Optimal Siting of Shale Gas Pipeline Infrastructure: Tradeoffs between Costs and Habitat Impacts

Work-in-Progress

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Background

- Infrastructure development for shale gas extraction (well pads, roads, gas and water pipelines) can cause environmental impacts including:
    - Species loss through habitat loss and fragmentation
    - Water quality from sedimentation
- Impacts likely vary by habitat through which pipeline is run, so the siting of pipelines affects environmental outcomes

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Background Cont.

- Shale gas development is largely driven by bottom-up decision-making by shale gas developers
  - May not address broader community objectives
  - May require greater private investments than would be necessary under a coordinated approach to develop a similarly functioning infrastructure
- A more coordinate infrastructure development, taking into account both private costs and environmental impacts, could help reduce overall
  - Environmental effects
  - Economic costs

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Purpose and objectives

Examine potential economic and environmental benefits from more coordinated approaches to shale gas development.

Develop a general conceptual model and apply it in a PA county to estimate:

1) Extent of potential economic gains (reduced costs) that could be realized through coordinated pipeline development

2) Degree to which a coordinated approach could mitigate negative environmental externalities

3) Cost of further addressing environmental objectives (e.g. habitat quality and fragmentation) in pipeline development

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Methodology

- Spatial optimization models using infrastructure data from Pennsylvania
- Contrast **current bottom-up decision-making** to two alternative pipeline development approaches:
  1. Coordinated design among private developers
  2. Strategy that accounts for environmental externalities resulting from development, in addition to the private costs and benefits
- “Private optimality” is defined as minimizing the sum of private costs
- “Social optimality” minimizes the sum of private and external costs (in terms of environmental attributes associated with habitat)

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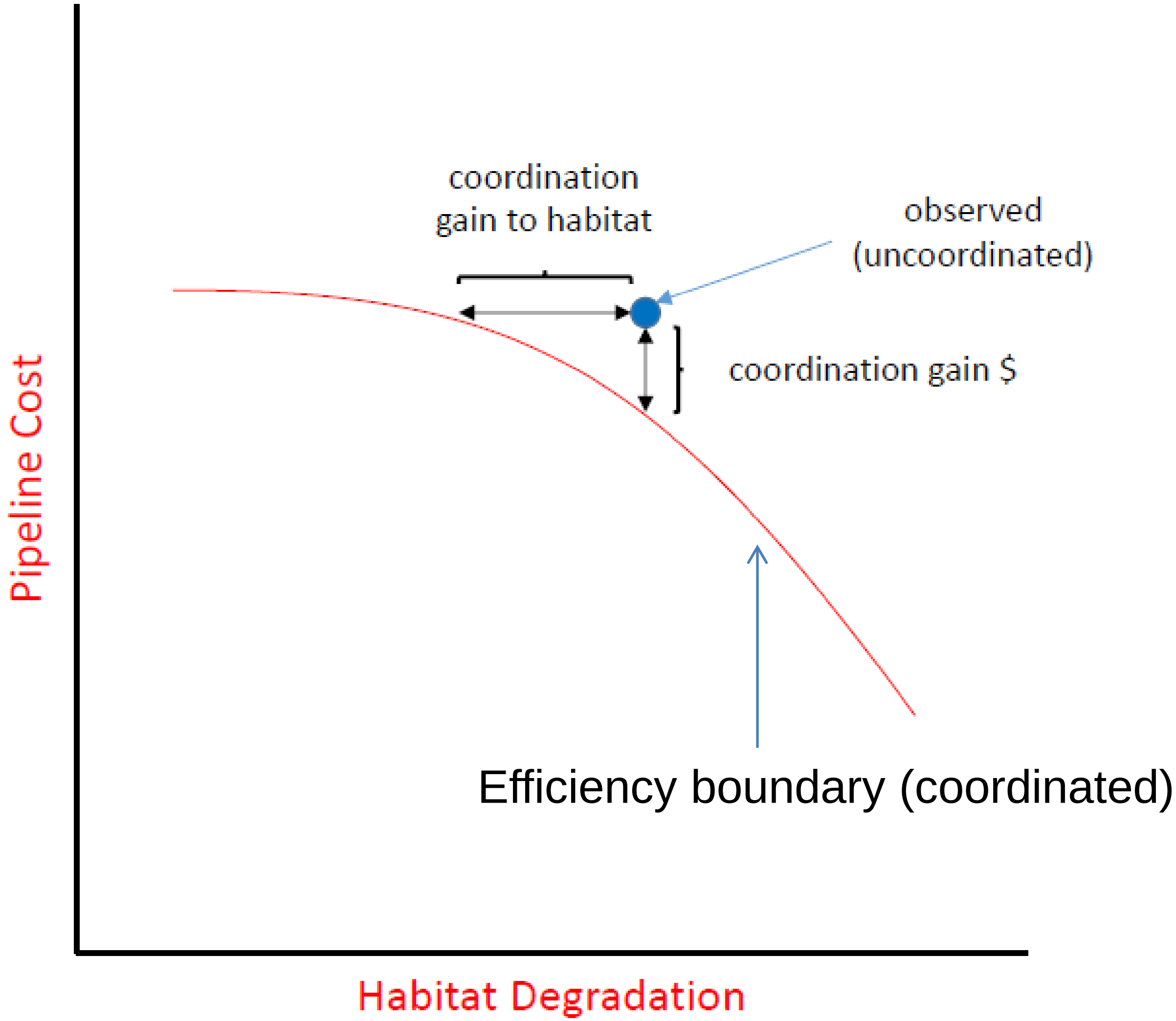
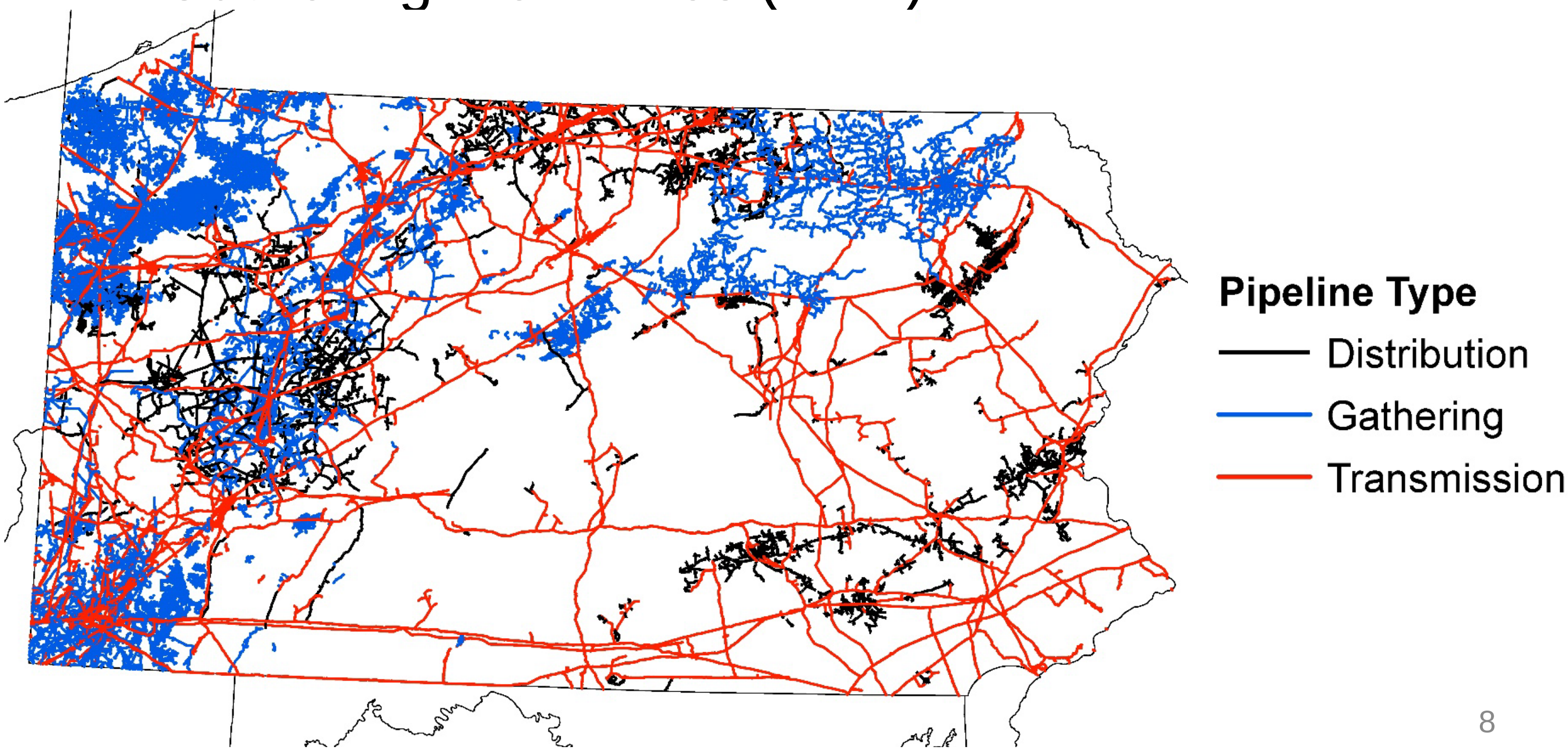
Methodology Cont.

Tradeoff curve between cost and environmental degradation:



Pennsylvania Pipeline Development

- More than 35,000 miles of pipeline (including all pipelines, not just shale)
  - Distribution: 22K miles (23%)
  - Transmission: 13K miles (36%)
  - Gathering: 15K miles (41%)



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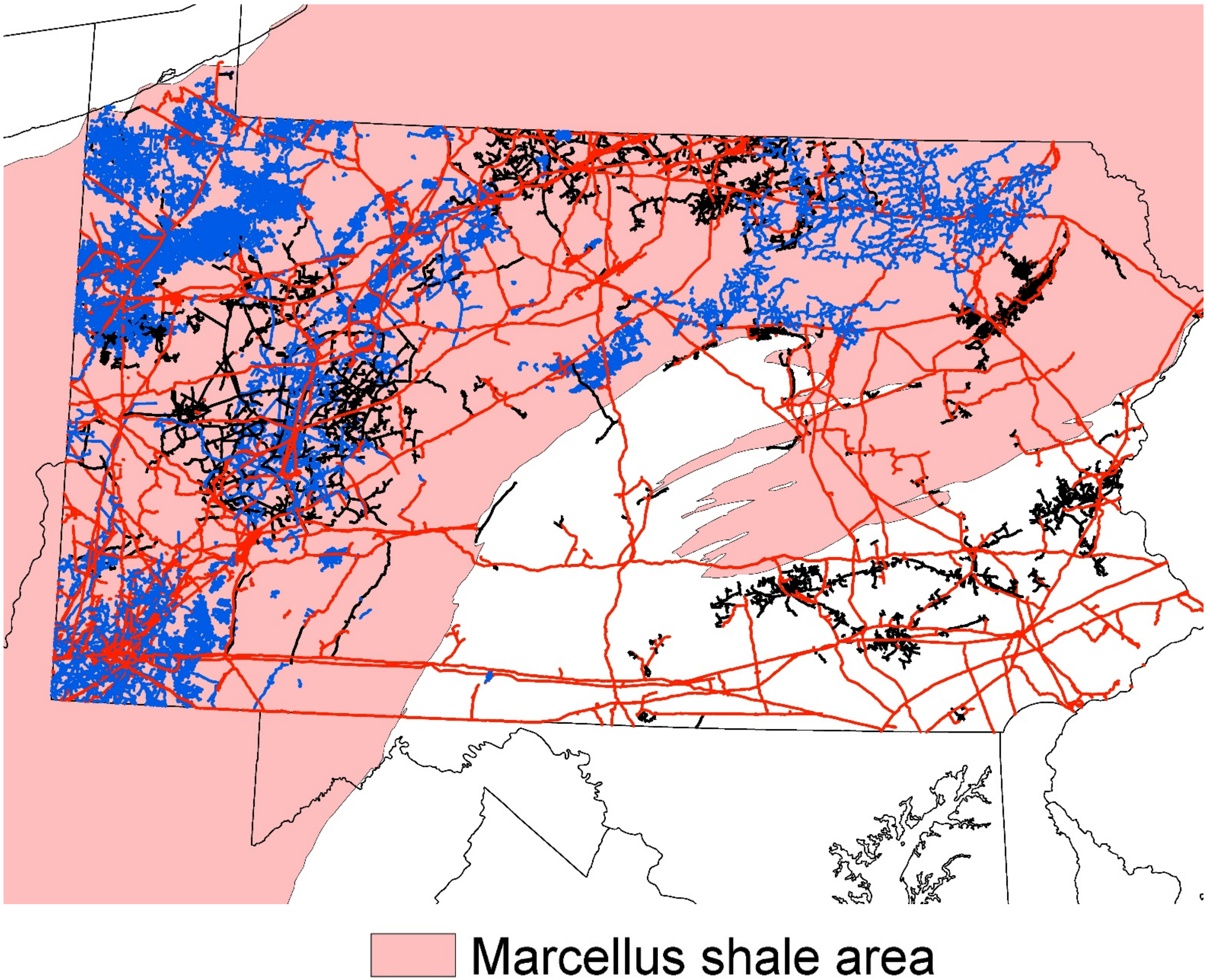
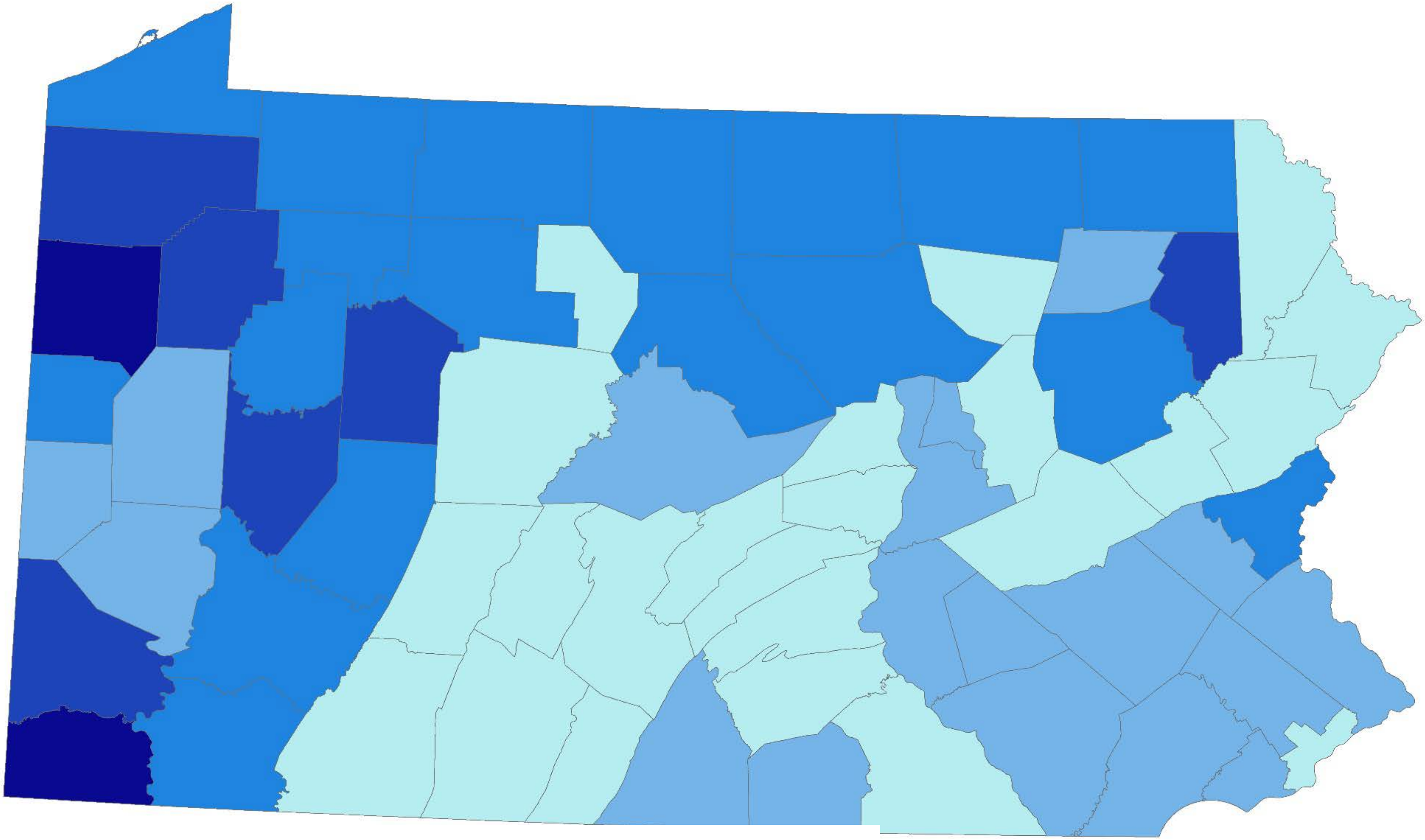
Pipeline Density Highest over Marcellus Shale



Average Pipeline Density Varies by County

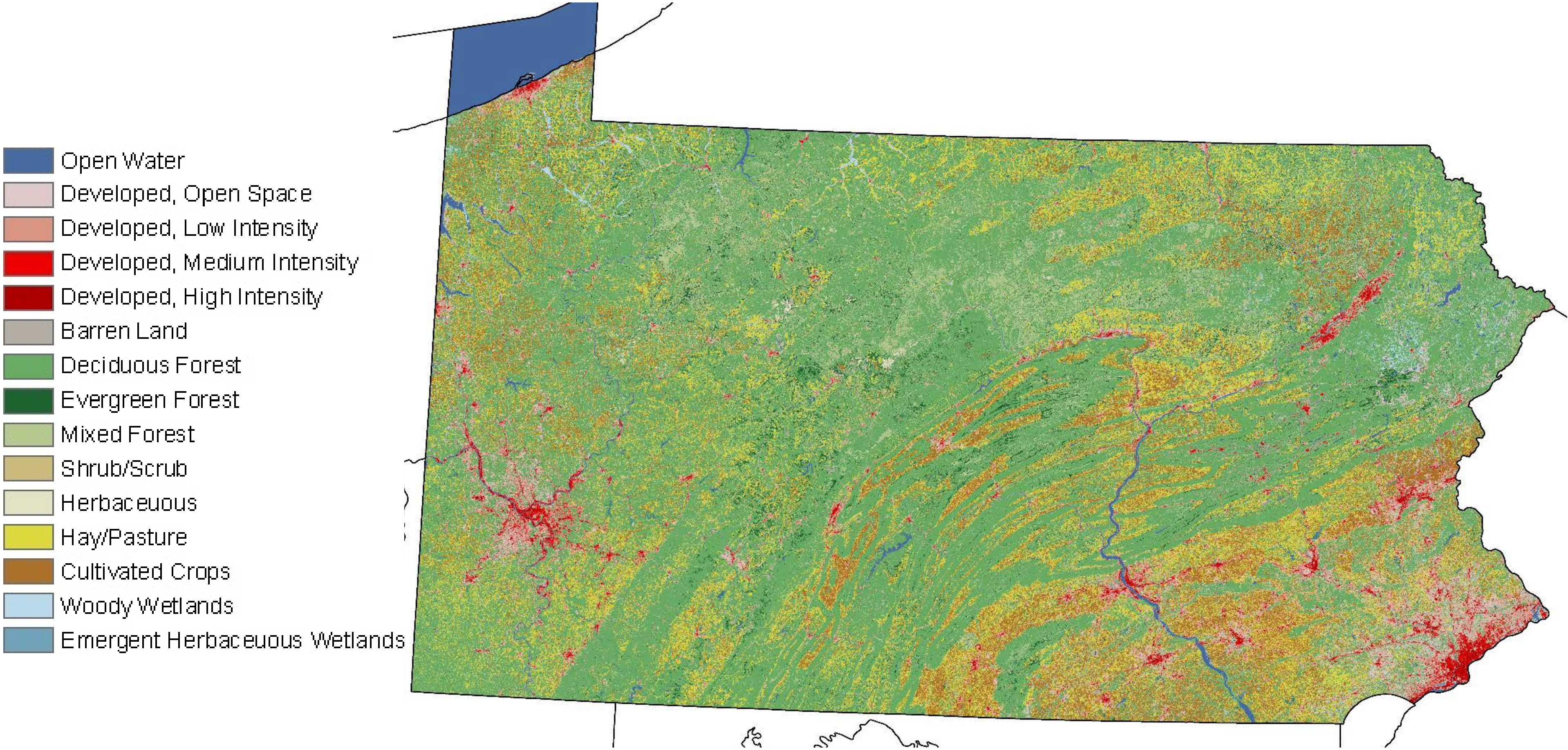


Density of Pipeline (m/acre), on average

- 0.154 - 0.816
- 0.817 - 1.73
- 1.74 - 3.22
- 3.23 - 5.36
- 5.37 - 8.27

Low ↕ High

Pennsylvania Landcover and Habitat



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Pipeline Impacts on Habitat Vary by County

Habitat Affected by Pipelines: Counties with the most pipeline			
	Forest & Wetlands	Agricultural	Developed
Mercer	29%	43%	26%
Greene	63%	26%	9%
Crawford	36%	43%	18%
Bradford	39%	47%	13%
Armstrong	63%	24%	12%

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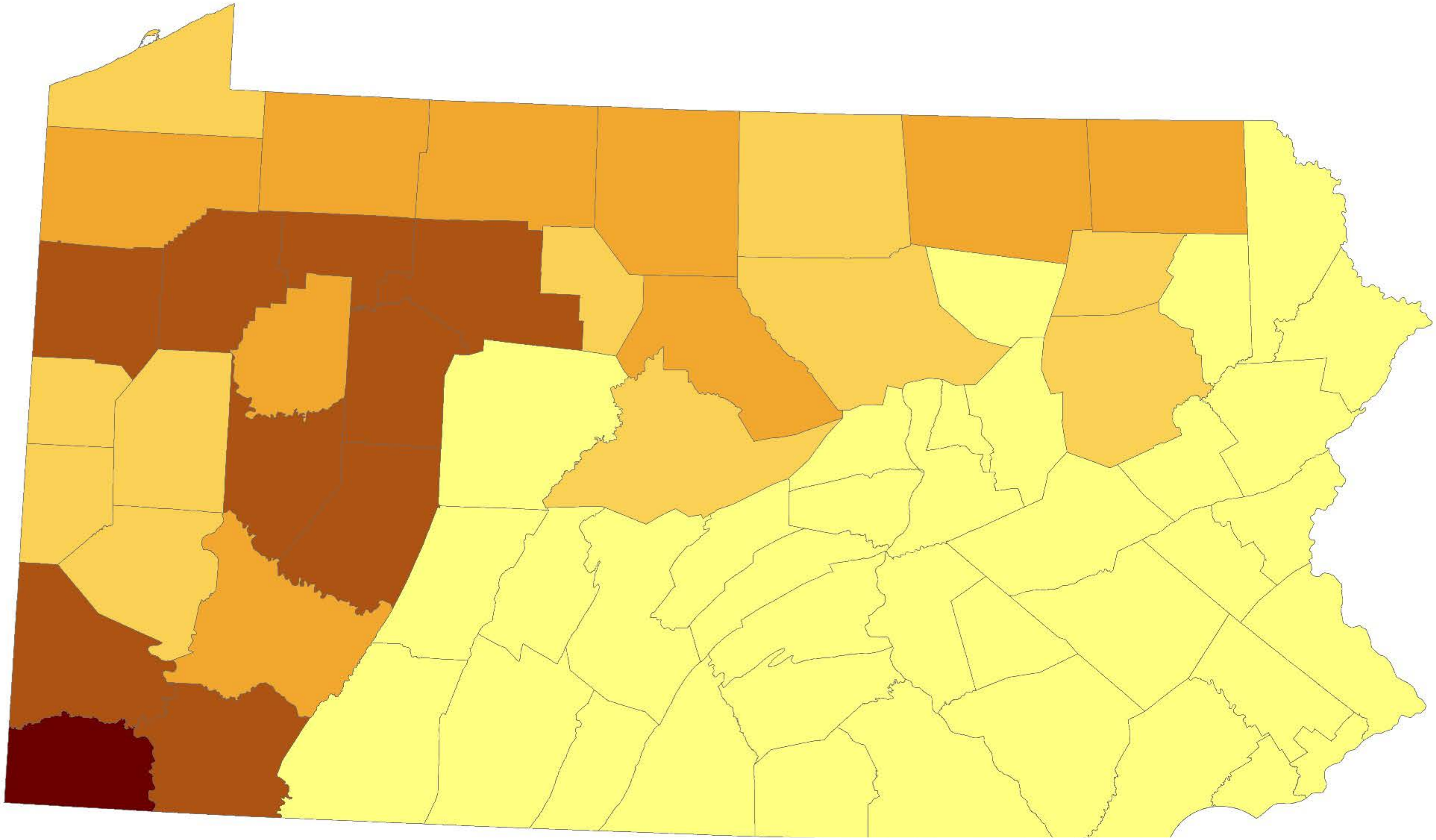
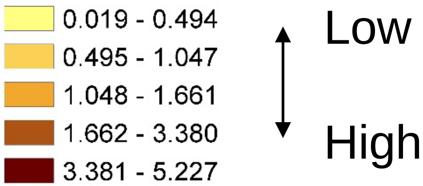
Forest and Wetland Impacts by County



Habitat Impacts = Pipeline (meters) over forest and wetlands/Total county area (acres)



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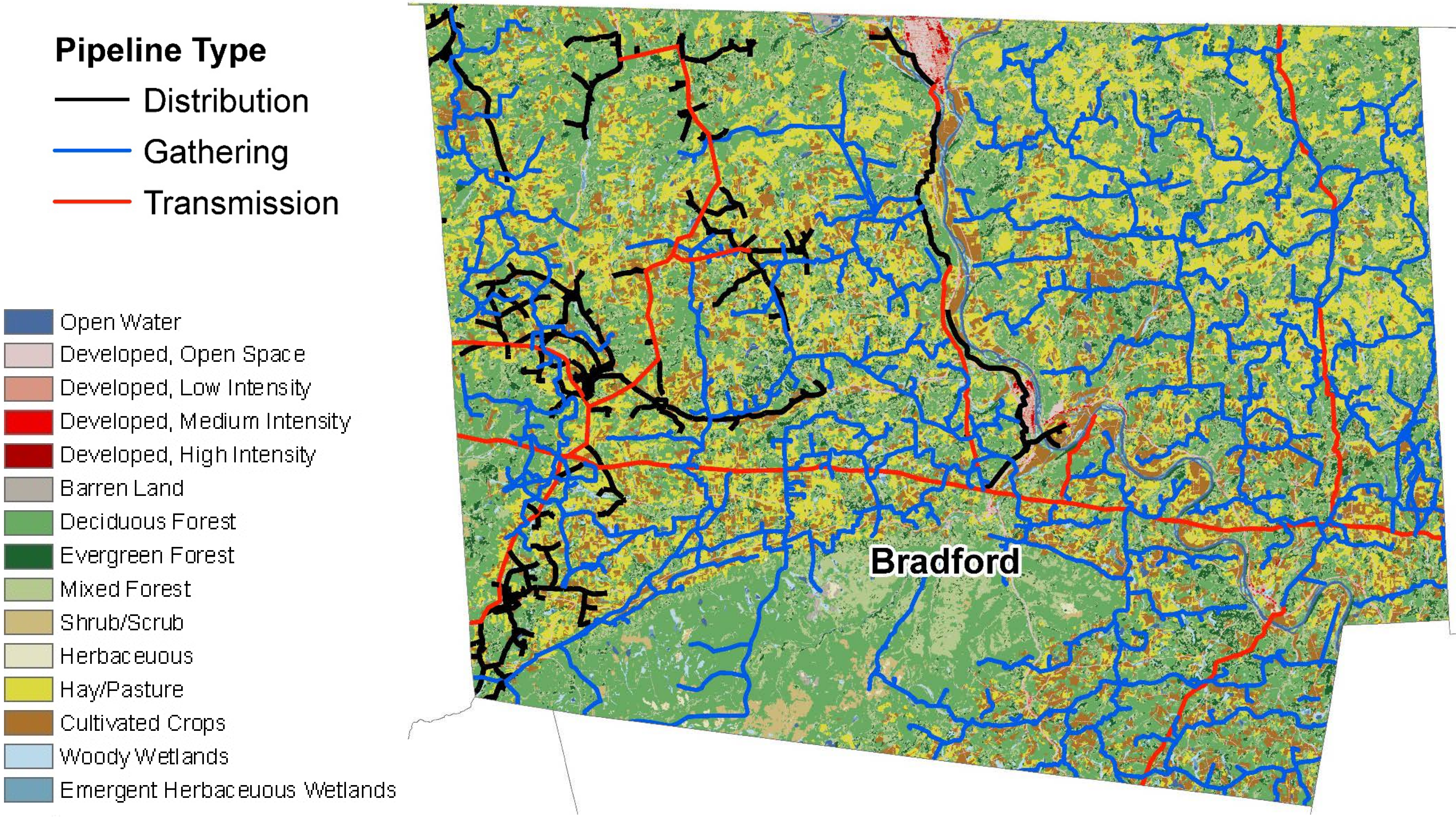
Bradford County



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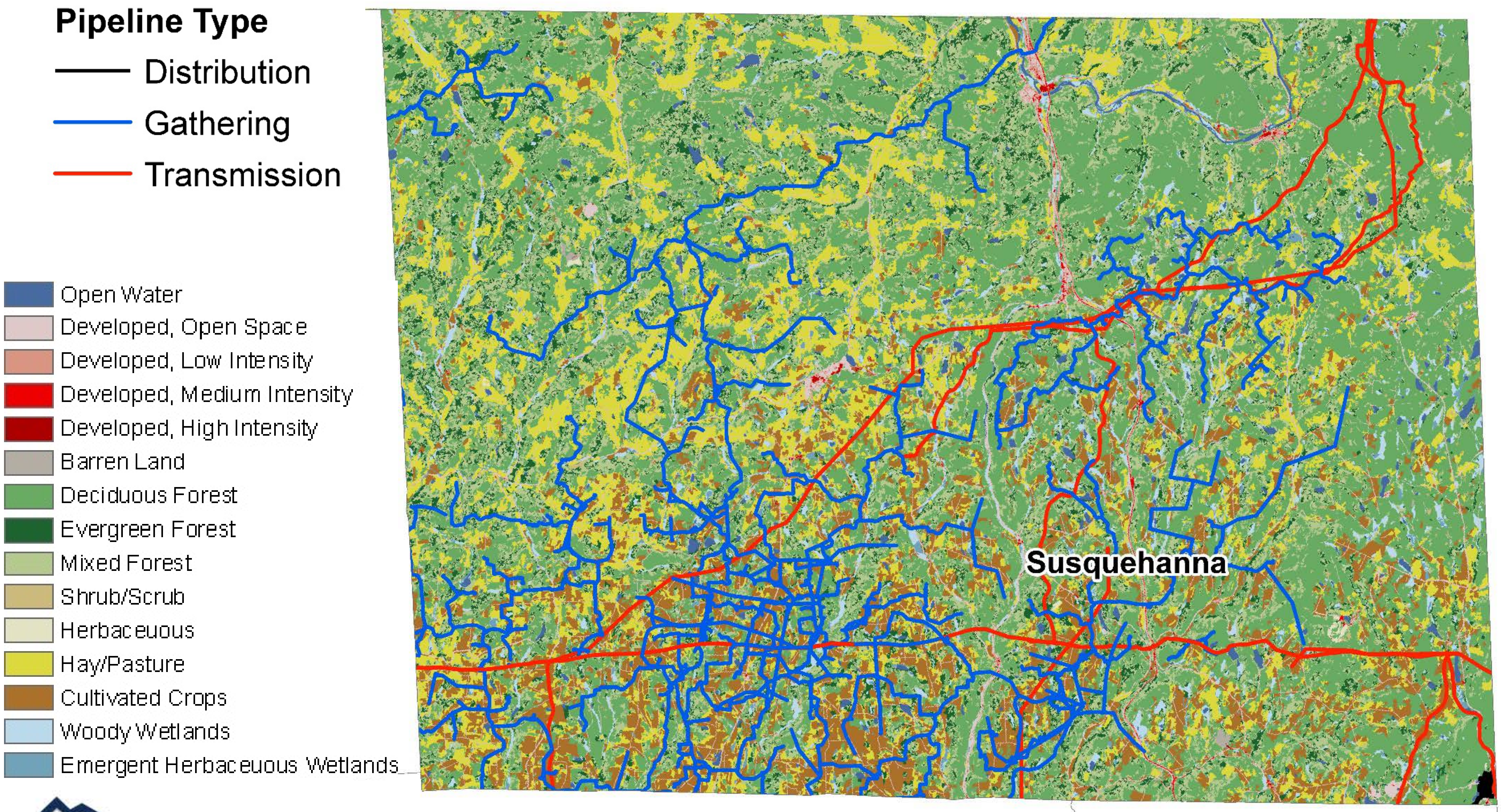
Susquehanna County



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Spatial Optimization Model

- Use gathering pipeline and landcover data from Pennsylvania counties
- Create a grid with information on actual infrastructure development and habitat for each “grid cell”:
  - Habitat type
  - Pipeline (yes/no)
- Solve for optimal gathering line configuration varying habitat impacts to create tradeoff curve

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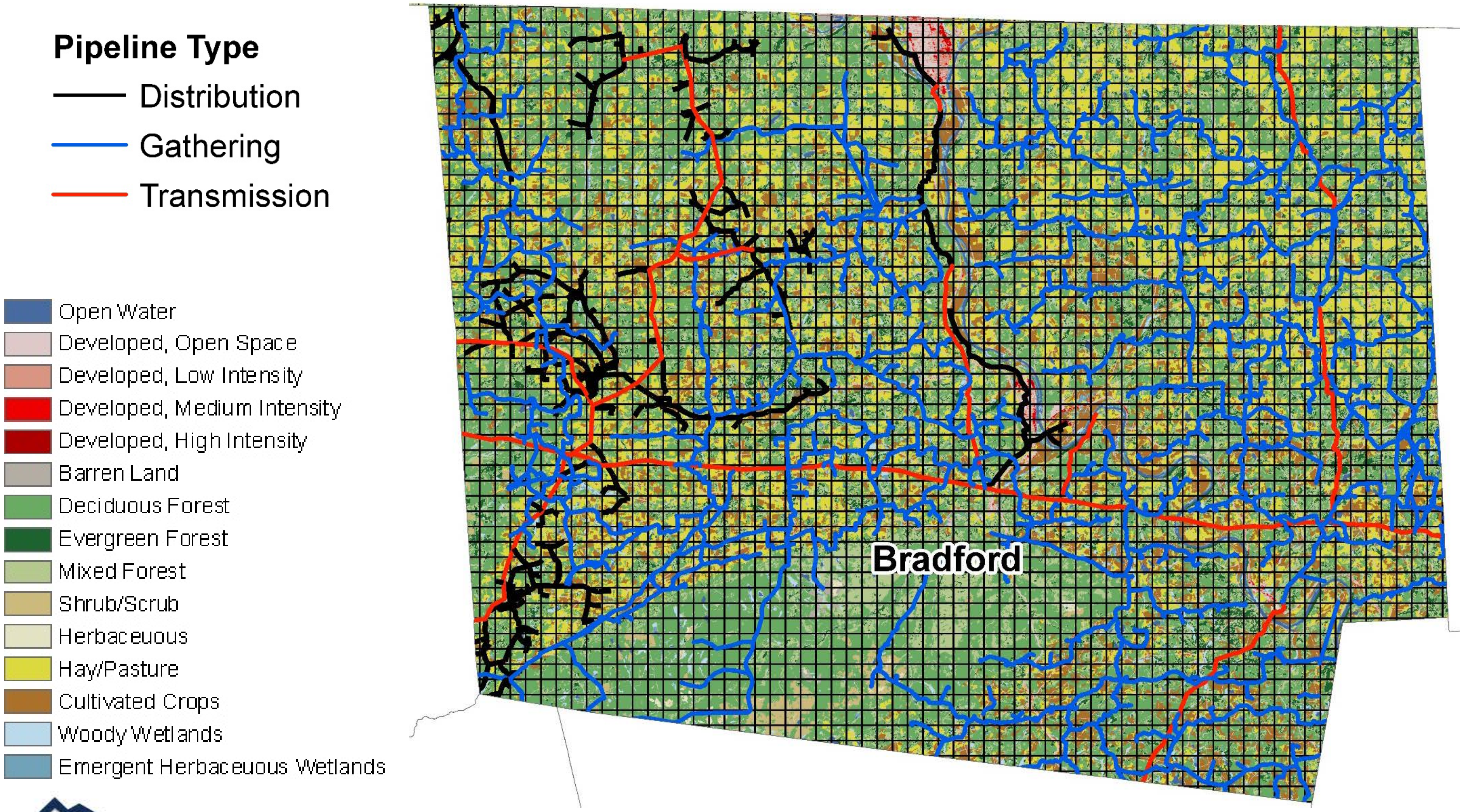
Grid for Analysis



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Discussion and Next Steps

- Work-in-progress
- Methodological approach suits a variety of settings
- Results will quantify
  - Cost of addressing environmental goals in pipeline development
  - Potential cost savings from coordination among developers
- We are developing and running the model for one PA county
- Expansion to other counties and states possible in the future
- Other potential areas of future work include jointly evaluating the siting of wells and pipelines

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Thank you

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