LAND USE AND ECOLOGICAL IMPACTS FROM SHALE DEVELOPMENT IN THE APPALACHIANS

THE NATURE CONSERVANCY

Summary Statement for DOE Quadrennial Energy Review Public Stakeholder Meeting
Pittsburgh, PA July 21, 2014

Background

The Central Appalachians are a national and global hotspot for forest and freshwater diversity. They have some of the world's best remaining examples of diverse, intact, and connected temperate forests and freshwater streams. Appalachian forests and rivers are also intricately linked to the well-being of local people and eastern cities including Pittsburgh, PA, Washington, DC, Harrisburg, PA, and Charlottesville, VA. The ecological services that flow from these rivers and forests – from clean, reliable water supplies to outdoor recreation – reach tens of millions of people every day. At the same time, the Central Appalachians are a rapidly expanding hub of energy development with abundant coal, natural gas, and wind resources situated close to the most densely populated region in the United States. This intersection of outstanding natural areas and valuable energy resources presents one of the most challenging contemporary conservation situations anywhere in the world.

Scope and Scale

There are at least 30 shale formations (in 25 states) with existing or potential oil and gas production across the United States (EIA, 2014). The Marcellus formation is the largest and underlies parts of New York, Pennsylvania, Ohio, and West Virginia.

Horizontal fracturing allows wells to drain a larger area than conventional vertical wells. This means well density is less but the size of pads, pipelines, water storage, compressor stations, and other infrastructure is larger.

Research by The Nature Conservancy (Johnson et al. 2010; Johnson et al. 2011) indicates each Marcellus well pad on average requires approximately 3 acres of land disturbance with an additional 25 acres required for associated access roads, gathering pipelines, water storage impoundments (28 acres total). Over two-thirds of this footprint is created by construction of gathering pipelines (19 acres). The development footprint for other shale formations varies, but not significantly.

No one knows for sure how many shale wells have already been drilled, but it likely exceeds 50,000 according to various sources (EIA, Frac Tracker). The amount of land converted for the infrastructure associated with 50,000 wells would be approximately 1.4 million acres based on an average of 6 wells per pad and extrapolating the infrastructure foot print measured by The Nature Conservancy in the Marcellus formation.

Approximately 20,000 shale wells were drilled in 2013 with a development footprint of approximately 560,000 acres. Drilling at this rate would require an additional 11.2 million aces during the next two decades, or about three-fourths the land area of West Virginia. It is possible shale infrastructure land requirements might be less with advances in technology and/or a decline in drilling rates (which might increase as well).

Observed and Projected Impacts

Water quality

- Shale development in Appalachians could increase impervious cover by 1.5 million acres which could lead to a 22% percent decline in watersheds classified in the best condition ("sensitive") Evans and Kiesecker (2014)

- Between 50-70% of Marcellus pads built in Pennsylvania are on soils and/or slopes prone to erosion and 21% built on potentially wet soils with risk of drainage problems (Drohan and Brittingham 2012)

Forests

- The Nature Conservancy estimates between 100,000 and 250,000 acres of forest will be cleared for shale gas infrastructure in Pennsylvania by 2030 (Johnson et al 2010; Johnson et al 2011) and that up to 1,000,000 acres of forest habitat are at high risk of development across the entire Marcellus formation (Evans and Kiesecker 2014)

- Forests adjacent to newly cleared areas are also affected by shale development infrastructure. These new edges increase light, reduce humidity, increase predation, provide favorable conditions for invasive species and make trees more vulnerable to storm damage. Forest conditions within 300 feet or more of the new edge no longer favor many forest species such as forest interior nesting birds, amphibians, and certain trees and plants.

- The Nature Conservancy estimates between 600,000 and 1,500,000 acres of forest could shift from forest interior habitat to forest edge habitat in Pennsylvania by 2030 due to shale development (Johnson et al 2010; Johnson et al 2011).

- Observed forest impacts in the two most heavily drilled counties in Pennsylvania include a forest loss of 4,800 acres and a 15% reduction in average forest patch size between 2004 and 2010 (Slonecker et al. 2012).

Species

- Forest interior nesting birds, such as black-throated blue warblers, could see extensive habitat impacts in parts of their range during the next two decades (Johnson et al. 2010).

- Because shale development is a recent phenomenon, there are only a handful of published studies on observed species impacts. Langlois and Brittingham (2013) have found that human associated bird species (e.g., robin, mourning dove, common grackle, house wren) were more abundant in proximity to Marcellus development than they are in forest areas without shale development. Forest interior species (e.g., black-throated blue warbler, magnolia warbler, red-eyed vireo, oven bird, scarlet tanager) were less abundant in proximity to Marcellus development than in non-development forest areas.

- Approximately 130 globally rare species have populations in areas at high risk for shale development in the Marcellus region. Some of those species, such as the green salamander and the snow trillium, have all or most of their populations in areas with a high probability of shale oil/gas development (Johnson et al. 2010).

- The Nature Conservancy estimates at least 80% of "intact" native eastern brook trout watersheds could see some shale gas development by 2030. Up to 60% could see relatively intensive (16-40 well pads) development (Johnson et al. 2010).

- Observed impacts for aquatic species show mixed results with mainly localized but not regional changes to population densities for eastern brook trout, mayflies, and macro invertebrates.

Ecological Impacts Summary

- Few studies documenting observed habitat and species impacts have been published but monitoring results will start to build soon.

- Projected impacts give us primary insights into possible ecological outcomes (though technology advances could change assumptions).

- Habitat fragmentation rather than habitat loss is the primary mechanism for ecological impacts.

- Habitat generalists, which are often common species, are likely to prosper, while habitat specialists, which are often more rare, are likely to decline.

- Pipelines (especially gathering lines) are the most important threat to terrestrial and aquatic habitats.

Strategies and Tools to Reduce Impacts

A variety of strategies and tools can be used to minimize shale development cumulative impacts on natural habitats and species.

Research Priorities

Empirical data on habitat and species impacts are limited but growing. As more monitoring results become available, research is needed to establish thresholds for key disturbances caused by shale

development that could cause landscape or regional declines in habitat condition and species populations. Key disturbances include forest Loss and fragmentation, sedimentation, surface hydrologic alterations, noise, light and well density (relationship to air and water quality).

Policy

Three important policy needs to reduce ecological impacts from shale development include:

- Improving and expanding state and federal mitigation frameworks so that companies are required or encouraged to avoid and minimize impacts to sensitive habitats (wetlands, endangered species, rare ecosystems, headwater streams, etc.). If such impacts are unavoidable, mitigation should focus on high quality and durable ecological outcomes.

- Shifting energy permitting away from site-by-site permitting to landscape or watershed scale development plans so that cumulative impacts can be evaluated during the permitting process.

- Requiring or providing incentives to co-locate gathering pipelines with roads, power lines, and other pipelines could dramatically reduce ecological impacts in the Appalachian region.

Tools

Energy companies have developed innovative and extremely advanced technologies to find and recover shale oil and gas resources. Technologies and practices for locating and operating shale infrastructure on the surface are considerably less advanced. New tools are needed to optimize the location of infrastructure and provide recommended practices to reduce impacts during construction and operations. The Nature Conservancy is working to address these needs in the Appalachian region:

- *Low Impact Shale Development Tool*. The Nature Conservancy, in cooperation with academic researchers and energy companies has developed a site optimization tool that enables developers and regulators to evaluate the ecological impacts and development costs for alternative infrastructure build out designs at a landscape or lease-wide scale. It is now being piloted at several sites in West Virginia and Pennsylvania.

- *Recommended Conservation Practices*. The Nature Conservancy has developed summaries of research related to ecological impacts from several categories of disturbance associated with shale development. Based on this science, The Nature Conservancy has proposed a set of recommended practices (fall 2014 publication) to avoid and reduce impacts in the following areas:

    - Landscape Planning
    - Habitat Buffers
    - Stream Crossings
    - Road and Pipeline Construction and Maintenance
    - Noise Control

- Light Control
- Water Sourcing
- Invasive Species Control

References Cited

DCNR. 2014. Shale Gas Monitoring Report. Pennsylvania Department of Conservation and Natural Resources. Harrisburg, PA.

Drohan, P. and M. Brittingham. 2012. Topographic and soil-specific challenges facing Marcellus Shale gas development in Pennsylvania and the north central Appalachians. Soil Science Society of America Journal, 76:1696-1706

EIA. 2014. Energy Information Agency, U.S. Department of Energy, Washington, DC. Maps of oil and natural gas plays in North America. Accessed 18 July, 2014. http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.htm

Evans JS, Kiesecker JM (2014) Shale Gas, Wind and Water: Assessing the Potential Cumulative Impacts of Energy Development on Ecosystem Services within the Marcellus Play. PLoS ONE 9(2): e89210. doi:10.1371/journal.pone.0089210

Frac Tracker. 2014. U.S. oil and gas wells database. Accessed 18 July, 2014. http://www.fractracker.org/downloads/us-oil-and-gas-wells-february-2014/

Johnson, N.. Gagnolet, T., Ralls, Stevens, J. 2011. Pennsylvania Energy Impacts Assessment. Report 2: Natural Gas Pipelines. The Nature Conservancy, Harrisburg, PA.

Johnson, N., Gagnolet, T, Ralls, R., Zimmerman, E., Eichelberger, B., Tracey, C., Kreitler, G., Orndorff, S., Tomlinson, J., Bearer, S., Sargent, S. 2010. Pennsylvania Energy Impacts Assessment Report 1: Marcellus Shale Natural Gas and Wind. The Nature Conservancy, Harrisburg, PA.

Langlois and Brittingham, M. 2013. Accessed 18 July 2014. http://news.psu.edu/story/282350/2013/07/22/research/grad-researcher-studies-impacts-marcellus-shale-development

Slonecker, E.T., Milheim., L.E., Roig-Silva, C.M., Malizia, A.R., Marr, D.A. and G.B. Fisher. 2012. Landscape Consequences of Natural Gas Extraction in Bradford and Washington Counties, Pennsylvania, 2004-2010. U.S.Department of interior, U.S. Geological Survey. Open-File Report 2012-1154.