well as the species that depend on them.

Is public perception of biodiversity accurate and sufficient?

It is important to know how the public perceives forestry and biodiversity and then gear management messages to help the public understand key aspects of management and how it can be used to maintain biodiversity. In general, the public has been unable to differentiate between the objectives of different land management agencies such as national parks, national forests and state parks and forests. The

public usually responds to aesthetic aspects of forest management for biodiversity and is often not able to discern a forest's age or history.

Now in its second year, your five-year project is still in its infancy. Are there any achievements you have made thus far you would like to mention?

During the first year of the study, we conducted pre-treatment assessments of the plant and bat communities in the study area for comparison post-treatment. We also performed preliminary interviews with stakeholders on concerns regarding harvesting in the area. The assessments revealed that most of the forest stands surveyed have a mixture of hardwoods such as oaks, hickories and maple in the canopy. We hypothesise that harvests of these species will increase the proportion of early successional species, with the degree of change related to the size of the clearing and the proportion of shade-tolerant species in the pre-treatment forest.

Ultimately, the goal of our research is to provide managers with the information they need to effectively restore early successional habitat in the southern Appalachians.

What are the expected project outcomes and large-scale impact?

If our hypothesis is supported, aggregated harvests will result in greater diversity of early successional species and larger blocks of functional early successional habitats. This will facilitate restoration of early successional biodiversity while maintaining large blocks of mature interior forest. We also expect to determine the appropriate size of management actions, eg. timber sales, that are needed to effectively create early successional habitat for conservation of biodiversity, but that are also acceptable to the public. Our economic model will provide managers of public and private lands with a tool they can use to examine the trade-offs between economic gain and biodiversity. Information on size, and aggregation of harvests needed to sustain early successional species, can be used to develop long-term, large-scale harvest and succession models.



After the watershed

A collaborative project led by the US Department of Agriculture's Forest Service is considering the social, biological and economic consequences of creating early successional habitats to increase biodiversity in the Appalachians

THE APPALACHIANS ARE a system of mountains in eastern North America and are home to a diverse range of flora – primarily deciduous broad-leaf trees and evergreen conifers; and fauna – including beaver, caribou, black bear, raccoon and wolves.

During the 19th and early 20th Centuries, large-scale destructive deforestation of the Appalachians was carried out to produce timber for sale. The impact of this activity on the wider ecosystem was soon realised and subsequently, protective efforts were implemented to protect the forest, with much of the mountain range being designated as national forests and parks.

Despite the importance of old-growth areas of woodland, these are not the only habitats in need of protection. The security and importance of early successional habitats is increasingly recognised by land managers and researchers. Early successional habitats develop when the canopy is disrupted or thinned, which results in open areas of forest where light can penetrate to the forest floor. This increased light penetration from the breakdown of canopies results in a rapid increase in biodiversity, as a wider variety of trees and shrubs are able to grow and support larger populations of birds, bats, insects, small mammals and reptiles.

A large and diverse team of researchers from Western Carolina University, Clemson University and the US Forest Service is exploring the effects of a recent decline in early successional habitats on species diversity. Their aim is to investigate whether woodland management practices and the activities of stakeholders

can be modified to aid the conservation of these areas and encourage their sustainable development. Ultimately, they seek to address the biological, social and economic aspects of early successional habitat maintenance.

Research ecologist Dr Susan Loeb, who is leading the project from within the US Forest Service, explains: "Many managers in the eastern US agree that they need to create more early successional habitats, but they do not have sufficient knowledge regarding how much habitat is needed or where it should be located. In other words, the size, shape, number and distribution of patches that are needed to sustain plant and animal species". It is clear that there is a recognised need to balance the demands of different stakeholders – eg. timber fellers, conservationists and members of the public – to ensure the sustainable management of the forest.

CONSIDERING BATS

Loeb's specific research interest involves the habitat requirements and ecology of a number of bat species native to the Appalachians. This particular work is focused on the endangered Indiana bat and other species such as red bats and tri-coloured bats in the context of how forest management strategies, habitat disturbance and approaches to early successional habitat maintenance affect bat communities. Loeb's research on this mammal is inspired by its important contribution to ecosystem services: "During the peak of lactation, it has been estimated that 1 million Brazilian free-tailed bats (a common maternity colony size) can consume 8.4 metric tons of

insects in one night, equating to approximately US \$23 billion worth of pest control services per year". Further to keeping insect populations under control, bats are also economically important pollinators and seed dispersers, and contribute to soil fertility in areas where they breed through deposition of large quantities of faeces – guano – on the forest floor.

The researchers hope to identify management strategies that are particularly effective for balancing the conflicting requirements of timber production, biodiversity and public perception

Other researchers involved in the collaboration are investigating different species and how the alternative treatment strategies for early successional habitats will impact their population ecology. For example, Drs Beverly Collins, Laura DeWald and Jeremy Hyman from Western Carolina University, USA, are considering the responses of plants and birds, respectively, to treatments; Dr Tamara Cushing from Clemson University is using information on timber harvest size and dollar value of different management strategies to model economic impact; and Dr Elizabeth Baldwin from Clemson University will investigate the public perception of various types of felling patterns.



SIGNIFICANCE OF SWISS CHEESE

By experimentally trialling different types of felling patterns in the creation of early successional habitats, the researchers hope to identify management strategies that are particularly effective for balancing the conflicting requirements of timber production, biodiversity and public perception.

Loeb and the other scientists hypothesise that the advantages of aggregating timber harvests in patterns – like holes in Swiss cheese – will be two-fold. “Firstly it will increase connectivity among early successional patches whilst maintaining larger tracts of interior forest to sustain diversity and maintain interior species; secondly it will maintain acceptable timber yield whilst being perceived more favourably by the public than a single large-scale harvest.” It was envisioned by the researchers planning the project that, just as the holes in Swiss cheese vary in size and distribution throughout the whole block, to understand the responses of flora and fauna to different felling patterns, cuttings of varying sizes and distributions could be considered in the identification of optimal management strategies.

EXPERIMENTAL APPROACH

To investigate different felling strategies, the project is considering 12 geographically distinct areas within the Fontana area of the Nantahala National Forest. Within each of these watersheds is eight different, 40 acre treatment types. One of these is a control where no felling is carried out and another contains a large 25 acre block cut. The three cutting size treatments are replicated with both an aggregated cutting pattern – where the cuts are grouped together within the 40 acres, and a dispersed pattern – where the cuts are more evenly distributed. The treatments are: single tree selection, where the forest is effectively thinned; five one-acre cut sites, representing a small clearing; or two 12-acre clearings, where the felling covers a significantly larger area.

The initial stages of the research project have involved the collection of pre-harvest data to

determine the current status of the biodiversity. This has included recording measurements on variables such as aspect, slope, elevation, canopy cover and ground layer composition, as well as a plant and animal species survey. Following timber harvest in spring 2014 to create the early successional habitat treatment patches, during the subsequent four years of the project the researchers will carry out species population surveys relevant to their particular area of research interest to track changes in biodiversity. Furthermore, additional assessments will be carried out to investigate public perception of the different cut strategies and to analyse their financial implications on timber harvest.

PROJECT IMPACT

It is hoped that the data collected will help identify a land management strategy that uses the development of additional early successional habitats to enable a good balance between the economically viable harvesting of timber, increased biodiversity and a positive public perception of forest management in the Nantahala National Forest. It is important to find a sustainable level of timber felling to maintain a level of early successional habitats capable of supporting a diverse range of species that contribute important ecosystem services, and also to allow sufficient reforestation to sustain a supply of mature trees for species that depend on mature forests.

Once a sustainable management strategy has been identified, effective dissemination of the justifications for the chosen approach to local residents and visitors to the national forest will be the next crucial step. It is recognised that there is room for improving communication with landowners and stakeholders and this will be an important focus for the ongoing project. As Loeb concludes: “Our research team has met with several interest groups and stakeholders in our study area to describe our research goals and methods to ensure their buy-in and cooperation”. It is only with the full understanding and cooperation of all stakeholders involved that an appropriate identified management strategy will be sustainably implemented in the future.

INTELLIGENCE

LANDSCAPE-SCALE THRESHOLDS OF EARLY SUCCESSIONAL HABITAT: RECONCILING BIODIVERSITY, PUBLIC PERCEPTION AND TIMBER YIELD IN MANAGED FORESTS

OBJECTIVES

To determine if different aggregations and sizes of early succession habitat created by timber harvests (single tree and group selection, small and large regeneration harvests) can increase abundance of early successional species at the stand and landscape levels while retaining acceptable timber yield, forest interior habitat and favourable public perception.

KEY COLLABORATORS

Drs Elizabeth (Betty) Baldwin and Tamara Cushing, Clemson University; **Drs Jeremy Hyman, Beverly Collins, and Laura DeWald**, Western Carolina University; **Dr Duke Rankin**; **Mr David Casey**; **Ms Lauren Stull**; **Ms Le'Andra Smith**, US Forest Service.

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DR SUSAN C LOEB was interested in primate behaviour as an undergraduate and had the opportunity to study chimpanzees in Gombe Stream, Tanzania. She then pursued graduate degrees in Ecology, focusing on the effects of habitat quality on wildlife behaviour, population dynamics and Physiological Ecology. Having received her PhD, Loeb was offered a position with the US Forest Service, Southern Research Station in Clemson, South Carolina to study the interactions between southern flying squirrels and red-cockaded woodpeckers, an endangered species that inhabits mature southern pine forests. This work continued for 12 years and helped managers develop conservation and recovery strategies for this species.

