

NOVEMBER 2018

OHIO BAT CONSERVATION PLAN

A COLLABORATIVE EFFORT TO GUIDE BAT CONSERVATION IN THE STATE OF OHIO THROUGH HABITAT MANAGEMENT, RESEARCH, AND EDUCATION.

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REVIEWERS

The Ohio Bat Working Group greatly assisted with the completion of this project. This organization aided in generating ideas for each of the sections of the plan, and they assisted with the review of the plan. The plan was also reviewed by bat biologists from out of the state of Ohio to establish consistency in goals and format with other states in the Midwest region.

EXECUTIVE SUMMARY

This is the first action plan written specifically for bats in Ohio. Primarily meant for organizations and individuals who work with bats regularly, this plan contains information about threats to native Ohio bats, habitat requirements and best management practices, research and monitoring efforts underway or research areas of need, and education and outreach efforts located in Ohio. At the end of each section, goals and implementation strategies are discussed in brief and highlight ways to stabilize or increase bat populations, improve our understanding of bats, and note areas of the state where more bat education may be needed. Developed by experts from multiple organizations located throughout the state, this plan contains the most up-to-date information on bat management and conservation in Ohio. However, continued support and efforts of individuals, government agencies, non-governmental organizations, and universities will be necessary to keep this plan relevant.

Native Ohio bats roost in a variety of habitats requiring places to hibernate, freshwater sources for drinking, and healthy forests for roosting and foraging. Appropriate land management that maintains a wide variety of quality habitats, from wetlands and riparian areas to forested ridgetops, is essential. Ohio has vast areas of potential suitable natural and man-made hibernacula (particularly related to abandoned underground coal mines), much of which has not been methodically surveyed. However, many caves and mines are in private ownership in the State of Ohio. Protecting known hibernacula and preventing unnecessary disturbance to hibernating bats are critical to bat conservation.

Bat populations in Ohio face many population pressures that have caused declines. Habitat loss, mainly resulting from development, removes roosting and foraging sites important to bats. Human disturbance of bats roosting or hibernating in caves also threatens bats at particularly vulnerable times. The emergence of white-nose syndrome (WNS), caused by the fungus *Pseudogymnoascus destructans* has led to the largest documented decline of bats. This fungus was first confirmed in Ohio in March 2011 at an abandoned mine in Lawrence County. Since then, WNS has been found in counties throughout Ohio, and resulting bat population declines are evident in monitoring data since the onset of the disease. Landscape-scale wind energy development is another cause of bat mortality events in Ohio. Due to these two more recent mortality events, threats like habitat loss, disturbance, and contamination have a cumulative impact.

The Ohio bat action plan identifies both short and long-term goals for land management and priority protection areas, research and monitoring, and education and outreach.

Short-term goals include:

- **Create a brief synopsis of best management practices for private landowners who wish to promote bat occupancy on their land.**
- **Use updated mine and cave survey information from the Ohio Department of Natural Resources (ODNR) Geological Survey to prioritize additional hibernacula to survey.**
- **Conduct an inventory of bat outreach and education currently taking place in the state and identify needs and focus areas.**

Long-term goals include:

- **Inventory hibernacula throughout the state and consider areas that would be ideal for land acquisition or conservation easements.**
- **Gain insight on the migratory ecology of bats in Ohio, including migration routes, origins, and destinations, as well as possible winter residency.**
- **Work with partners to plan an Ohio-wide bat day that would allow researchers to survey areas throughout the state and educate the public about bats.**

A complete list of goals can be found at the end of each section of this plan. Addressing the current threats to Ohio bats and managing bat populations will require cooperation and partnerships among government agencies, private landowners, non-governmental organizations, and the public. These partnerships should be used to cooperatively address the goals identified in this plan.

INTRODUCTION

IMPORTANCE OF BATS

The world needs bats. Bats help by pollinating plants and controlling pests by eating insects each night. Some plants that depend on bats for pollination and seed dispersal include, but are not limited to, agave, mango, avocado, cloves and bananas. As a top predator for night-flying insects, bats play an important role in the ecosystem by regulating the number of those insects, including mosquitoes, beetles, moths, and other agricultural and forest pests. In fact, bats are conservatively estimated to save around \$3.7 billion annually for farmers in reduced crop damage and pesticide usage (Boyles, 2011). Bats have also been critical for certain research projects that could be beneficial to humans. Researchers have been studying the anti-coagulating saliva of vampire bats for years to see if it can be used in medicine for people with blood-clotting issues (Fernandez et al., 1998). In addition, the echolocation of bats is and has been studied for more accurate sonar capabilities in military and medical contexts. More recently, scientists are studying bats and their amazing longevity to understand why they do not suffer brain or bone deterioration common in other species. Scientists are looking for clues that might aid in the production of medicines for diseases like Alzheimer's and osteoporosis (St. Clair, 2017).

Ohio is home to 11 species of bats, all of which are insectivorous. These species are often grouped into two categories: cave-dwelling and migratory tree bats. Cave-dwelling bats normally include northern long-eared, Indiana, Rafineque's big-eared, eastern small-footed, little brown, big brown, and tri-colored bats. These bats are known as cave-dwelling bats because they often hibernate in caves, mines, or rock crevices during the winter (from approximately late October to early April). However, the name can be a bit misleading because they roost in a variety of habitat in the late spring and summer. They also are well-known to migrate between their winter and summer roosting habitat. It is believed that cave-dwelling bats do not migrate as far as the migratory tree bats though. After emerging from hibernation and migrating to summer roosts, males will roost singly or in small groups and females with pups (baby bats) will roost in large groups called maternity colonies. These roosts may be in trees, man-made structures like barns, and rock crevices.

Migratory tree bats include hoary, eastern red, evening, and silver-haired bats. These bats tend to roost in trees in the summer, and then migrate elsewhere in the winter. Very little is known about the migratory ecology of bats. It was originally assumed that they flew south for the winter and north for the summer, but recent research has shown that bats move in all directions when migrating and stop at areas along the way to quickly refuel. Further research on these patterns could lead to better prioritization of areas that are protected along migratory routes, as well as better wind farm regulations (McGuire et al., 2011).

While it is easy to talk about bats in these two large groups, it is important to recognize that every species of bat has its own unique ecology. What may be ideal for one species of bat may not benefit another. Therefore, knowledge of the preferences of each species is important. However, in general, it is most beneficial to manage for a diverse forested landscape with numerous water resources in the summer and maintain a protected buffer around any hibernacula in the winter. More information about each species of bat can be found at the Division of Wildlife's (DOW) species guide index at <http://wildlife.ohiodnr.gov/species-and-habitats/species-guide-index>.

All of Ohio's native bats are state-listed. Two species, the Indiana bat and northern long-eared bat, are also federally listed as Endangered and Threatened, respectively. The evening bat is listed as a species of interest due to a lack of records and resulting information, and the remaining bats are all listed as state species of concern. These listings are largely due to white-nose syndrome (WNS), but they have also been influenced by disturbance to hibernacula and loss of habitat. With the steep declines of cave-dwelling species, like the little brown bat and tri-colored bat, due to WNS and other confounding threats, it is more critical now than ever that scientists, land managers, and others working to conserve bats coordinate to protect these species and the habitats in which they live.

BAT BIOLOGY

Bats are mammals; this means that they are endothermic (regulate temperature internally), have fur, give birth to live young, and nurse their pups with milk. Except for red bats which can have up to four pups, most bats in Ohio have one to two pups each year, which is a relatively low reproductive rate for a mammal of their size (Barclay et al., 2004). As a result, their populations are slower to recover from declines. They are the only mammal that is capable of true-flight. Bats use their hands to fly, and they do not have hollow bones that aid in flight like a bird. Their elongated finger bones and forearms are covered in a membrane of skin that helps to provide lift. Their fingers allow each section of their wing to be readily manipulated for extremely precise flying maneuvers that are necessary when hunting insects. They also have a large heart for their size, so they can pump blood faster when needed (Swartz et al., 2012).

Bats are nocturnal and typically forage from sunset to sunrise. Each species tends to be more active at different times of the evening, however all species are thought to take breaks to rest and feed their young throughout the evening. Around the world, bats have diverse diets including fish, pollen, fruit, insects, frogs, and blood. In Ohio, bats only eat insects. This is true of about 70 percent of bat species in the world. In fact, they are the top predator of night-flying insects. Different species of bats consume different groups of insects, whether that be beetles, moths, etc. They forage for these insects using echolocation (Appendix A). Bats emit ultrasonic frequencies that bounce off objects in their surroundings and travel back to their ear. Their brain can process this information similar to how humans would process sight. They can tell the shape, texture, and distance of the object through echolocation. As they fly in the dark, they use this extra sense to navigate their habitat.

Bats roost in a variety of habitats and habitat use varies between species and between seasons for each species. Bats also have an incredibly strong site fidelity meaning they return to the same areas each year to roost and hibernate. Only when considering all parts of a bat's life cycle can appropriate actions be taken to conserve them. For example, a big brown bat might roost in a tree or a barn during the summer, but it will likely move to a cave or a mine to hibernate throughout the winter. In Ohio, bats usually emerge from hibernation during April, migrate to summer habitat, and begin looking for suitable roosting spaces to raise their pups. Normally pups are born between late May and June in Ohio. From June to July, mothers will leave the roost to forage and then come back to the roost to feed their pups throughout the night. They will do this until the pup is able to fly, usually in less than 30 days. Starting in August, all pups should be able to fly. By mid-August, some bats will begin migrating to their winter locations. These migration distances vary. Migratory tree bats tend to travel further than cave-dwelling bats, but there is a lot of inter-species variation. From September to November, they will use these locations to mate and to forage in an effort to increase fat reserves before they hibernate. Mating happens through a phenomenon known as fall-swarming, a process by which males and females congregate to copulate. This process normally takes place around the openings of caves and mines. By November, bats will begin to hibernate, and they will continue hibernating from November until April. Some bats are active in warm snaps and will move around the hibernaculum, or even move between hibernacula. The females store the sperm in a process known as delayed fertilization until they emerge from their hibernacula in the spring (Brack et al., 2010). It should be noted that life cycles can vary between years depending on the weather, and they can vary in Ohio based on elevation.

BATS OF OHIO

Below is a table describing the different behaviors and habitats used by bats in Ohio. The only bat that is not mentioned in this table is the Rafinesque's big-eared bat. While this species has historically been found in Ohio, it has not been recorded since the late 1950s in Adams County (DOW, unpublished data). As a result, it is not included in this plan.

Activity	Species									
	Indiana Bat	Little brown Bat	Northern long-eared Bat	Tri-colored Bat	Small-footed Myotis	Eastern Red Bat	Hoary Bat	Silver-haired Bat	Evening Bat	Big Brown Bat
Roost Trees	Efadsfgstrby5 (sometimes live); under loose bark; tree in canopy gap	Cavities, under loose bark; tree in canopy gap	Live or dead; cavity, crevices, and (under bark); tree in gap not required	Live (or dead) trees; in dead (seldom live) leaf clusters	[Unknown]	Foliage Roosting	Foliage Roosting	Primary cavity, sometimes under bark	Primary cavity, sometimes under bark	Cavities, under loose bark; tree in gap
Use of man-made roosts?	Not often	Building, bat boxes & condos; possibly used more than trees	Yes, but less use than trees: bat boxes, sometimes buildings	Yes, but less use than trees: open, lighted areas, e.g., under porch roofs	Not often	No	No	Sometimes	Sometimes	Buildings, boxes & condos; possibly more use of these than trees
Roost Tree Species	Oak, hickory, elm, maple	[Unknown]	Oak, maple, ash, understory species. (e.g., sassafras & redbud)	Deciduous forest, especially in oaks. Occasionally in pine-dominated stands and in pine	[Unknown]	Variety hardwoods including: Maple, Oak, Beech, Elm, Hickory, and Blackgum	Variety of hardwoods and evergreens	Evergreen and Hardwoods	Primarily: pine species, sometimes hardwoods	Oak, beech, maple, aspen
Roost Tree Habitat	Riparian or upland	Riparian, open forest, edge, near water	Upland forest	Upland or riparian	[Unknown]	Riparian forests, forest gaps	Clear-cuts, forest gaps	Clear-cuts, riparian forest	Forest gaps	Riparian, open forest, edge and gaps, near water
Roost Area Fidelity	Yes, but with frequent roost switching within an area	Yes, especially manmade roosts	Yes, but with frequent roost switching within an area	Yes, especially compared to other foliage-roosting bats	Yes	Yes	Yes	Yes	Yes	Yes, but may switch roosts within the areas
Foraging Habitat	Forested streams, upland trails, edges, ponds, in open understory conditions	Forested areas over water, along margins of lakes and streams	Cluttered conditions under forest canopy in uplands: paths, edges, harvest areas	Forested streams with open spaces, edge habitats, uplands & bottomlands	[Unknown]	Riparian forests, forest gaps	Clear-cuts, forest gaps	Forest gaps	Forest gaps	Clear-cuts, forest gaps, fields
Foraging Strategy	Aerial hawkler	Aerial hawkler & less often gleaner	Gleaner & aerial hawkler	Aerial hawkler	Aerial hawkler	Aerial hawkler	Aerial hawkler	Aerial hawkler	Aerial hawkler	Aerial hawkler

Table 1: Description of the foraging and roosting preferences for 10 of the bats found in Ohio.

THREATS TO BATS

Bat populations in Ohio, and throughout most of the world, face threats that have caused large declines in their numbers. One of these threats is habitat loss caused by development of the natural landscape. Since bats have a strong site fidelity, losing a site they normally visit can lead to extra energy expenditure to find an area that suits their needs. There are ways to mitigate this habitat loss. Constructing and placing bat houses in developed areas may replace some roosts that have been lost. With the steady increase in forest maturation and cover seen in Ohio in recent years, implementing various forest management methods could also enhance habitat for bats. For example, creating and leaving more snags (dead trees) on the landscape or removing invasive underbrush that prevents tree regeneration and growth improves forest habitat for bats.

Habitat loss is not the only challenge that bats face today. They have also been affected by the non-native, invasive fungus *Pseudogymnoascus destructans*. This fungus was first found in New York in 2006 when researchers found around 10,000 dead bats outside of a cave system they had been studying. Researchers have estimated that this disease has killed an estimated six to seven million bats throughout the United States and Canada (USFWS, 2012), and mortality continues to rise as this disease spreads west across the continent. White-nose syndrome causes bats to wake up more often during hibernation. The fungus grows on the wing-membrane and muzzles. This growth is particularly irritating to bats and causes them to arouse. Each time they wake up, they lose precious fat reserves they have stored to survive throughout the winter. They also have other physiological responses during this time including evaporative water loss, increased acidity in tissues and body fluids, and wing damage. Without resources to replenish those fat reserves (i.e., no insects to consume during winter), they eventually starve to death. Because of this increased arousal, it is more important now than ever that disturbance to hibernacula is reduced.

Disturbance and vandalism in hibernacula can lead to bats waking up even more often and decreasing their chances of survival even further. The fungus can be spread by contact between bats and unintentionally by humans. The spores are microscopic and can easily be carried on clothing, equipment, and bat fur. It is only under ideal conditions that the spores grow into the white, fuzzy fungus that can be seen with the naked eye. Therefore, it is important to clean all clothing and equipment after visiting a cave or mine. The previous distinction between cave-dwelling bats and migratory bats is significant when looking at the impact of this disease. This fungus grows best in humid environments with temperatures between 35 and 50 degrees Fahrenheit, i.e., underground caves and mines. So, while the fungus can be spread by the migratory tree bats, the disease that the fungus causes (WNS) is only known to impact cave-dwelling species to date. Ohio has two larger hibernacula that are surveyed at regular intervals. As of 2018, the mine in Lawrence County had seen an average decline of 99.8 percent across species. The mine in Preble County saw an average decline of 89.5 percent across species from 2012 to 2016 (DOW, unpublished data). Studying bats and protecting their habitat so that potentially recovering populations have habitat to seek refuge in and occupy is critical at this time.

Another recent mortality event for bats has been wind turbine collisions. With a large movement in recent years to produce more green energy, wind turbines have become a more noticeable feature on the landscape. These turbines can produce renewable energy, but they have unintentional effects on wildlife. Birds and bats traveling through wind farms suffer mortality as a result of the turbines. This has largely impacted migrating bats, particularly the hoary bat. It is thought that more than 300,000 bats are killed at wind facilities each year. With this decline and without any minimization measures, it is possible that species like the hoary bat could be below species viability thresholds in the next 50 years (Frick et al., 2017). Scientists are currently studying bat migration to reduce these large mortality events. In addition, this research can assist with the determination of the impacts of wind energy on populations, not just the level of mortality. It is through these continual efforts and research of scientists, land managers, private landowners, and the concerned public that Ohio will be able to further understand the needs of our native bat species and protect their populations into the future.

THE BEGINNINGS OF THE BAT CONSERVATION PLAN

An Ohio Bat Conservation Plan has been in development for a number of years. Initially, the plan was a partnership between the DOW and USFWS to help prevent the spread of WNS and address the disease if it did in fact reach Ohio. Unfortunately, before the plan could be finished, WNS had already been found in Lawrence County, Ohio. As WNS began to impact bats across the United States, other states began to create plans on how to prioritize conservation goals for bats. Five years after the initial plan became obsolete, conversations began to discuss following suit in Ohio. The goal for the plan was to have people that regularly work with bats gathering to discuss the future of bat conservation in Ohio. On April 16th, 2017, representatives from a variety of organizations sharing an interest in bats gathered for the first time to start the brainstorming process. After numerous meetings and drafts, the Bat Action Team's efforts resulted in this guide for people working with bats in three respective areas: research, education and outreach, and habitat management. It is a collaboration to focus efforts and combine resources in specific areas around the state. It will take continual partnership between the Bat Action Team and Ohio Bat Working Group to implement this plan. As a result, Ohio will be able to address the gaps in these three areas and better promote bat conservation.



ACTION PLAN AND CONSERVATION STRATEGIES

HABITAT MANAGEMENT

Bat species in Ohio are facing population pressures on multiple fronts. Cave-dwelling bat populations have seen dramatic declines due to white-nose syndrome (WNS); migratory bats are experiencing significant mortality from wind power development (USFWS, 2017; Arnett and Baerwald, 2013); and all bats face pressures resulting from human activities which degrade or eliminate suitable habitat. Due to these pressures, it is important to ensure remaining bats have the best habitats available to support their continued survival and reproduction. Ohio bats need places to hibernate, freshwater sources for drinking, and healthy forests for roosting and foraging. Appropriate land management that maintains a wide variety of quality habitats, from wetlands and riparian areas to forested ridgetops, is essential to our efforts to conserve and increase bat populations in Ohio.

Land managers can make decisions that provide diverse, healthy bat habitats across Ohio's landscape. In general, management goals should increase diversity of all types: diversity of species and communities, spatial diversity, structural diversity, and landscape diversity (Fassnacht et al., 2015). Management goals should consider the season in which the land is used by bats and accommodate that accordingly. Property that is being used for fall swarming and hibernation needs to have alternative management techniques than those that are being accessed by bats in the summer or during all seasons. Successful management planning should also consider the goals and objectives of neighboring landowners. Doing so will help improve habitat connectivity, create effective riparian buffers, and improve the distribution and size of habitat gaps and patches across the landscape so they are ecologically meaningful for bats. Developing such habitat diversity will help the landscape be resilient to events such as extreme weather and the changing climate.

Of particular importance when planning habitat management is the control of invasive plant species. Generally, invasive species such as bush honeysuckle, autumn olive, and buckthorn out-compete native species leading to reduced diversity. This disruption of native systems may impact bats' food sources, roosting and foraging habitat, and suitable hibernation sites. Techniques such as prescribed fire, herbicide application, or mechanical treatments may be necessary to control and minimize the spread of invasive species.

Efforts that identify, inventory, and protect existing bat habitat and other high-quality natural and man-made features can also help bats. Ohio has a vast region of potential suitable natural and man-made hibernacula (particularly related to abandoned underground coal mines), much of which has not been methodically surveyed. Recent surveys of hibernating cave bats in Pennsylvania indicate that they may be changing their behavior in response to WNS, moving to parts of caves that traditionally would have been considered too cold (Johnson et al., 2016). This knowledge could lead to more or alternative suitable hibernacula than previously estimated or perceived. Securing permanent protections for these cold refuges would allow long-term management plans to be developed and implemented. Additionally, inventorying bats during the summer through acoustic monitoring and mist net surveys can increase the knowledge about the habitat preferences of all bats.

Ohio has a wide variety of natural and artificial habitats (such as bat houses, crevices in bridges, or man-made ponds) that are managed for multiple purposes. Land managers are encouraged to consider bats when making decisions about the amount, timing, and frequency of management and to integrate bat habitat management considerations into all ongoing activities across the state. Land managers can use this plan and subsequent documents to guide management decisions to support improved bat habitat in the future.

FOREST HABITAT

HISTORY AND OWNERSHIP

When settlers first came to Ohio, the state was predominantly forested. Some have estimated the forest cover was as much as 95 percent. Due to settlement and human expansion, forest cover had declined to just 10 percent of the state by the 1900s. By the early 1940's, poor farmlands were abandoned and conservation practices were implemented that allowed forests to reestablish. Forests have returned gradually to Ohio, plateauing at 30 percent in the 2016 inventory cycle (Albright, 2016).

CURRENT STATUS

Today, the most common tree species are red maple, sugar maple, yellow-poplar, black cherry, white ash, shagbark hickory, white oak, and northern red oak. These species combined, however, account for only 56 percent of the total number of trees in the state, a testament to the diversity of Ohio's forest resources (Appendix B) (Albright, 2016).

Forests in general are getting older and have larger trees (Appendix B) (Albright, 2016). There has also been documented evidence that forests are becoming more dominated by maple trees, likely due to a lack of disturbance over the last 100 years.

Counteracting the last century of forest recovery in Ohio has been the intrusion of many invasive pests, including plants, insects, and disease. Some of these invasive species, such as the chestnut blight and emerald ash borer, have caused significant mortality of certain tree species. Invasive plants can take the place of native plants, and they have the potential to impact forest structure primarily in disturbed areas and regenerating forests, thereby negatively affecting future bat habitat. Invasives can significantly reduce the quality of a forest stand for bat foraging and roosting habitat over time.

When considering managing forests for wildlife, including bats, it is important to remember that most of Ohio's forests (85 percent) are privately-owned. State and local governments own about 10.5 percent of forests with the federal government owning the remainder. Therefore, privately-owned forests can provide many opportunities for bat habitat improvement and protection. If a landowner is considering taking measures to manage their land for bats, a forest plan developed with groups like the Division of Forestry, through their service foresters, can provide a valuable tool. These plans can show landowners the resources for their property and provide guidelines on how to manage for the species that are important to them.

MANAGEMENT: ENHANCEMENT AND BEST MANAGEMENT PRACTICES (BMPS)

Trees can be used by certain species of bats throughout the year. At least 15 of the 20 bat species found in the eastern United States use trees either part of or throughout the year. In Ohio, research mostly focuses on the use of trees by federally listed species of bats in the summer leading to a lack of information on the roosting ecology of most species in the state. Of the 11 species of bats known in Ohio, three are known to roost in the foliage of trees. These bats are the hoary bat, tri-colored bat, and eastern red bat. These three species typically roost singly or in small groups. Other bats tend to roost in cavities or under tree bark during the summer. This includes the *Myotis* genus, big brown bats, evening bats, and silver-haired bats. Some of these cavity roosting bats roost singly like the foliage roosting bats (the evening bat, small-footed bat and silver-haired bat). However, the other bats in the *Myotis* genus and the big brown bat are known to roost in larger colonies anywhere from 10 to 1,000 bats. They use trees for roosting during the day and resting at night when not feeding. These trees can be in forests, suburban areas, metropolitan areas, and in rural landscapes. Certain species (little brown bats and big brown bats) are more tolerant of human disturbance, whereas others such as the Indiana bat are more sensitive to disturbance.

Each of the 11 species of bat in Ohio has specific habitat preferences. There are certain features of some tree species, such as exfoliating bark, crevices, and cavities, that many bat species find attractive (Kunz, 1982). Trees that exhibit these features are beneficial to keep on the landscape. In addition to these features, some bats colonize in the largest available trees. Female Indiana bats, for example, typically select trees that are at least 26 inches in diameter at breast height (dbh) to give birth and rear their young. Because Indiana bats roost in large maternity colonies, large trees provide ample protection and warmth. Large trees are not the only trees that make appropriate summer roosts. Bats that prefer to roost in foliage may use trees with small diameters as well. Habitat availability and competition for roosts can also determine the types of trees that bats will roost in during the summer. For example, the northern long-eared bat has been documented to have high flexibility in roosting sites using both trees with large and small diameters (Rojas et al., 2017).

Because bats use a wide variety of tree sizes and species, living as well as dead, it is ideal to keep snags or dying trees on the landscape along with trees in a diversity of sizes (New Jersey U.S. Fish and Wildlife Service Field Office, 2008). Snags chosen for creation should be species that are likely to degrade slowly and are relatively large, thereby providing habitat for the longest period. In short, diversity in forest structure is key to managing habitat for a diversity of bat species. This is not just a diversity of tree species, but also a diversity in the level of mid-story growth within the forest. Larger species of bats are less adapted to cluttered environments, so reducing flora in the mid-story can ease their flight through forests (Sleep and Brigham, 2003). Removing clutter can also encourage growth of certain trees, like oaks, by allowing more sunlight through the canopy. An easy way to reduce the amount of clutter is to remove invasive species from the area. This will also promote the growth of native plants in the area. Native plants tend to be better food sources for native insects, which can increase the amount of food available for bats. Finally, there may be situations where an undisturbed tract of land is suitable for preservation. The land can be set aside in perpetuity for the use of bats and numerous other wildlife.

With proper planning, all of this can often be accomplished without sacrificing other forest management goals. Service Foresters from the Division of Forestry and private land biologists from the Division of Wildlife are well-equipped to help landowners manage their properties. Contacting these professionals can help with prioritizing short and long-term goals for the property, such as managing the habitat for bats, and then a list of actions can be developed to obtain those goals.

Due to the risk of harming roosting bats, an obvious consideration should be to conduct disturbance activities during a period when most bats are not using trees. Cutting during the summer time leads to an increased risk of damaging maternity roosts where female bats are raising their pups. This can harm not only adult female bats but especially pups as they are unable to fly for several weeks after birth. It should be noted that it is illegal to take (kill) in any manner or possess a bat in Ohio (Ohio Revised Code 1531.02). Therefore, the DOW and U.S. Fish and Wildlife Service (USFWS) recommend not cutting trees between April 1st and September 30th. This will decrease chances of impacting a roost tree when it is occupied by bats. If a project intends to perform tree-clearing activities during this window, the USFWS and DOW should be consulted. Often, surveys are recommended to determine that those proposed tree-clearing activities during the summer will not negatively impact bats.

There is also a risk in conducting activities near a hibernaculum during the fall swarming period. Fall swarming can occur from August to November, and this is a period when bats are particularly vulnerable. Disturbances at hibernacula during this time can not only inhibit mating, but they can reduce fat reserves and reduce the chances that bats will survive through hibernation. For this reason, it is best to maintain a buffer around known hibernacula and conduct surveys in the area when possible. These surveys can inform the land manager if there are bats using hibernacula on the site during the winter. If there is a known hibernaculum on site, or if surveys find a hibernaculum on the property, the USFWS and DOW recommend avoiding cutting trees between March 15th and November 15th. If the surveys show that bats are not using the area, it should be safe to cut trees outside of the tree-roosting season, which, as previously noted, is from April 1st to September 30th.

Many bats preferentially use riparian areas for travel and foraging. So, while there is no specific requirement under Ohio law to retain a no-harvest or limited harvest area around most streams, the Ohio Division of Forestry recommends at least 25 feet of trees on both sides of the stream. This is an opportunity for bat habitat enhancement through creating no-cut or limited harvest buffers around streams.



GRASSLAND HABITAT

HISTORY AND OWNERSHIP

European settlement contributed to the decline of native grasslands as they were converted to farmland. Ohio has lost approximately 99 percent of its historical grasslands. To date, most grasslands are privately owned, but many public entities have also invested in preserving grassland habitat around the state (Figure 1). These efforts allow the grasslands that are left to continue to add value to the landscape and wildlife (Gibson, 2015).

CURRENT TRENDS/HABITAT DESCRIPTION

Grassland habitat can be used by larger bats, like big brown bats, silver-haired bats, and hoary bats, for foraging habitat during the summer. However, due to the lack of cover and protection from predators, it is not typically a highly used habitat for bats, particularly smaller and more clutter-adapted species like Indiana and northern long-eared bats. Grassland that borders forest habitat has been shown to be used more frequently due to the proximity to cover and potential roosts (Heim et al., 2015). Therefore, when managing for grassland habitat regarding bats, grasslands adjacent to forested area should be given priority.

MANAGEMENT: ENHANCEMENT AND BMPS

Grassland habitat can be managed to maintain and increase quality. These methods include prescribed fires, mowing, disking, and invasive species management. Most of these methods aid in providing disturbance to areas with poor nutrient cycling.

It is important to consider bats when managing grasslands so that there are not negative impacts from management practices. For example, prescribed fires should be conducted between November 1st and April 14th near forested habitat. This will prevent impacts to roosting maternity colonies that may be in the area during the summer. If there is the possibility that the project is near a winter hibernaculum, it is best to consult with the USFWS to make sure that there are not adverse effects to any hibernating bats.

It is also ideal to break grassland areas into units when managing with any of the methods. This can lead to an increase in habitat diversity and give local wildlife a place of refuge immediately after burning.

Finally, it is important to manage the amount of pesticides and herbicides that are used in grasslands and in areas adjacent to them. Pesticides and herbicides have been shown to influence bats ability to echolocate through limiting their spatial memory capacity (Hsiao et al., 2016). Pesticides have also been indicated as having a negative impact on the reproductive rate of bats that forage through glean-ing (Stahlschmidt and Bruhl, 2012). Reducing the use, or mitigating the effects of, pesticides and herbicides could greatly benefit bats and other species. Mitigating the impacts of pesticides could include adding vegetation to lessen the effects of run-off or maintaining a buffer around water resources. Following the label on herbicides, using properly working equipment, and using herbicides for your target species can also mitigate unwanted results (Quarles, 2013). Further information on proper management of grasslands can be found in the Ohio State Wildlife Action Plan (2015).



Figure 1: The map above is taken out of the Ohio State Wildlife Action Plan (2015). It is a depiction of the grasslands found in Ohio.

CAVE, MINE, CREVICE AND CLIFF HABITAT (ADAPTED FROM HOBBS AND HAZELTON, 2011)

HISTORY AND OWNERSHIP

Ohio's caves generally have not been extensively studied and are smaller and less numerous than caves in neighboring states. This is due, in part, to the direct and indirect effects of the glacial history of the state. Despite these influences, carbonate caves and other karst features still exist in Ohio. They are known primarily from the western part of the state while rock recesses and shelters from areas underlain by non-carbonate rocks (e.g., sandstone, conglomerate) are developed mostly in the eastern half of Ohio.

How a cave is defined is often debated and its definition can be influenced by its total length, depth, passage dimensions and number of levels. White (1988) provided a characterization that is widely used: "a natural opening in the Earth, large enough to admit a human being, and which some human beings choose to call a cave."

Using White's 1988 definition, more than 400 caves and rock shelters have been documented in Ohio. Human-sized passages in Ohio's carbonate caves often measure less than 60 feet in length but several caves have more than one mile of surveyed passage.

Ohio has a rich history of mining for coal and other mineral resources. Although total numbers are unknown, mines are concentrated in the eastern half of the state and are known to provide important habitat for hibernating bats.

CURRENT TRENDS/HABITAT DESCRIPTION

A. Caves and rock shelters

Caves and rock shelters provide important habitat for bats throughout the year: as summer roosting areas, refuges during the spring and fall migratory periods, and as winter hibernacula (Figure 2). Bats also use these locations during fall swarming.

Big brown, little brown, tri-colored, northern long-eared, and big-eared bats have historically been documented using many of Ohio's caves for hibernation and summer bachelor colonies. However, the numbers present in any single cave have been consistently low (<150); (Hobbs and Hazelton, 2011).

Crevice and rock shelters are also used by bats. Big brown bats are most common in these exposed habitats, as they can withstand much colder temperatures and temperature fluctuation. In fact, big brown bats have been documented hibernating in artificial structures like buildings (Whitaker and Gummer, 1992). However, recent studies by Johnson, et al. (2016) suggest little brown bats may be using colder habitats post-WNS infection. So, rock shelters may play a more important role in their survival today.

Caves and rock shelters were monitored in Summit County, Ohio for more than a decade and significant numbers of little brown, big brown, northern long-eared and tri-colored bats were hibernating in them, pre-WNS. It is estimated that more than 10,000 bats once hibernated in crevices in Liberty Park, Summit County. These habitats may still be important to bat populations in a post-WNS era even with declines and should continue to be monitored closely.

B. Mines

Although not naturally created, Ohio has several mines known to be important hibernacula for bats, and an unknown number of abandoned underground mines that may provide suitable habitat. Mines mimic conditions found in naturally occurring caves such as moderated temperature, elevated humidity, and decreased light. Certainly, mines in Ohio have historically harbored more bats than any known Ohio cave (Preble County and Lawrence County, rated as federal Pri-

ority 2 and 3 Indiana bat mines, respectively). These mines have been found to have little brown, northern long-eared, Indiana, tri-colored and big brown bats during surveys. The surveys for these mines are traditionally done biennially and have been regularly conducted since 1999 in Lawrence County and 1994 in Preble County.

MANAGEMENT: ENHANCEMENT AND BMPS

Regardless of the form, many caves, rock formations, and mines have the potential to be bat habitat, either seasonally, transiently, or year-round, and have not been extensively studied. The State of Ohio has prioritized protection of the caves or mines with the largest congregation of hibernating bats. However, new information regarding the importance of crevices and recesses should drive efforts to study these habitats more closely and seek protection where appropriate.

An Ohio cave protection bill was passed into law and became effective 22 March 1989 (Ohio Revised Code Sections 1517.21-26, and 1517.99) protecting these important habitats for cave life, including bat species. Whether in private or public ownership, caves and mines that harbor bats are still threatened by WNS and human-inflicted destruction such as vandalism or over-use by cavers. In some cases, caves or mine entrances should be gated with bat-friendly gates to prevent access when wildlife or geology has been threatened by human activity. These gates are specifically engineered not to impede the passage of bats or other cave biota but limit human disturbance. Additionally, a proper bat gate will be designed with the cave environment in mind; natural systems that maintain environmental conditions essential to bat habitat such as water passage and airflow should not be disturbed by the placement of the gate.

The habitat surrounding hibernaculum openings is integral to the life cycle of cave dwelling bats. The cave environment can be affected by the vegetation immediately around the entrances (Culver and Pipan, 2009), and the landcover nearby plays an important role in pre- and post-emergence feeding and mating behavior. This habitat should be considered as important as the cave or mine itself. Consider establishing a protected buffer around hibernacula.

Conservation options for caves and mines, such as bat-friendly gating, are limited and often expensive but other options are available. Many caves and mines are in private ownership in the State of Ohio. One conservation strategy is to protect them with conservation easements. This legally binding document prevents land and structures such as caves or mines to be altered and therefore conserved, while remaining in private ownership. For more information, please visit the Nature Conservancy's website at <https://www.nature.org/about-us/private-lands-conservation/conservation-easements/what-are-conservation-easements.xml>.

In order to limit the spread of WNS, the caving community should follow strict decontamination guidelines set forth by the USFWS: https://www.whitenosesyndrome.org/sites/default/files/resource/national_wns_decon_protocol_04.12.2016.pdf.

Known hibernacula as well as lesser-known caves, shelters, and mines should also be monitored regularly to ensure they are protected for current bat populations and available for future reestablishment of bats as their populations recover from WNS.



Figure 2: Cave and rock shelters in Ohio (Natural Heritage Database, unpublished data).

WATER RESOURCES: WETLAND HABITAT, RIPARIAN CORRIDORS, AND LAKE ERIE

HISTORY AND OWNERSHIP

Ohio is a water-rich state bounded on the south by the Ohio River and the north by Lake Erie. These water bodies, as well as thousands of miles of inland streams and rivers and thousands of acres of lakes and wetlands, provide crucial habitat and important resources for bats.

A. Wetlands

There were approximately nine million acres of wetlands in Ohio prior to European settlement. Wetlands have sustained the most historic loss of all the habitat types in the state due to draining to convert the land to farming areas (Dahl and Allord, 1997).

B. Riparian Corridors

There are 254 principal streams and large rivers in Ohio. These streams and their associated streamside terrestrial vegetation are a significant part of Ohio's landscape and an important source of bat habitat. The rivers in Ohio have been historically disturbed by pollution, because of both development and mining practices. However, they are generally considered to be in increasingly better condition over time (Ohio State Wildlife Action Plan, 2015).

C. Lake Erie

Lake Erie was commonly used throughout the 1700s and 1800s for transportation, which contributed to pollution and habitat destruction in and around the lake. The Clean Water Act of 1972 began to restore some of the lake, but it still suffers from certain issues, like algal blooms (Rotman, 2010).

CURRENT TRENDS/HABITAT DESCRIPTION

A. Wetlands

Most wetlands in Ohio are privately-owned, but there are a few high-quality wetlands that are publicly managed (Ohio State Wildlife Action Plan, 2015) (Figure 3). Some bat species are thought to use wetlands as a source of water and for foraging areas due to high insect activity. Wetlands provide cover while still having less clutter than a forest. This makes ideal habitat for bats with high wing-loads, or the larger bat species (Howland et al., 2016).

B. Riparian Corridors

Riparian corridors provide efficient flight corridors for bats to fly down without having to dodge as many obstacles (Greif and Siemers, 2010). They are also an important source of hydration and provide a source of food in late spring and summer in the form of emergent aquatic insects (Voigt and Kingston, 2016).

C. Lake Erie

Lake Erie is the second smallest and is also considered the most stressed, warmest, shallowest, and most productive of the Great Lakes. It is subjected to more urbanization, sediment loading, industrialization, and agricultural practices than any of the other lakes. There is evidence that Lake Erie provides a migratory pathway for certain bat species, like the silver-haired, hoary, and eastern red bat. These bats may use the lake as a landmark to travel around or across, so it is important to take certain measures to improve this resource (Hatch, 2015).

MANAGEMENT: ENHANCEMENT AND BMPS

Water resources are crucial when conserving habitat for bats. Female bats especially drink large amounts of water to aid in lactation as they feed their pups in the summer. Bats also have a high metabolism because they burn energy quickly while flying, requiring them to drink water continuously. Water also tends to increase the vegetational and structural diversity, providing more suitable roost habitat. Some species predominately roost during the summer months near water. For example, the Indiana bat was found to roost predominantly in areas with abundant and accessible sources of water (Carter et al., 2002).

Low water quality can impact bats in several ways. Water quality can affect the biodiversity of aquatic emergent insects which can influence prey availability for bats; toxins that find their way into water can impact bats through bioaccumulation. Therefore, impacts to water quality such as sediment drift and pesticide run off should be reduced. As previously mentioned, pesticides can reduce the echolocation and reproductive ability of bats (Hsiao et al., 2016 and Stahlschmidt and Bruhl, 2012). Fortunately, preserving vegetation and adding vegetation borders can aid in managing for both burdens. In addition, pesticides and herbicides should be used in moderation and according to the label. More information on restoring water systems and preventing pollution can be found in the Ohio State Wildlife Action Plan (2015).

A lack of water resources can make for less suitable roosting habitats for bats (Li and Kalcounis-Rueppell, 2017). Therefore, protecting wetlands and river ways from development is one of the highest priorities for their management. Programs like the Wetland Reserve Program or USDA Agricultural Conservation Easement Program can aid in this effort. These programs allow for landowners to protect, enhance, create and/or restore wetland habitat in exchange for payment of the difference between the agricultural value and ecological value of the land. Placing conservation easements on sections of tributaries that are deemed particularly ecologically important can also help (Ohio State Wildlife Action Plan, 2015).

Bats have been shown to be able to use man-made and alternate water sources if they have good roosting structures in the nearby premises. Some examples of man-made and artificial water sources include ponds, sewage treatment plants, and man-made ditches (Howland et al., 2016). Therefore, it is important to conserve and manage a multitude of water resources with the aforementioned practices.



Figure 3: The map above is modified from the National Wetlands Inventory (USFWS, 2013). It includes both emergent wetland and forested/shrub wetland.



GOALS FOR HABITAT MANAGEMENT

Categories	Term	Priority	Goal Description
Land Prioritization and Management	Long	2	Maintain snags and dying trees on the landscape on public lands.
	Long	2	Keep a buffer of trees, particularly large trees and snags, around riparian areas when there is a timber harvest.
	Long	3	Construct artificial roosts to place in critical wildlife habitat such as urban parks and wildlife areas.
	Long	3	Manage against an overabundance of flora (clutter) in mid-story growth in areas with known bat activity through the removal of invasive species.
	Long	3	Promote proper and minimal use of pesticides with landowners and public agencies through education events and programs.
Land Protection	Long	1	Find hibernacula throughout the state for land acquisition or conservation security.
	Long	3	Minimize disturbance at bat roosts with educational signs and information.
	Long	2	Minimize disturbance at hibernacula by installing bat-friendly gates for those with eminent threats and providing information at others.
Other	Short	1	Create a document about best management practices for private landowners that wish to promote bat occupancy on their land.
	Long	3	Work with the education and outreach committee to focus on promoting best management practices for bats to private landowners and public entities not already involved in the plan.

RESEARCH AND MONITORING

The purpose of this section is to outline near-term goals for research and monitoring efforts in the state of Ohio. The goals outlined below reflect the gaps in current knowledge that must be addressed to more effectively promote conservation and management of bats in the state. Research goals were also developed to monitor threats to bats. At present, most bat species in Ohio are undergoing dramatic mortality events resulting from susceptibility to either WNS or interactions with commercial wind turbines. These threats are relatively recent phenomena,

but bats in Ohio have long been threatened by habitat loss and degradation. It is worth emphasizing that these goals are not an exhaustive list of important research questions. During the creation of these goals it was noted that conservation questions and issues are constantly changing. Therefore, the goals addressed are focused on the first five years of implementation of the Ohio Bat Conservation Plan. A five-year review of this plan will provide an opportunity to build off completion of these goals and to ask additional questions.

CURRENT STATUS

Collecting data on bats is difficult because of their life history. Bats are nocturnal, they can change roosts regularly, and they can fly long distances in a short period of time. Their use of echolocation makes them difficult to capture because they can often detect a method of capture before they are caught. Furthermore, even after a bat has been captured once, they have a low recapture rate (Kunz, 2003). Bats were historically difficult to track because technology had not yet developed a tracking device small enough to be attached to a bat. Flying animals are thought to be particularly sensitive to increased weight loads, and bats are easily affected because higher loads impact their maneuverability (O'Mara et al., 2014). As a result, tracking bats was not common place until after the mid-1960s when experimental studies determined increased loads were not unusual for bats throughout the various seasons (pregnancy in spring and summer and fat stores in the fall), and bats could therefore be subjected to transmitter attachment (Davis and Cockrum, 1964).

Some bat species gather in large colonies in winter hibernacula allowing for close observation of their numbers and activities, but this is not always the case, and knowledge of their spring, summer, and fall activities is more limited. Because of all these limitations, bats have been an understudied taxon for many years. Advances in technology have allowed for smaller transmitters to track bats and acoustic detectors to record bat calls as they fly through an area. In addition, increased losses of bats due to habitat loss, collisions with structures, and emerging pathogens have led to increased concern and research.

In Ohio, most surveys for bats have been conducted for land development projects. This had led to surveys being conducted primarily in areas with underlying interests not related to research and monitoring. Therefore, while knowledge of the spatial and temporal distribution of bats across the state has increased in the last few decades, there are still pockets of the state where bat activity and abundance is unknown such as the northwestern portion of Ohio (DOW, unpublished data). The Division of Wildlife began a statewide acoustic survey to overcome this gap, placing routes across the state to obtain more knowledge of bat activity. The mobile survey records calls while driving at 15 miles per hour, ensuring that each bat is recorded once. This method allows for a measure of activity and relative abundance (Britzke and Herzog, 2009). Through the years, this project has expanded, but there are still areas that are unevenly covered. For example, the southeastern portion of the state has more routes per county than other portions of the state. As this project continues, an even geographic coverage would be ideal.

Another facet of the summer habits of bats that is relatively unknown in Ohio is roosting locations. The only bats that are regularly tracked and/or banded are northern long-eared and Indiana bats. Therefore, other species of bat's roosts are rarely located in the state. Information on the roosts of bats is crucial to their conservation. If suitable roost habitat is not protected, there could be a decline in locations for bats to raise their young.

As previously mentioned, bats have seen major declines in recent years. Development can impact local bat populations by leading to the

destruction of potential bat habitat (Kunz, 2003). This includes both destroying roosts and habitat connectivity (Scott et al., 2010). In addition to habitat destruction, run-off from construction sites can pollute waterways and environments elsewhere that bats may use (Environmental Protection Authority, 1996). Bats have also declined from collisions with man-made structures such as wind turbines (Arnett et al., 2008). Finally, bats have suffered major declines because of WNS with an estimated six to seven million deaths in the United States since 2007 (USFWS, 2012). These numerous pressures on bat populations require research to determine their impacts and how to mitigate for them.

To attempt to protect bats from declines due to wind turbine collisions, researchers and managers need to better understand the migration timing and pathways for bats. This knowledge could lead to increased curtailment (stoppage of blade movement) during the peak migration periods and result in less mortality of bats at wind facilities (Arnett et al., 2013).

Protecting bats from habitat destruction requires knowledge of habitat use by bats, as well as the impacts of development and different management techniques on bat populations. If developers are aware of bat habitat use in the area, they can accommodate bats through measures such as seasonal clearing, retaining key habitat areas, and or creating or enhancing habitat in a nearby area to help offset the development impacts. In addition, the success of mitigation through protection and enhancement of property needs to be better understood to establish potential management techniques for private landowners and companies.

Finally, the impacts of WNS on bat populations and activity across the state needs further assessment. White-nose syndrome was first documented in Ohio in 2011. It has led to declines of winter populations of around 89 and 99 percent in our two largest hibernacula in the state (Sparks, 2016; Schultes, unpublished data). The impacts of WNS on Ohio's bat population viability has yet to be understood. Other states, like New York, are starting to see recovering populations (Langwig et al., 2016). Other studies have suggested that bats, particularly the little brown bat, have sought out certain refuges during the winter months that have aided in their persistence with WNS (Johnson et al., 2016). Ohio needs to continuously monitor hibernacula across the state to determine if these recoveries are occurring in this state as well. Locations with noted recovering populations can then be protected to encourage population growth within the state. Ultimately, the more knowledge that people who manage and protect land throughout the state have on bats, the more equipped they are to enact measures for their conservation.

In addition to formal research projects, numerous bat surveys are coordinated with the USFWS Ohio Ecological Field Office each year that are conducted by qualified consultants for project compliance with Section 7 of the Endangered Species Act. Results of these project surveys can provide updated distribution information regarding federally listed species that may influence development of new research.

GOALS FOR RESEARCH AND MONITORING

Goals for research and monitoring were divided into important life history stages of species occurring in Ohio: summer populations, winter populations, and migratory periods. These life history stage distinctions seek to further understand bats during those time periods. Conservation management of bats may occur at any time and thus was divided into its own category. A brief description of goals is included and assigned a priority based on issues currently affecting bats and their listing status in the state.

Categories	Term	Priority	Goal Description
Summer Populations	Short	2	Identify and survey parts of the state that have been under-surveyed through mist-netting efforts.
	Long	3	Add calls to the Ohio call library for more accurate species identification.
	Short	2	Continue to survey bats through a statewide acoustic program and compare results across years.
	Long	1	Continue monitoring bat roosts of the big brown bat and little brown bat, particularly maternity colonies, throughout the state through the bat roost monitoring program to better understand distribution and habitat use.
	Long	3	Continue to evaluate the effectiveness of artificial bat roosts and whether they encourage more use in an area.
	Long	1	Begin to track and band little brown bats and tricolored bats to better understand population status.
	Short	2	Encourage banding of all bats throughout the state to promote better opportunity for band recoveries and distribution information.
Winter Populations	Short	1	Use updated mine and cave survey information from ODNR's Geological Survey to prioritize additional hibernacula to survey.
	Long	1	Identify non-standard hibernacula, such as rock shelters and railroad tunnels, throughout the state to survey them for bats.
	Long	2	Study patterns in hibernation behaviors and habitat use of WNS-susceptible species.
Migration	Long	1	Gain insight on the migratory ecology of tree bats in Ohio, including migration routes, origins, and destinations, as well as possible winter residency.
	Long	2	Begin to track and band hoary bats, red bats, and silver-haired bats to better understand population status.
Conservation Management	Long	1	Quantify the impacts of wind energy on each of Ohio's bat species, as well as the effect of curtailment measures.
	Long	1	Evaluate the effectiveness of land management strategies in Ohio and mitigation impacts.
Other	Long	3	Identify a data-sharing policy for researchers to be able to access records for appropriate projects.
	Long	2	Assess connectivity among populations of each of Ohio's bat species across the state.
	Long	2	Continue to stay informed about WNS treatment opportunities, both through habitat manipulation and applicable treatments, in order to determine the viability for use in the state.
	Short	2	Survey areas around the state for potential fall swarming locations.
	Long	1	Determine the spatial and temporal distribution of bats across Ohio and assess how it has changed since WNS.
	Short	2	Create a list of research projects regarding bats that are occurring around the state that will be posted on a website. This website should be updated yearly.

EDUCATION AND OUTREACH

The information contained in this section is a resource for those who work with bats in formal or informal education and outreach settings. While not all the listed resources may apply to a specific situation, the goal of this section is to provide helpful tools to increase public knowledge and awareness of bats, particularly in Ohio.

For most people who are not aware of the benefits of bats, dispelling common negative myths is often the first step to get them to appreciate these animals. After educating interested members of the general public on bat life history, there is an opportunity to get people involved in research or monitoring of local populations. With increased awareness, these people can educate their relatives, neighbors, and coworkers, which can lead to community action.

As with any plan, identifying, tracking, and achieving meaningful goals is a tangible way to monitor progress towards the goal of species conservation. The last part of the Education and Outreach Strategies section contains goals relative to state-wide education and outreach. These include both short and long-term goals for educators, the general public, and other entities that regularly work with bats. Through cooperation among various education entities in Ohio, these goals prioritize efforts throughout the state and can allow for more cohesive programs.

CURRENT STATUS

An informal survey was conducted through the Ohio wildlife educator's listserv in February 2018 that asked what kinds of bat programs are currently being conducted around Ohio. Twenty-four organizations responded with their information. Out of those organizations, 22 currently conduct bat-related programs and two currently do not but expressed interest in expanding their offerings.

The total bat-related program count from the 22 organizations was approximately 300 programs per year. Wildlife educators, often wildlife rehabilitators, with bats that are under an education permit (not bats that are currently being rehabilitated) can use those bats for education programs, and as a result offered the most education programs. City parks offered the least number of programs, typically only one or two per year. As a result, city parks are a group that should be contacted to encourage an increase in programs in the future. Soil and Water Conservation Districts, county parks, and state parks averaged 10-15 programs per year. The Cincinnati Museum Center has conducted about 50 programs a year but have performed as many as 450 when the building is open and operating.

Most programs included information about different Ohio bat species, life history, habitat needs, and WNS. Building bat houses was also a common topic for many of the education programs.

Programs are reaching all ages. Pre-K through early childhood programs have been adapted to classroom curriculum. Family-based programming is most frequently taught in workshop form. Adult

programs can be categorized by general education, citizen science and inquiry-based labs.

Many of the programs were offered in fall around Halloween and Bat Week (a nationwide effort at the end of October to increase awareness about the importance of bats), but a good number were tied to summer camps, hikes, and evening events in warmer months. It would be ideal to focus on promoting programs throughout the year to address these limitations.

Geographically, organizations were distributed as follows: seven in central Ohio, five in northeast Ohio, five in southeast Ohio, five in southwest Ohio, and two in northwest Ohio. All the organizations are included because they expressed an intent to conduct programs in the future.

Statistics on the number of people that are reached were either not collected or not provided as a part of this informal survey. This is an important part of better understanding the success and reach of education programs throughout the state.

A more thorough inventory of the programs will be conducted. Once that inventory is complete, the gaps can be identified, and goals can be better tailored to address those gaps. In addition, one topic that was not mentioned in this survey that could use more focus in future programs include citizen science opportunities involving bats.



GOALS FOR EDUCATION AND OUTREACH

Categories	Term	Priority	Goal Description
Baseline Information	Short	1	Conduct an inventory of the bat outreach and educational currently taking place in the state and identify needs/focus areas. This would include not just educational programming, but materials (publications, signage, etc.).
Media Relations and Releases	Short	1	Designate a team that will handle the distribution of information on social media. This team should identify social media sites that would be willing to distribute information, and work to create content on bat related events, info, citizen science projects, etc.
	Short	3	Create a list of articles and potential authors to be published in various magazines (wildlife as well as other disciplines).
Citizen Science	Short	2	Create a list of citizen science opportunities and how to get involved. Make sure this list is distributed to bat partners around the state.
	Short	2	Help to distribute reports from citizen science projects.
	Long	2	Offer programs that train people on the citizen science projects (e.g., emergence survey training).
Outreach	Short	1	Develop a list of relevant parties connected to bats (i.e., cavers, nuisance control operators, agency call centers, educators) and develop contacts for future information dissemination/workshops/outreach.
	Short	2	Promote bat conservation programs year-round. Currently, topic tends to be promoted in October (around Halloween).
Educational Events	Long	3	Work with partners (i.e., Cincinnati BatFest, OBWG) to plan an Ohio-wide Bat Blitz/field day that will allow for researchers to survey areas throughout the state and educate the public about bats.
Additional Resources	Long	1	Create a one-stop resources page for educators (info on bat ecology, public health issues, nuisance situations, etc.), and add that information on the educator's page run by the DOW along with information about funding resources.
	Long	2	Promote use of the bat trunks in months where they are used less and advertise the bat trunk inventory list to schools across the state encouraging them to create their own trunks for when they hold programs.
	Long	3	Develop a list of sites on public lands that could benefit from informational signs regarding bats and begin to develop those materials.

PLAN IMPLEMENTATION

A committee consisting of members of the Bat Conservation Plan Action Team and the Ohio Bat Working Group will voluntarily implement the goals and objectives for each of the three sections comprised in the Bat Conservation Plan. This committee will be composed of people representing at least four different organizations. Committee members will at least meet annually to discuss the progress of goals enacted in the plan. Goals may be revised, removed, or added to the plan as the committee sees fit. The annual meeting will also identify any new research projects that may be developed for meeting specific goal(s). The committee will coordinate with each project contact for an annual status report. If additional assistance is needed for a project the committee will communicate this to the Plan action team to find or suggest appropriate additional resources. Due to the continuous communication needed to host events and publish outreach messages, a smaller group of the committee will meet once a quarter to discuss the status and progress of the education and outreach goals. Tasks will be assigned to specific people to keep the group on track for the following quarter. Any resources that the committees need from the community at large can be presented annually at the Ohio Bat Working Group meeting or through the Ohio Bat Working Group listserv. Finally, every five years, this plan will be thoroughly reviewed. At this point, the entire plan will be analyzed and updated by the committee as appropriate.

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APPENDIX A: GLOSSARY

Acoustic survey/monitoring: Bats travel through their environment using echolocation (see echolocation). Companies have created specialized equipment that allows for biologists to record these echolocation calls. Acoustic monitoring can allow for scientists to determine the level of activity in an area. The calls can also be narrowed down to a frequency group (see frequency group) or a species through manually looking at the call features or automatic classifiers.

Aerial hawk: This is a foraging strategy that some bats use where they hunt and grab their prey mid-flight.

Bat roost: A location where a bat goes to rest during the day and throughout the night while feeding. The roost is also where young will be raised during the summer. Males are often known to roost singly while females can roost in large colonies (see maternity roost).

Echolocation: When bats emit sounds that reflect off the environment. These sounds then travel back to the bat. Then, bats can use the time the sound took to echo, the change in pitch, and other features to determine the location of objects in their environment. The calls emitted by bats are in the ultrasonic range (above 20 kilohertz), so humans are not able to hear them without specialized equipment.

Frequency group: A collection of bats that call within similar frequency ranges. The frequency groups are normally split into low, mid, and high or *Myotis* frequencies.

Gleaner: This is a foraging strategy that some bats use where they hunt for prey and pluck them off of objects like plants or structures.

Hibernacula/Hibernaculum: A location where some bats roost in the winter time. While in a hibernaculum, bats reduce their activity levels and metabolism, as well as lowering their body temperatures to ambient conditions. A hibernaculum could be a mine, cave, rock shelter, or even a tree.

Maternity roost: A specific roost where females gather together with their young. Often, the females will leave their young in the roost at night while they go out to forage. Roosting in large groups allows the females to more easily regulate their body temperatures (Dietz and Kalko, 2006).

Ohio Bat Working Group: This group has aimed to establish a format for communication and collaboration for people interested in bats across the state of Ohio. The main venue for this is the annual Ohio Bat Working Group Conference. This meeting typically entails educational lectures from bat biologists, rehabilitators, consultants, and other working with bats from around the state. This organization has agreed to assist with the implementation of the Bat Conservation Plan.

Prescribed fire: The process of intentionally burning an area of land for management purposes. Prescribed fires reintroduce disturbance to an area that has historically been repressed. This disturbance allows for nutrient cycling on the landscape. It also opens up forest at the mid and understory.

Priority Hibernacula: A designation by the USFWS to prioritize conservation and research efforts for Indiana bat hibernacula nationwide. A Priority 1 hibernaculum will have had more than 10,000 Indiana bats, a Priority 2 hibernaculum will have had between 1,000 and 10,000 Indiana bats, a Priority 3 hibernaculum will have had between 50 and 1,000 Indiana bats, and a Priority 4 hibernaculum will have had less than 50 Indiana bats. The designation of a Priority hibernaculum requires the aforementioned number of Indiana bats to have been counted after 1960, and it currently has to have suitable or stable microclimates. These distinctions were defined in the 2017 Indiana Bat Population Status Update (USFWS, 2017).

Riparian buffers: A riparian area is the area surrounding a river. A riparian buffer consists of maintaining vegetation along the banks of the river and slightly further out to provide better water quality.

Torpor: This is when bats lower their body temperature to the outside, or ambient, temperature. Bats will be less active during this time. Bats go into torpor during the day throughout the spring, summer, and fall. Torpor is also used by bats during hibernation.

White-nose syndrome: A disease caused by a fungus (*Pseudogymnoascus destructans*) that impacts bats during hibernation. This disease causes bats to wake up from torpor (see torpor) and diminishes their fat reserves saved up for hibernation. Without food resources to replenish the fat reserves, bats often starve to death. White-nose syndrome is only known to impact cave-dwelling bats, but the fungus can be carried by both cave-dwelling bats and migratory tree bats.

Wildlife rehabilitator: A person who has a specific license distributed by the Division of Wildlife that allows them to take in injured/orphaned wildlife to rehabilitate them. This rehabilitation process is advised by veterinarian staff and will continue until the animal can be released into the wild.

APPENDIX B: CURRENT STATUS OF OHIO FORESTS

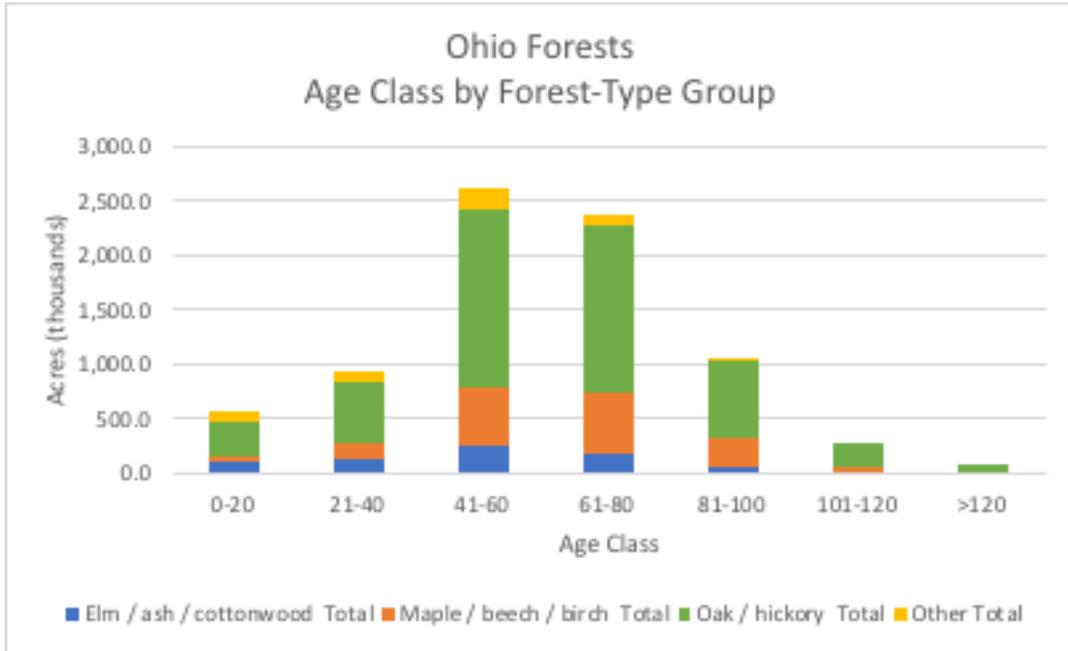


Figure 1: The amount of each age class in each forest-type group. Age class is represented by the average age in the forest parcel (Albright, 2016).

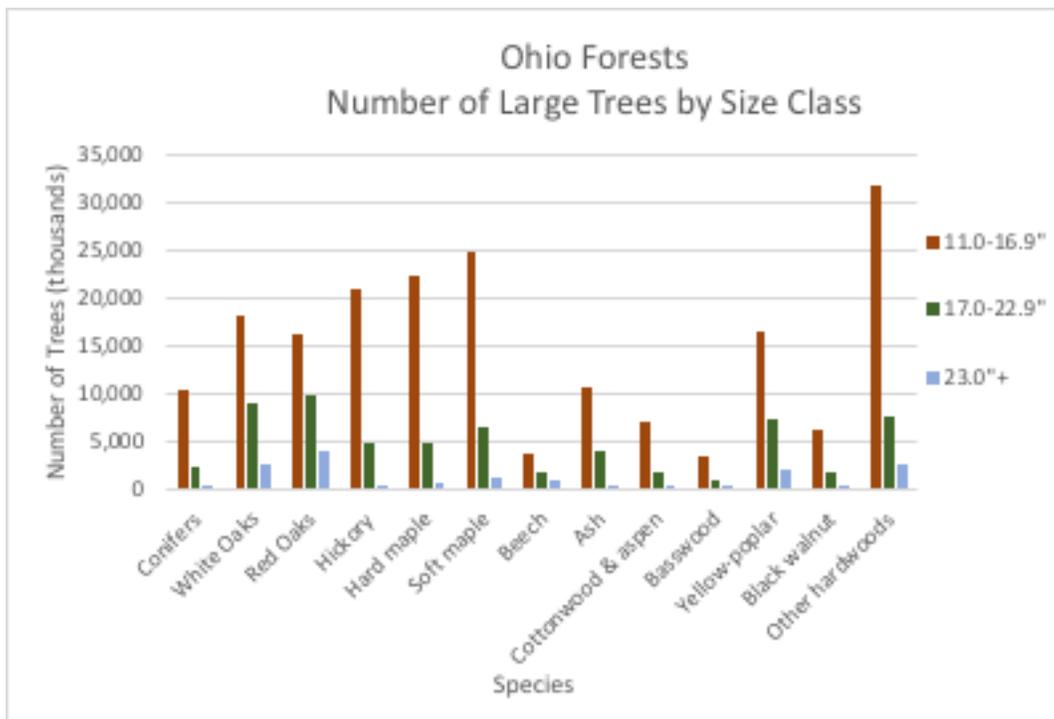


Figure 2: The number of various species of trees throughout the state separated by size class. The size is a measure of dbh (Albright, 2016).