

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

NOISE



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Sounds of nature are an important characteristic of the Appalachian mountains. As oil and gas production has increased throughout the region, it has brought with it many sources of noise, including high volumes of truck traffic, construction equipment and operations, the fracturing process, and compressor stations. These chronic or sporadic sources of noise can impact surrounding wildlife by interfering with communication and other auditory cues, reducing habitat quality, and causing changes in physiology and behavior. Noise-reducing practices can help to alleviate these impacts.



STATE OF THE RESEARCH

The impact of anthropogenic noise on wildlife is a relatively new subject, and consequently only a small body of research is available. Research demonstrates that noise can affect the behavior and habitat use of wildlife, interfere with communication and other auditory cues (e.g., sounds to detect predators or prey, alarm and mating calls), and cause physiological responses. Although effects on communication and behavior may not seem significant, they can translate into loss of habitat, reduced reproduction and reduced survival.¹⁻⁴ Noise may also exacerbate environmental stressors, such as those caused by habitat fragmentation.^{2,4}

The response of wildlife to noise varies for a number of reasons, such as the timing, intensity and frequency of the sound, and the species' habitat and

tolerance to noise.¹ Some species seem to be fairly noise-tolerant and show little or no response to noise, while other species show significant changes in behavior and reproductive and survival rates. Excluding laboratory experiments, responses of wildlife to noise have been predominately studied on birds, mammals and marine animals.

Noise levels can significantly differ depending upon the frequency of the sound and the surrounding environment.^{5,6} Noise may affect wildlife in similar ways regardless of habitat type, but the distance and severity of those effects might not be similar. Surrounding topography and vegetation greatly influence how sound travels.^{5,6} There can also be significant differences in noise level depending on where an animal is in the environment (e.g., high in a tree or at ground level) and other environmental factors, like temperature and wind.⁵

Examples of Noise Levels



Adapted from the Occupational Safety and Health Administration.

Examples of wildlife responses to noise:

- Change in vocalizations of some birds, mammals, frogs and insects in noisy environments.^{2,7-9}
- Decrease in bird density and nesting success up to 700 meters from compressor stations.^{1,10}
- Common physiological responses to noise can include an increased heart rate and changes in metabolism and hormone balance.^{3,4,11}



Black-throated blue warbler and young. © Steve Maslowski, USFWS

As a result, there remains a significant lack of scientific information regarding species-specific responses and tolerances to noise. Knowledge is also limited in how species rely on sounds in the subsonic (below the range of human hearing) and ultrasonic (above the range of human hearing) frequencies. In some cases, even though humans might not hear the noise, it can be very disruptive to wildlife, even from long distances. Considering the importance of acoustic signals in behavior and reproduction, noise and sound vibrations are likely to affect many species. Particularly in the Appalachian region, which has large expanses of relatively quiet habitat, noise from gas development and operations can change the natural soundscape of the area.



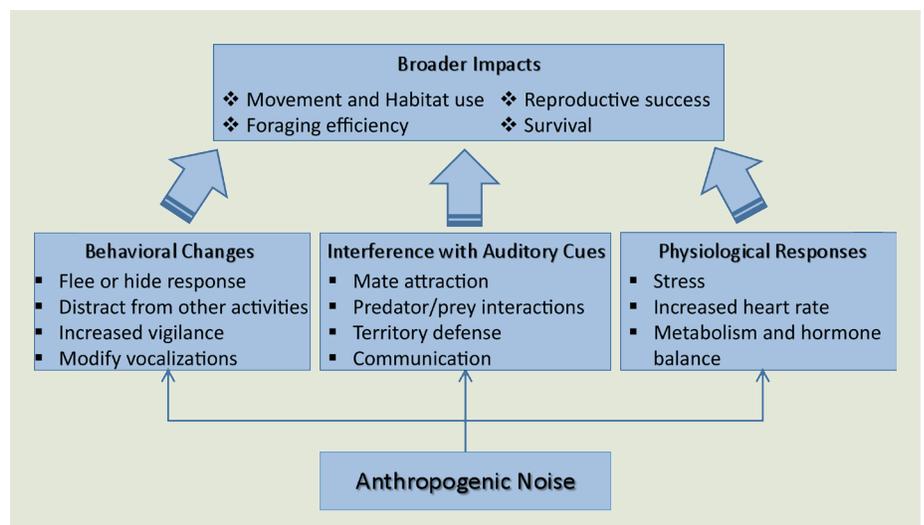
EVIDENCE OF IMPACT Behavioral Changes

Noise may affect wildlife in different ways, depending on how regularly it occurs. Sporadic noise, which is often perceived by wildlife as a threat, results in energetic costs associated with flight behavior, increased vigilance and reduced foraging time.¹ Chronic or frequent noise, such as compressor stations that run all day throughout the lifetime of the well, can affect the way an animal uses its energy budget on a daily basis, negatively impacting its reproductive success and long-term survival.³

Behavioral responses to chronic or frequent noise include changes in foraging, mating and anti-predator behavior; shifts in vocalizations to reduce masking effects (i.e. the masking of a signal by noise of a similar frequency); and habitat avoidance and abandonment.^{1-3,7,11-17} One study found reduced pairing success and lower species density of ovenbirds nearly a half-mile from operating compressor stations, and similar results have been found for eastern bluebirds.^{1,10}

Responses to noise vary widely among species, suggesting that noise tolerance

is species-specific.^{1,9,18} Part of the reason for such a high variability in noise tolerance might be the extent to which a species can alter their vocalizations to avoid masking effects, which has been shown to occur in species of birds, mammals, frogs and insects.^{2,7,8} These animals modify their vocalization to compete with noise by increasing the redundancy, changing the timing, frequency, and/or duration of their calls.^{1,7,9} For example, robins have been documented singing at night instead of during the day to avoid acoustic interference.¹ Although these changes in vocalizations suggest that animals can



Adapted from Francis (2013), A framework for understanding noise impacts on wildlife: an urgent conservation priority, Page 309



One of the quintessential signs of spring is the chorus of spring peepers. Anthropogenic noise may interfere with the mating calls of this and other frog species.
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successfully adapt to noisy environments, the consequences on mate attraction, territorial defense and other important behaviors and functions are relatively unknown and are likely significant.¹

Interference with Auditory Cues

Species use acoustic signals for several purposes, such as mate attraction, alarm calls, establishing and defending territories, orientation, predator-prey detection, and communication within and among species.^{1,2,10,11,13-16,19-21} Interference with these signals can affect survival and reproductive rates, reduce habitat quality, and change species' behavior and interactions.^{1-3,10,13,15,19,22-25} For instance, predators that rely on noise to detect prey might miss foraging opportunities as a result of noise. Similarly, prey might miss alarm calls or other noises to avoid predators.¹

Frequent or chronic noise can cause animals to miss auditory cues or distract from other functions (e.g., foraging, breeding) to the extent that they avoid or abandon otherwise suitable habitat, changing how species use habitats, access resources, and indirectly impacting reproductive and survival rates.^{9,10,13,19,22} Elk and mule deer have been shown to increase movement and abandon optimal habitat in response to increased levels of development, seismic activity and frequent noise.^{12,26,27}

Noise-tolerant species may benefit from inhabiting noisy areas by taking advantage of decreased predation rates and less competition, but might also suffer from reduced reproductive

success.^{1,13,19,25} For example, a species of treefrog in Panama prefers calling in noisier habitats possibly because one of its predators, the gleaning bat, avoids hunting in noisy environments. However, calling in a noisier environment reduces the transmission distance of the treefrog's call, presumably reducing its effectiveness in attracting a mate.² Noise has been shown to reduce habitat for other species of bats as well.^{9,28}

Physiological Responses

Severely damaging physiological responses, such as permanent hearing loss and hypertension, do not begin to occur in humans until noise levels reach 90 dB.^{2,29} However, common physiological responses to noise at various levels can include an increased heart rate and changes in metabolism and hormone balance.^{2-4,11} The small amount of research in this area suggests these responses can lead to decreases in reproductive and survival rates, however more research is needed to understand this linkage.¹



CONSERVATION PRACTICES AND SCIENTIFIC SUPPORT

Scientific literature supports noise-reducing practices to help alleviate the impacts of noise on wildlife. The following practices are derived from management and guidance [documents](#) developed by state agencies, scientific/conservation organizations and industry groups.

Reduce Noise

Scientific literature demonstrates that sound is best reduced by increasing distance from the source, and is also influenced by the environment (e.g., trees, topography), wind, temperature and the design of the structure.^{5,6} Suppressing subsonic, audible and ultrasonic noise, particularly at compressor stations, can reduce the amount of sound released into the surrounding environment and minimize the overall impact of noise on wildlife. A variety of noise-reducing methods are available to use, including enclosing infrastructure, traffic restrictions, and using mufflers

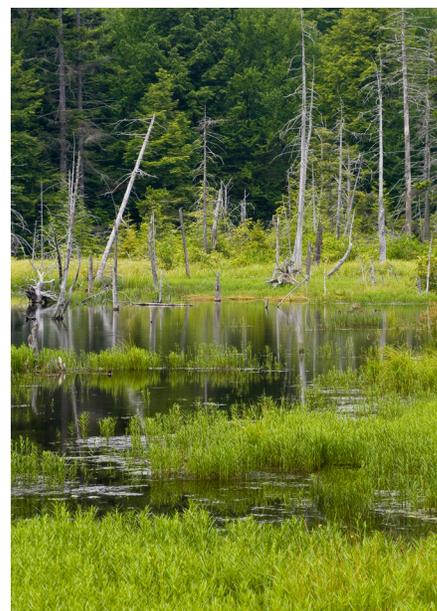
and sound barriers.^{13,30} For example, sound barrier walls around compressors have been shown to reduce the area affected by up to 70 percent, and vegetative barriers are a low-cost option but are typically less effective.^{10,13,18,22}

Existing conservation practices

include minimizing noise through a variety of methods: (1) Consolidate infrastructure to minimize noise and surface impacts; (2) Control noise from drill rig engines, pump jacks and compressors by using noise-reducing methods such as mufflers, vegetative screening or sound-absorbing walls;³¹ (3) Locate noise-producing facilities in a way that reduces sound travel; (4) Use remote, automated monitoring systems after the well is completed to reduce traffic and associated noise.

Avoid Areas and Times Important to Wildlife

Scientific literature shows that noise can interfere with species communication and intensify stress during mating and breeding seasons.^{13,21,30,32,33} During [these times](#), avoiding important breeding habitats, such as wetlands, and implementing methods to reduce noise might lessen impacts. Research demonstrates that noise associated with traffic can be



Wetlands are important breeding areas for amphibians. Reducing noise around these areas, especially during breeding seasons, might help reduce impacts to wildlife.
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reduced by re-routing trucks to avoid sensitive areas, altering the timing and/or distribution of traffic, enforcing speed reductions, temporary road closures, quieter road surfaces and vegetative noise barriers.^{16,19,23,24,34}

Existing conservation practices include seasonally reducing noise from industrial development and traffic, especially in breeding and brood-rearing habitats. Reducing chronic noise near bat hibernacula during winter hibernation is particularly important in avoiding disturbances to hibernation.

Monitor and Implement Adaptive Management

Scientific literature reflects the importance of conducting noise assessments in subsonic, audible and ultrasonic frequencies as a part of an effective adaptive management strategy.^{2,35} Measuring noise levels can prove to be problematic, as measurement techniques, surrounding topography and

vegetation and environmental variables (e.g., temperature, wind) can impact calculations.⁵

Developing and implementing an adaptive management program, including monitoring and evaluation, documentation of environmental changes, and mid-course corrections to practices

if necessary can significantly improve the effectiveness of management practices.

Existing conservation practices recommend that all facilities be tested and monitored to determine noise levels. Some organizations recommend not exceeding an audible noise level of 55 dB(A) at 300 feet from the source.

TNC Recommended Conservation Practices

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

-  **Reduce noise by:**
 - **Properly siting noise-producing facilities**, including well pads, access roads, and compressor stations, by accounting for topography, surrounding vegetation and sensitive areas (e.g., wetlands, bat hibernacula).
 - **Careful design of noise-producing facilities**, including the use of less noisy equipment, natural or artificial sound barriers (e.g., sound barrier walls, vegetative screening) and noise-reducing or absorbing equipment (e.g., mufflers).
-  **Keep noise levels below 55 dB(A)** at 300 feet from the source.
-  **Changes to the duration and timing of noisy activities** might reduce adverse impacts to wildlife during critical periods, like breeding and hibernation.
-  **Monitor noise levels** (decibel and frequency) before and during development and support research on how noise affects wildlife and actions that can reduce those impacts to aid adaptive management strategies.

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](https://www.nature.org/shale-practices-refs) for a list of references used in this document



The drilling and fracturing process can exceed 95 dB(A) and continues 24 hours a day until completion. Noise-reducing practices, like this sound barrier can reduce noise levels in the surrounding areas. © Penn State Cooperative Extension