Available online at www.sciencedirect.com
SCIENCE DIRECT®
Forest Ecology and Management 219 (2005) 81–94
Forest Ecology and Management
www.elsevier.com/locate/foreco

Small-mammal responses to pine regeneration treatments in the Ouachita Mountains of Arkansas and Oklahoma, USA

Roger W. Perry [a,*], Ronald E. Thill [b]

[a] Southern Research Station, United States Forest Service, P.O. Box 1270, Hot Springs, AR 71902, USA
[b] Southern Research Station, United States Forest Service, 66506 Hayter Street, Nacogdoches, TX 75965, USA

Received 14 April 2005; received in revised form 31 August 2005; accepted 1 September 2005

Abstract

We compared the initial effects of four forest regeneration treatments (single-tree selection, group selection, shelterwood, and clearcut), and unharvested controls (mature, second-growth forest) on relative abundance of small mammals and small-mammal habitat throughout the Ouachita Mountains of western Arkansas and eastern Oklahoma. We compared small-mammal capture rates in 20 forest stands (4 replicates of 5 treatments) for 2 years prior to harvest treatments, and 1.5, 3.5, and 5.5 years after treatment. We also examined relationships among small mammals, treatments, and habitat conditions. Before harvest, all stands where characterized by high basal areas (BA), little understory vegetation, and low small-mammal capture rates. Compared with pre-harvest numbers, the number of individuals captured increased nearly five-fold in treated stands 1.5 years after harvest. After harvest, capture rates for all taxa combined were significantly greater in harvested stands (regardless of treatment) than in unharvested controls. Fulvous harvest mice (*Reithrodontomys fulvescens*) capture rates were greatest in clearcuts. Fulvous harvest mice, cotton rats (*Sigmondon hispidus*), and pine voles (*Microtus pinetorum*) were associated with abundant herbaceous vegetation in the understory and low BA. Eastern woodrats (*Neotoma floridana*), golden mice (*Ochrotomys nuttalli*), and *Peromyscus* spp. were associated with moderate to dense woody vegetation in the understory and intermediate BA levels. No taxon of terrestrial small mammal was captured exclusively in unharvested stands; most taxa we captured appear to be either disturbance-adapted or tolerant to disturbances from timber harvest.
Published by Elsevier B.V.

Keywords: Clearcut; Forest management; Group selection; Regeneration; Shelterwood; Silviculture; Single-tree selection; Small mammals; Timber harvest

1. Introduction

From the 1940s until the 1980s, forest management and research throughout the southeastern U.S. (the Southeast hereafter) focused on wood production (Kessler et al., 1992; National Research Council, 1990). However, in the early 1990s, the U.S. Forest

* Corresponding author. Tel.: +1 501 623 1180x108; fax: +1 501 623 0186.
E-mail address: rperry03@fs.fed.us (R.W. Perry).

0378-1127/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.foreco.2005.09.001

Service began to emphasize a more ecological approach to management, an approach that continues wood-product output while emphasizing biological diversity (Sharitz et al., 1992). In the early 1990s, public opposition to clearcutting in the Ouachita Mountains led the U.S. Forest Service to begin studying the social, economic, and environmental effects of alternative regeneration treatments (Baker, 1994). Since then, the U.S. Forest Service has reduced the use of clearcutting in the Southeast and now relies more on natural-regeneration systems of even- and uneven-aged management. Because clearcutting was among the dominant methods for regenerating pine (*Pinus* spp.) forests on national forests in the past (and is still the dominant regenerating method on timber industry lands in the Southeast), substantial information exists on the ecological effects of clearcutting (e.g., Kirkland, 1990). However, little information is available on the effects of alternative regeneration treatments on biotic communities. As an important part of an adaptive forest management program that integrates ecologically based decisions, land managers need to know how timber harvesting affects biological communities, habitats, and individual species.

The importance of maintaining species diversity in forest ecosystems is widely recognized (Salwasser, 1990; Millar et al., 1990). Small mammals play important ecological roles in forest ecosystems. They serve as primary prey for many species of raptors, snakes, and furbearers, and consumption of tree seeds by small mammals can affect forest regeneration (Smith and Aldous, 1947; Pank, 1974). Fossorial species may affect hydrological processes on forested watersheds (Ursic and Esher, 1988). Small mammals consume the larvae and pupae of forest insect pests, which may reduce the severity of insect outbreaks (Hanski, 1987).

Effects of clearcutting on small-mammal communities are well documented in North America. Kirkland (1990) reviewed 21 published studies documenting these effects; most of these studies found small-mammal abundance and diversity increased initially after clearcutting. In regions of North America other than the Southeast, studies that examined the effects of alternative regeneration treatments or thinning have found individual species may respond differently to each treatment type (e.g., Cambell and Clark, 1980; Ramirez and Hornocker, 1981; Martell, 1983; Von Trebra et al., 1998). In the Southeast, most studies examining the effects of forest management on small mammals have focused on small-mammal responses to short-rotation, intensively managed pine plantations (e.g., Atkeson and Johnson, 1979; Langley and Shure, 1980). Few studies have been conducted in naturally regenerated pine–hardwood forests, and we are unaware of any studies comparing small-mammal responses to a diversity of timber harvest and regeneration methods in this region.

As part of a large scale, multidisciplinary research initiative examining the social, economic, and ecological effects of timber harvest in the Ouachita Mountains of Arkansas and Oklahoma, we examined the effects of different stand-level forest-regeneration treatments on small-mammal capture rates. We compared winter small-mammal capture rates in mature, unharvested forest stands, and stands under four regeneration treatments (single-tree selection, group selection, shelterwood, and clearcut). We also examined relationships between habitat components and small mammals, and how timber harvest affected those habitat components.

2. Methods

2.1. Study areas

We conducted the study in the Ouachita Mountains of west-central Arkansas and east-central Oklahoma, throughout the Ouachita National Forest and the southern-most district of the Ozark-St. Francis National Forest. The Ouachita Mountains region is dominated by a series of east–west ridges and valleys where elevations range from 152 to 853 m. Throughout the region, mean annual precipitation ranges from 111.8 to 137.2 cm and mean annual temperatures range from 13.9 to 16.1 °C (Skiles, 1981).

We randomly selected 20 mature, second-growth, mixed pine–hardwood stands from those available within randomly selected townships and ranges. Five stands were selected from four physiographic blocks (5 stands/block; Baker, 1994). Selection criteria for candidate stands were tree age $\geq$60 years, aspect =