A Roost Affair: Conserving Bats in Wyoming

Bats are an important but often overlooked component of healthy ecosystems, biological diversity, and agricultural economics in the United States. Worldwide, there are an estimated 1,232 species of bats, 18 of which are found Wyoming. Twelve of these species are considered residents either seasonally or year-round. Bats are found throughout the state and constitute 15% of all mammalian species in Wyoming, thus contributing extensively to Wyoming's biological diversity. As the primary predator of nocturnal insects, bats also play an important role in regulating insect populations and insect-related ecological processes. Additionally, many insects consumed by bats are among North America's most costly agricultural and forest pests.

Most of Wyoming's bats mate in late summer, with pups born in May through July when insects are most available. Females with pups often form large maternity colonies, while males form smaller, separate bachelor colonies or roost alone. In fact, reproductive success and overwinter survival may largely depend upon the availability of suitable roosts. Consequently, distribution and abundance of roosts may ultimately determine distribution and abundance of many bat species, since suitable roost sites are likely a limiting resource. Bats need roosts for day shelter, raising young, and hibernation, although not all bat species hibernate.

Despite their great diversity, bats have historically been poorly studied, misunderstood, and persecuted. Declines in many bat populations at both continental and local levels have led to concern for the future of resident and migratory bats in Wyoming. Reasons for declines are complex and may include habitat loss, modification, and fragmentation; loss of wintering and migratory habitat; roost disturbance; pesticide use; and disease, including white-nose syndrome. Bat conservation is a relatively new phenomenon in the state, and 10 of 12 of Wyoming's resident bat species are classified as Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (Department) because of their low reproductive rates and high conservation needs. Three species are also listed as sensitive by the US Forest Service, and four species are listed as sensitive by the Bureau of Land Management.

PHOTO BY BOB LUCE, WYOMING GAME AND FISH DEPARTMENT

Bats in Wyoming are exposed to many threats that may lead to population declines.

Guidelines for managers

In an effort to address population declines and conserve bat habitat, the Department has put together a list of Best Management Practices (BMPs) for bats in Wyoming. This document is intended to provide landowners and land managers with a variety of simple and inexpensive actions to improve, protect, and preserve habitat for bats. The following BMPs should provide some reasonable guidelines and suggestions for managing habitats and minimizing threats to benefit bats, although, of course, not all of the BMPs will be appropriate in all situations. The recommended BMPs are broken out into major habitat types and conservation issues for convenience. When managing habitat for bats, it is critical to take a landscape level approach that incorporates roost sites, foraging habitat, and water sources. All these components must be in close proximity (within several kilometers) for bats to use them efficiently.

NATURAL CAVES AND ABANDONED MINES

A cave is any naturally occurring cavity, recess, or system of interconnected passageways that is large enough to be traversed by humans. Cave habitats may be simple or complex, often with many smaller tubes, cracks, and fissures. Although caves typically last for long periods of time, they are uncommon in many areas; consequently, bats have also come to depend on abandoned mines, which have been part of the natural landscape for over 100 years, due to their similarity to natural

Species, residency status, and associated habitat types of bats in Wyoming.

Bat Species	Status	Natural Caves & Mines	Rock Shelters	Buildings	Bridges & Culverts	Forests & Woodlands	Grasslands & Shrub-steppe	Riparian Corridors & Water Features
Western small-footed myotis	Resident	X	X	X	X	X	X	
Long-eared myotis	Resident	X	X	X		X	X	X
Northern myotis	Resident	X		X		X		X
Little brown myotis	Resident	X	X	X	X	X		X
Fringed myotis	Resident	X	X	X	X	X	X	X
Long-legged myotis	Resident	X	X	X	X	X		X
Hoary bat	Resident					X		X
Silver-haired bat	Resident					X		X
Big brown bat	Resident	X		X	X	X	X	X
Spotted bat	Resident	X	X	X		X	X	X
Townsend's big eared bat	Resident	X	X	X		X	X	X
Pallid bat	Resident	X	X	X	X	X	X	X
California myotis	Peripheral		X	X	X	X	X	X
Yuma myotis	Peripheral	X	X	X	X	X	X	X
Eastern red bat	Peripheral					X		X
Brazilian free-tailed bat	Peripheral	X	X	X	X	X	X	X
Eastern pipistrelle	Accidental	X	X	X		X		X
Big free-tailed bat	Accidental	X	X	X		X		

caves. Abandoned mines provide similarly diverse habitats, ranging from large, open pits to major shafts and adits to small, shallow pits or trenches. Both caves and abandoned mines provide climates that are less variable than the surface, with stable internal temperatures, high humidity, low evaporation, and little to no light. Although relatively constant, not all internal temperatures in caves and abandoned mines are similar and may be influenced by the number, size, and position of portals; the size, slope, and contour of passages; the overall volume of the interior; the seasonality and dynamics of airflow; and water intrusion.

PHOTO BY SHELLY JOHNSON, WYOMING GAME AND FISH DEPARTMENT

Caves provide stable internal temperature and humidity levels for hibernating bats, such as this Townsend's big-eared bat.

Caves and abandoned mines provide some of the most important roosting sites for bats, including winter hibernacula, summer maternity roosts, day roosts, night roosts, and crucial rest stops during spring and fall migration. These important roosts are often traditional and used by successive generations of bats over many years. Although caves and abandoned mines occupy a very small percentage of the total land base, they are disproportionately important as bat habitat, and their preservation is one of the most important issues in bat conservation.

- Protect and maintain caves and abandoned mines in Wyoming. Unless crucial habitat designation directs otherwise, assume all caves and abandoned mines utilized by bats are crucial to the preservation of bat populations.
- Protect the environment in which caves occur, including soils, surface landforms, natural drainage patterns and hydrologic systems, and cave microclimate and ecosystems.
- Maintain all vegetation above caves and abandoned mines inhabited by bats and near portals to avoid altering the internal climate and light levels, reducing insect populations, and removing visual barriers. Manage timber harvest and prescribed burning within a 0.4-km (¼-mi) radius of caves and abandoned mines inhabited by bats to avoid changing climate conditions in caves.
- Avoid building roads within 90 m (300 ft) of caves and abandoned mines inhabited by bats, within 0.4 km (¼ mi) of visible caves and abandoned mines, or where roads will cause erosion or alter the climate or flow of water in or around caves and abandoned mines. Maintain vegetative screening along roads to minimize visibility. Close or apply seasonal restrictions on roads that increase public

access to vulnerable cave and abandoned mine habitat.

- Enhance and protect abandoned mines with suitable conditions for bats, even if no bats have been documented, since suitable abandoned mines may later become occupied.
- Avoid mining and renewing activities above, inside, or near caves and abandoned mines inhabited by bats or within the immediate watershed of a cave.

PHOTO BY BOB LUCE, WYOMING GAME AND FISH DEPARTMENT

Caves are a non-renewable resource and one of the most important habitats for bats.

- Prior to closing a mine or renewing mining activity, evaluate all abandoned mines as bat habitat. Multiple surveys within and across seasons are essential to determine the significance of abandoned mine structures to bats for hibernation, maternity, day roost, night roost, and lek roost activities.
- Where possible, avoid hard closure of abandoned mines occupied by bats, including activities such as bulldozing, backfilling, blasting, sealing with concrete, and foaming.
- If hard closure or the loss of habitat during renewed mining is unavoidable, safely exclude or remove bats during a non-critical season to avoid mortality. Perform exclusions during seasons when abandoned mines are not in use or during early spring or fall if used year-round.
- Mitigate the loss of occupied roosts by protecting or reopening nearby abandoned mines. Survey abandoned mines within 8 km (5 mi) of the closure site for potential replacement habitat. Abandoned mines occupied by the same species or with similar microclimates should be prioritized and protected by gates or fences prior to the exclusion of bats from current roosts. Avoid locating mitigation sites within the sphere of potential mine expansion.
- After mining is completed, reclaim mine lands with consideration for the unique foraging and roosting needs of bats. Reclaim with native vegetation and appropriate roosting habitat, and protect remaining abandoned mine shafts and adits with bat-friendly closures.
- When entering caves inhabited by bats, reduce disturbance by minimizing noise and number of participants. Use only red lights and those powered by batteries or cold chemicals such as cyalume, and avoid bright flashlights and carbide lamps. Avoid smoking and passing too closely to or lingering near roosting bats. Upon exiting the cave, use proper techniques for disinfecting as outlined in the section on White-nose Syndrome.
- Do not use firearms, fireworks, open fires (including campfires, matches, and candles), camp stoves, or toxicants inside caves and abandoned mines inhabited by bats or near portals.
- At caves and abandoned mines where human safety is a concern, where adequate surveys cannot be performed, or where human disturbance affects bat populations, install bat-friendly closures to allow passage by bats while restricting access to humans. Close hibernation sites to visitation from November

1 to April 1 and maternity sites from April 1 to October 1.

- Keep the locations of caves, abandoned mines, and bat roosts confidential. Avoid including them on maps, road or trail signs, brochures, or press releases. Direct persons who inquire about local caves to a reputable speleological society.
- Establish educational programs and use signs and other interpretive media to inform the public about how activities in abandoned mines are unsafe for humans, how activities in caves and abandoned mines can threaten bats, and how caving can be enjoyed without affecting bats (such as caving in early spring and fall when it is least likely to disturb bats).

ROCK SHELTERS

A rock shelter is any shallow crevice or small cave in a cliff, rock outcrop, or talus slope. Rock shelters are small (less than 5 to 10 m^3 [175 to 350 ft^3]), moderately well lit, and display a lack of complexity. These sites offer protection from predators and suitable roosting habitat, usually for smaller colonies and single individuals. Cliffs and large rock features may serve as massive heat sinks, allowing roosting bats to minimize their daily use of energy. They are often suitable as maternity and night-roosting habitat during summer, but are generally too exposed to temperature fluctuations to provide significant hibernacula. As a result, some bats may roost in rock shelters during summer but hibernate in caves and abandoned mines during winter.

Cliffs, rock outcrops, and talus slopes are unique habitats that lend topographic diversity to homogeneous areas. As a result, they may also benefit bats indirectly by influencing vegetative structure and diversity and increasing insect diversity and abundance. The stability and persistence of cliff and rock habitat may encourage fidelity to specific areas as roosting habitat, which may extend beyond the lifetimes of individual bats. Consequently, these rocky habitats provide important roosts for several species of bats.

- Protect and maintain cliffs, rock outcrops, and talus slopes in Wyoming. Limit their use and development wherever necessary and possible, and avoid practices that degrade or alter them.
- Protect the unique vegetation community that often exists around cliffs and rock outcrops to maintain insect abundance and diversity. Maintain the microclimate of these areas used as roosts by protecting and managing vegetation up to 240 m (790 ft) from the roost area.
- Alter the timing of rock extraction activities in cliffs, rock outcrops, and talus slopes to avoid disturbing known maternity colonies between April 1 and October 1.
- Minimize human disturbances to roost sites in rock shelters. Where recreational climbing or hiking may impact key roost areas, implement use restrictions and close areas with known maternity colonies to climbing from April 1 to October 1.

PHOTO BY MERLIN D. TUTTLE, BAT CONSERVATION INTERNATIONAL, WWW.BATCON.ORG
Rock shelters provide bats, such as this western small-footed myotis, with summer roosts.

- Interact with recreational climbers to maintain confidentiality of cliff and crevice roosts used by bats and encourage support of bat conservation efforts. Avoid revealing exact locations of bat roosts in the literature.
- Establish educational programs and use signs and other interpretive media to inform the public about how activities near bat roosts can threaten bats and how climbing and hiking can be enjoyed without affecting bats (such as climbing in early spring and fall when it is least likely to disturb bats).

BUILDINGS

Buildings offer a range of internal and external habitats for roosting bats, sometimes even more diverse than their natural habitat. The attics and other interior spaces of buildings, such as beneath floorboards, inside insulation, and between bricks and wood, provide roosts analogous to caves, cavities, and crevices. Exterior spaces between tile, corrugated roofs, wooden shingles, and clapboard, and crevices between bricks and stones, behind shutters, and between vents all provide roosts similar to natural crevices and tree bark. Most bats use buildings on a seasonal basis as maternity roosts, night roosts, bachelor roosts, and transient roosts during migration. Several different species commonly roost in abandoned or little-used structures that are unlikely to place them in direct contact with people, but the big brown bat and little brown myotis are also common in buildings occupied by people.

- Protect and maintain buildings that provide roosting habitat for bats and avoid demolishing or altering them wherever possible. Unless critical habitat designation directs otherwise, assume all buildings utilized by bats are crucial to the preservation of bat populations.
- Manage prescribed burning and timber harvesting activities, particularly clear-cutting, within a 0.4-km (¼-mi) radius of buildings inhabited by bats.
- Where possible, allow bats to remain in buildings occupied by humans. In most cases, especially where bats are roosting on or near the exterior of the building, they can be allowed to remain without endangering the building or human occupants.
- Minimize bat mortality when conducting repairs and renovations on buildings. Where possible, maintain or relocate entrances, crevices, and roosting areas.
- Before demolishing old or abandoned buildings, conduct surveys to determine whether bats use the buildings as roosts.

PHOTO BY SHELLY JOHNSON, WYOMING GAME AND FISH DEPARTMENT

Gaps and crevices in buildings and bridges provide bat habitat analogous to natural openings in rocks and tree bark.

Consider alternatives to demolition that will conserve the buildings as roosts for bats.

- Where demolition of or exclusion of bats from buildings is unavoidable, time demolition or exclusion activities from October 1 to April 1 to minimize impacts to roosting bats.
- Minimize human disturbances to unoccupied buildings that serve as roosts by implementing use restrictions and closing maternity areas from April 1 to October 1 by installing locks or fences.

PHOTO BY SHELLY JOHNSON, WYOMING GAME AND FISH DEPARTMENT
Bridges are commonly used as seasonal night roosts.

- Keep the locations of buildings used as roosts confidential. Avoid including them on maps, road or trail signs, brochures, press releases, or other literature.
- Establish educational programs to increase public awareness about the importance of buildings as bat roosts, the risk to bats from building renovation and demolition, and how to safely and responsibly share buildings with bats.

BRIDGES AND CULVERTS

Bridges and culverts with suitable conditions can provide important roost sites for bats. Because these structures often occur in riparian corridors, their proximity to important foraging habitat, water sources, and travel corridors increases their value to bats. Most bats use bridges and culverts on a seasonal basis, mainly as night roosts in open areas between bridge support beams that are protected from the wind. Bats less frequently use bridges and culverts as day roosts, which must provide greater protection from weather and predators. When used, day roosts are usually in expansion joints or other crevices.

- Protect and maintain bridges and culverts that provide roosting habitat for bats, and avoid demolishing or altering them.
- Conduct surveys to determine whether bats use bridges or culverts as roosts prior to construction or demolition. When possible, time maintenance, repairs, and renovations on bridges and replace culverts from October 1 to April 1, and maintain or recreate crevices and roosting areas. Covering crevices that are open at the top with tarps can minimize disturbance.
- Consider alternatives to demolition that will conserve bat roosts, such as building the new structure nearby and leaving the old one standing.
- Where possible, design and construct new bridges or culverts to enhance the availability of roost sites, particularly new structures that replace older ones that provided bat roosts. Construct bridges with expansion joints or other crevices or cavities suitable for bats and modified box culverts to accommodate bat colonies. Retrofit existing structures with roost potential by installing manmade habitats, such as Texas Bat-Abode or the Oregon Wedge. Boxes installed beneath flat-

bottomed bridges can offer additional roosting opportunities for bats.

- Avoid coating wooden bridges with creosote, which may repel bats.
- Establish educational programs to increase public awareness about the importance of bridges and culverts as bat roosts, and enlist the Wyoming Department of Transportation and city and county entities responsible for bridge and culvert maintenance and construction as allies.

FORESTS AND WOODLANDS

Although only a few bat species are obligate tree-roosters, many populations within forested landscapes may depend on tree roosts. Major types of roosts used by temperate bats include cavities in snags or live trees; crevices behind exfoliating bark, within very rough bark, and in wood; and foliage. Cavity roosts generally provide relatively stable microclimates and offer protection from predators. Bark roosts provide a more abundant but less permanent, less secure, and less thermally stable roosting environment than cavities; bats that roost in bark often must change roosts frequently. Foliage roosts are the most exposed, but their abundance makes them easy to find near foraging areas and might reduce commuting distance. Tree-roosting bats usually roost alone or in small family groups.

Forests and woodlands are also important foraging habitat for bats. Some insect species on which bats rely for food, including many moths, reproduce on shrubs, trees, and flowering plants of the forest environment. Bats that feed by gleaning insects from the surfaces of vegetation are particularly dependent on forests and woodlands for foraging. Forests are also more sheltered and often warmer than open environments, providing valuable cover to slow, maneuverable bats that avoid open areas. Open meadows and water features within the forest, forest edges, and the space above the canopy are important foraging areas for many bats.

- Protect and preserve large tracts of forests and woodlands that provide roost and foraging resources for bats. Maintain existing canopy where the canopy meets the desired

PHOTO BY BOB LUCE, WYOMING GAME AND FISH DEPARTMENT

The silver-haired bat roosts almost exclusively in trees and is found most frequently in stands of late-successional forest.

needs for bat habitat. If it is possible to retain only a limited amount from harvest, preserve larger, intact tracts of late-successional forest.

- Manage for vertical and horizontal heterogeneity, multiple layers of native plants, and a variety of age classes to provide habitat for a diverse insect community and a variety of roosting opportunities for bats.
- Within extensive areas of forest habitat, manage for a mosaic of different communities across the landscape, including wet meadows, bare ridges, and other small-scale openings (less than 7.3 ha [18 ac]); aspen stands; linear elements such as trails, forest roads, and riparian corridors; and interspersed shrub habitats.
- Protect and maintain water features within forest and woodland habitat to provide a source of water as well as important foraging habitat and migration and commuting routes.
- Maintain, restore, and regenerate aspen stands within coniferous forests. Protect large stands of aspen trees, which are strongly preferred by bats.
- Conduct pre-harvest bat inventories to document bat use and habitat inside proposed timber harvest boundaries and firewood-cutting areas, and evaluate the impact of harvest on bat foraging and roosting habitat.
- Retain trees known to be used by bats for roosts. The reuse of trees by bat colonies and the use of some trees more heavily than others suggest some bats exhibit long-term fidelity to trees and emphasize the importance of protecting existing roost trees.
- Establish a 0.4-km (¼-mi) radius buffer zone around all bat roosts, within which timber management activities should not occur. Whenever activities must occur within this buffer zone, provide a minimum 150-m (500-ft) radius buffer of intact forest around roosts to avoid altering airflow and thermal regimes.
- Preserve all live trees with cavities, dead-topped trees, snags used by bats, soft snags, and from 6 hard snags per ha (2.5 per ac) to 21 hard snags per ha (8.5 per ac). Retain an abundance of live trees of various ages to replace existing snags over time and maintain snag densities in the future.
- In the vicinity of known maternity colonies, conduct restoration or management activities such as prescribed burning, thinning, livestock grazing, firewood cutting, and pesticide application from October 1 to April 1.
- Avoid clear-cutting in forests and woodlands. Clear-cutting on a large scale has a negative effect on bats that roost in trees and forage in forest interiors and on their insect prey that reproduce in forests.
- Where possible, avoid post-fire salvage logging. Where salvage logging is inevitable, remove trees from one portion of the burned area only, leaving another representative area intact that retains the full complement of snag sizes and densities.
- Make logging slash available to wood gatherers, and, if necessary, limit firewood

PHOTO BY SHELLY JOHNSON, WYOMING GAME AND FISH DEPARTMENT

Small-scale gaps in the forest provide bats with foraging areas and commuting corridors.

PHOTO BY BOB LUCE, WYOMING GAME AND FISH DEPARTMENT
Maintaining a variety of nearby roosts is essential for bats foraging in shrub-steppe habitats, such as this Yuma myotis.

cutting in certain areas. Limit cutting to snags less than 29 cm (11 in) dbh and downed material only, and implement road closures and obliteration to limit access to snags. Avoid fuelwood harvest in the vicinity of known maternity roosts during late spring and summer.

- Limit the use of pesticides. Where possible, use silvicultural strategies to reduce the number of susceptible hosts and the need for pesticides. Use species-specific control measures, such as pheromone confusants and sterile male release, rather than nonspecific measures. Use pest control as part of an Integrated Pest Management (IPM) program where it is necessary.

GRASSLANDS AND SHRUB-STEPPE

Grassland and shrub-steppe habitats often produce a high density and diversity of insects. Consequently, these habitats can serve as important foraging habitat for bats, even if they are some distance away from suitable roosts. Open areas provide especially good foraging habitat for bat species that are less maneuverable in cluttered environments, and the edges of these habitats near wooded areas, cliffs, or other features are important to some of the smaller, more maneuverable bat species.

Although grassland and shrub-steppe habitats usually contain less vertical structure and complexity than other bat roosting habitats, they often encompass patches of other habitat types that provide diverse and abundant roost sites. Bat roosts within grassland and shrub-steppe may include rock outcrops, talus slopes, cliffs, caves, abandoned mines, bridges and other manmade structures, and trees. The small size of bats allows them to exploit even very small and inconspicuous shelters as roosts, such as crevices in and under rocks and holes in the ground. In addition, some shrubs may provide night roosts that allow bats to remain close to foraging habitat throughout the night, although shrubs are probably not suitable as day roosts, since they provide little protection from predators, temperature extremes, and wind.

- Protect and preserve native grasslands and shrub-steppe habitats that provide important roost and foraging resources for bats. Limit use and development wherever necessary and possible, and avoid development, vegetation conversion, or other disturbances near known roost sites.
- Manage for diverse grasslands and shrub-steppe habitats. Avoid creating monocultures of nonnative grassland or farmland.
- Where grassland or shrub-steppe habitat has been converted to cultivated farmland, improve habitat for bats by leaving grassy strips and natural areas between fields, expanding field margins, retaining crop residue, and enhancing farmland diversity.
- Within extensive areas of grassland and shrub-steppe habitat, protect and maintain a mosaic of potential roosts across the landscape, such as caves, abandoned mines, rock shelters, trees, buildings, and bridges.

- Manage grassland and shrub-steppe to conserve or increase diverse insect populations.
- Protect and maintain water features to provide a source of water for bats and increase insect production and foraging habitat.
- Limit the use of pesticides. If pest control is necessary, use an Integrated Pest Management (IPM) program to target specific insect pests, avoid the loss of non-target insects that are food for bats, and minimize exposure of bats to harmful chemicals.

PHOTO BY BOB LUCE, WYOMING GAME AND FISH DEPARTMENT

Riparian corridors and water features provide essential foraging, roosting, and commuting habitat for many bat species.

RIPARIAN CORRIDORS AND WATER FEATURES

Clean, available water and productive, diverse riparian areas are essential components of bat habitat. Water is not only important to bats for drinking, it also provides important foraging habitat, abundant insect prey, increased vegetative and structural diversity, and corridors for daily travel and migration. In the arid West, water can play an important role in determining the distribution, abundance, and species richness of bat populations.

A major benefit of riparian areas is the availability of drinking water. Most bat species must have access to open water where they can drink in flight; rivers and streams provide a large proportion of drinking water for bats. Access to and availability of drinking water is especially important during late pregnancy, lactation, and hibernation. Water features and associated riparian vegetation also provide important foraging habitat, especially for species that feed directly over the water's surface. High quality riparian habitat supports a much richer insect fauna than surrounding upland areas and provides valuable cover for foraging bats. Riparian corridors also provide potential roosting habitat, including snags, mature trees with loose bark, and deciduous trees, as well as rock crevices, eroded stream banks, and cliffs. Some bat species will preferentially select roosts in riparian corridors because of their proximity to water. Consequently, riparian corridors provide some of the most important habitat for bats.

- Within extensive areas of aquatic and wetland habitat, maintain habitat diversity by managing for a mosaic of types and conditions, including different species of native aquatic and riparian vegetation with vertical diversity (from submerged and emergent aquatic vegetation to riparian woodland), horizontal diversity, and shoreline conditions.
- When planting trees, select native species, and avoid Russian olive and tamarisk (salt cedar). These exotic species out-compete and use more water than native plants and host relatively few insect species.
- Retain and restore natural features of rivers and streams, such as meanders, oxbows, gravel bars, calm pools, and riffles to promote high insect diversity and enhance foraging opportunities. Avoid channelizing streams, increasing river flow, or infilling meanders and ponds. Calm pools within turbulent streams provide areas where bats can echolocate without background noise.

PHOTO BY MERLIN D. TUTTLE, BAT CONSERVATION INTERNATIONAL, WWW.BATCON.ORG

The long-eared myotis is one of many bat species that is dependent on riparian areas for foraging.

- Manage streams and springs for stable, year-round flows, particularly during critical time periods for bats, such as the maternity season (April 1 to October 1) as well as winter for some species.
- Create large artificial ponds, particularly near occupied bat habitat such as woodlands, caves, or abandoned mines. Incorporate as many natural features as possible, including varied depths and diverse vegetation.
- Repair old stock ponds rather than replacing with tanks, which lack aquatic and riparian vegetation. Tanks provide only a small surface area of water that may be inaccessible to larger, less maneuverable bat species.
- Maintain accessibility to water by eliminating, modifying, or reducing obstructions such as fencing. When springs are developed into stock tanks, avoid using covers, latticework, or similar structures that can make them unavailable to bats.
- Maintain proper livestock stocking rates and distribution to protect water features. Manage grazing intensity at a level that will maintain the composition, density, and vigor of desired plants and not damage shorelines or water quality.
- Where necessary, use livestock grazing to maintain an open vegetative structure around small water bodies to allow access to bats, particularly in areas where other water may be unavailable.
- Avoid placing mines, oil and gas drill sites, sand or gravel pits, geothermal sites, and roads immediately adjacent to riparian areas.
- Ensure that ponds containing mining wastes are netted to exclude bats.
- Reduce and control point and non-point sources of pollution to attain water quality necessary to support living resources. Bats may be killed directly by drinking contaminated water or indirectly by a reduction in the number or diversity of available insects.
- Avoid using foggers for mosquito control near water resources.
- Strictly limit pesticide application in and near riparian corridors and water features to

activities that improve or maintain vegetation (such as elimination of competitive noxious weeds). Where pesticides are necessary, use as part of an Integrated Pest Management (IPM) program, and only use those pesticides approved by the US Environmental Protection Agency specifically for use in and adjacent to aquatic areas.

- Carefully plan aerial application of herbicides to prevent the drift of chemicals into water resources, and employ drift retardants. Depending on wind speed, provide a buffer zone of 1.6 to 6.4 km (1 to 4 mi) downwind and 75 m to 1.6 km (250 ft to 1 mi) upwind of the aircraft. Avoid spraying herbicides in winds exceeding 16 kph (10 mph) or during calm weather when temperature inversions may prevent sprays from reaching the ground. Pellet herbicides are less prone to wind drift and are preferred near aquatic areas.
- Consider alternatives to herbicides for vegetation management, including regulation of muskrat populations, water level manipulation, livestock grazing, prescribed burning, mowing, disking, crushing, and excavating.

OIL AND GAS PRODUCTION PITS

Little is known about potential impacts of oil and gas development on bat populations. However, oil and sludge pits may resemble smooth, water-like surfaces to travelling bats, which can then become trapped when attempting to drink. Although bats covered with a film of oil may be able to escape the pit, they may still be unable to fly. Hundreds of carcasses from a number of bat species have been removed from oil pits around the country. Because bats have been documented using oil and gas production pits in Wyoming, these areas have the potential to serve as population sinks if left exposed for bats to use.

- Production, Emergency, or National Pollutant Discharge Elimination System (NPDES) pits must be maintained to exclude bats at all times. If netting is used, it must be maintained so as not to become a trap for bats.
- Production equipment with vent pipes, exhaust stacks, or other areas that may provide access for bats must be screened to

Bat species associated with major conservation issues in Wyoming.

Bat Species	Oil and Gas Production Pits	Wind Energy Development	White-nose Syndrome
Western small-footed myotis			
Long-eared myotis	X	X	X
Northern myotis			
Little brown myotis		X	X
Fringed myotis			
Long-legged myotis			
Hoary bat	X	X	
Silver-haired bat	X	X	
Big brown bat		X	X
Spotted bat			
Townsend's big eared bat			
Pallid bat			
California myotis	X		
Yuma myotis			
Eastern red bat	X	X	
Brazilian free-tailed bat		X	
Eastern pipistrelle		X	
Big free-tailed bat			

exclude them. Mesh screening must be no larger than 0.6 cm (¼ inch).

- Avoid placement of infrastructure, including roads and well pads, within 0.4 km (¼ mi) of known bat roosts.

WIND ENERGY DEVELOPMENT

There is growing concern that impacts to bats from wind energy development projects are substantially underestimated. Many researchers hypothesize that the abundance of North American bats could be significantly reduced within the next 10 years if efforts are not undertaken to minimize impacts to bats at wind energy facilities. Almost half of the 18 bat species that occur in Wyoming have been associated with fatalities at wind energy facilities in the United States, with migratory foliage-roosting species most heavily impacted.

- Whenever possible, develop strategies in cooperation with wind energy proponents that extend survey periods beyond the minimum recommendations to improve understanding of potential impacts to bats.
- Project proponents should provide access to researchers, such as universities, Bats and Wind Energy Cooperative, and Bat Conservation International, to improve the understanding of impacts to bats.
- For human health and safety, discourage handling of dead or injured bats by individuals without rabies prophylaxis.
- Ensure that the use of experimental technologies, such as bat deterrents and radar, is robustly evaluated to improve understanding of applications.
- If habitat evaluation and pre-construction monitoring indicate that potential risks to bats are higher than initially expected due to concentrated roosting or foraging activity, then consider alternative strategies, such as selecting a new site, curtailing construction, or revising project design.
- After project area habitat evaluations have been performed, implement appropriate BMPs for habitats as identified in previous sections, implement bat and wind survey recommendations developed by the Wyoming

PHOTO BY MERLIN D. TUTTLE, BAT CONSERVATION INTERNATIONAL, WWW.BATCON.ORG

Foliage-roosting bats, such as this hoary bat, are likely to be the most impacted by wind energy development.

Bat Working Group, and minimize impacts to bat SGCN.

- Where possible, locate new wind energy facilities on lands that are already developed, cultivated, or disturbed. Place linear facilities, such as transmission lines and access roads, in or adjacent to existing disturbed corridors to minimize habitat loss or fragmentation.
- Avoid placement of infrastructure, including roads and turbines, within 0.4 km (¼ mi) of known bat roosts.
- When siting wind turbines within 3.8 km (2 mi) of areas that are potentially high-risk for bats, including wetlands, riparian areas, forests, and flight concentration areas, consider increasing survey effort by increasing survey length and intensity to improve the evaluation process and siting of turbines. Use site-specific information to make final siting determinations for projects.
- Where possible, encourage the use of programmable turbines that allow for adjustment of cut-in speed, or curtail nightly operation of wind turbines during high-risk periods, including migration and times of low wind speed (less than 22 kph [13 mph]) when energy production is minimal.

PHOTO BY MARVIN MORIARTY, UNITED STATES FISH AND WILDLIFE SERVICE

The little brown myotis, one of the most common bats in the United States, is also one of the hardest hit by white-nose syndrome; symptoms result from a cold-adapted fungus.

WHITE-NOSE SYNDROME

White-nose syndrome (WNS) is named after the conspicuous white fungus, *Geomyces destructans*, that grows on the muzzles and exposed skin of some infected bats, although not all infected bats will demonstrate this symptom. Since the discovery of WNS in New York in 2006, over 5.5 million bats are estimated to have died from WNS-related symptoms, the majority of which are cave-roosting species. Although the exact cause of death is under investigation, scientists believe that infection of the skin leads to increased evaporative water loss through the wings and ears. This results in frequent thirst-associated arousals, which causes bats to burn off accumulated fat stores quicker, leading to death by starvation or freezing. Bats spread the fungus by aggregating, but human activity has also been implicated in the transfer among some caves. Although WNS has not yet been documented in the West, it is believed it will continue to spread westward, eventually affecting bats throughout much of the US. However, there are a number of actions humans can take to help mitigate this spread.

- Avoid any unnecessary entrance into known bat roosts, hibernacula, or any potentially affected sites, and observe all federal, state, and local cave restrictions and closures.
- Although some bats in a cave may demonstrate symptoms of WNS, do not assume all bats are suffering from the fungus.
- Take care to avoid cross-contamination within and among caves. Thoroughly scrape off any dirt from clothing, boots, and equipment upon leaving a cave. Seal all items in a plastic

bag until they can be cleaned and disinfected. Decontaminate all clothing, footwear, and gear with bleach or professional antibacterial cleaner between every cave visit. Refer to current decontamination protocols (Abel and Grenier 2011). Do not take gear into a cave that cannot be fully decontaminated.

- When necessary or prudent, limit or restrict public access to caves by installing bat-friendly closures to reduce the potential spread of WNS by human activity.
- Establish educational programs and use signs and other interpretive media to inform the public about the threat of WNS to bat populations and the importance of proper decontamination between cave visits.
- Report unusual behavior, such as daytime flight, especially during cold weather, and dead or dying bats found on the ground, trees, or buildings to the Wyoming Game and Fish Department.

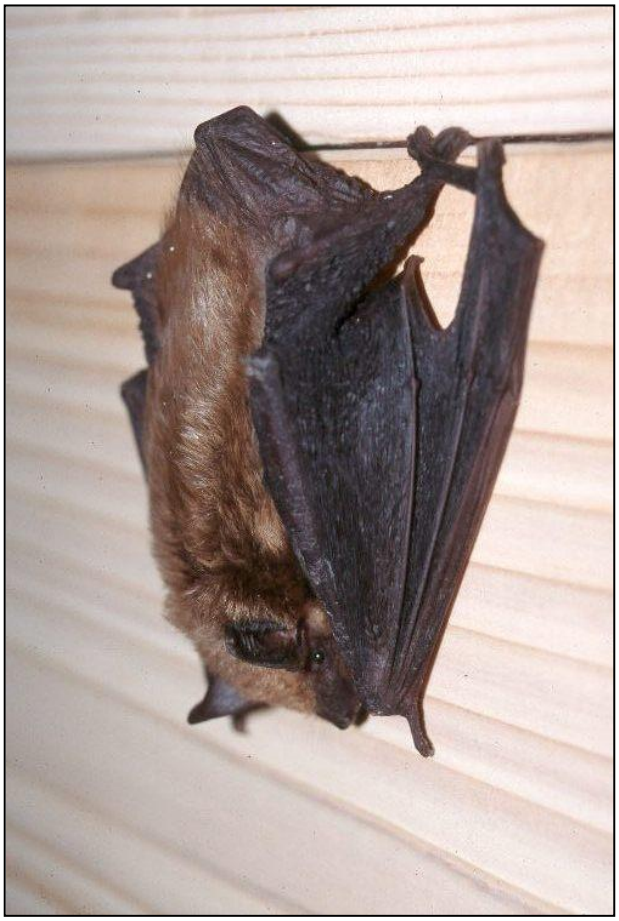

PHOTO BY BOB LUCE, WYOMING GAME AND FISH DEPARTMENT
Big brown bats are likely the most common bat species in Wyoming and one most often encountered by humans.

CONTACT INFORMATION

The Department uses information about where bats are roosting to learn more about bat populations in Wyoming. Personnel can also help you with ways to share your building with bats, or, if necessary, techniques for excluding bats from your building. **If there are bats roosting in your home or other buildings, please contact the Nongame Mammal Biologist at the Wyoming Game and Fish Department, at (307) 332-2688 or (800) 654-7862.**

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PHOTO BY MERLIN D. TUTTLE, BAT CONSERVATION INTERNATIONAL, WWW.BATCON.ORG

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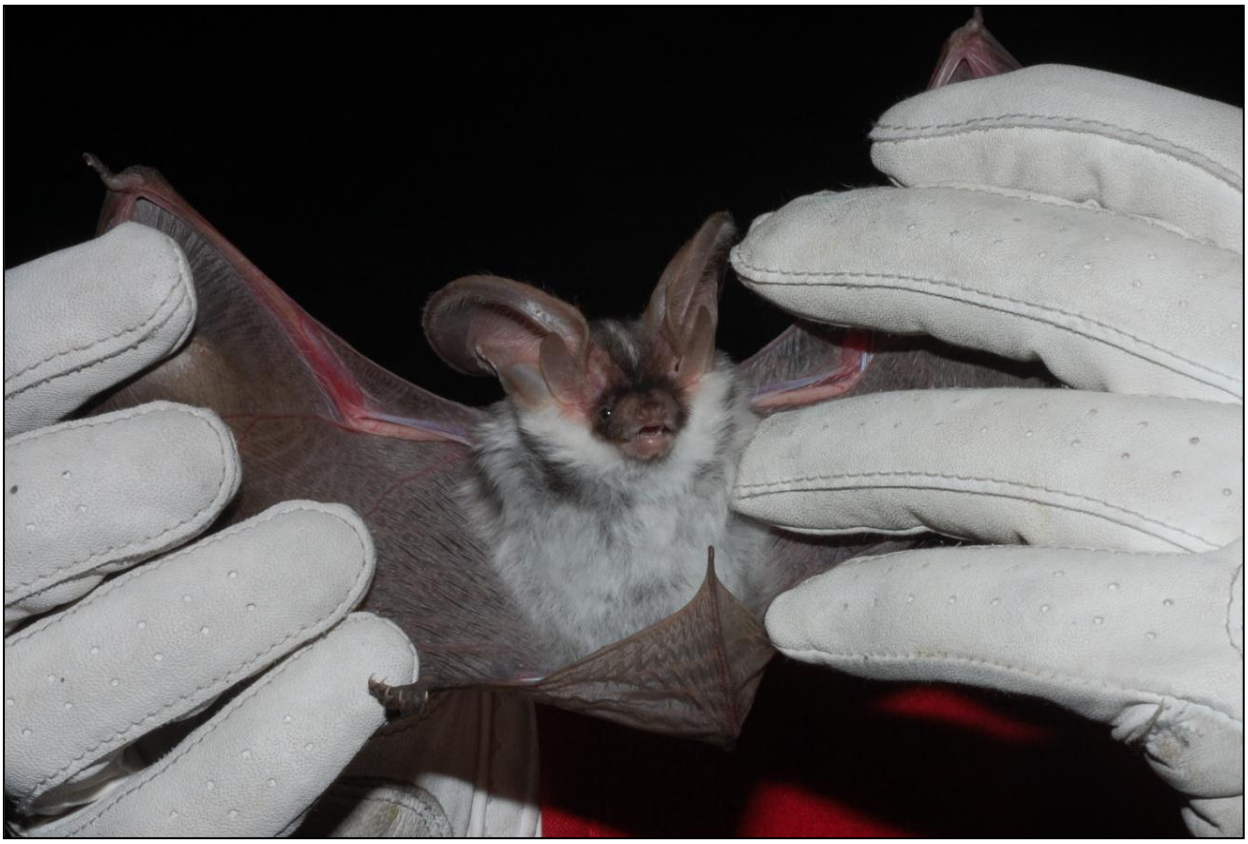

PHOTO BY SHELLY JOHNSON, WYOMING GAME AND FISH DEPARTMENT

The spotted bat is one of 12 resident Wyoming bat species, 10 of which are recognized as Species of Greatest Conservation Need by the Wyoming Game and Fish Department.

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PHOTO BY BOB LUCE, WYOMING GAME AND FISH DEPARTMENT

Pallid bat