

Bat Impact Assessment Techniques: A Guide for Developers

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Introduction

People usually don't think much about bats. At best they are mysterious creatures of the night and at worst feared and loathed pests. But like them or not, bats have a significant impact on humans and the environment. They have influenced our cultures: the Chinese consider them good luck, and they have contributed to American pop culture as vampire bats in horror movies. When people come in contact with bats they have a wide range of reactions, from passively observing them on a summer evening swooping and diving after insects, to more intimate interaction when they get into someone's home.

Bats are considered a non-game species, which means that they are not hunted for food, fur, or sport. However, some bats are federally protected by the Endangered Species Act of 1973 (ESA), because their numbers are declining or are at a level where they may go extinct. In addition, some states have laws that protect bats that occur in that state. Some states have their own threatened and endangered list, while others may have a law that specifically protects bats.

During the project development process, in many cases project proponents need to determine if bats may be impacted and if so, to what degree. Developers and planners can use this paper as a guide to better understand the importance of bats, why they are in need of conservation, what regulations protect them, and what survey methods to use, to help their projects comply with environmental regulations.

Basic Ecology of Bats

To understand how impacts to bats are determined, a general understanding of bat ecology is first necessary.

Bats are mammals, so, like humans, they produce milk, have hair, and give birth to live young. They are insectivores, more closely related to shrews than to rodents like mice or rats. There are about 1,000 species of bats in the world, with about 45 species in the U.S. They eat many types of food, including amphibians, birds, blood, fish, fruit, insects, mammals, nectar,

pollen, reptiles, and even other bats. Most U.S. bats eat insects, but a few in the southwest feed on nectar.

Bats are generally categorized as either mega-bats or micro-bats. Mega-bats live in the old world tropics, such as rain forest areas of Africa and Southeast Asia, and include flying foxes with wing spans that can reach almost six feet. Micro-bats are found throughout the world and, as you would expect, are usually smaller than mega-bats. They include the bumblebee bat, one of the smallest mammals in the world, which weighs less than a penny. All bats in the U.S. are micro-bats.

Bats in the U.S. are classified into two categories based on where they live: cave bats or tree bats. Cave bats live in caves for part or all their lives but are sometimes found in tree cavities or crevices. Tree bats spend most of their lives roosting in tree foliage. Some species of bats, such as the big brown and little brown bats, have adapted to live in buildings, allowing them to prosper and spread beyond their original ranges. Presumably, they historically lived in large hollow trees.

Many bat species have a long life span. For example, the little brown bat can live for more than 30 years. However, they have only one or two young a year. These low reproduction rates make bat populations more vulnerable when large mortalities occur, and recovery to original population levels takes more time than for many other small mammals such as mice and other rodents, which have high reproductive rates.

Migration and hibernation are two important survival strategies for bats. Many species of bats in the U.S. migrate either to caves to hibernate during the winter (cave bats) or to warmer areas in the south (tree bats). In the spring most female bats migrate north to summer habitat to raise their young. In the fall bats return to wintering areas or caves. Male bats migrate too, but usually not as far as females and may stay nearer to where they spend their winters.

In addition, bat migration varies among species. The hoary bat has the longest migration, with some individuals flying from the Midwest to the southwestern U.S. Much about bat migration remains a mystery, however, with little known about what bats actually do during migration, i.e. whether they follow landscape features, if they fly as a group or as individuals, and at what altitude they fly.

Overall, bats are important to ecosystems and have significant roles in the food chain.

Bats that hibernate and live in caves are very important to cave ecosystems. Their guano provides a food source for many animals and fungi that live in caves. Insect-eating bats, which make up most U.S. species, provide an invaluable service and are one of the only nocturnal predators of flying insects. Insectivorous bats are known to eat agricultural pests such as the adults of southern corn rootworm, cutworm moths, green stink bugs, scarab beetles, and leafhoppers. Bats also eat forestry pests like the Asiatic oak weevil that prey on the acorns of oak trees. Bats play a critical role in reducing insect populations that would otherwise damage our food supply and natural resources.

Regulations and Compliance

On the state level, different bat species have different levels of protection, which depend upon the state's particular wildlife laws. State laws can specify when bats can be taken, or if they can be removed at all. If a species is on a state's threatened or endangered species list, then they are protected further, but just in that particular state.

On the Federal level, nine bat species are designated as threatened or endangered in the U.S. and its territories, and are therefore protected by the ESA. These species cannot be taken, meaning that they cannot be harassed, harmed, shot, wounded, killed, trapped, captured, or collected. Harm may be further defined as habitat destruction or degradation that may lead to "taking" a species.

The list of species protected under the ESA includes:

- gray bat (*Myotis grisescens*) – endangered
- Hawaiian hoary bat (*Lasiurus cinereus semotus*) – endangered
- Indiana bat (*Myotis sodalis*) – endangered
- lesser long-nosed bat (*Leptonycteris curasoae yerbabuena*) – endangered
- little Mariana fruit bat (*Pteropus tokudae*) – endangered*
- Mariana fruit bat (*Pteropus mariannus mariannus*) – threatened*
- Mexican long-nosed bat (*Leptonycteris nivalis*) – endangered
- Ozark big-eared bat (*Corynorhinus townsendii ingens*) – endangered
- Virginia big-eared bat (*Corynorhinus townsendii virginianus*) – endangered

Source: U.S. Fish and Wildlife Service 2010a. Species with an asterisk are from U.S. territories.



Figure 1: Indiana Bat

Source: Jeremy Sheets



Figure 2: Hoary Bat

Source: Jeremy Sheets

If federal money or a federal action is involved in funding a project, then the National Environmental Policy Act (NEPA) is triggered. NEPA has steps in place so that stakeholders can have a decision-making role in the development process. Projects may require an Environmental Assessment (EA) or a more detailed Environmental Impact Statement (EIS), depending upon the scope of the project and the extent of the potential impacts. The documentation is then submitted to the relevant Federal agencies, which varies depending upon the type of project and the resources potentially impacted.

Projects that do not follow the NEPA process may still need to consider impacts on threatened or endangered species. Often coordination between companies and regulatory agencies is voluntary, but regardless, if an endangered species is impacted, the U.S. Fish and Wildlife Service (USFWS) can enforce the ESA. Complying with state or federal endangered species laws can be as easy as opening a dialogue with the regulatory agencies. In other cases, it can be considerably more complex if it appears that endangered species may be involved.

With any project the first step is to determine if there are any federal or state-listed threatened or endangered species present, and if a project will impact those species. There are many online tools that can be used to quickly determine if there are threatened or endangered species potentially present. If an online search for threatened and endangered species is negative, then the project is in compliance, and the project can proceed.

However, if species are thought to be present, steps to determine the impacts on each

species will need to be discussed with both federal and state regulatory agencies. For wind farm projects, USFWS suggests a five-tiered approach, from planning stages of preconstruction to post-construction monitoring:

Project Planning Tiers

1. Preliminary evaluation and screening of potential sites.
2. Site characterization.
3. Field studies to document site wildlife conditions and predict project impacts.
4. Post-construction fatality studies.
5. Other post-construction studies.

Source: Wind Turbine Guidelines Advisory Committee 2010.

This five-tiered approach can be applied to other types of development projects. Early coordination using this approach may produce the quickest results. Surveys that use sound science and best management practices should be applied during this process. Once coordination and a tiered approach are planned, then a project can proceed.

Survey Techniques

To determine the presence of bat species, there are a variety of surveys methods from which to choose, each with specific benefits and drawbacks. All survey methods are subject to state and federal regulations, and most are subject to seasonal and weather protocols. The majority of the survey protocols described here have been adapted from Indiana bat survey guidelines developed by USFWS. The 10 types of surveys described here include:

- Habitat assessment
- Emergence count
- Mist netting
- Acoustic monitoring
- Radio tracking
- Cave surveys
- Radar surveys

- Thermal imaging
- Mortality survey
- Combined techniques

Habitat Assessment

Habitat assessments are preliminary surveys looking at a proposed site to determine if further data collection will be needed for specific species of concern. Typical habitat assessments are desktop reviews, onsite habitat surveys, and potential roost tree surveys.

Desktop reviews consist of an in-office approach to determine if bat species of concern or a relevant type of habitat is present on a proposed project. Site maps and capture records in the literature are used to determine if bat species are likely to be present. While this review is efficient, it cannot determine if a bat species is actually present on site.

Onsite habitat surveys consist of field visits to a proposed site to visually confirm the presence of bat habitat in the area. Potential bat habitat is recorded by map or global positioning system (GPS), photographs, and field notes. Onsite surveys can be conducted throughout the year, but they are more efficient when foliage is present, because the actual structure of the habitat is more visible, making a better assessment possible. Onsite surveys can determine if quality bat habitat exists, but they do not confirm the presence or absence of a bat species.

Potential roost tree surveys assess a site for active roost trees without capturing bats. In the eastern U.S. most potential roost tree surveys are conducted to determine if the federally endangered Indiana bat is present. These surveys are usually conducted from spring to fall, when bats are actively occupying a tree roost. To determine if a tree qualifies as a potential roost tree, a biologist surveys a site to see if any trees are present that meet Indiana bat roost criteria. If such trees are present, then an emergence count is conducted to determine if bats are using the tree.

Emergence Count

An emergence count involves counting bats that leave a roost to forage. This data can determine the actual number of bats that may live in the area, but it cannot give information about an individual bat unless it has a radio transmitter (see Radio Tracking). To conduct an emergence count, at dusk a biologist observes a roost and counts bats that exit. To ensure an accurate estimate, USFWS requires a minimum of two emergence counts on each occupied roost.

Mist-netting

Mist-netting requires a federal and state-permitted biologist to actively capture bats while they are foraging. Mist-netting occurs between mid-May and mid-August, when bats are active. Biologists monitor the nets for five hours starting at dusk. Mist-nets are set in linear corridors with canopy cover, along forest edges, or over water sources to maximize the number of bats captured (Figure 3). While mist-netting can determine what species occur on a site and probable absence, it cannot determine population characteristics.



Figure 3: Bat Netting Over a Stream

Source: Jeremy Sheets

Acoustic Monitoring

Acoustic monitoring records bat echolocation calls using a bat ultrasonic detector. These recordings can help biologists gather data on bat usage of a site, but USFWS does not accept them as evidence of the presence or absence of a specific bat species. Currently, bat calls cannot be reliably identified to species in all cases, because some species have very similar calls, and the recording environment can make it difficult to discriminate between species. However, most calls can be identified to a group or genus.

Passive acoustic monitoring provides a way to detect and store bat calls over long periods at a stationary site with little effort (Figure 4). Recording data over different seasons may produce a better understanding of what species inhabit a site and at what times of the year they are present.



Figure 4: Installing Bat Detectors

Source: Jeremy Sheets

Active acoustic monitoring involves recording bat calls from free-flying bats. A bat detector and a personal computer or PDA is required to conduct active acoustic surveys. As bats fly by the bat detector, a bat biologist spotlights the bat and records the species. Active acoustic monitoring can be conducted anytime bats are flying.

Radio Tracking

Radio tracking involves capturing bats and placing a small radio transmitter on their backs (Figure 5). A radio receiver and antennae are then used to track the bat. Radio tracking can be used to determine where bats roost, forage, migrate, or hibernate on the landscape. The two most-common applications are finding bat roosts and using triangulation to determine where bats forage. Combined foraging and roost sites can give a minimum home range for an individual bat.



Figure 5: Indiana Bat with Transmitter

Source: Jeremy Sheets

Cave Surveys

Cave surveys are used for bats that hibernate in caves during the winter months. These bats are usually found with other bat species and are sometimes intermixed. Some species, such as the Indiana bat, hibernate in large colonies, while others hibernate singularly or in small groups. With white-nose syndrome (see below) spreading throughout the eastern U.S., cave surveys are restricted due to the possibility of researchers spreading the disease to new areas.

There are two common types of cave surveys: portal surveys and hibernation counts. *Portal surveys* are usually conducted during spring emergence and fall swarming when bats are visiting caves but not necessarily residing in them; if bats are year-long cave residents, portal surveys can be done in the summer. These surveys require a permitted biologist to capture and record physical data about individual bats.

Hibernation counts require researchers to enter a cave during the winter months and count individual bats. These counts can only be done by a biologist with the proper permits. Population characteristics can be determined by hibernation sampling and are used to determine the status of species such as the endangered Indiana bat.

Radar Surveys

Radar surveys use X-band (also called Marine) radar to track bats (and birds) that migrate through or otherwise use a site. Radar can reach up to one mile from its source and can determine where bats or birds are flying. However, radar cannot tell birds or bats apart, and it cannot function in rain. In addition, radar requires specialized technicians to run the equipment and analyze the data. Despite these constraints, radar is more effective in determining bat movements during migration and at a longer range than most other survey methods.

Thermal Imaging

A thermal imaging camera films the night sky, recording anything that gives off heat. The recordings are then analyzed for bats or birds that may have flown within the camera's range. Thermal imaging, which can be used at any time of year, is capable of telling exactly where bats fly in an area and can determine if bats are being killed by a structure.

Mortality Survey

Mortality surveys determine how many bats fatalities occur on a site. Regulatory agencies may require these surveys on a wind farm to determine how many bats are being killed, to determine if incidental take permits are in compliance. Search transects are established on site, and personnel walk each transect, looking for bat carcasses and noting their positions. Mortality surveys can occur from spring migration through summer residency to fall migration and may be required for several years. While they can determine how many bats a project impacts, they require intensive quality control to reduce searcher bias.

Combined Techniques

In many cases a project requires a combination of survey techniques. By combining techniques, one survey type can help overcome another's limitations. An example is mist-netting and acoustic monitoring. Mist-netting requires a way to funnel bats into the mist-net and does not work well in open habitats, while acoustic monitoring can record bats in open habitats. However, acoustic monitoring cannot determine individual presence of a bats species on site, while mist-netting can. Used together, acoustic monitoring and mist-netting can provide a better picture of the on-site bat community than either method alone.

Case Studies

Two projects conducted in 2010 in Michigan and Indiana demonstrate how combining survey techniques produces a better picture of the bat community on a site. Both projects used mist-netting supplemented with acoustic surveys to determine the presence of the federally endangered Indiana bat. The Michigan site is on the northern fringe of the Indiana bat's range, while the Indiana site is well within that bat's range. Both sites were mostly agriculture land with small wood lots scattered across the landscape and wooded streams crossing the property.

The Michigan project used mist-netting, acoustic monitoring, and passive acoustic monitoring to determine bat activity during spring migration through summer residency and into fall migration. Mist-netting and acoustic survey produced no Indiana bats or any potential Indiana bat recordings, suggesting the bat may not occur in the area. In addition, the acoustic data did not record any potential Indiana bat calls, but it did record the call of a tricolored bat that was not caught or detected by the mist-netting and acoustic survey. The tricolored bat had never previously been caught or recorded in that county, demonstrating that a multiple survey and combined tactics approach can be a more effective strategy. For this site, with the probable absence of Indiana bats, the regulatory agencies will likely not require additional survey work, allowing the project to proceed.

The Indiana site used mist-netting, acoustic survey, radio telemetry, and emergence counts. Mist-netting caught Indiana bats, and the supplemental acoustic surveys produced potential Indiana bat calls. Three Indiana bats that were caught during the mist-netting, and two of the bats had small radio transmitters glued to their backs and were released. One of them was radio tracked to two roost trees within a week, allowing emergence counts to be made. One roost tree produced only the bat with the transmitter, while the other produced the same bat and an additional bat. By using multiple techniques, not only do we know Indiana bats were present on site, but we also know of at least two roost trees the bats use.

Each of these surveys provided information for the project developers to proceed in minimizing their impact on bats. The Michigan project likely does not have any federally threatened or endangered bats in the area and can proceed and be in compliance. The Indiana project resulted in recording the presence of a federally endangered bat, and the project developer will have to consider how their project is going to affect that species. They may be

required to do a number of things, such as mitigation, turbine blade curtailment, or acquiring endangered species take permits.

A New Threat Faced by Bats

Many bat populations have been declining for a number of years, but with the recent emergence of a fungal disease, many bat species now face a new threat. White-nose syndrome, named for a white fungus that grows on muzzles of bats, affects many cave bats in eastern North America, and it is moving into the Midwest. At this time no tree bats with white-nose syndrome have been documented; only bats that live or hibernate in caves are known to be infected. According to USFWS, the disease was first found in New York in the winter of 2006-2007 and has since spread to many New England states, northwest into Ontario, southwest to the Appalachian Mountains into Tennessee, and possibly found as far west as Oklahoma (See Figure 6).

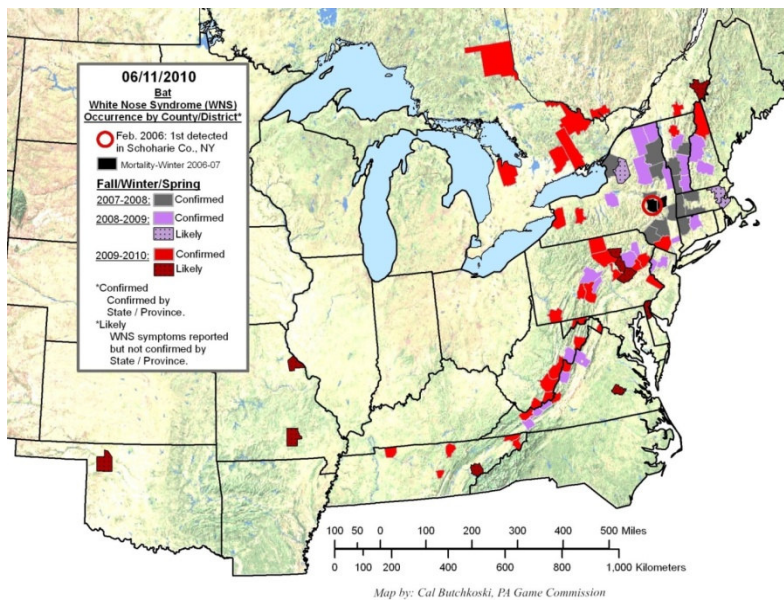


Figure 6: White Nose Syndrome Occurrence

Source: U.S. Fish and Wildlife Service 2010b

Between 95 to 100 percent of bats infected with white-nose syndrome die as a result. Since 2006 more than one million bats have died, and it is possible that this disease may result in the extinction of one or more bat species. As the number of bats continues to plummet it is

anticipated that the ESA and state endangered species regulations will be applied to more bat species, and many now-common bat species will become protected.

Conclusion

When starting a new project, the analysis should consider potential impacts to bats as early in the process as possible. Simply looking at a project's location can tell a lot about its potential impact on bats. In addition, early communication with regulatory agencies can help speed up the process of determining what, if any, surveys need to be carried out and acquiring needed survey permits. Clearly defining project goals will help also expedite the impact assessment process and identify feasible solutions or mitigation strategies.

Resources

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