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Environmental Effects of Shale Gas Development in the Chesapeake Watershed

Forest Impacts

Nels Johnson, Tamara Gagnolet, Scott Bearer

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The Nature Conservancy's mission is to protect the lands and waters on which all life depends.

- Global organization
- Science-based strategies
- On-the-ground presence in every U.S. state and over 35 countries
- Almost 1 million members
- Vision, innovation, and partnerships

Susquehanna Forests and Rivers

Pennsylvania is a stronghold of extensive forest habitats in the Chesapeake Watershed...

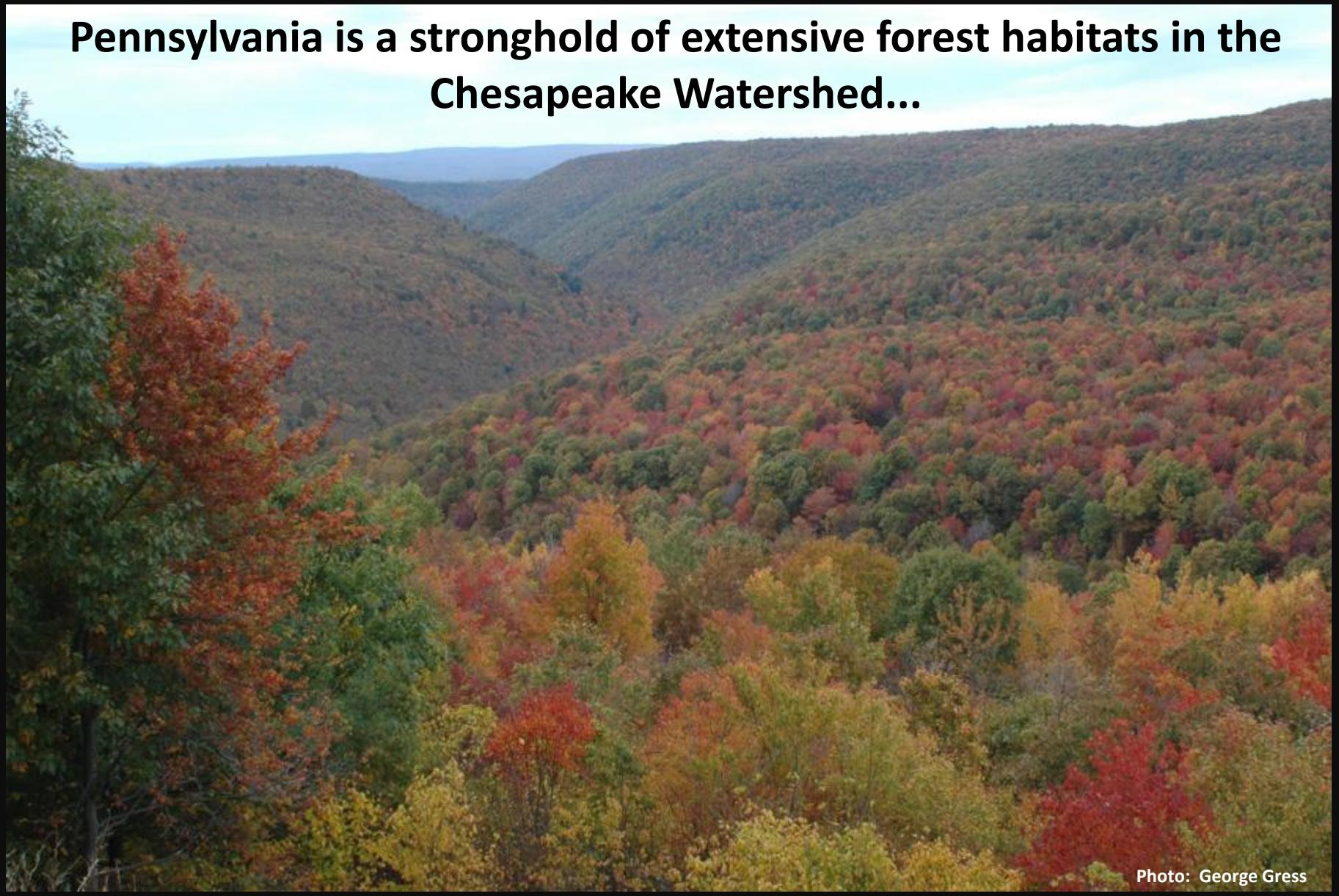

Photo: George Gress

Susquehanna Forests

…but new energy development is clearing and fragmenting valuable forests.

Photos: Nels Johnson

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Energy

- Chesapeake Basin is in the crosshairs of energy production and energy markets.

- Energy development can have significant impacts on land use, natural habitats, water quality, water quantity, air quality, and human health.

- The Nature Conservancy is focused on impacts to:
  - water quantity (ecological flows)
  - natural habitats (land use footprint)

- Voluntary & regulatory approaches to reduce cumulative impacts

- Development-by-Design

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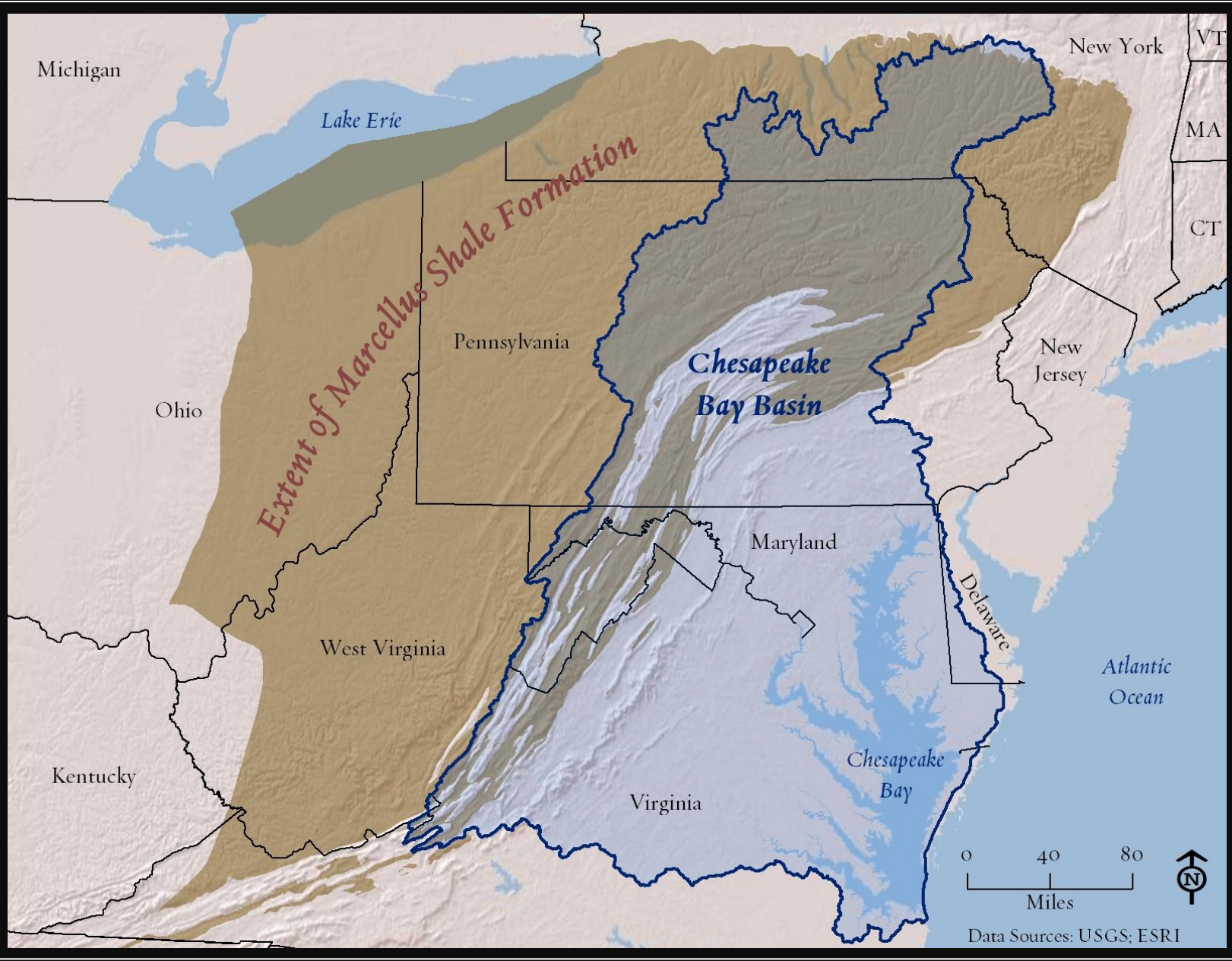
Marcellus Shale and Chesapeake Watershed



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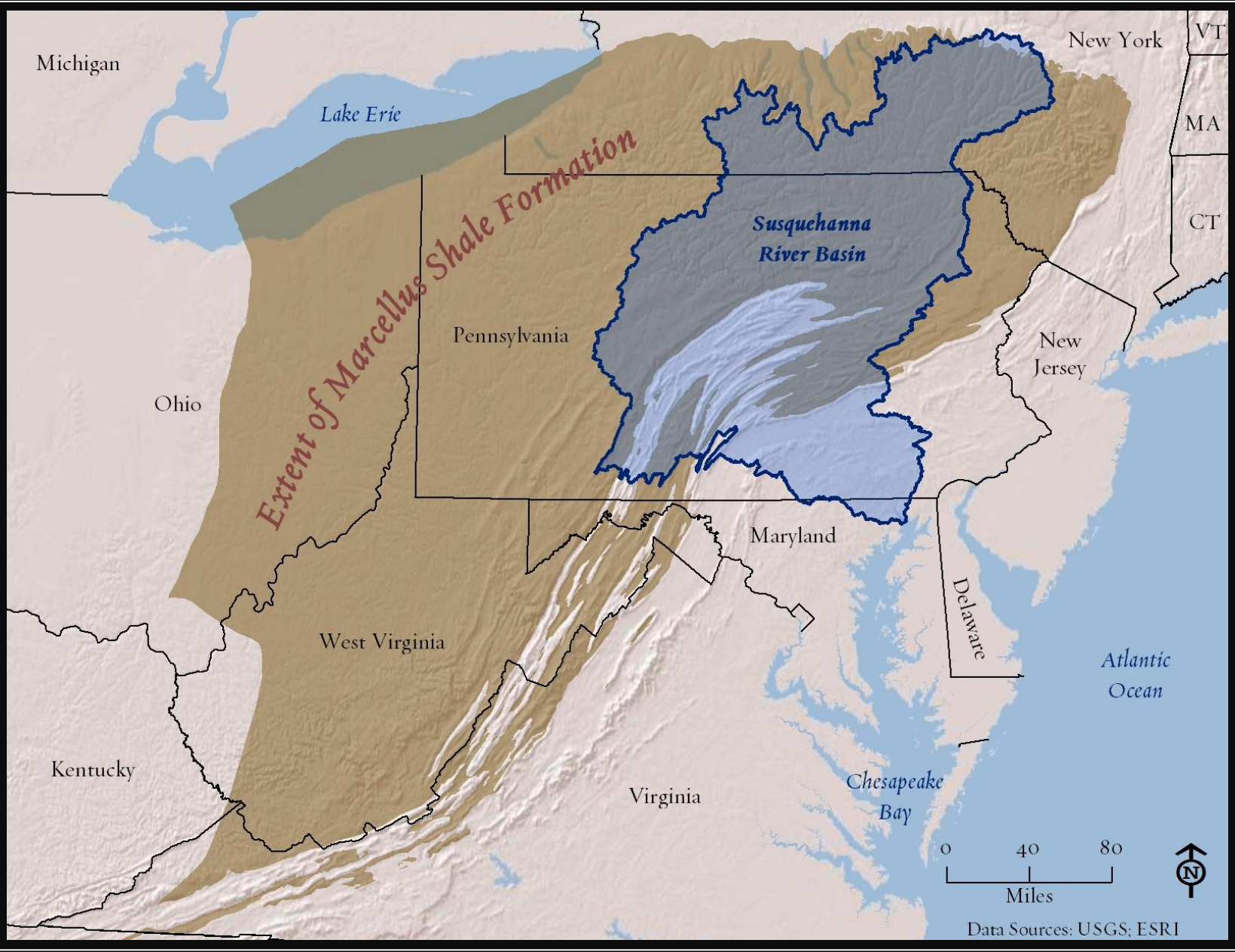
Marcellus Shale and Susquehanna Basin



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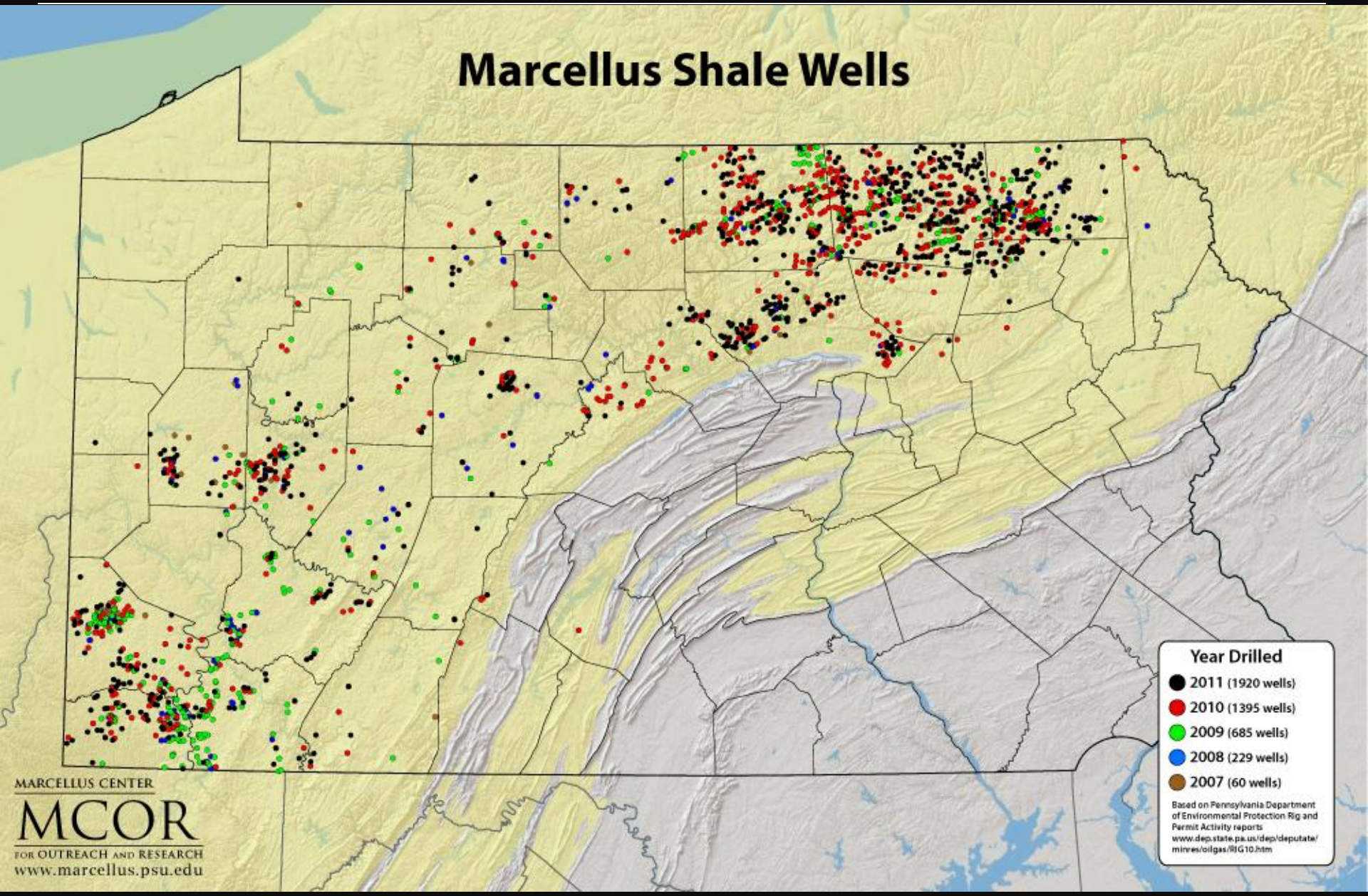
Marcellus Shale Wells



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Pennsylvania Energy Impacts Assessment

- **Project Goal**: Develop projections of how new energy development could impact natural habitats in Pennsylvania to shape strategies that avoid or minimize those impacts

- **Energy Types:** Focused on energy types that have the most potential for land use change during the next twenty years in Pennsylvania:
  - ***Marcellus Shale natural gas***
  - ***Wind***
  - ***Wood biomass***
  - ***Electric transmission lines***
  - ***Gas pipelines***

Pennsylvania Energy Impacts Assessment

- **Analytical Team:** Staff from The Nature Conservancy, Western Pennsylvania Conservancy, Audubon Pennsylvania

- **Assumptions**:
  - 20-year time period
  - Stable and sufficient prices and capital investment for steady development growth
  - Continued recent trends and patterns of energy development

- **Keep in mind** that:
  - Energy projections are informed scenarios – *not predictions*
  - The assessment focuses on impacts to forest habitats and *does not* address other potential environmental impacts, including water quality, water quantity, air quality, and migratory pathways

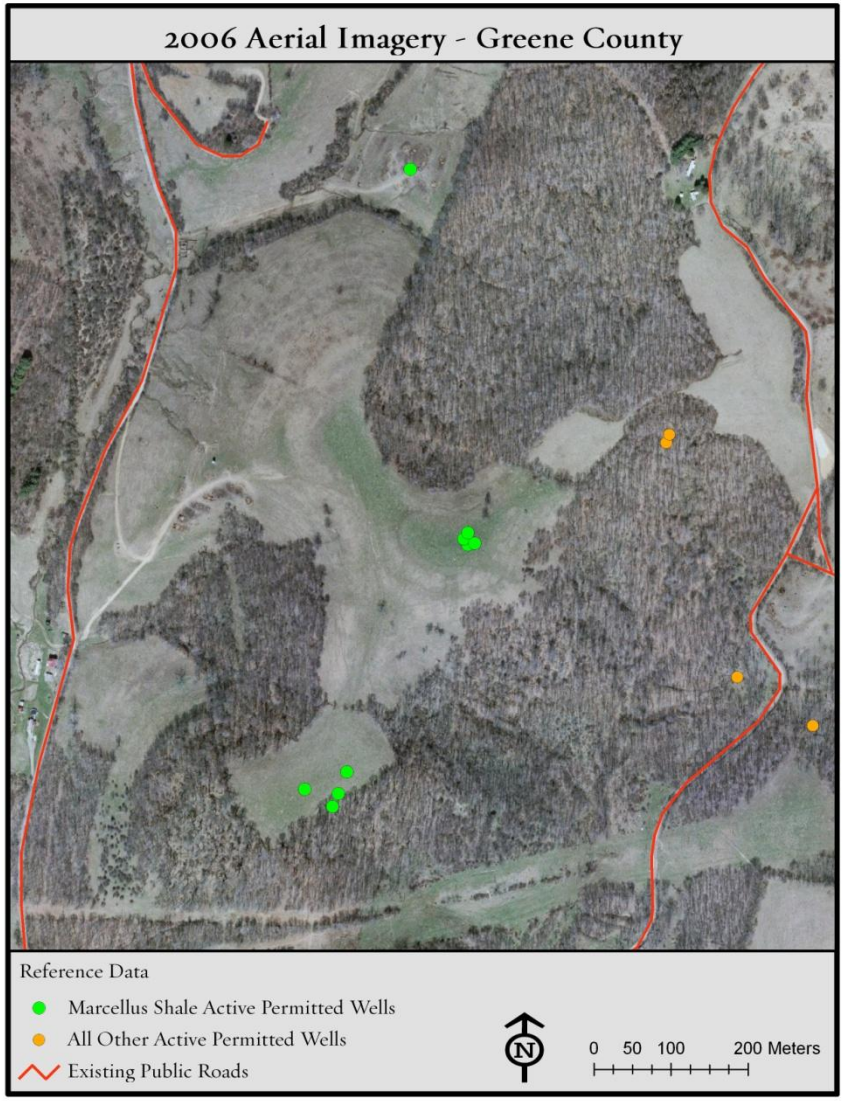
Assessment Steps

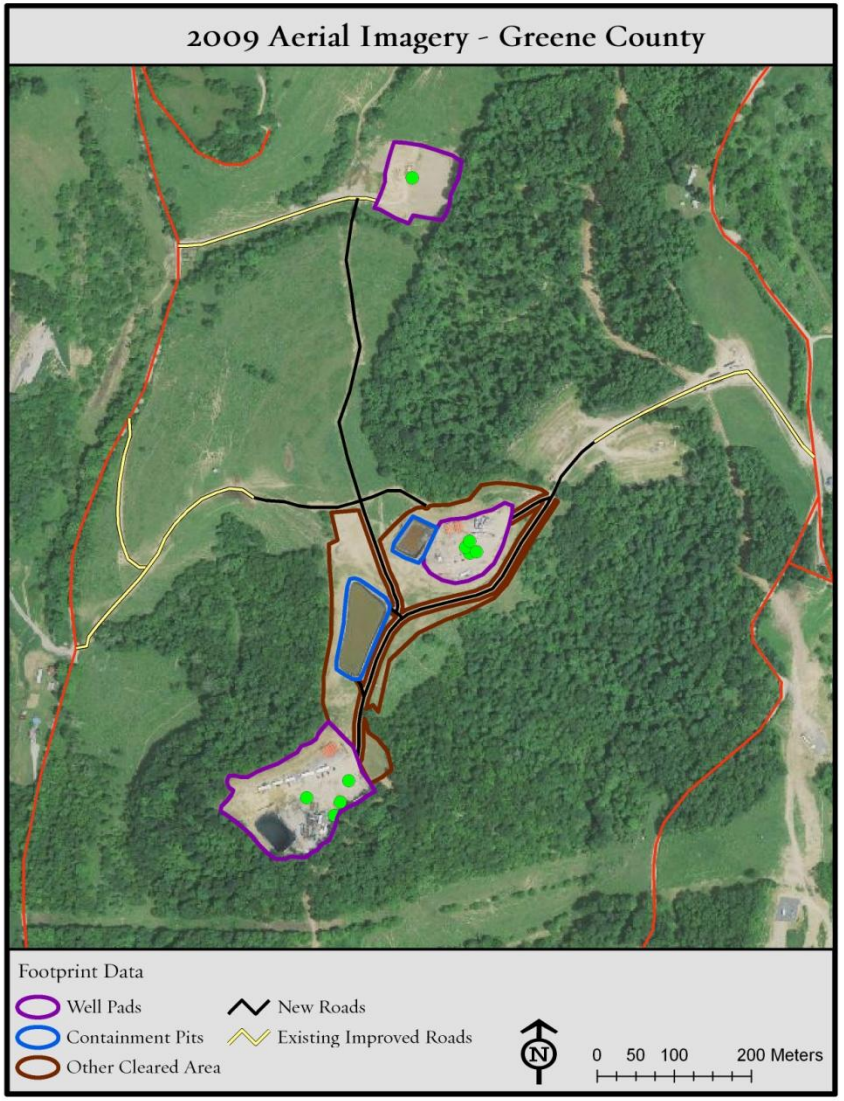
- *What is the **SPATIAL FOOTPRINT** of existing energy development?*

- ***PROJECTIONS:***
  - ***HOW MUCH** energy infrastructure might be developed by 2030?*
  - ***WHERE** is energy development more and less likely to occur?*

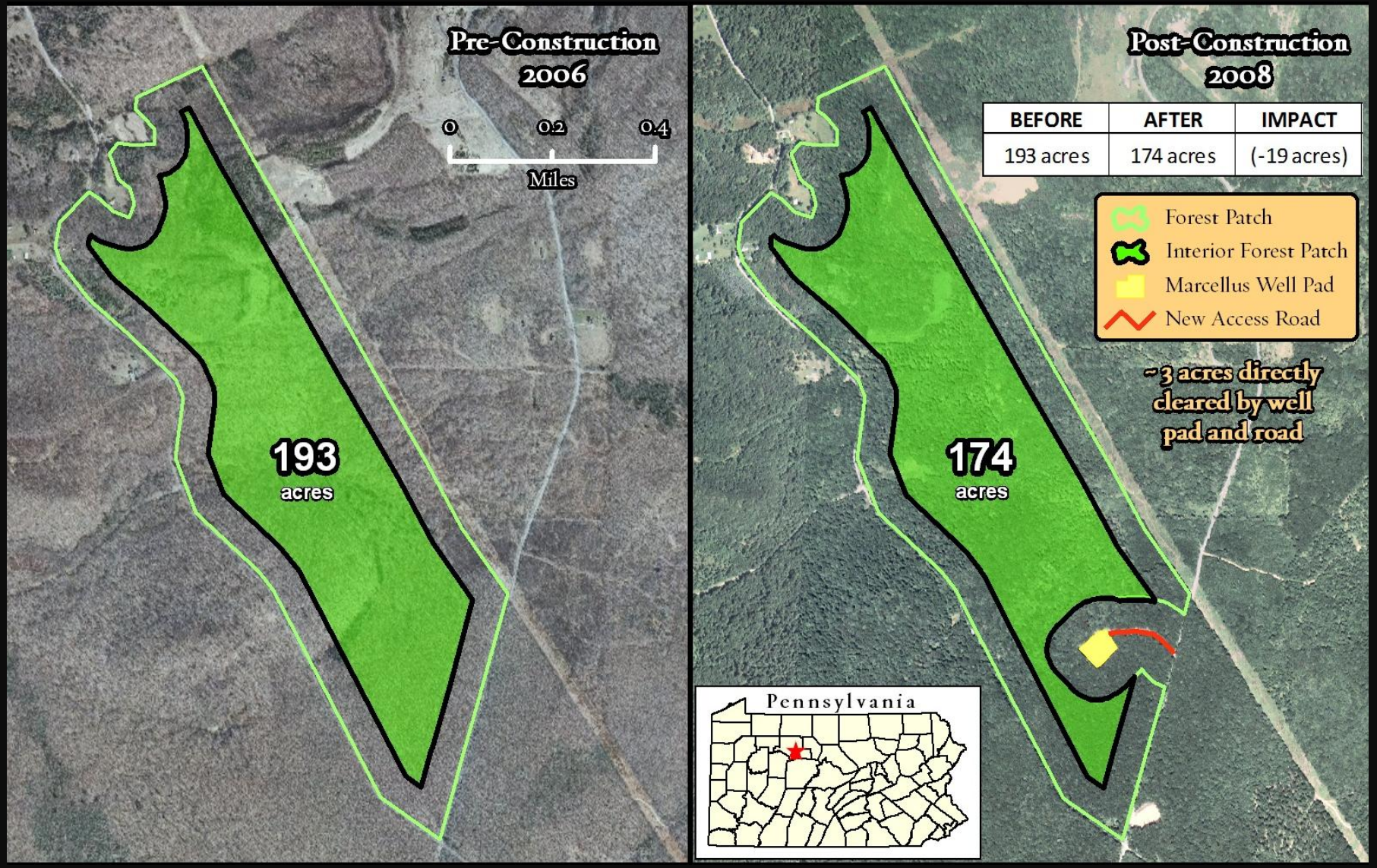
- ***CONSERVATION IMPACTS:***
  - *How could future energy development affect forest habitats?*

Spatial Footprint





Forest Habitat Impacts



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Forest Habitat Impacts

Average Spatial Disturbance for Marcellus Shale Well Pads in Forested Context (acres)		
Forest cleared for Marcellus Shale well pad	3.1	8.8
Forest cleared for associated infrastructure (roads, pipelines, containment pits, etc.)	5.7	
Indirect forest impact from new edges	21.2	
TOTAL DIRECT AND INDIRECT IMPACTS	30	

How Many Marcellus Wells?

Photo: Tamara Gagnolet

250 horizontal drill rigs

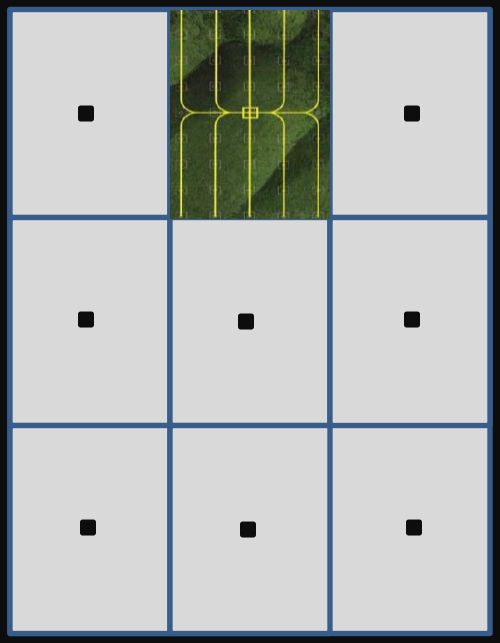
x 1 well drilled per month (or 12/yr)

x 20 years

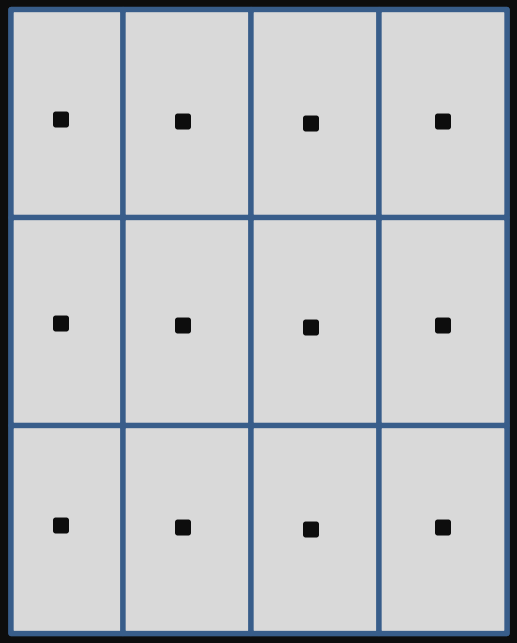
= **60,000 new wells** drilled by 2030
(27,600 in PA Susquehanna Basin)

How Many Marcellus Well Pads?

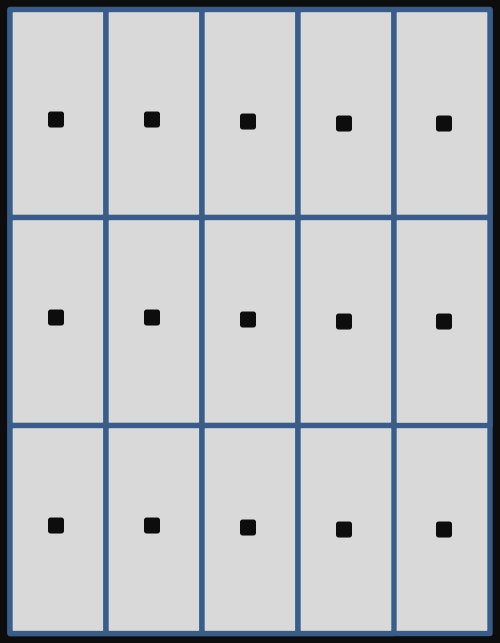
Projected Marcellus wells
distributed differently across the landscape



Low Scenario
10 wells per pad

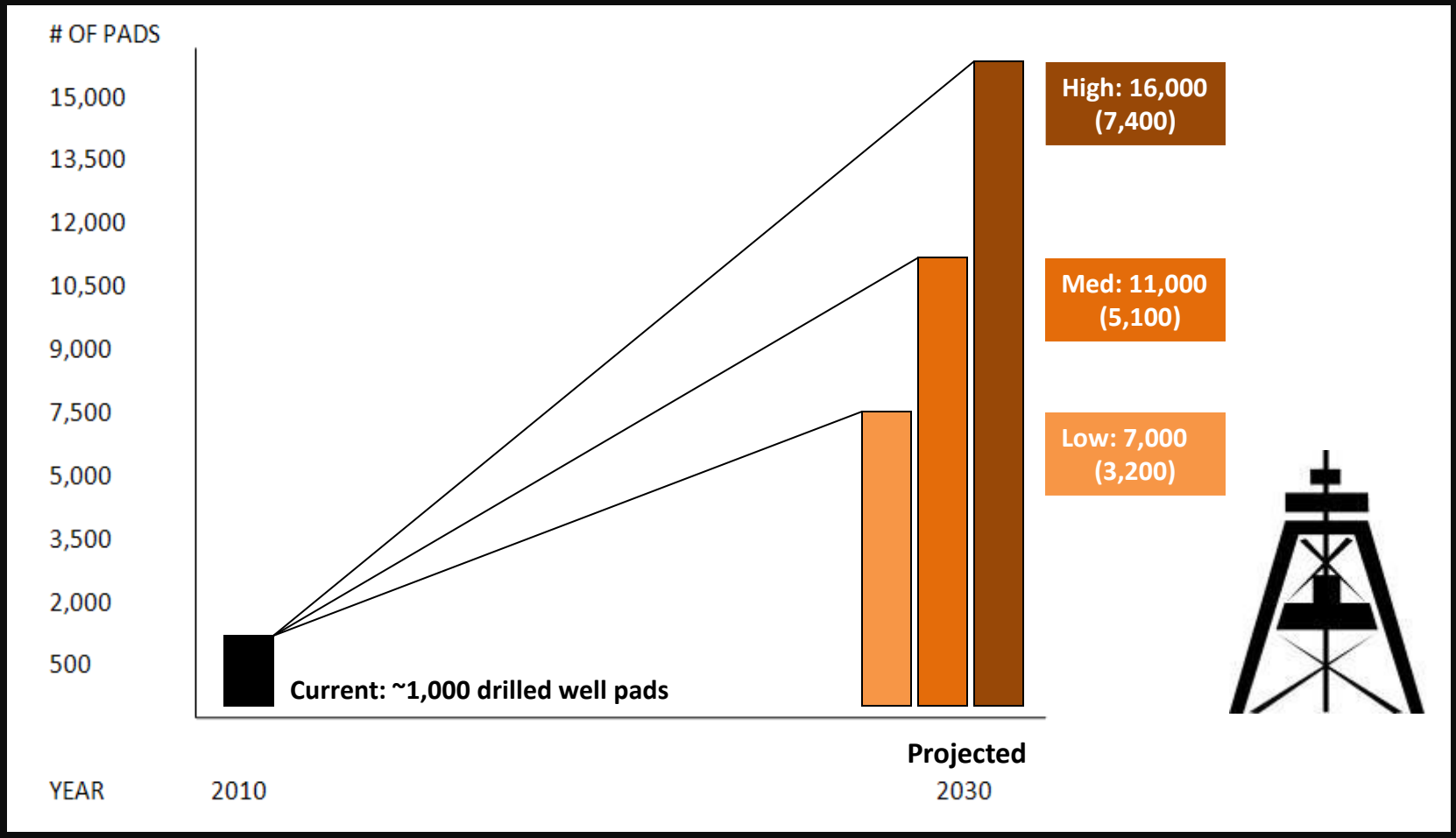


Medium Scenario
6 wells per pad



High Scenario
4 wells per pad

How Many Marcellus Well Pads?

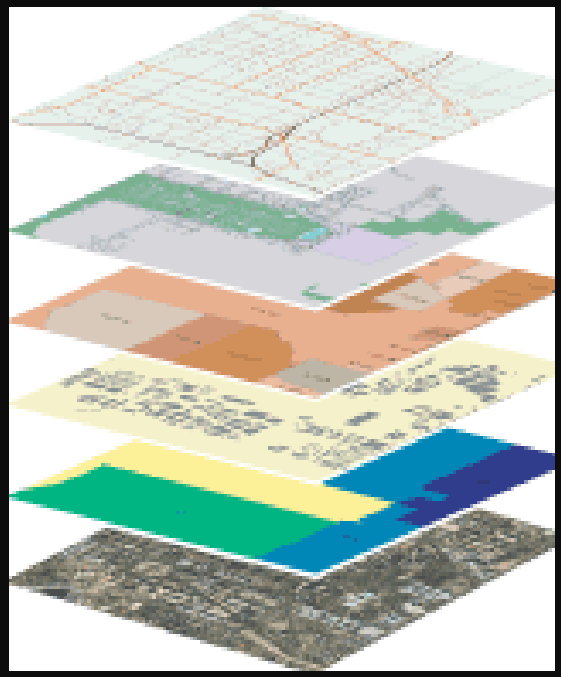


Where Is Marcellus Development Most Likely?

Modeled the relationship between:

- Drilled and permitted Marcellus wells (from PA-DEP data), and
- Spatial variables related to geology and infrastructure:

  - Thermal Maturity
  - Shale Depth
  - Shale Thickness
  - Percent Slope
  - Distance to Roads
  - Distance to Pipelines



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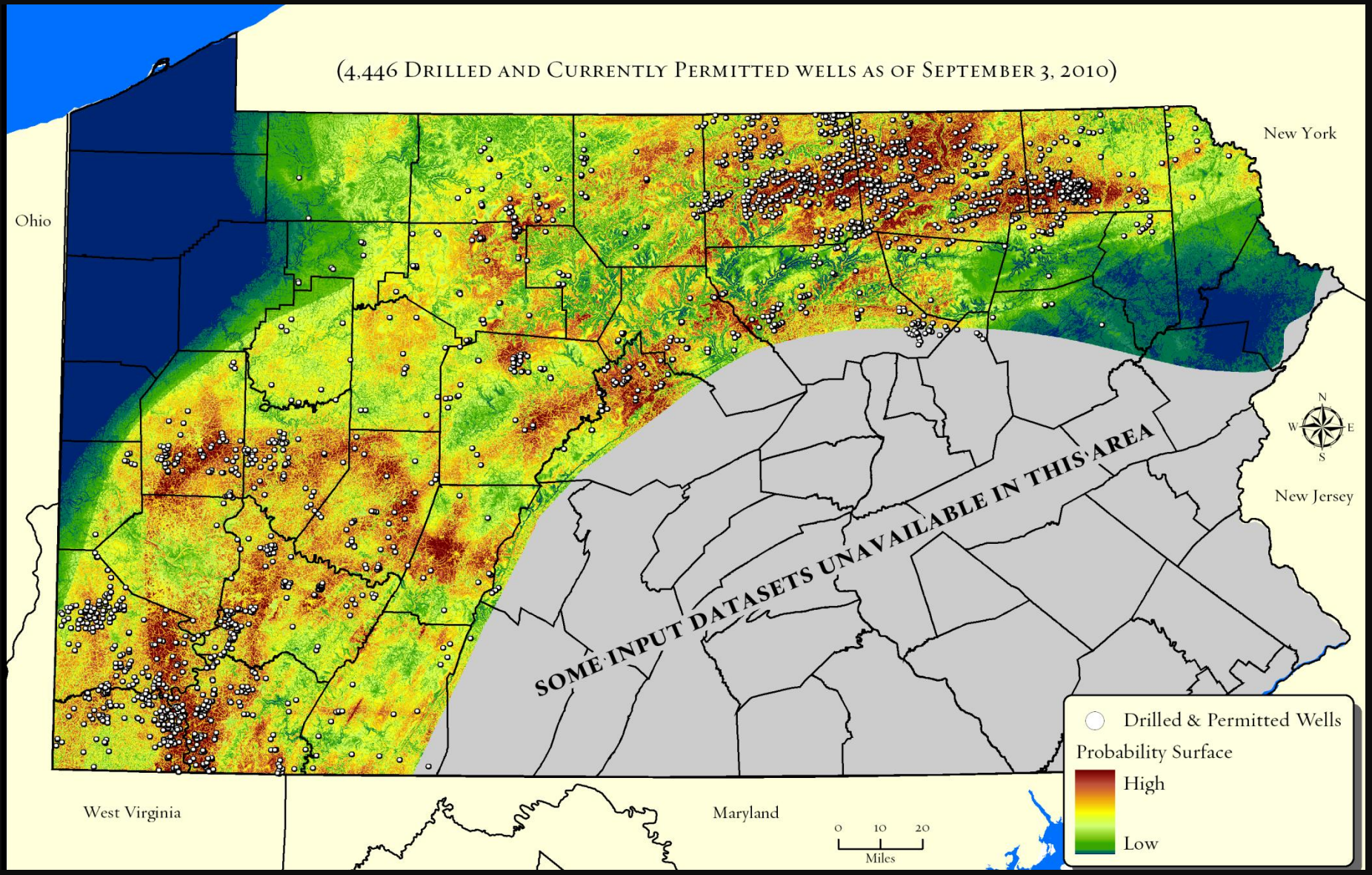
Where Is Marcellus Development Most Likely?



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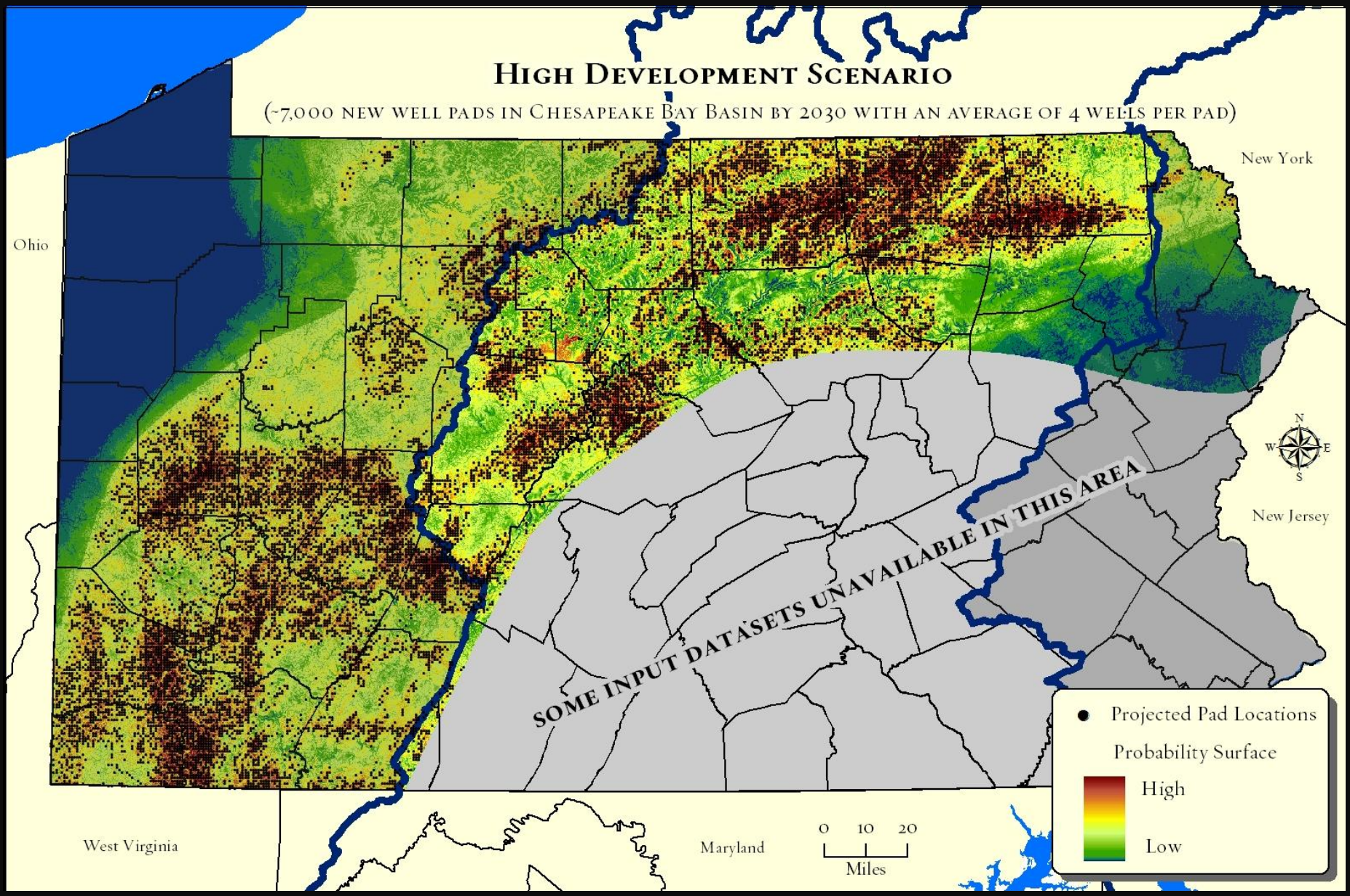
Where Is Marcellus Development Most Likely?



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How Many New Gas Pipelines?

Photos: Nels Johnson

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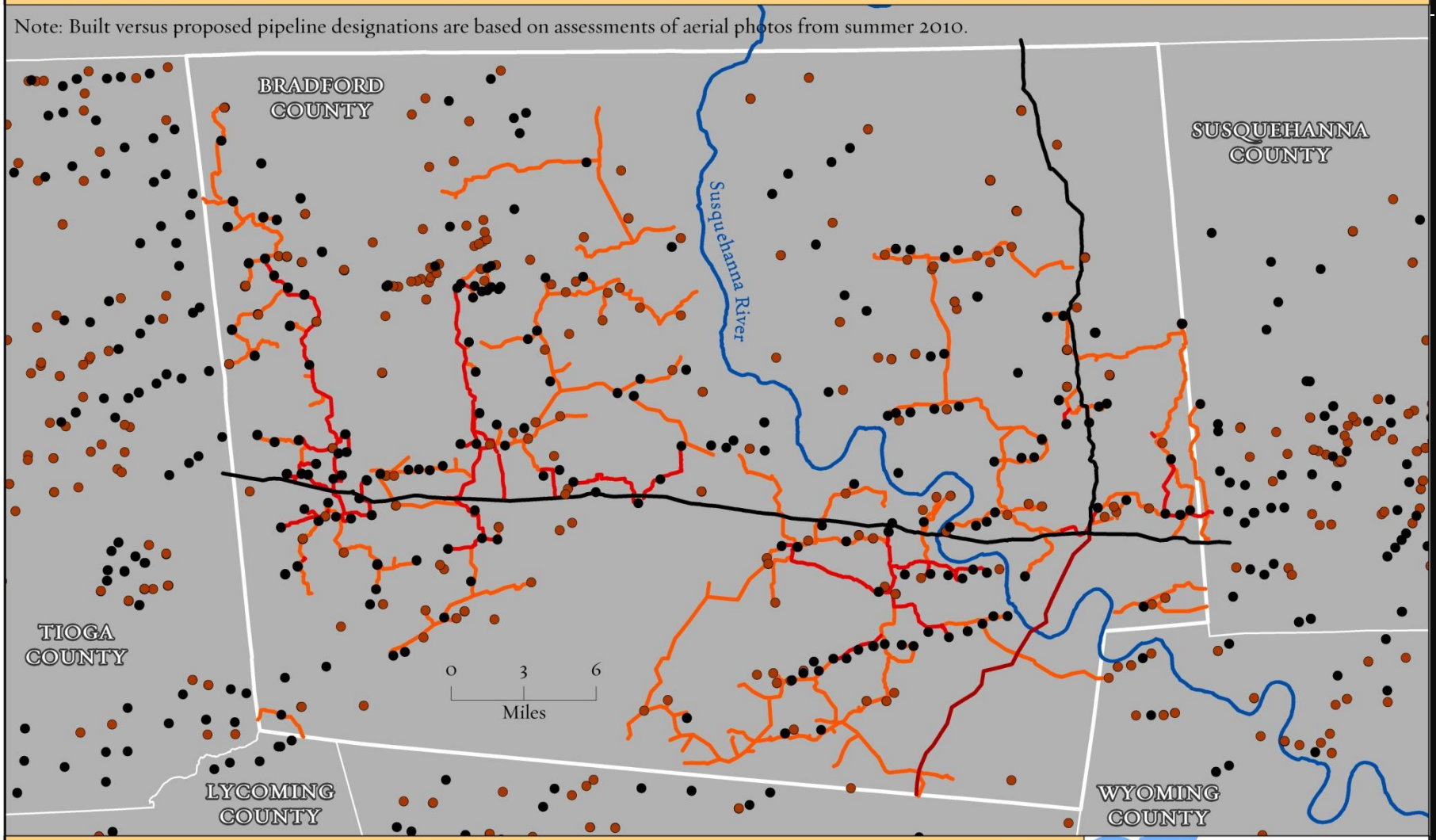
Marcellus Shale Gas Development in Bradford County

Note: Built versus proposed pipeline designations are based on assessments of aerial photos from summer 2010.



- Built Transport Lines
- Proposed Transport Lines
- Built Gathering Lines
- Proposed Gathering Lines
- Drilled Marcellus Gas Wells *
- Permitted Marcellus Gas Wells *

N W E S

* According to permit data from PA DEP, as of Dec 31, 2010.

"This map was created using County of Bradford Geographic Information Systems digital data, but this is a secondary product and has not been verified and is not authorized by the County of Bradford."

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How Many New Gas Pipelines?

2008 Aerial Imagery - Bradford County

N

0 125 250 500 Meters

Aerial Imagery from NAIP

2010 Aerial Imagery - Bradford County

N

0 125 250 500 Meters

Aerial Imagery from NAIP

How Many New Gas Pipelines?

- Based on our assessment of gas pipelines in Bradford County, PA:
  - Rights-of-way cleared for gathering pipelines are typically 100 feet but range from 30 ft to 150 ft, and
  - Gathering pipelines stretch an average of **1.65 miles per well pad**.
- Using our Marcellus development projections, we could expect to see between **10,000 and 25,000 miles of new gathering pipelines** built in PA by 2030.

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How Many New Gas Pipelines?

- Pennsylvania's existing network of large diameter natural gas pipelines will at least double, and possibly even quadruple, over the next two decades.
- The pipeline footprint alone is larger than the cumulative area impacted by all other Marcellus gas infrastructure combined.

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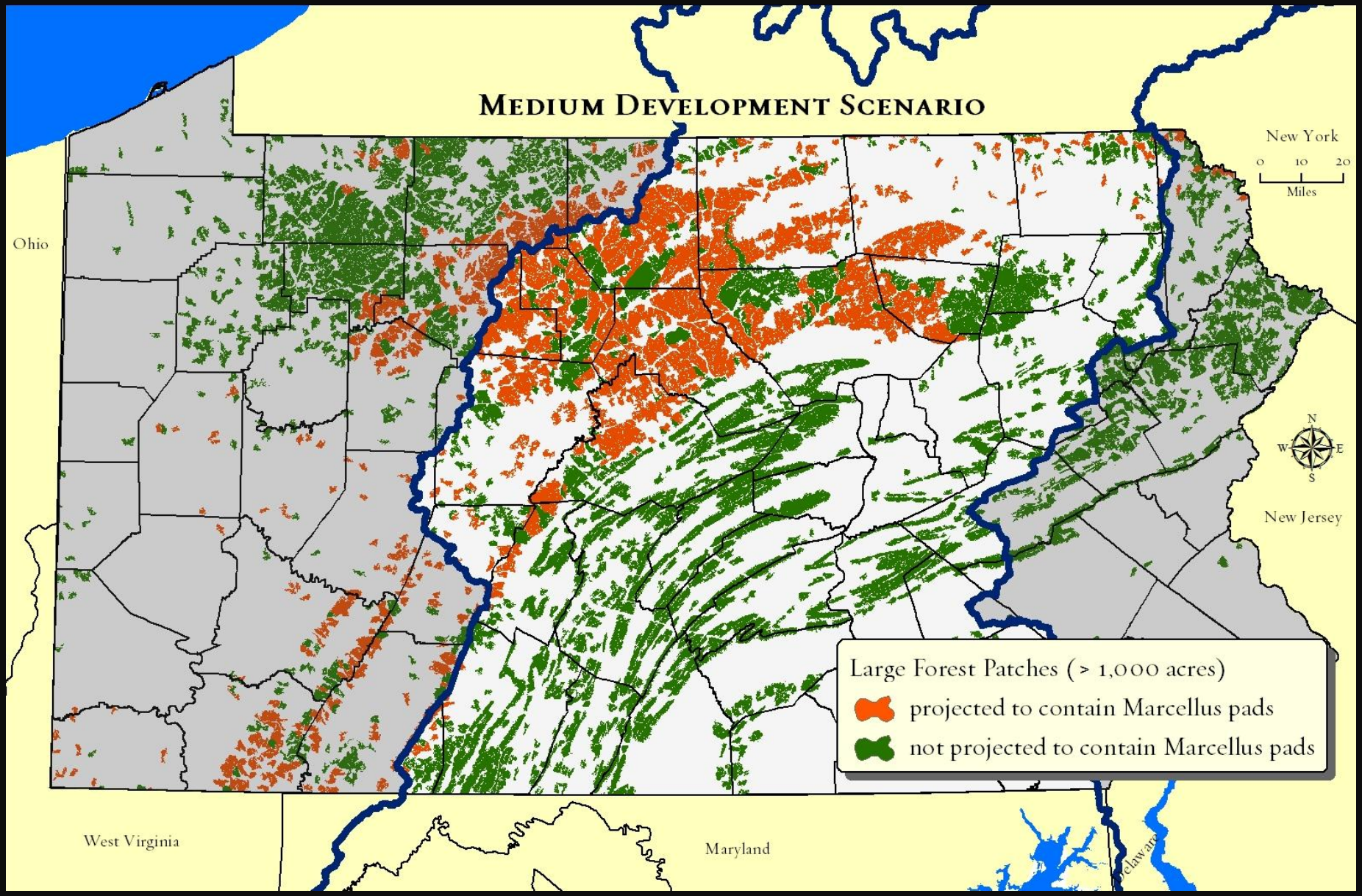
How Could Forests Be Affected?



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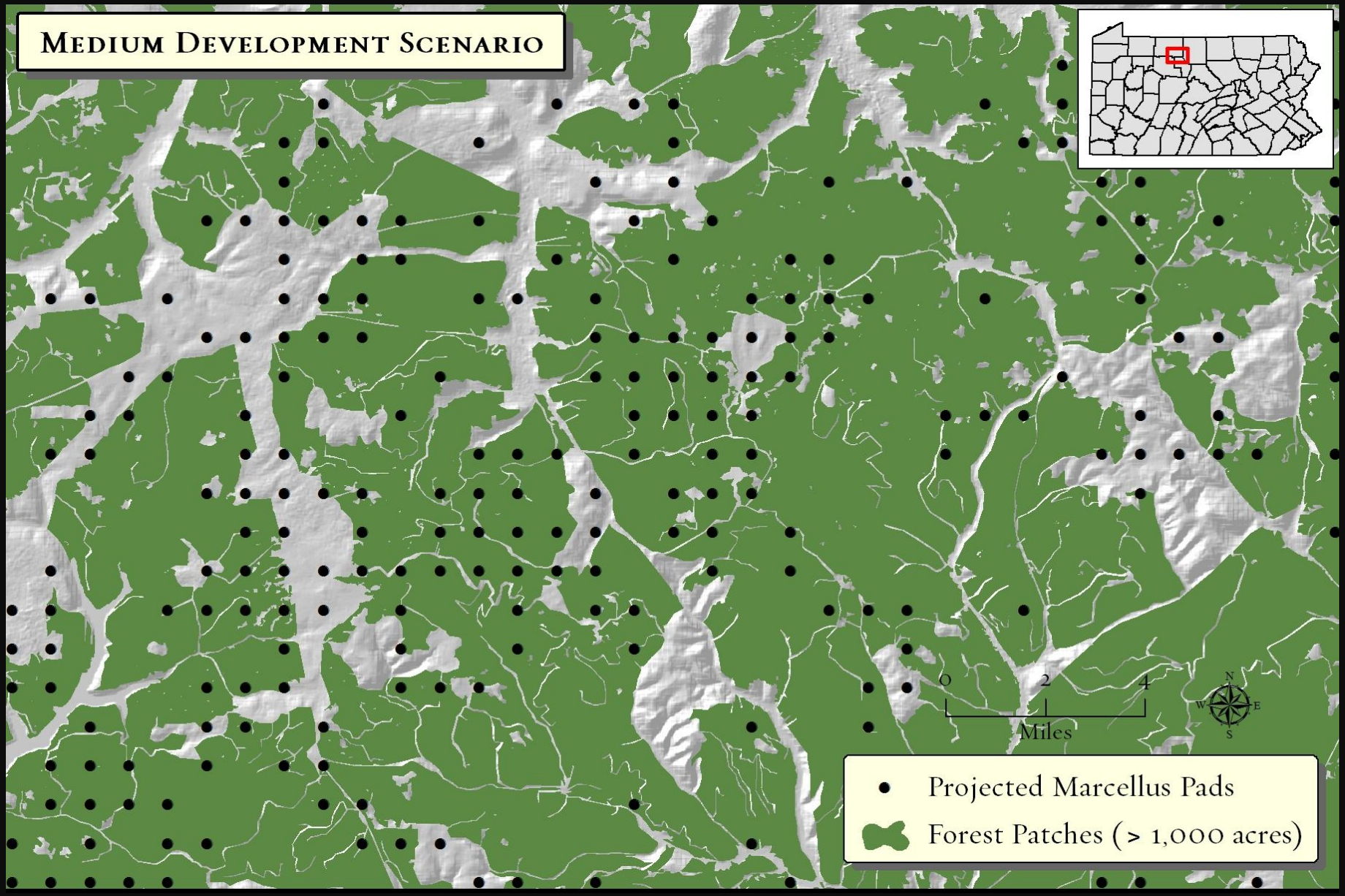
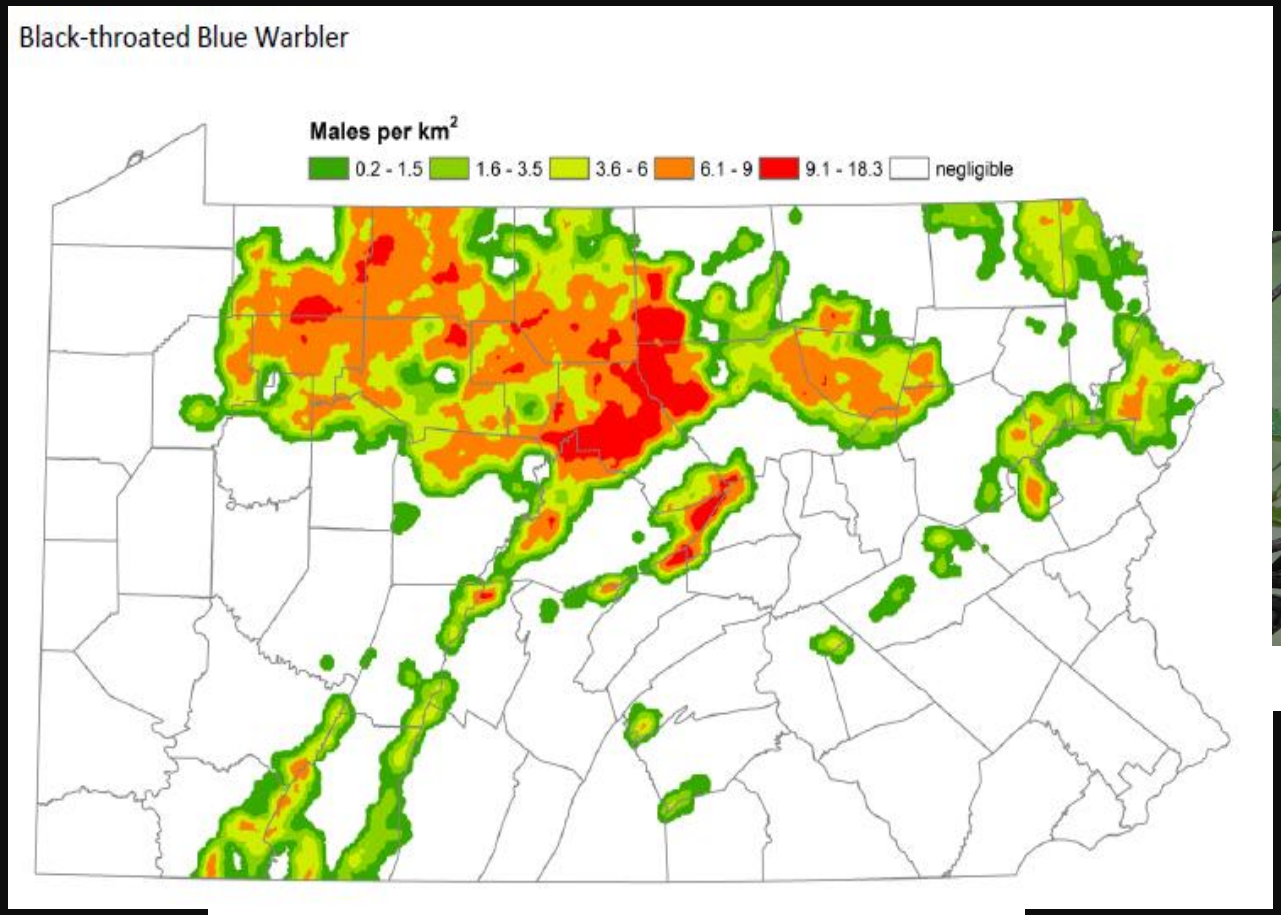
Projected Marcellus Well Pads



How Could Bird Species Be Affected?



Source: Draft map from 2nd Pennsylvania Breeding Bird Atlas (2010)

Black-throated Blue Warbler

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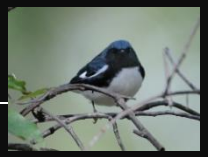
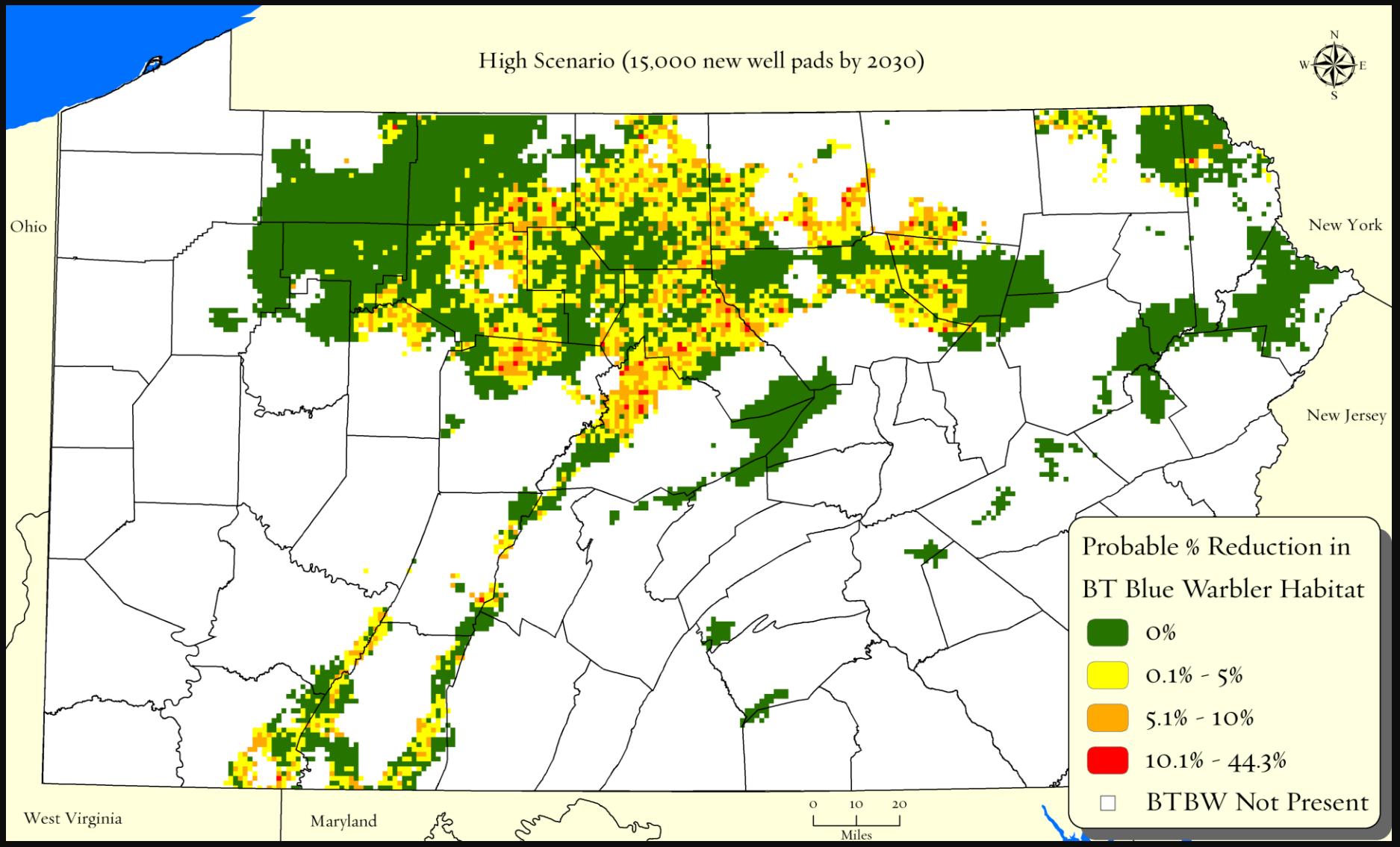
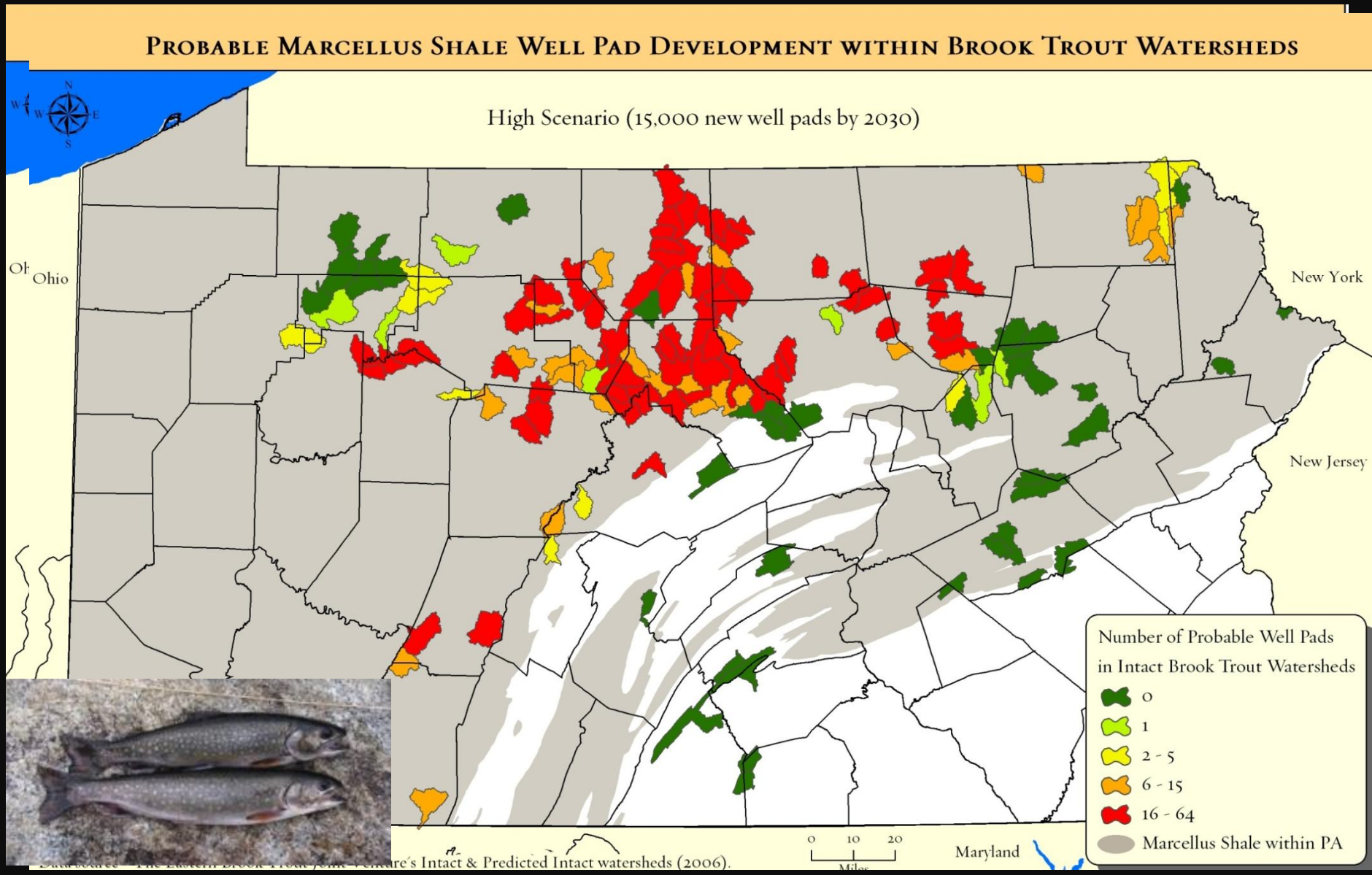
How Could Bird Species Be Affected?



Black-Throated Blue Warbler



How Could Brook Trout Be Affected?



How Could Rare Species Be Affected?

- 329 species tracked by the PA Natural Heritage Program have populations in areas with high probability of Marcellus development.
- 40% of those species are globally rare
- Most of those species are critically endangered or imperiled in Pennsylvania.

Examples of species at risk:

Snow trillium (*Trillium nivale*)
73% of known populations

Green salamander (*Aniedes aeneus)*
all known populations

Total Forest Impacts

- Based on our spatial footprint assessment and development projections, **45,000 – 110,000** acres of forest cover could be cleared by Marcellus gas development in PA's Susquehanna Basin by 2030.

- Such clearings would create new forest edges where predation, changes in light and humidity levels, and expanded presence of invasive species could threaten forest interior species in an additional **220,000 – 520,000** forest acres adjacent to Marcellus development.

- Impacts to forest interior species will vary depending on their geographic distribution and density. Native brook trout may be especially vulnerable to Marcellus gas development

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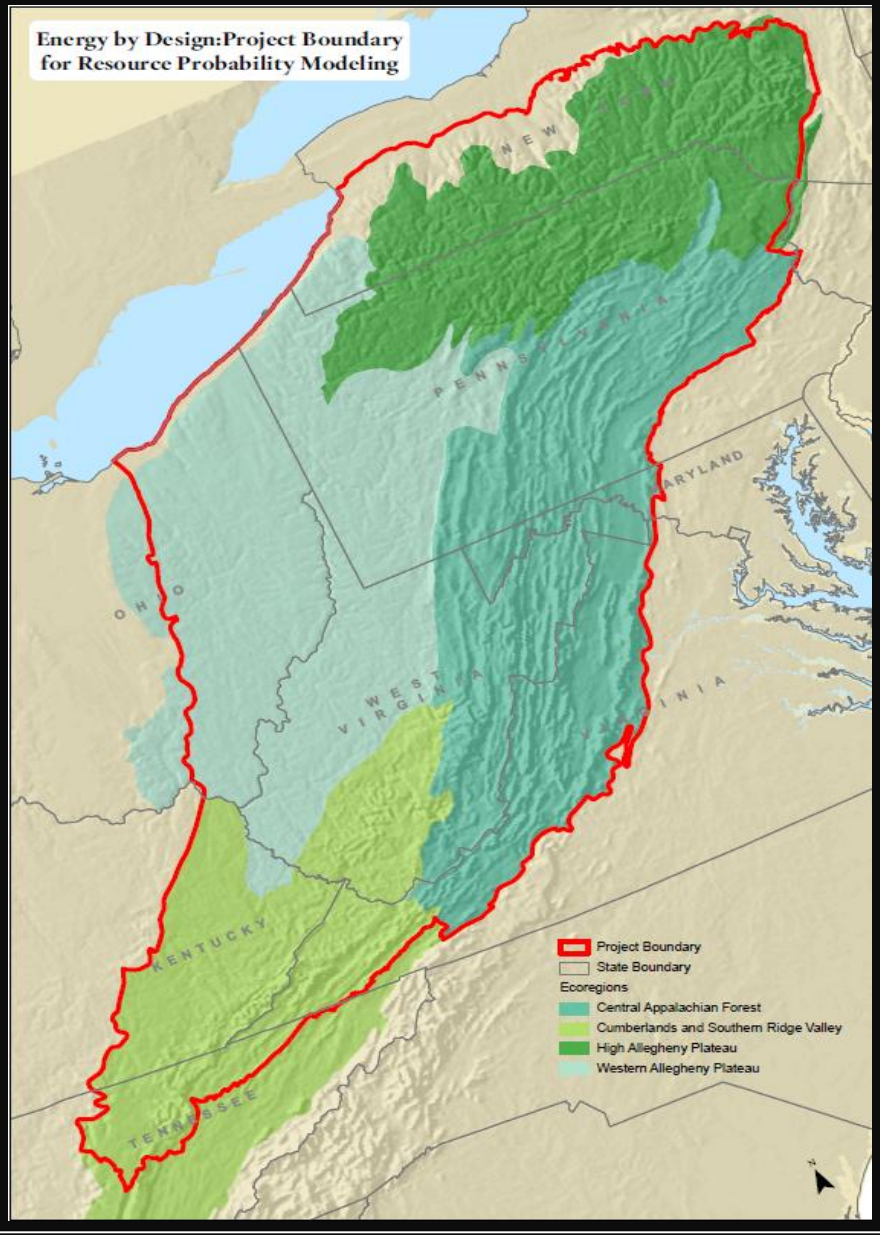
How Can We Avoid & Minimize Impacts?

- Site well pads and roads in existing open areas and co-locate transmission with existing rights-of-way
- More wells on each pad and (recognizing economic constraints) extend lateral well distances
- Create tools to integrate habitat/environmental data into energy infrastructure planning
- Establish landscape approach to energy permitting
- Inform energy and consulting company staff in use of habitat data and Best Management Practices (BMPs)
- Rigorous implementation, monitoring, and enforcement of E&S controls for roads, pipelines, and pads

Appalachian Energy Impacts Assessment



We are now expanding the energy assessment to cover the entire Appalachian geologic basin

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Marcellus Development By Design (DbD)

GOAL - test feasibility of strategies and practices to avoid, minimize, and mitigate natural habitat damage in priority landscapes from Marcellus gas development

- **<u>Habitat BMPs</u> – consolidate, link to science, fill science gaps where needed**

- **<u>Decision Support Tool</u> – partner with Univ. TN to develop Decision Support Tool that optimizes gas development and habitat conservation**

- **<u>Landscape Level Demonstration Projects</u> – field testing BMPs and decision support tool to avoid, minimize, mitigate habitat impacts from Marcellus gas development**

Questions / Comments

The report and other information can be found at:

www.nature.org/paenergy

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