

FINDINGS FROM THE  
HARDWOOD ECOSYSTEM  
EXPERIMENT FOR  
SPECIES OF  
CONSERVATION  
CONCERN

*A Summary*

### **What is the Hardwood Ecosystem Experiment?**

The Hardwood Ecosystem Experiment (HEE) is a collaborative project between the Indiana Department of Natural Resources Division of Forestry (DoF) and researchers from Purdue University, Indiana State University, Ball State University, Indiana University – Purdue University, University of Indianapolis, and Drake University. The project began in 2006 with the primary goal of understanding the long-term ecological and social impacts of forest management on public and private lands. The project takes place at Morgan-Monroe and Yellowwood State Forests.

### **What types of forest management are studied as part of the HEE?**

The Hardwood Ecosystem Experiment is designed to study the long-term impacts of different forest management methods. The first forest management method studied is even-aged management, which creates areas of forest of the same age. In the even-aged management areas, researchers are examining the effects of shelterwood harvests (gradually creating a patch of forest of the same age by removing trees in successive harvests) and clearcut harvests (all trees removed in one harvest). Researchers are also examining the effects of uneven-aged management which includes single-tree selection (thinning trees throughout the area) and patch cuts or group selection (removing small patches of trees in several locations in the area). These treatments are compared to an area where no overstory harvesting occurs (also called the “control”), but managers may remove invasive species and other minor treatments. By examining the effects of even-aged forest management, uneven-aged forest management, and the control, researchers that are part of the Hardwood Ecosystem Experiment are working to understand what type of forest management, if any, is needed to promote the valuable animal and plant species in public and private forested land.

### **What Species of Concern and State Endangered Species have been found at the HEE?**

From 2006-2015, the following Species of Concern and State Endangered Species have been detected in even-aged or uneven-aged HEE Research Units post-harvest during surveys \*:

- Eastern whip-poor-will
- Ruffed Grouse
- Sharp-shinned hawk
- Red-shouldered hawk
- Broad-winged hawk
- Sandhill Crane
- Bald Eagle
- Worm-eating Warbler
- Black-and-white Warbler
- Yellow-rumped Warbler
- Cerulean Warbler
- Silver-haired bat
- Eastern red bat
- Hoary bat
- Little brown bat
- Northern long-eared bat
- Tri-colored bat
- Indiana bat
- Smoky shrew
- Timber rattlesnake

\*All of the species were either directly within the harvest area or in the forest surrounding the harvested area.

## Specific species and groups of concern

### Worm-eating Warbler

Survey data from breeding birds in 2006-2014 showed Worm-eating Warblers occurred at sufficient densities in all management treatments (Figure 1). Worm-eating warblers were common in all harvest types. Although lower in patch and clearcuts, the species was equally common in controls, first-stage shelterwoods, and single-tree selection areas (Figure 2) (figures based on Kellner *et al.* 2016).

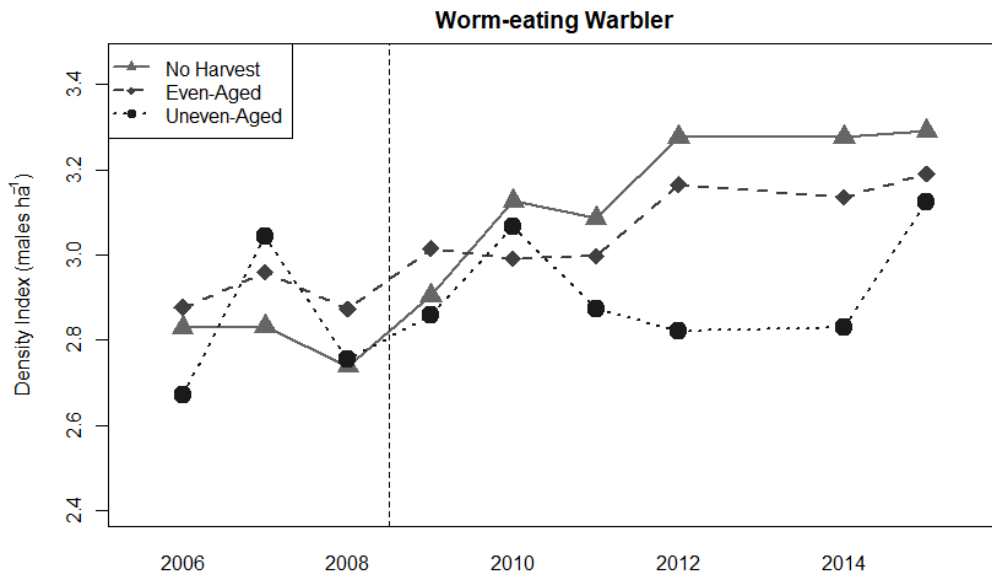


Figure 1. Worm-eating Warbler density from 2006-2014 across the three treatment types (no harvest, even-aged, and uneven-aged).

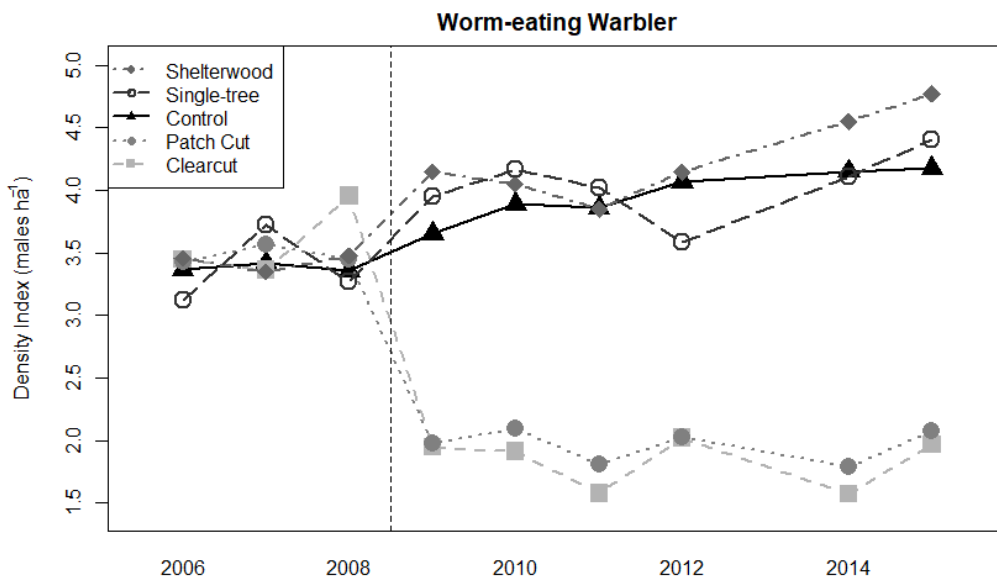


Figure 2. Worm-eating Warbler density from 2006-2014 across the various types of timber management (shelterwood, single-tree, control, patch cut, and clearcut).

Survey data that rely on singing males can underestimate the importance of habitats used by birds for purposes other than attracting mates or announcing territories, as demonstrated by Patrick Ruhl, a Ph.D. candidate at Purdue. Patrick has used mist nets to capture birds in clearcuts over the past 3 years. He notes (also see Ruhl and Dunning 2015, Ruhl *et al. in press*):

“During our bird banding study, Worm-eating Warbler has been the most commonly encountered species within the 6 clearcuts. We captured more Worm-eating Warblers than early successional specialists such as Yellow-breasted Chats or White-eyed Vireos. In fact, many of the adult Worm-eating Warblers in breeding condition were using clearcuts early on in the breeding season (in June). Over the last 3 summers, we have banded 533 individuals in the clearcuts. In addition, our study of female Worm-eating Warbler roost preference suggests that early successional young forest habitat may serve an important role in Worm-eating Warbler roosting and postfledging ecology. We recorded more roost locations for female Worm-eating Warblers (several of these females still taking care of dependent fledglings) in clearcuts than in the surrounding mature forest habitat.”

### Cerulean Warbler

Based on the research by Dr. Kamal Islam and his graduate students, relative abundance estimates of Cerulean Warblers changed between pre-treatment and post-treatment years but territory sizes remained the same (Kaminski and Islam 2013). Cerulean Warbler numbers during the 2 years following harvest increased at even-aged treatment sites and decreased at uneven-aged treatment sites with little change at control sites (Figure 3; Kaminski and Islam 2013). Relative abundance estimates at even-aged treatment sites subsequently remained stable for 2009-2012 before starting to decline gradually in 2013. In contrast, relative abundance estimates at uneven-aged treatment sites increased in 2011-2012, but overall have fluctuated between years. In the control sites, relative abundance estimates of Cerulean Warblers have remained the same. However, there is much inter-year variation in the number of detections at the individual management units (Figure 3).

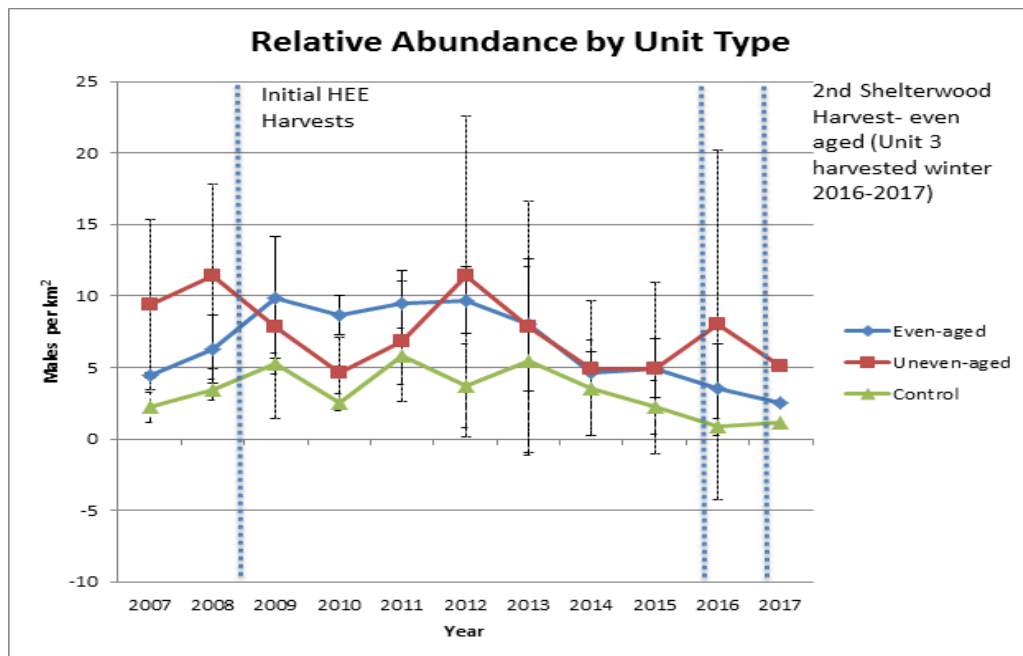


Figure 3. Relative abundance estimates of Cerulean Warblers across 9 HEE management units in Morgan-Monroe and Yellowwood state forests, Indiana, 2007-2017.

## Bats

Indiana and northern long-eared bat roosts have been found throughout Yellowwood and Morgan-Monroe State Forest for the last 4 years. HEE researchers have found over the first 12 years of the study that various species of bats utilize a number of areas with different forest management. Populations of certain bats, especially Northern long-eared bats, have declined during the study due to the appearance of white-nose syndrome, a disease caused by a fungus to which hibernating individuals are susceptible.

## Sorex Shrews

In 2016, for the first time since harvests were implemented, long-tailed shrews in the genus *Sorex* were captured in 10-acre clearcut and 1-acre patch cuts (Nelson 2017). Short-tailed shrews were in highest abundance in the areas with no overstory harvest, but their numbers have been increasing recently in 10-acre clearcuts (Nelson 2017).

## Timber Rattlesnakes

HEE researchers found that harvesting had no effect on the home range size, average daily distance traveled, or the proportional use of area by timber rattlesnakes within timber harvest boundaries (MacGowan *et al* 2017). Home range is the area that an animal lives within and moves throughout the year, and the size of and movement within a home range is one indicator of habitat quality. Changes in size and movement often are a response to habitat changes, such as those created from timber harvesting; for example, an animal can expand or contract its home range, or shift where its home ranges occurs to take advantage of new or displaced resources in the habitat. During 2007 to 2011, HEE researchers monitored the movement of 47 adult timber rattlesnakes (both male and female) on control and even-age sites (Figure 4).

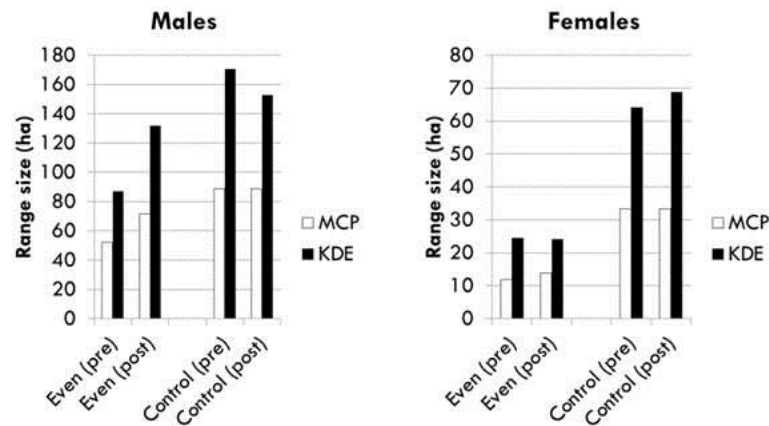


Figure 4. Range size (ha) for both male and female timber rattlesnakes before and after the harvests

On these same sites, adult annual survival of timber rattlesnakes ranged 72 – 98% during the active season, and 96 – 99% over winter. Only adult females demonstrated annual changes in survival. However, it was not different among control and timber harvest sites – in fact, it was virtually identical. Survival decreases for females was best explained by a time lag with low prey abundance from the preceding year. That is, when we had a poor mast year that led to decreases in small mammal populations, female timber rattlesnakes had lower survival the following season. Predation (n=5) was the most common source of mortality followed by human persecution and overwinter mortality (each n=2), and vehicle strike (n=1) (Olson *et al* 2015).

### What is the best management scenario for the endangered and threatened species in our forests?

From the first 12 years of data collection for the Hardwood Ecosystem Experiment, it is clear that no single management scenario is best for all species. The many species in our forests prefer different types of habitat, whether that is early successional or more mature forests. A number of the species studied as part of the Hardwood Ecosystem Experiment utilize both early successional and mature forest habitat indicating that a mosaic landscape created by various types of forest management may help to support a wide variety of species. Other research has shown that young forest and shrublands are increasingly rare and constitute only 17% of available forest habitat in Northeast and Northcentral states. Yet 49 of the 100 bird species of greatest conservation need rely on these as primary habitat, and 95 of 187 species of neotropical migrant songbirds that breed in the Midwest use shrub/young forest habitats to some degree. The data from HEE offer further support for the importance of young forests created through forest management. In addition to being used by many species of special concern and state endangered species, our even- and uneven-aged units with young forests harbor more bird species than areas without overstory harvests (Figure 5, Kellner et al. 2016).

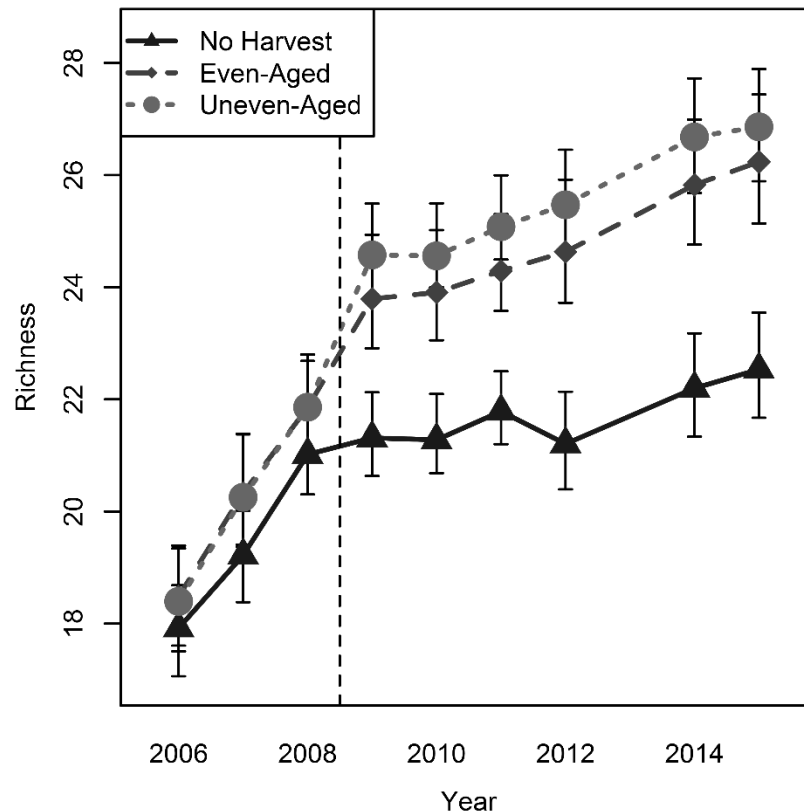


Figure 5. Number of species of breeding birds (richness) in forests of Morgan-Monroe and Yellowwood with different treatments for overstory harvesting (from Kellner et al. 2016).

### Where can people find more information?

More information about findings from the HEE can be found on the HEE website ([heeforeststudy.org](http://heeforeststudy.org)). On the HEE website, you can find videos featuring HEE researchers and their early findings plus a list of publications.

## References:

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