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

SUMMARY OF RECOMMENDED PRACTICES

The Nature Conservancy has **summarized potential ecological impacts** of Appalachian shale energy development based on research relevant to the region, has **reviewed leading existing practices**, and is **recommending science-based conservation practices** to avoid and reduce risks from shale infrastructure and operations on Appalachian wildlife, habitats and the services they provide.

The Appalachian region hosts some of the world's healthiest and most biologically diverse temperate forest and freshwater systems, which provide clean, reliable water supplies, outdoor recreation opportunities, and other services for tens of millions of people every day. At the same time, the region is home to the largest global unconventional oil and gas reserves, and shale development is transforming Appalachian landscapes and communities. Developing these energy resources requires a vast infrastructure network — including well pads, pipelines and roads — which removes and fragments natural habitats and alters wildlife behavior. Occurring primarily in forested and agricultural areas, this land conversion also strains the health of our freshwater systems.

Research by The Nature Conservancy estimates that shale oil and gas infrastructure development could profoundly influence terrestrial and aquatic ecosystems on a large, landscape scale through habitat loss, habitat fragmentation and degradation of ecosystem services important to the Appalachian region.[1,2,3] How we choose to meet U.S. and global demand for energy will have significant implications for both biodiversity and human well-being.

Existing federal and state regulations address a number of potential environmental impacts associated with shale development, but, considering that unconventional oil and gas extraction is relatively new to the Appalachian region, regulatory gaps remain. Leading oil and gas companies have adopted voluntary practices to reduce potential impacts, but their successes are largely unknown and have not been widely implemented across the entire industry.

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This collection of documents describes the potential ecological impacts of Appalachian shale development and recommends science-based practices to reduce them, in the following categories:

- Landscape-Scale Planning
- Ecological Buffers
- Road Development
- Stream Crossings
- Water Withdrawals
- Noise
- Artificial Lighting
- Seasonal Timing of Activities

View the scientific literature behind our impact summaries and recommended practices, and browse additional resources to learn more about shale development.

Our Objective:

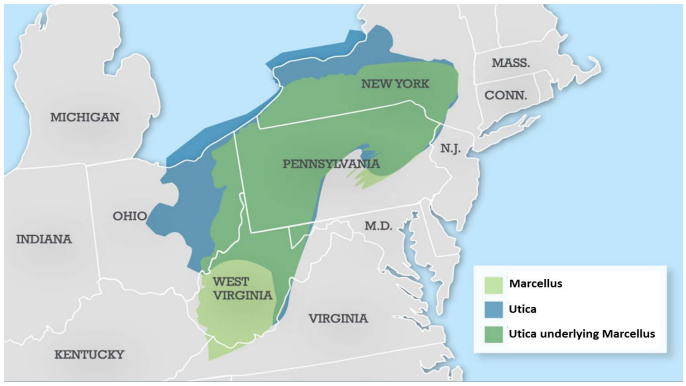
The Nature Conservancy's recommended conservation practices aim **to avoid and reduce risks from shale infrastructure and operations to Appalachian wildlife, habitats and the services they provide**. Given the amount of development that has already happened and is projected to occur, the goal of these science-based recommendations is to influence how shale development happens in the Appalachian region (see map). The Nature Conservancy's recommended practices can be used as guidelines in development plans and leases.

Our Approach:

- **Focuses on the surface impacts of infrastructure development** (including well pads, compressor stations, roads and pipelines), which have been underrepresented in studies of impacts and associated risks.
- Addresses the planning, design, construction and operational phases of development.
- Is **based on the best available science** and scientifically supported best practices.[4] Additional research is critical to better understand the interactions of species, communities and ecological systems relative to shale development.
- Recognizes that **landscape-scale planning is the foundation for these recommended practices**. Comprehensive planning at a landscape scale can influence the design and placement of infrastructure to avoid sensitive local and regional features, as well as reduce the overall footprint and impact of development.

Considerations in Application:

- This collection of documents does not address ecological risks associated with air quality or the transport, use, storage or disposal of fracturing chemicals. Nor does it address the subsurface risks associated with the hydraulic fracturing and production processes. Additional measures will need to be taken to analyze and address these risks.
- Implementation of these recommendations should not occur to the detriment of public health and safety. Additional measures will need to be considered to address any public health and safety risks.
- Recommendations might need to be adjusted on a continual basis to meet site-specific objectives; to comply with new or modified regulatory requirements; to consider landowner preferences, operational costs and technical feasibility; and to incorporate new information and technology.



Home to both rich ecological resources and large oil and gas reserves — including the Marcellus and Utica shale formations — the Appalachian region is the geographic focus of this collection of documents. © Marcellus Shale Coalition

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The Nature Conservancy is a science-based organization working globally to protect ecologically important lands and waters for nature and people. The Nature Conservancy has studied the ecological impacts of energy development and has advanced strategies and tools that reduce those impacts around the world. We work with partners to find intelligent solutions that meet society's needs for energy while keeping our lands and waters healthy and productive.

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For more information, contact shale_practices@tnc.org

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The Nature Conservancy recommends the following conservation practices:

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Landscape-Scale Planning

Plan well pads and associated infrastructure at the landscape level to reduce the risk of cumulative surface impacts on Appalachian ecosystems and the services they provide.

- Prior to development, conduct an inventory to identify ecologically important areas and document a baseline condition.
- Coordinate early with all stakeholders to identify suitable alternatives and assess risk through a cumulative environmental impacts analysis.
- Maintain regional forest cover. Research suggests maintaining at least 60 percent forest cover in a watershed to adequately support wildlife and ecosystem functions.
- Limit increasing total impervious cover, particularly beyond key thresholds, to maintain existing watershed condition. Key thresholds for watershed condition occur as impervious cover exceeds 3 percent (loss of biodiversity) and 10 percent (reduced biodiversity and water quality).
- Maintain connectivity between core habitats and migratory corridors and continue to recognize the role of public lands and special designation rivers in providing these functions.
- Manage water allocation at the basin scale, accounting for social and environmental needs and cumulative use.
- Consolidate and co-locate infrastructure (e.g., combine rights of way), using areas that have already been disturbed and where it does not increase risk to public health and safety.
- Implement reclamation and restoration strategies during all phases of development.

Avoid placement of pads, roads, and pipelines in and near ecologically important habitats and areas subject to severe erosion.

- In the Appalachians, these areas include large forest patches greater than 1,000 acres, cave entrances, rocky outcrops, scrub oak/pitch pine barrens, freshwater habitats, floodplains, wetland and vernal pool complexes, seeps, bogs, fens, and slopes greater than 10 percent. They also include the specific habitats of species with special designations.
- Infrastructure should not encroach on ecological buffers necessary to support watershed condition and key feeding, breeding and hibernation habitats.
- Consider the time of year construction and operations will take place, and take appropriate actions to minimize disturbances to wildlife, including practices that reduce impacts from soil erosion, noise and light.

Regularly perform monitoring and maintenance activities throughout the lifetime of the infrastructure to:

- Prevent the spread and establishment of invasive species.
- Identify areas where excessive erosion or infrastructure failure has taken place after storm events, such as roads, drainage systems and stream crossings.
- Inform adaptive management strategies.

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Ecological Buffers

- **Preserve a buffer of at least of 330 feet around freshwater habitats** (i.e. streams, rivers, wetlands, ponds and lakes) to support fish and aquatic wildlife and to reduce sediment runoff, provide flood retention, moderate stream flow, maintain water temperatures, and provide vegetation inputs that form habitat in aquatic systems (including roots, branches, limbs and leaves). For larger streams, a buffer greater than 330 feet might be necessary to assure infrastructure is not sited in the floodplain.
- **Preserve canopy cover over headwater and cold water streams** to maintain water temperatures and physical habitat.
- **Avoid disturbance to sensitive species and habitats,** including those with special protection status by working with fish and wildlife management agencies to identify occurrences and develop site specific management plans. For example, larger buffers might be necessary around cave habitats to avoid extra stress on bat populations already significantly reduced as a result of white-nose syndrome.
- **Maintain vegetated buffers** that (1) are continuous along and around sensitive features; (2) connect lowland and upland areas; and (3) are composed of (or mimic the function of) natural vegetation.
- **Monitor buffers** during and after construction to ensure they are maintained throughout all phases of development, including identification and treatment of invasive plant species.

Road Development

- **Plan at the landscape level**, using existing corridors and forest edges and co-locating infrastructure, to minimize forest fragmentation.
  - Keep corridors narrow and preserve canopy cover to reduce edge effects and follow natural contours.
- When developing new roads, **avoid and minimize the placement of roads in and near ecologically important habitats and areas subject to severe erosion.**
  - In the Appalachians, these areas include large forest patches greater than 1,000 acres, cave entrances, rocky outcrops, scrub oak/pitch pine barrens, freshwater habitats, floodplains, wetland and vernal pool complexes, seeps, bogs, fens, and slopes greater than 10 percent.
  - Infrastructure should not be encroach on ecological buffers necessary to support watershed condition and key wildlife habitats.
- **Construct and maintain proper road drainage and erosion control** consistent with U.S. Forest Service Environmentally Sensitive Road Maintenance Practices for Dirt and Gravel Roads. Use materials less likely to produce dust and that will not alter roadside soil and stream chemistry.
- **Regularly inspect and maintain roads,** particularly after storm events, to repair surfaces, apply water to control dust, clean and repair ditches and stream-crossing structures, and conduct invasive-species management.
- **Minimize traffic** by restricting road access, particularly during times of the year when wildlife are most sensitive to road mortality and during wet periods to minimize damage to roads and risks of erosion.

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Stream Crossings

- **Consolidate infrastructure and use existing crossings** to minimize the number of new stream crossings.
- When developing new road crossings, **construct crossings that are at least 120 percent of bankfull width and that maintain natural streambed substrate** by using bridges, open-bottom culverts or embedded closed-bottom culverts. Crossings should allow for dry passage and provide comparable water depth and velocity conditions upstream and downstream.
- Temporary bridges may be used if they are able to withstand the anticipated traffic load. Fords should be avoided, especially when sensitive species are present.
- When constructing pipeline crossings, **use installation techniques that minimize the amount of sediment released into the stream and maintain adequate flow** to protect aquatic species.
- **Inspect regularly** and keep free of debris to reduce risk of flooding.

Water Withdrawals

- **Manage water allocation at the basin scale** by (1) accounting for social and environmental needs and cumulative use, (2) reporting permitted and actual withdrawals, (3) monitoring for site-specific hydrologic and biological conditions, and (4) instituting timely enforcement mechanisms.
- **Reduce surface and groundwater consumption** by requiring water conservation practices and accountability across the supply chain and by maximizing the use and re-use of lower-quality water sources.
- **Reduce or eliminate withdrawals where and when they individually or cumulatively risk adverse ecological impacts.** Specifically withdrawals should:
  - avoid sensitive habitats including headwater and intermittent streams, high-value streams and streams with rare or sensitive species;
  - limit alteration to the flow regime using regional science-based recommendations, when available — in the absence of regionally specific recommendations, a precautionary standard can be used;
  - not diminish groundwater recharge rates;
  - maintain existing water quality and not further impair water quality by diminishing stream flow.
- **Minimize impacts from access and diversion** by (1) co-locating water supply and storage facilities, (2) incorporating a safety factor to account for uncertainty in estimates of surface water availability, (3) avoiding the construction of new dams or weirs to create slack water pools, (4) limiting the maximum instantaneous rate of withdrawal from a stream, and (5) using appropriate procedures to minimize risk of transferring invasive aquatic species.

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Noise Control

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.

Artificial Lighting

Reduce light spillage by properly shading and directing light downward, diffusing light to reduce glare, using low-pressure sodium lamps, and avoiding and minimizing flaring (green completion).

Reduce the amount, intensity and timing of artificial lighting particularly (a) during migration periods and other critical times for wildlife, and (b) near aquatic and sensitive habitats. In the Appalachian region, bird and bat migrations usually occur from April through May and August through October.

Monitor light levels and support research on how artificial light affects wildlife — and actions that can reduce those impacts.

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Seasonal Timing of Activities

- [x] **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.

- [x] **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).

- [x] **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.

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