

Reducing Ecological Impacts
of Shale Development:
RECOMMENDED PRACTICES
FOR THE APPALACHIANS

SEASONAL TIMING OF ACTIVITIES

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Activities associated with shale oil and gas and other types of development, such as construction, road traffic, vegetation management, drilling, and hydraulic fracturing, can disrupt fish and wildlife behavior and reproduction due to human presence, sedimentation, and noise and light disturbances. The degree to which species might be impacted by these activities can depend on the time of year and the type of impact. The potential for disturbance increases during critical life stages such as juvenile development, breeding, migration and hibernation. Restrictions on particular forms of development activities during critical times might help to reduce impacts on wildlife in the Appalachian region.



STATE OF THE RESEARCH

Loud and chronic noises, human presence, artificially lit infrastructure and other factors associated with shale development can cause some terrestrial and aquatic species to avoid or abandon suitable habitat, change their behavior and daily activities, and experience lower reproductive success and higher rates of mortality.¹⁻⁷ Research indicates that impacts can be more severe during critical life stages.⁸⁻¹⁰

Critical life stages of wildlife, including breeding, rearing, migration and hibernation, occur seasonally and drive the reproduction and survival of populations. Subsequently, disturbances during these times can impact breeding success and long-term survival of populations.

Oil and gas development during breeding seasons has been shown to negatively influence some species of birds, mammals, amphibians and reptiles, and some studies suggest these impacts can increase with well density.^{11,12} Noise, human presence and other activities can interfere with and alter mating calls, impair the ability of parents to care for young, and disrupt hibernation.¹³⁻¹⁸ These effects vary widely among species depending on a number of factors, such as the animal's behavior, physiology, habitat, type of disturbance, tolerance to disturbance and ability to acclimatize.^{10,19}

Substantial research also shows that water withdrawals for shale gas operations can alter the magnitude and timing of seasonal stream flow patterns, impacting stream habitats, aquatic species and

water quality.²⁰⁻²² Small streams and tributaries have been increasingly targeted for withdrawal, making the likelihood of cumulative impacts downstream greater.^{21,23-27} In the Appalachian region, more than 1,000 species rely on the seasonal patterns of stream and wetland habitats to cue and support critical life stages (e.g., spawning).²⁰

Further research could improve understanding of the severity of impacts to species based on when development activities occur and the long-term consequences to wildlife populations and water quality in the Appalachian region. This research might help management strategies be more effective and could point to whether development activities are less harmful to wildlife when temporally concentrated or distributed.

Seasonal timing is an important consideration in reducing disturbances related to all aspects of oil and gas development. The information in this document focuses on seasonal timing of activities related directly to wildlife and does not address the timing of vegetation management or land clearing.



EVIDENCE OF IMPACT Habitat Avoidance and Abandonment

Disturbances from shale development, such as truck traffic, construction and compressor stations, can cause species to abandon or avoid habitat they might otherwise use for breeding, food or shelter.¹ This behavior has been observed in some species of birds and mammals and can be exacerbated during times when wildlife is already stressed. For example, [artificial lighting](#) has been shown to deter birds from establishing nests nearby.²⁸

Clearing forested land for well pads and associated infrastructure can be damaging to wildlife inhabiting the area and increase the potential for insect and disease spread. Several bat species roost or form maternity colonies in trees during the summer months.^{29,30} Removal of these trees reduces critical habitat features and can ultimately reduce the populations of these species.³⁰

Disturbances can also change movement patterns and habitat use of wildlife.⁷ For example, rather than acclimating to the presence of active well pads, mule deer used areas farther from well pads as development in-

creased, resulting in displacement to less-suitable habitat.^{31,32} Other species are more tolerant of disturbances, such as white-tail deer that will approach well pads to take advantage of grazing opportunities. Regardless, development alters the way wildlife use habitat.^{33,34}

Road Mortality

Vehicle-wildlife collisions are a direct impact of [roads](#), including access roads for shale infrastructure. Rates of road mortality depend on the surrounding landscape and habitat features; road characteristics, like surface type, traffic volumes, and road width; time of day and time of year; and species life stage, age, and sex.³⁵⁻³⁷ Individuals within a species, such as dispersing young and females migrating to nesting grounds, can be more susceptible to road mortality during these times of high movement. For example, road mortality of bats is higher for dispersing young (late summer) and when closer to commuting routes and roost areas.³⁵ These impacts, along with isolating populations and reducing gene flow, can affect local population dynamics.^{3,35,38-40}

Amphibians and reptiles are particularly vulnerable to road mortality which occurs more frequently during seasonal movements and between important habitats, such as wetlands.^{3,35,41} Studies suggest female freshwater turtles are more susceptible to road mortality than males during their breeding season, which might be because they travel farther than males or are attracted to roadside habitat for nesting.^{35,42}

Lower Reproductive Success

Disturbances during the breeding season can reduce the ability of some species to find a mate and successfully breed. [Noise](#) and human presence can interfere with mating calls, lead to abandonment of young, and upset other breeding and rearing behaviors. Breeding success might also be hindered because females of many species are more sensitive to human presence while pregnant and while caring for young.^{7,39} For example,



Turtle populations, including painted turtles and snapping turtles, are highly susceptible to road mortality. Traffic restrictions can help reduce vehicle-wildlife collisions.
© Christian Engelstoft

elk females and calves have been observed to be more sensitive to disturbances during the early calving season.^{4,7}

Birds can also be impacted by disturbances during their breeding season. Noise from drilling activities occurring in early to mid-spring can conflict with the breeding songs of forest-interior birds, thereby impacting breeding success.¹² For example, ovenbirds have been found to have lower pairing success up to 2,000 feet from loud compressor stations.⁴³ Similarly, breeding activities of a variety of bird species can be disrupted by traffic noise and reduced air quality.^{6,35,44} Raptor nests can be abandoned or left for prolonged periods as a result of frequent or excessive disturbance, often reducing the survival of young.¹⁷

Aquatic species are sensitive to sedimentation, which can be caused by construction and other activities, during early development when eggs and larvae are immobile. The accumulation of fine sediment can fill pool habitats and plug spawning gravels, affecting many species of fish, including native brook trout.^{8,45-49} Foraging opportunities for mammals and birds might be reduced due to the loss or delay in seasonal hatches of aquatic invertebrates, such as mayflies and stoneflies, as a result of sedimentation.⁵⁰⁻⁵²



Winter habitat is crucial to the survival of wild turkeys.
© Kent Mason



Disturbances during breeding and rearing periods can affect the behavior of parents and young. © Kent Mason

Disruption of Migration and Hibernation

Development activities and infrastructure can affect migration patterns of birds, fish, mammals, amphibians and reptiles by interfering with navigation or fragmenting important habitat areas along a migration route. Roads and other infrastructure can obscure olfactory and pheromone cues used in migration and orientation.³ For example, snakes might use scent trails and pheromones to find hibernacula, where they concentrate in the fall, and again when they disperse in the spring.⁵³

Wildlife are under considerable stress during winter.⁵⁴ Some species in the Appalachian region, such as black bears, rattlesnakes and bats, enter into hibernation to conserve energy during winter months when food is scarce. Human activity including visual and vibrational disturbances, can wake animals out of hibernation, causing them to use valuable energy reserves and decreasing their chances of survival.^{54,55} Bears have been shown to respond to disturbances within 650 feet around denning sites, and in some cases abandon dens during hibernation.^{54,56}

Birds migrate along various routes within the Appalachian region in the spring and fall for food, shelter and rest.^{57,58} Artificial lighting during these times can interfere with migratory routes by disorienting and attracting birds.⁵⁹⁻⁶¹

Fish and aquatic wildlife migrations can be impeded or delayed as a result of improperly designed and maintained

[stream crossings](#).⁶²⁻⁶⁴ Crossings that simulate natural stream characteristics, such as width, velocity and substrate are less likely to create barriers.^{45,62,65-67}

Bats use cave and karst formations to hibernate from late fall to early spring, and disturbances near these sites during hibernation can arouse bats. A single arousal out of hibernation can cause a little brown bat to expend approximately 65 hibernating days' worth of fat reserves.⁶⁸ If bats are disturbed too often, they might run out of fat reserves before spring and could starve to death.

Altered Stream Flows

The individual and cumulative effects of surface and groundwater [withdrawals](#) for shale gas operations pose a high risk to regional water availability, water quality, stream habitat, and species abundance and diversity. Individual withdrawals have the potential to impact the magnitude and timing of seasonal flow patterns, which support stream habitats, species diversity and water quality.²⁰⁻²²

Many riverine functions depend on the unique, slower and shallow habitats in headwater reaches and on the edge of streams and rivers. Surface water withdrawals can cause rapid fluctuations of stream flow. Withdrawals can remove water from shallow habitats, stranding juvenile fish, mussels and aquatic insects, and resulting in a loss of connectivity between upstream and

downstream areas, and preventing movement of species along a stream.⁶⁹ This poses particular risks to species with limited mobility (e.g., developing fish and amphibian eggs).^{70,71}



CONSERVATION PRACTICES AND SCIENTIFIC SUPPORT

Scientific literature suggests conservation actions that encourage seasonal restrictions on some activities during times critical to Appalachian wildlife. A complete inventory is necessary to adequately implement seasonal restrictions. The following practices are derived from management and guidance [documents](#) developed by state agencies, scientific/conservation organizations and industry groups.

Implement Seasonal Restrictions

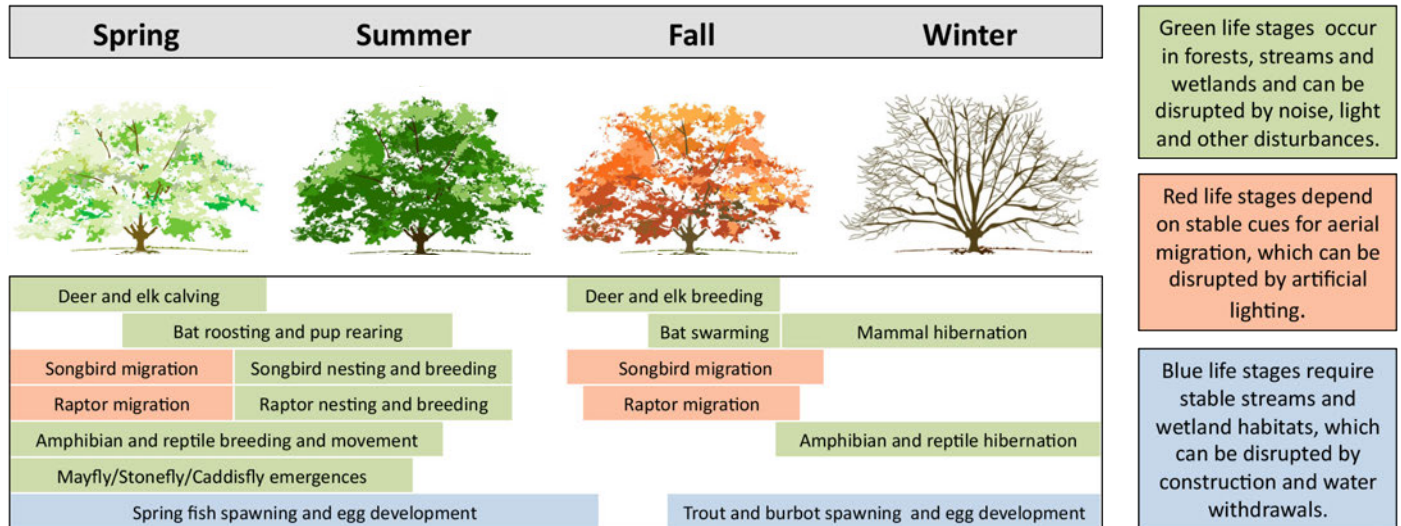
Scientific literature indicates that minimizing noise, light and other disturbances during critical periods might reduce impacts to wildlife.^{2,6,9,44,72}

Studies have demonstrated that seasonally limiting road access through road closures and gating has benefited elk, wolves and black bears by reducing avoidance behavior and road mortality.^{36,73-76} Reducing speed limits and implementing road closures, particularly during dispersal and breeding seasons of amphibians, can drastically decrease mortality rates.³⁶



Shale development can disrupt hibernation, patterns of movement and habitat use in many species, including bats. © Robert and Linda Mitchell

Seasonal Activity of Appalachian Wildlife



Consideration of the seasonal activities of nearby wildlife during planning, construction and operations might help lessen impacts to wildlife. This graphic only represents some Appalachian species, and specific timing of activities varies by species, age, sex and a variety of other environmental factors.

Construction and maintenance activities during wet periods increase the risk of severe erosion and sedimentation.^{45,46,66,77-79} Limiting heavy construction activities during spring thaw and other wet periods can lessen risks. Regular monitoring and maintenance, particularly on infrastructure that can deteriorate from heavy traffic and storms (e.g., drainage features and stream crossings), can reduce adverse effects on aquatic habitat.

Shielding artificial lighting during times and near areas important to wildlife – including priority bat foraging and roosting areas, wetland habitat, and places where large numbers of birds concentrate to nest, feed and roost, or within migration routes – can reduce impacts to wildlife.^{28,59,84-87}

Timing can also influence the impacts and effectiveness of land clearing and pest and vegetation management activities. For example, land clearing can be problematic for oak trees in the spring, when the sap is running.

Existing conservation practices recommend implementing seasonal restrictions on traffic, construction and operations, noise, light, and maintenance activities during critical nesting, mating,

dispersal, migratory and hibernation seasons.

Establish Ecological Buffers

Scientific literature suggests that disturbances from development can be reduced by establishing buffers around important habitats, particularly during sensitive periods.^{5,17,88-96} Reducing impacts to bat populations by minimizing disturbing activities has become increasingly important as *Myotis* populations in the Appalachian region have recently been decimated by white-nose syndrome. Upland and interior buffers around caves and other bat hibernacula can help reduce the disturbances to bats and other cave-dwelling species.⁹²

Existing conservation practices recommend establishing [buffers](#) around important habitat, breeding and hibernation areas. Prior to development, identify wildlife or habitat areas that might benefit from buffers by completing a [survey](#) of biological and physical components – including species of conservation concern, active raptor nests, important habitat areas and high-quality streams.



When shale development overlaps with critical seasonal activities of wildlife, it can impact the reproductive success and survival of species. © Tamara Gagnolet, TNC

TNC Recommended Conservation Practices

Based on scientific literature and existing practices, The Nature Conservancy recommends the following practices:



Prior to development, conduct an inventory to identify nearby wildlife and ecologically important areas and **establish appropriate buffers** for nesting and hibernating species, such as active raptor nests and bat hibernacula.



Implement seasonal restrictions on construction and operations during critical nesting, mating, dispersal, migratory and hibernation periods. In general, heavy activity should be limited during spring and early summer, the most sensitive seasons. Restrictions include:

- **Limiting road access, traffic and speed** during mating and dispersal periods for mammals, reptiles and amphibians to reduce road mortality, especially between wetlands. Traffic and use of heavy machinery should also be limited during spring thaw and other wet periods to minimize risks of excessive erosion, road damage, and stream and wetland sedimentation.
- **Avoiding construction in and near streams** during critical life stages for fish, reptiles and amphibians, particularly during spawning times (May through July, and October through November).
- **Minimizing noise and artificial lighting** to reduce disturbances to reproductive behavior, hibernating wildlife and disruption of migratory pathways. Upward lighting should especially be avoided during bird migration periods (early April through early June, and mid-August through mid-October).



Consider the time of year when vegetation management and land-clearing activities are least disruptive to wildlife, while accounting for other constraints. For example:

- Limit mowing during nesting season for grassland birds (late April through mid-August).
- In bat roosting areas, avoid removing trees in the spring/summer months.
- Take precautions to limit the spread of invasive plants, insects and disease.

These recommendations are part of a suite of recommended practices intended to avoid and reduce impacts of shale development on Appalachian habitats and wildlife. These practices might need to be adapted to incorporate new information, consider operational feasibility, and comply with more stringent regulatory requirements that might exist.



Visit nature.org/shale-practices-refs for a list of references used in this document