Ecological Risks of Shale Gas Development

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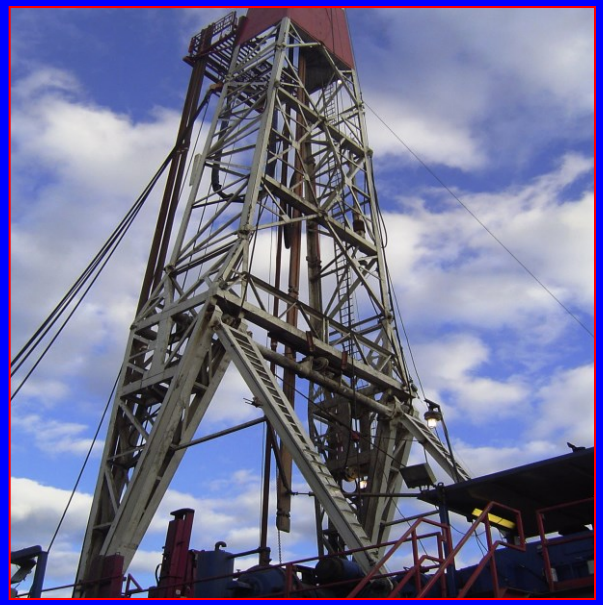

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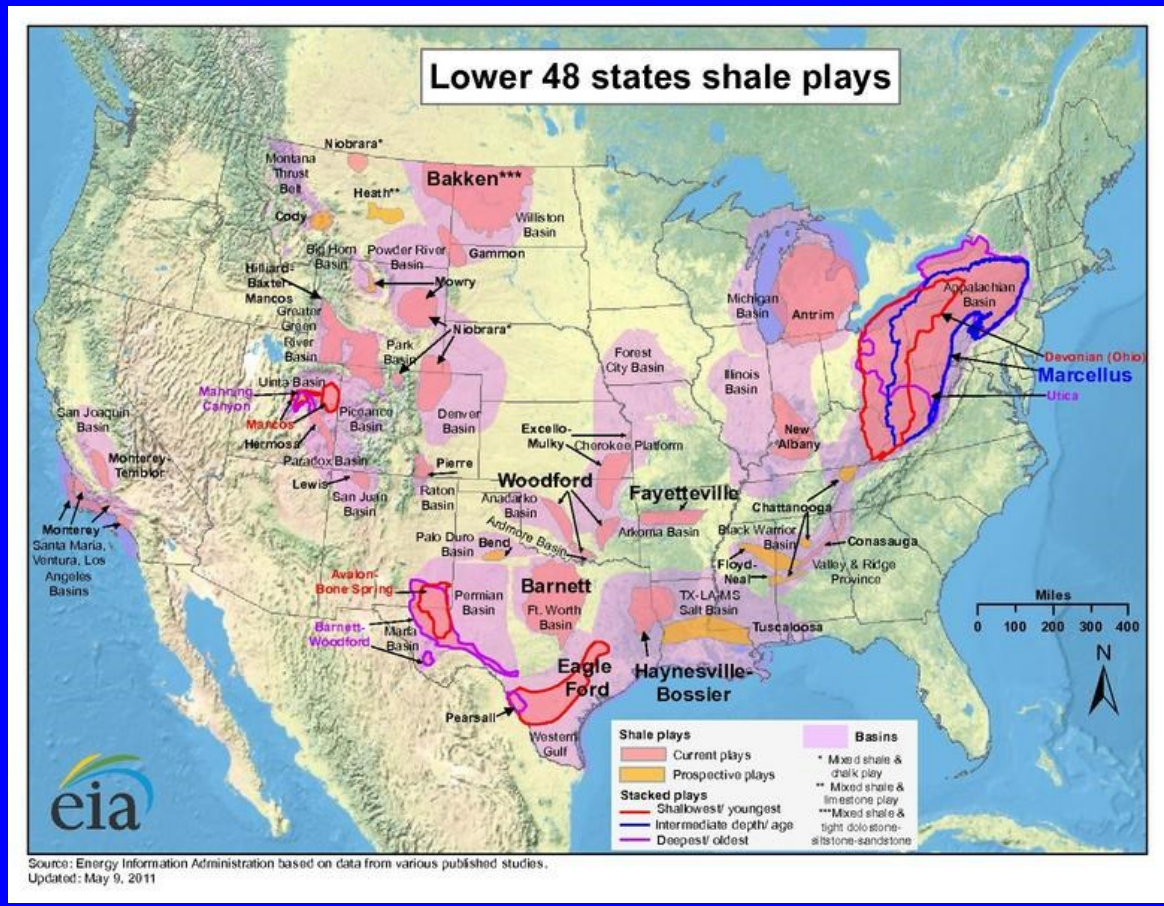
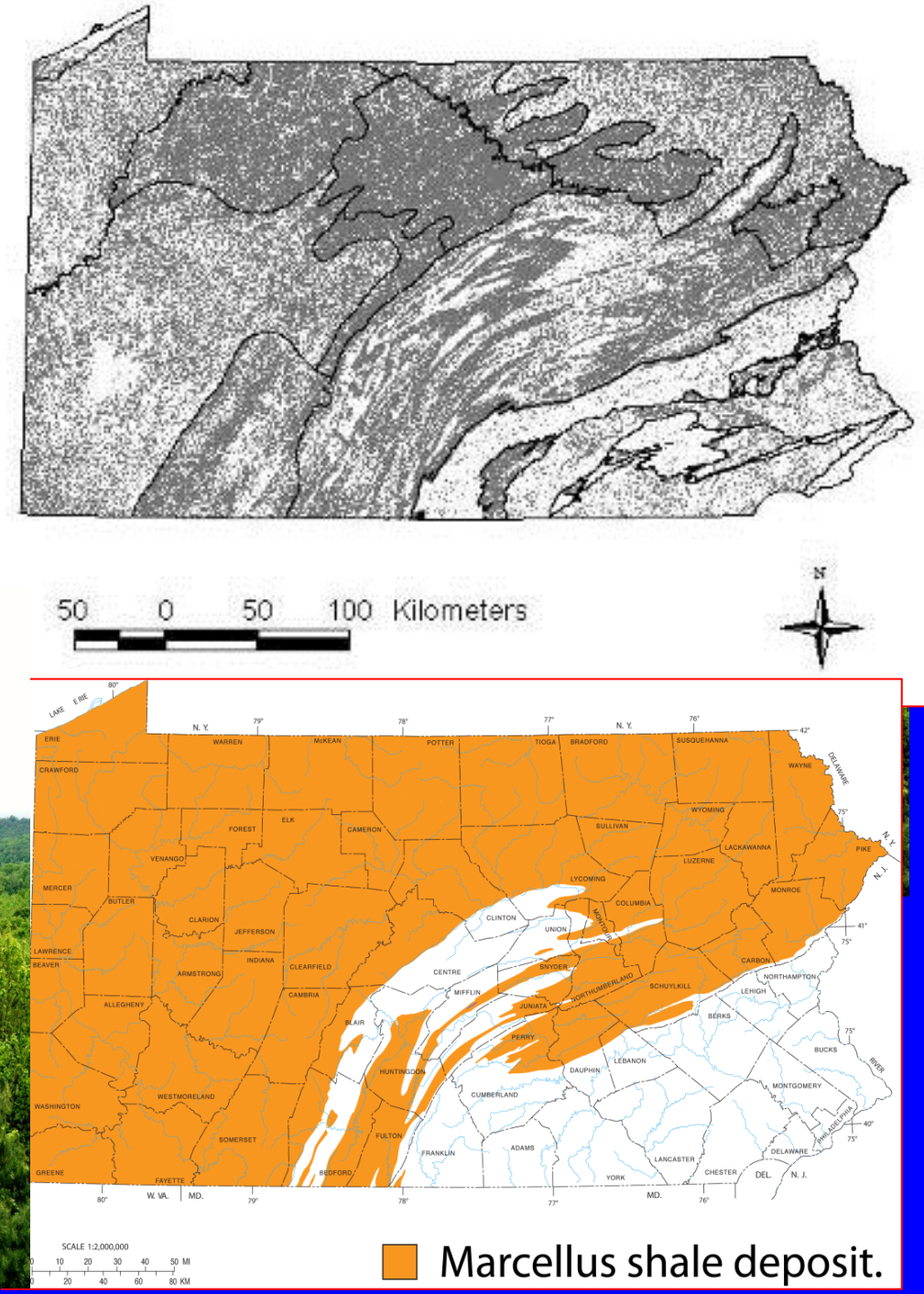


The overlap between core forest and the Marcellus shale results in high vulnerability for this habitat



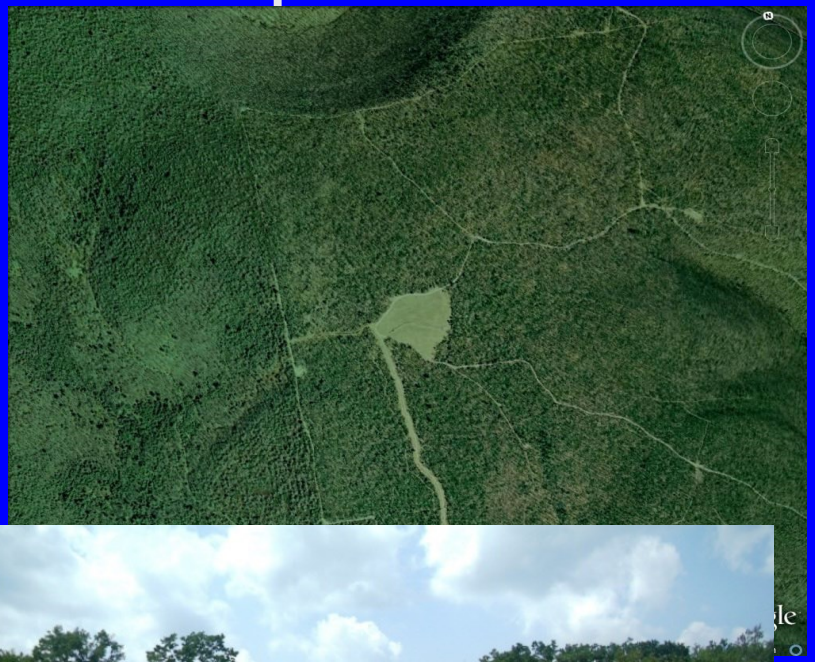
Core forest habitat has high ecological value and is particularly important for forest interior/ area sensitive songbirds.

Gas well development changes the landscape

Landscape effects differ between shallow and deep (unconventional/shale) development

Shallow

Deep



Shallow

Deep

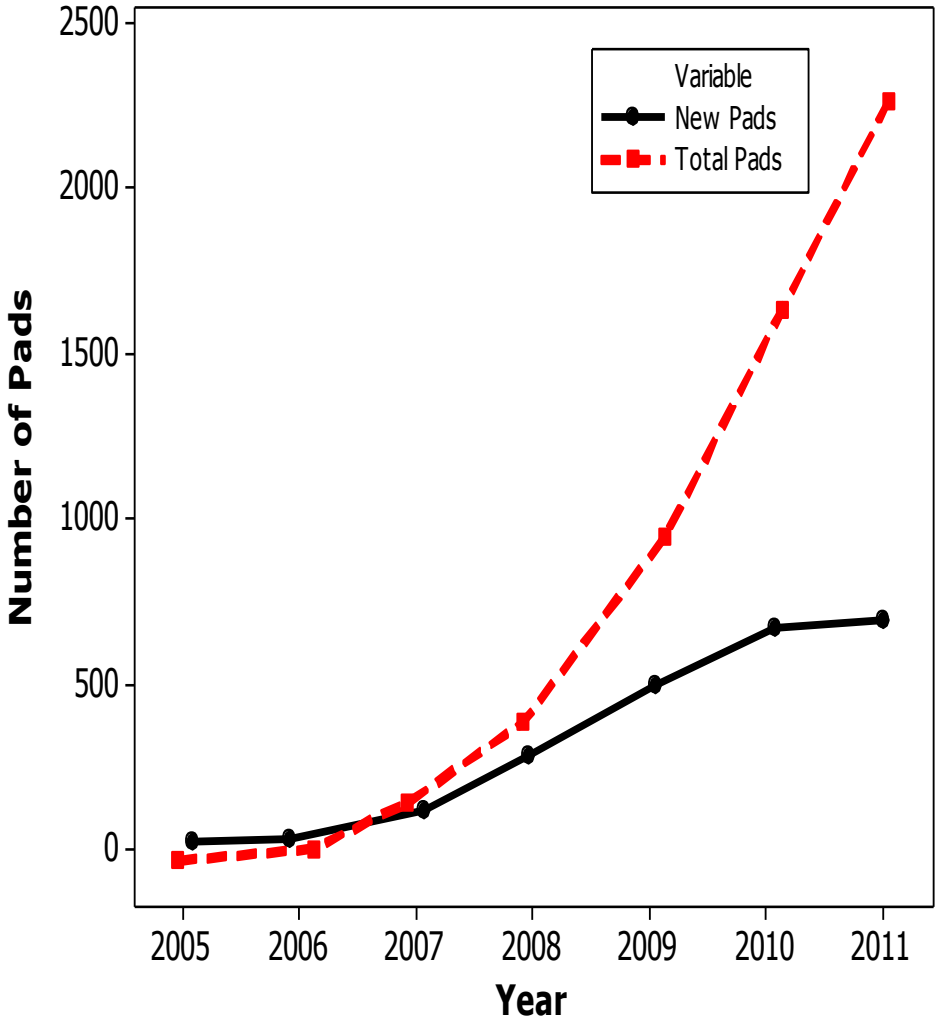
The pad footprint averages 1 ha (2.47 acres)

Pad+ local disturbance= 2.7 ha (6.7 acres)

Range = 0.1- 19 ha (0.25-49.4 acres)

Drohan and Brittingham 2012

Numbers of pads developed is a good indication of landscape change



>2350 pads built in PA 2005-2011

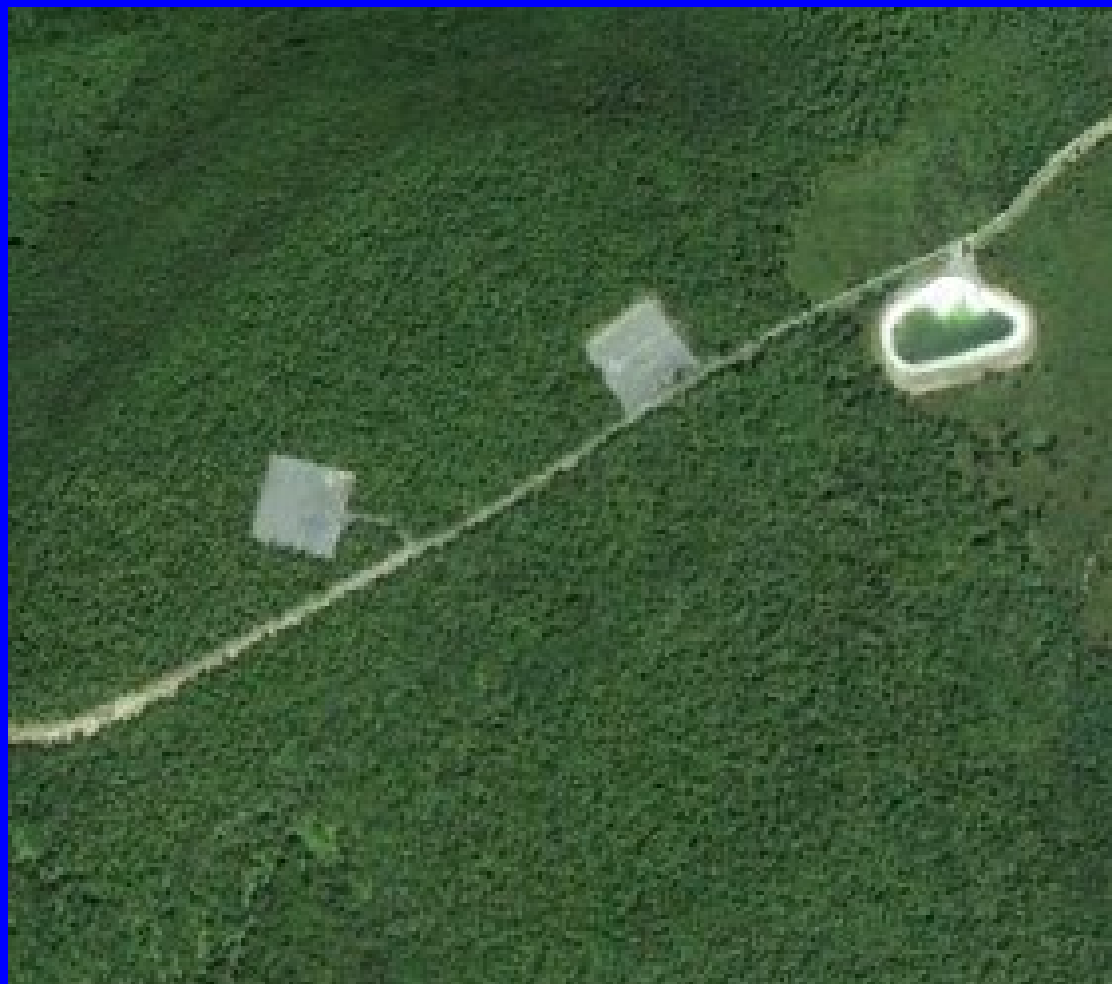
48 % of pads are in farmland and 52% in forest lands

Approximately 25% of wells are going into core forest (forest > 100 m from pre-existing opening or edge) Drohan et al. 2012

25% in core forest

25% in edge forest (< 100 m from an edge)

2% in woodlots



Pipelines and roads create linear corridors and will probably have a larger ecological effect than the pads themselves

Pipeline Corridors may act as barriers to dispersal for some species

Spotted Salamander

And as avenues for invasion for others

Bown-headed Cowbird

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Wolf predation on woodland caribou increased near linear corridors such as pipelines, seismic lines and roads – Alberta Canada

James and Stuart-Smith 2000

Width of seismic line influenced whether it was a boundary or part of the territory

- Seismic lines 8 m wide acted as territory boundaries
- Low impact (2-3 m) seismic lines were incorporated into territory

Bayne et al. 2005

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Bradford County Gathering Lines - Johnson et al. 2011

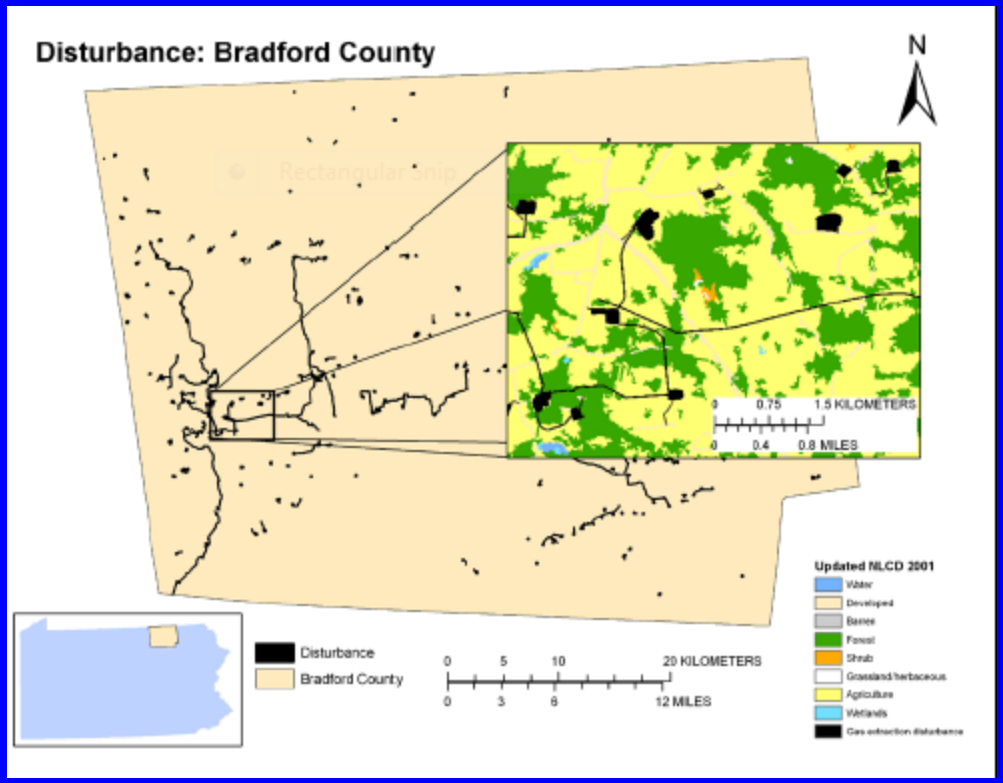
2.65 km per pad (1.65 miles)

16,093-40,233 km new gathering lines predicted at build out (10,000 – 25,000 miles)

Landscape consequences of natural gas extraction- Bradford County, PA

Pipeline construction is major contributor to forest loss

Loss of core forest is 2 times loss of overall forest



Slonecker et al. 2012 USGS open file report 2012-1154

New and expanded roads and heavy truck traffic reduce habitat quality for most wildlife. Many studies showing effects of roads on wildlife and response of wildlife to roads including avoidance, increased mortality and altered species composition

Northrop and Wittemyer 2012 Ecology Letters gives overview of energy related studies

Habitat Fragmentation is a result of gas exploration and development and is a primary concern

- Change in species composition and abundance (winners and losers)
- Spread of invasive species
- Disturbance to sensitive habitats
- Negative effects on biological diversity and ecosystem functions

Species composition differed with well abundance and proximity to wells

Barton, Fronk, Brittingham – Preliminary results of ongoing work

- Forest interior species declined
- Human-associated species increased
- Early successional species showed no pattern

New pads, pipelines and roads act as corridors for Invasive Species

Barlow, Mortensen, Drohan, & Hayes (In prep)

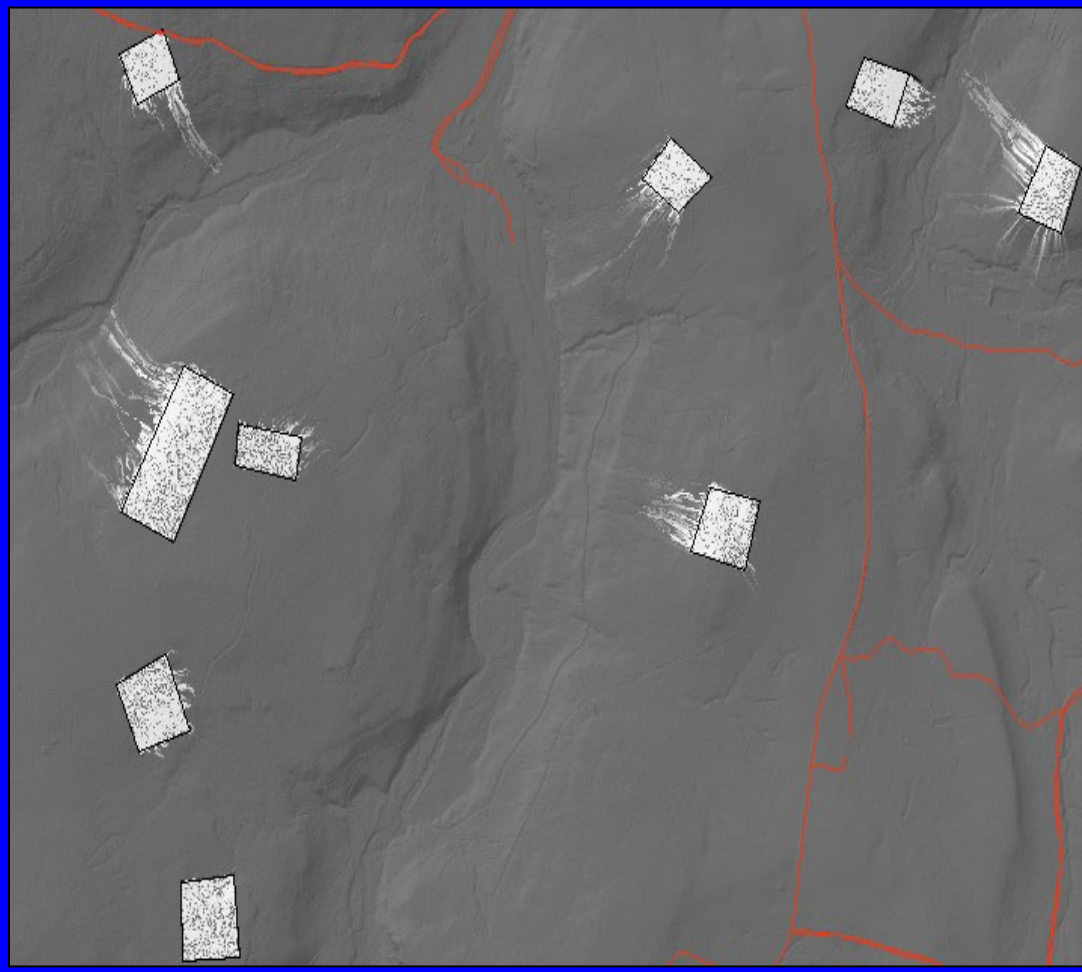
- 60 % of surveyed pads had invasive plants
- Invasion dependent upon:

- Regional invasive plant pressure
- Degree of forest fragmentation
- Type of road: gravel worse
- Land-use history
- Proximity to different disturbance types

Disturbance of Sensitive Habitats

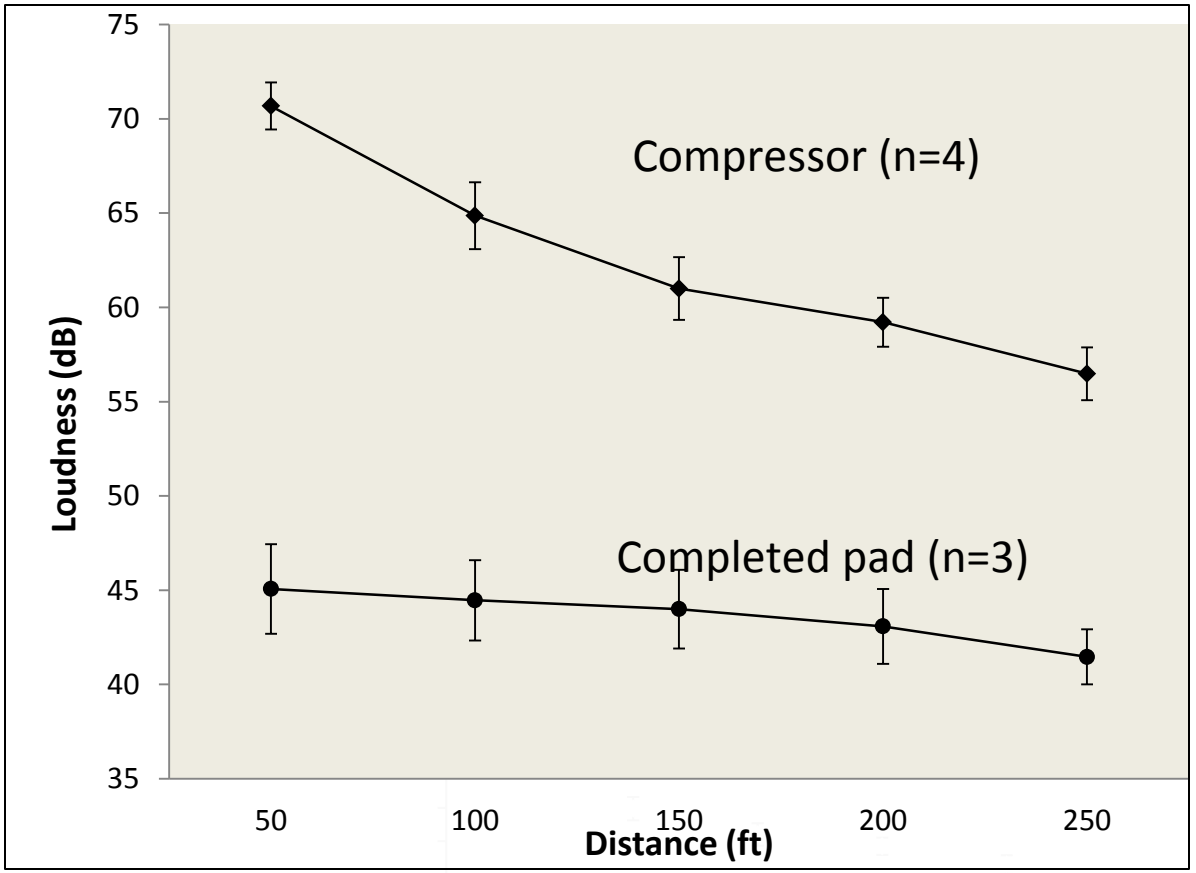
There is evidence of hydrologic capture associated with shale-gas roads and pad development resulting in some areas becoming wetter and some drier. (Drohan

- Hydric soil change
- Wetland hydroperiod change
- Surface runoff change
- Potential change to amphibian migratory or breeding habitat



Noise and Light Pollution associated with pad development and drilling may have local site-specific impacts but probably not long-term effects

Compressors are a long-term source of noise



Sound is important for communicating and noise from compressors can affect this process

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Songbird density declined with noise, pairing success declined with noise, young males got noisy territories (Bayne,Habib, and Boutin 2008,Habib, Bayne, and Boutin 2007)

No research on effects on amphibians

Noise from compressors has been documented to affect species richness and community structure resulting in changes in reproductive success with consequences to ecological services such as seed dispersal and pollination (Francis et al. 2009, 2011, 2012)

Concern over effects on species with small populations or limited distributions. Many of these are target of direct management or mitigation


Timber rattlesnake

In Pennsylvania, 93% of pads are on private land - Drohan et al. 2012

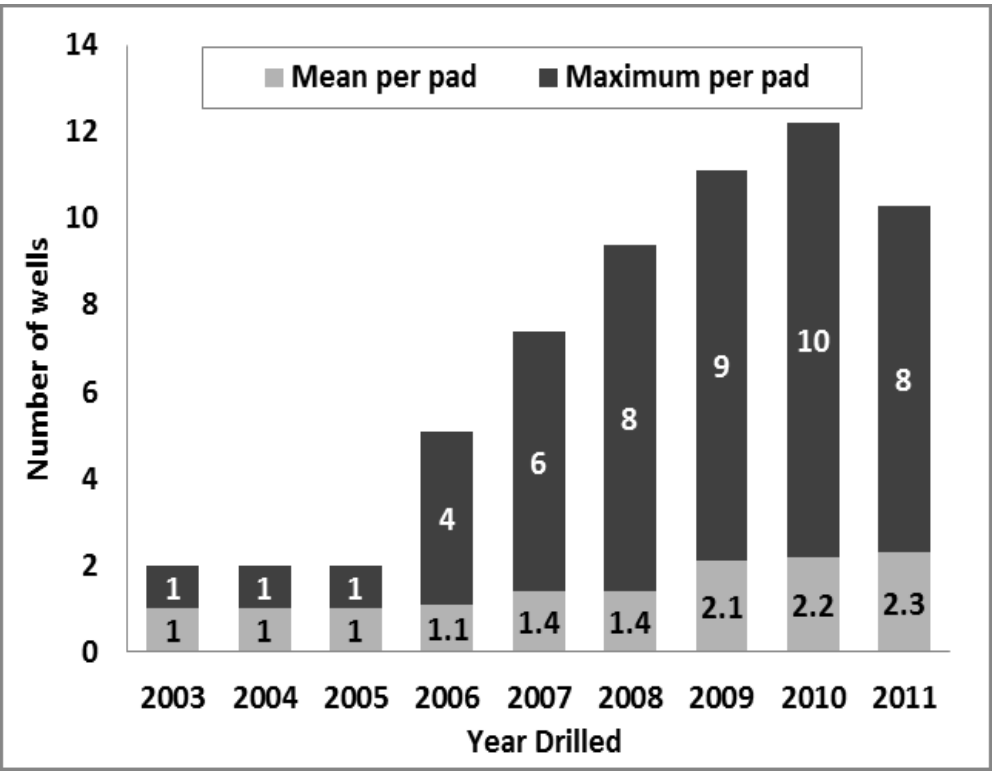
- Private landowners lack planning and management resources available on public land
- Lack of planning oversight or control
- Surface owner often is not mineral owner
- Increased risk and uncertainty

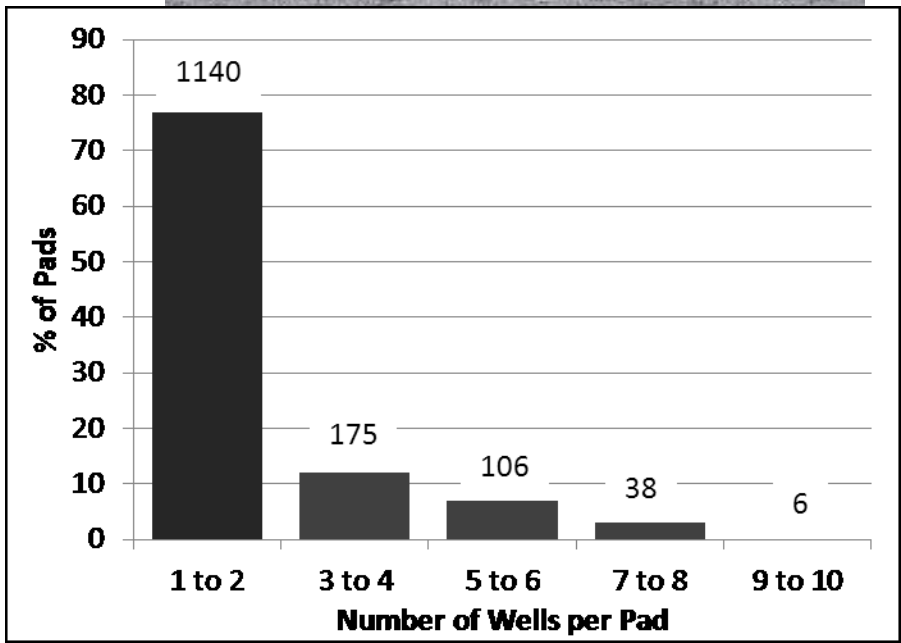
Over 75% of pads have only 1-2 wells per pad

(Drohan et al. 2012)

n=2,931 wells and 1465 pads

Mean = 2.3 wells per pad





Restoration potential and timing is a big unknown

In PA, 16% of pads reclaimed, 84% not reclaimed

Most reclamation is to grass cover or clover not to shrub cover or trees

Research Needs

- Thresholds of change for different species and groups of species
- Mechanisms underlying species responses
- Restoration methods and potential

Electronic Field Guide-http://marcellusfieldguide.org/

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