Hoosier Ecosystem Experiment
A century in the woods

By Scott Haulton and Duane McCoy
Photography by John Maxwell

The forests of Indiana have a varied history of surviving both natural and manmade changes. Each change has affected forests differently, but the forests have survived, albeit in an altered state.

Making sure that forests thrive while meeting various natural and induced challenges demands answers to difficult questions. This is where the Hoosier Ecosystem Experiment (HEE), a century-long study to determine the effects of different management techniques on the plants and animals of the forests, comes in.

The various tornadoes, droughts, wildfires and other natural phenomena that occurred before humans settled here kept the forests and their wildlife residents diverse across the whole landscape. At concurrent times, some forested areas would be in short-term recovery, others in long-term. The rest would be at their normal state.

Humans have caused more drastic and long-term changes to forests, actually moving them to a more uniform big-picture status. First we cleared millions of acres for farms and cities, and hunted many forest animals to excess, drastically dropping their populations and diversity.

We also farmed unstable areas, eroding the topsoil before economic changes resulted in many of those changed lands being reclaimed by the forest. Another heavy toll was levied by unregulated harvesting of what was left for railroad ties and other products.

The natural change agents, being natural, of course persisted.

The sum effect of all the changes is a greatly reduced amount of Hoosier forestland. This makes the impact of today's related decisions more lasting than ever before.

Those who work in forestry have reacted in the last century by slightly increasing the number of our forested acres while beginning to manage those lands more responsibly and consistently. Some forest inhabitant populations have increased as a result, but others have not, plus there is not as much variety in woody vegetation as there once was.

HEE, which is headquartered in Morgan-Monroe and Yellowwood state forests in the hills of Morgan, Monroe and Brown counties, is a cooperative effort of the DNR divisions of Forestry (DoF) and Fish and Wildlife (DFW), as well as Purdue, Indiana State, Ball State and Drake universities, plus other organizations and individuals.

Among the many questions HEE hopes to answer:

- Should we move our forests to a more diverse composition with areas in oak-hickory while letting others continue to migrate into a more uniform beech-maple composition?
- If we do, what would be the impacts to the forest inhabitants in the immediate area?
- What impact do changes across the landscape of a much larger area have on forest inhabitants?

(Opening pages) Yellowwood State Forest in Brown County, one of two HEE study sites. (Opposite page top left, then clockwise) A forester can quickly estimate lumber volume using a Biltmore stick; and an angle gauge; a Yellowwood SF long-horned beetle specimen at Purdue; wood-boring beetles and moths are sampled using different types of traps, as shown in this display, which are placed in the forest. (Above left to right) A Morgan-Monroe State Forest site 15 years post harvest; Dr. Jeffrey Holland from Purdue (standing) and graduate students Shulin Yang and Carolyn Foley study HEE long-horned beetles.

Even- vs. Uneven-Age Approaches

The study looks at different types of silvicultural prescriptions, forestry-speak for long-range harvest and management plans designed to optimize the growth, regeneration and administrative management of particular forest types.

The two most general systems are even-age and uneven-age. "Even-age" is managing so that all of the trees in the stand are eventually of the same age, primarily through the methods of clear cutting, seed tree or shelterwood cutting. Trees to be left in a shelterwood cut are selected not only for their ability to produce seed, but also for their potential to produce high-quality trees for the future forest. Shelterwood leaves more trees uncut and helps "shelter" the forest floor and young saplings from wind and direct sunlight but is removed after the incoming new stand is established.

"Uneven-age" aims toward developing a distribution of different ages in one stand, by selecting single trees or groups of trees to be removed periodically to maintain a distribution of age classes on the site over time.

Both approaches manipulate only vegetation. Animals and other forest components like soil, water and sunlight, interact in countless ways with vegetation. This effect is complicated by ecological disturbances from natural events like windstorms, floods, fires and even beaver dams.

Such disturbances have immediate and local impacts that may become difficult to see once the forest grows back. Disturbances in mature forests may create patches of open ground that eventually support a young forest that, in time, resembles the mature forest from which it was created.

These processes affect plant and animal species in various ways—some species benefit by the creation of new habitat types, while others may find the new conditions at the disturbance site unsuitable and need to move.

Forests react to timber harvesting in much the same way; there's an immediate effect from the harvesting of the trees, but the impacts of this effect change with time and the forest grows back. Understanding the effects of forest disturbance and timber harvesting requires grasping both the immediate effects and those that are more long term.

Those working on HEE expect timber harvesting effects to change over time, which will affect each forest component differently. To better understand the complete story, the researchers are studying a vast array of plants and animals over many years, looking at a wide range of forest inhabitants ranging from insects to white-tailed deer.

HEE Bugs

Purdue's Dr. Jeffrey Holland and his graduate students are studying many species of long-horned beetles. Many of these beetles play important ecological roles by decomposing rotting wood, acting as natural thinning agents and reducing fire fuel load; others are devastating pests of forest trees. Understanding how different beetles change over time under different timber harvesting techniques allows forest managers to both promote the beneficial bugs and limit economic losses from the villains. In

(Top left then clockwise) DNR biologist Zack Walker radio tracks a Morgan-Monroe SF timber rattlesnake; Walker (front) and Brian MacGowan from Purdue prepare to capture a rattlesnake; Walker places a rattlesnake in a bite-proof bag; then helps guide the snake through a hole into a clear plastic tube, which protects the researchers from snake bites; the rattlesnake in the tube. Jeff Riegel from Purdue coats a purple sticky insect trap with glue. A *Crecropia* moth; HEE researchers from Drake University are surveying forest moths.

Holland's study, beetles are sampled using four different types of traps, each uniquely designed to attract certain beetles. So far, trapping has been extremely successful with 70 different long-horned beetle species found.

Dr. Keith Summerville of Drake focuses his research on forest moth species, which appear to be directly affected by the removal of host trees, but the broader, indirect impacts of timber harvesting on these insects is poorly understood.

Summerville's work borrows from a scene similar to one you observe each summer. He attracts moths with a battery-powered light, then traps them in a funnel-capped bucket. After one year of sampling, the Drake researcher has identified more than 350 species and 5,000 individuals of moths at the sites in Morgan-Monroe.

HEE REPTILES & AMPHIBIANS

Some HEE subjects may strike fear by their very mention, but they're still important to forest health. Timber rattlesnakes, which Purdue's Brian MacGowan and DFW's Zack Walker are working with, have declined in population throughout most of their range and are designated as state endangered. The rattlers' decline has been associated with habitat loss, habitat fragmentation and human persecution. Although previous researchers have studied rattlers, this is the first study to investigate how the species reacts to timber harvesting. HEE workers have captured 19 rattlesnakes and implanted many with a radio-tracking device to monitor their movements.

The same two researchers also are studying box turtles, whose numbers have declined across their range. Although Indiana has a few healthy box turtle populations, they are widely scattered across the state, which contributes to their status as a state species of special concern. Again using implanted radio-tracking devices, MacGowan and Walker study the movements and habitat use of turtles.

Woodland salamanders spend most of their time under rocks, logs and leaf litter, so most people overlook them. Dr. Rod Williams of Purdue is not most people. He's studying this secretive but common forest resident. Williams' sampling method is twofold. He checks both under 1-foot-square plywood cover boards that are arranged throughout the study grounds and through the leaf litter within study plots. So far he's found four salamander species: red-backed, zig-zag, slimy, and southern two-lined.

HEE MAMMALS

Other seldom-seen residents in our forests are small mammals like chipmunks, mice and voles, which play important roles as seed dispersers, seed predators and food for larger animals. Dr. Robert Swihart of Purdue guides this work.

The subjects are live-trapped at various sampling areas, then fitted with a uniquely numbered ear tag and released. Additionally, Swihart collects information describing the habitat around each trap to determine if particular habitat components are important to the small mammals.

The small mammal category includes those not restricted to life on the forest floor, specifically bats. While we have learned much about forest bats in recent years, few studies have investigated how these important and in some cases imperiled species respond to forest management. The Indiana bat, a federally endangered species, is of particular concern. These bats winter in caves throughout the South and Midwest, then spend their summers in forests across Indiana and other locations farther north.

In recent years forest management agencies, such as the DoF, have designed specific timber harvesting methods to avoid further imperiling this endangered bat, but there is still much to learn about the relationship between all forest bats and timber harvesting. Enter ISU graduate student Jeremy Sheets, whose work documents which species are present and abundant at the HEE site, setting the stage for future research.

Sheets "traps" these challenging subjects in two ways, the second of which makes those quotation marks around the verb necessary. In the first, a fine "mist net" is stretched across forest roads and streams, areas bats are thought to routinely travel. This technique allows researchers to handle each bat captured to determine its age, sex, reproductive status and whether it has been captured before. Bats that fly through or over forested areas are tracked using an Anabat® detector that converts the echolocation calls of bats into an electronic file. Researchers then analyze the calls to identify species.

While this technique allows researchers to "capture" many more bats than using nets alone, it does not allow Sheets and his helpers to directly handle each bat, so they are unable to obtain the specific information about each of them that the net method allows.

HEE SONGBIRDS

Another flier being studied is forest songbirds. Many species make up this large and diverse group. Each has different habitat requirements, foraging techniques, and dietary preferences. The wealth of previous research shows that some songbirds benefit from the same timber-harvesting changes in forest structure that cause many other species to move.

Compounding songbird complexity, various timber-harvesting techniques seem to affect songbird species in different ways. Over time, researchers expect the assemblage of songbird species to change further as forest regeneration openings develop and mature.

Few studies have concurrently and thoroughly researched all of these issues in Indiana's forests until Dr. John Dunning of Purdue and his associates started working with HEE. As timber is harvested on the sites in the coming years, they will study how songbirds respond, not only at the specific harvesting sites but also across the larger study area.

Dunning's graduate student assistant, Melissa Malloy, focuses on the distribution of common

(Opposite page) Morgan-Monroe SF timber rattlesnake with implanted radio transmitter. The HEE is monitoring how forest management affects rattlesnake movements and habitat. (Above left, then clockwise) Purdue researcher Jamie Nogle checks under salamander cover boards; the HEE is also studying forest wildlife such as this zig-zag salamander; box turtle with radio transmitter; and chipmunk.

Bryan Price photo

breeding songbirds across the study regions, but may also eventually look at the effect of forest management on breeding success, which is a reliable indicator of population-level effects.

While all summer-resident songbirds found at the research area are included in the study, some species of special management or conservation interest will receive additional attention. These include migratory songbirds, such as the wood thrush and Acadian flycatcher, plus year-round residents like blue jays, which play important ecological roles as nest predators and acorn dispersers. HEE will also study rare birds, including the worm-eating warbler, a habitat specialist that breeds in the steep forested slopes of southern Indiana.

The cerulean warbler is another songbird of special conservation concern in Indiana forests being studied. This tiny migratory bird has experienced long-term population declines on its breeding grounds during the past 40 years, prompting Dr. Kamal Islam and his students at Ball State to investigate its habitat needs and possible opportunities for management. Although cerulean warblers are generally associated with mature forests, their territories are often characterized by canopy gaps, suggesting that these openings, which are typically created by timber harvesting, may be an important habitat feature for this species.

Although the cerulean warbler is a declining species throughout its range, more than 90 have been found at the site during the first year of study.

HEE TREES

We haven't lost sight of the trees in this forestry study. Many found on the HEE area are oaks, which can regenerate themselves by producing acorns that develop into seedlings before becoming mature trees.

(Opposite page left then clockwise) Many songbirds, especially acorn dispersing species like the blue jay, will be monitored through various silviculture treatments. Riegel and Nogle prepare to mark HEE study site boundaries with spray paint. Marked acorns and exclusion boxes help researchers monitor forest wildlife acorn consumption. An X-ray photo of acorns shows darker nuts damaged by weevils. (Above) Riegel and Nogle check various mammal exclosure cages and mast traps.

Oak-dominated forests depend on the process of regeneration for their survival and persistence over time. However, acorns and young seedlings and saplings must overcome a variety of challenges before becoming mature trees. Other recent research on oaks has shed light on these factors, and how they contribute to the oak forest decline many people believe is occurring throughout the eastern United States.

Swihart, with the help of field technician Jeff Riegel, has monitored the production of acorns by more than 50 black and white oak trees since 2006. The two HEE researchers study the frequency and abundance of acorn production, determining how many acorns are fit for germination and are not infested with the weevil that greatly contributes to seed loss in some areas. Swihart also studies which forest wildlife benefit from this important food supply, how acorn consumption varies with food availability and consumer density, and whether differences occur in these relationships due to tree-harvesting techniques.

Swihart and his associates use a series of semi-permeable exclosures that differentially restrict access to acorns by animals of various sizes, from mice to deer. In this way, researchers can determine how each animal contributes to the overall loss of acorns.

The deer component focuses on their effect on seedlings and acorn consumption. In many places, deer browsing has been found to strongly affect how a young forest develops. Deer selectively feed on plants, finding some tastier than others. This pickiness indirectly gives less preferred, unbrowsed species a competitive advantage. In extreme cases, much of the vegetation within the reach of deer has been consumed.

HEE work on deer will contribute to a better understanding of how we can better manage forest resources for timber production and healthier natural communities.

Both during the study and after, HEE will give us a better idea of the effects of our management on many plants and animals across the landscape of Indiana. This will help us face the future with better information, which will tell us how to protect and enhance our forest resources, no matter who or what is causing changes. ■

Note: The wood thrush, Acadian flycatcher and cerulean warbler, in addition to being migrants, also nest in Indiana.

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See a video of the Hoosier Ecosystem Experiment photo shoot at OutdoorIndiana.org.