Energy Development in the Great Plains:
Ecological Implications and Restoration Opportunities

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Energy Use


THE UNIVERSITY OF CHICAGO MEDICINE
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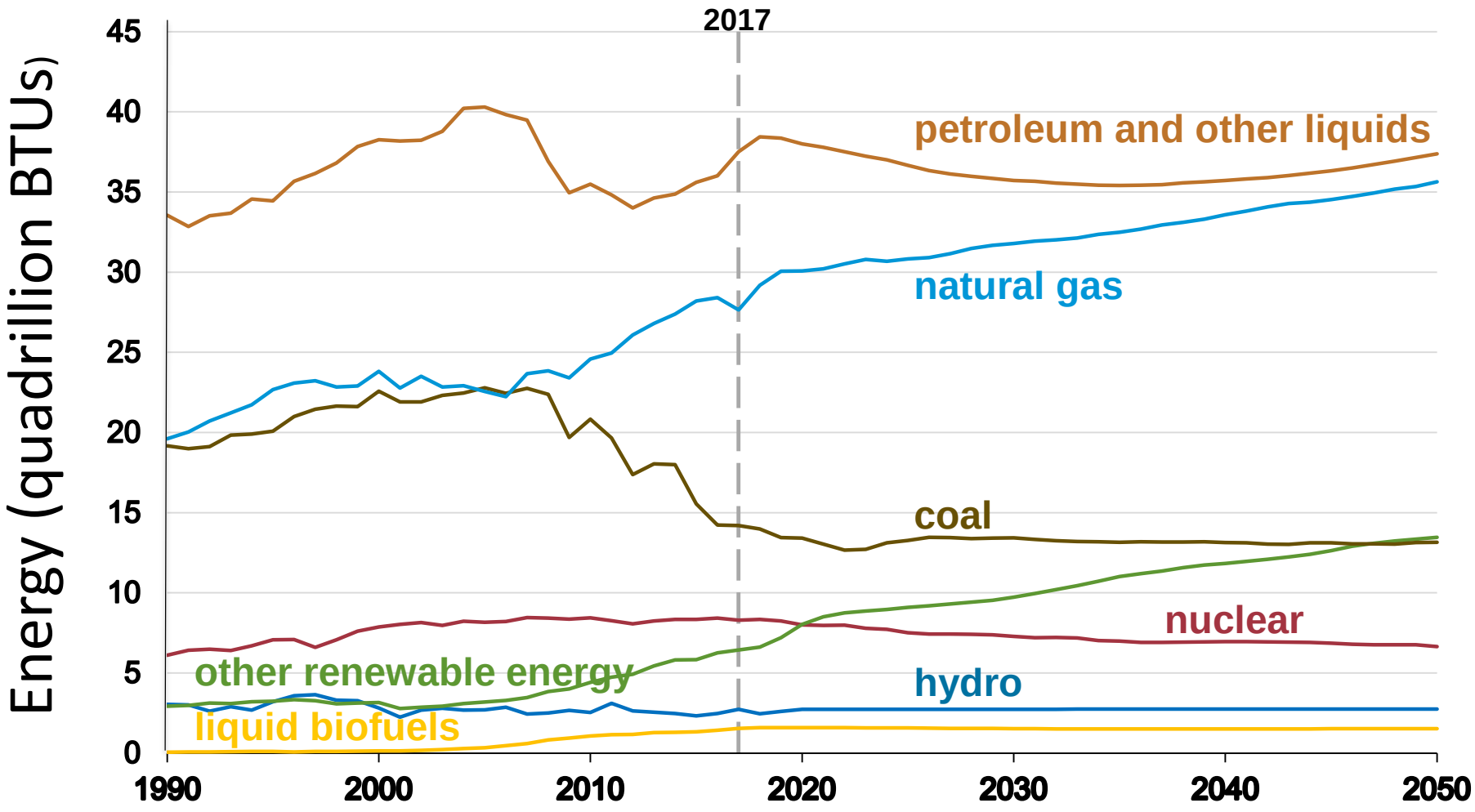
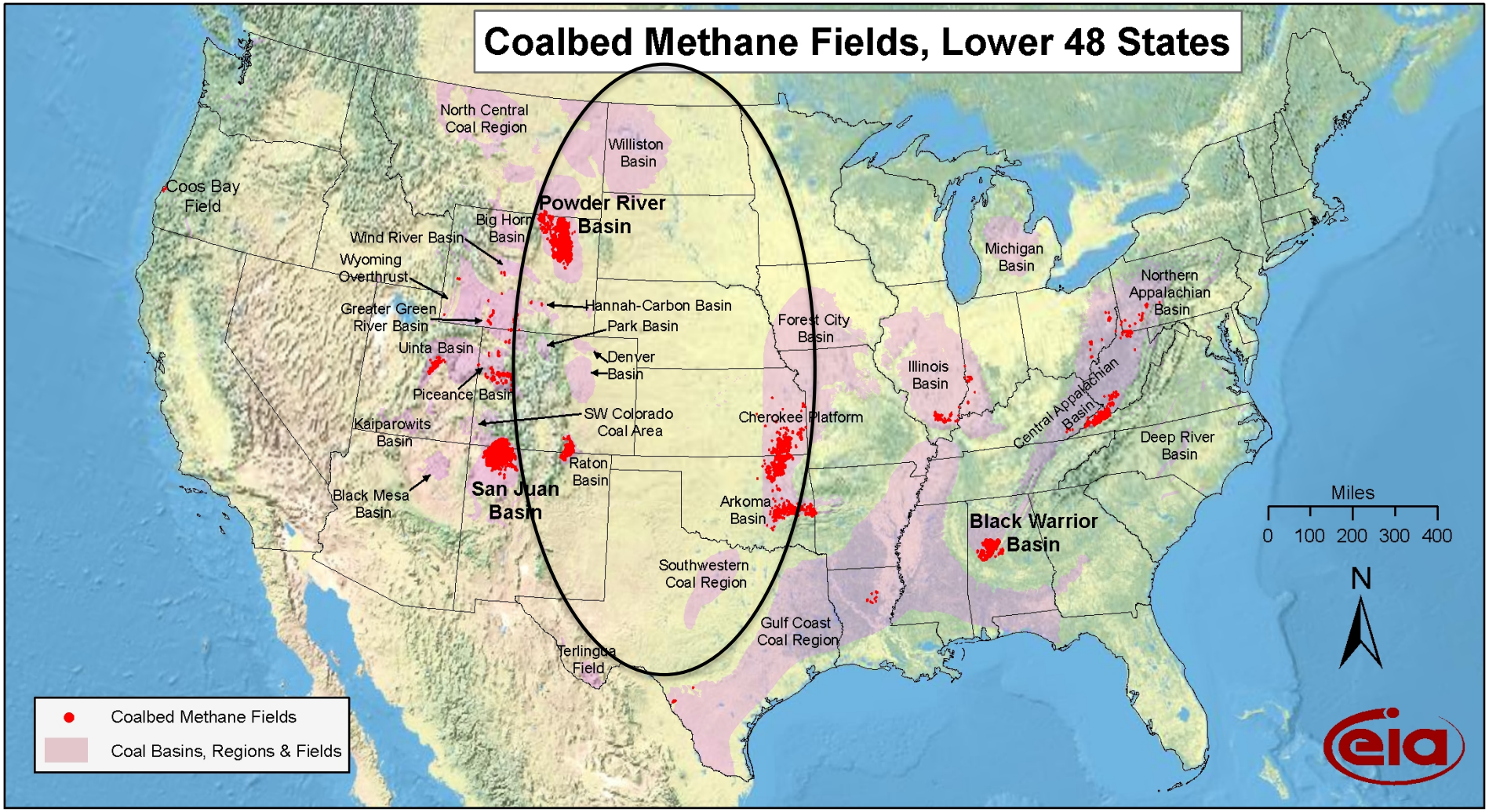
Energy Use

Sources of Energy Consumption



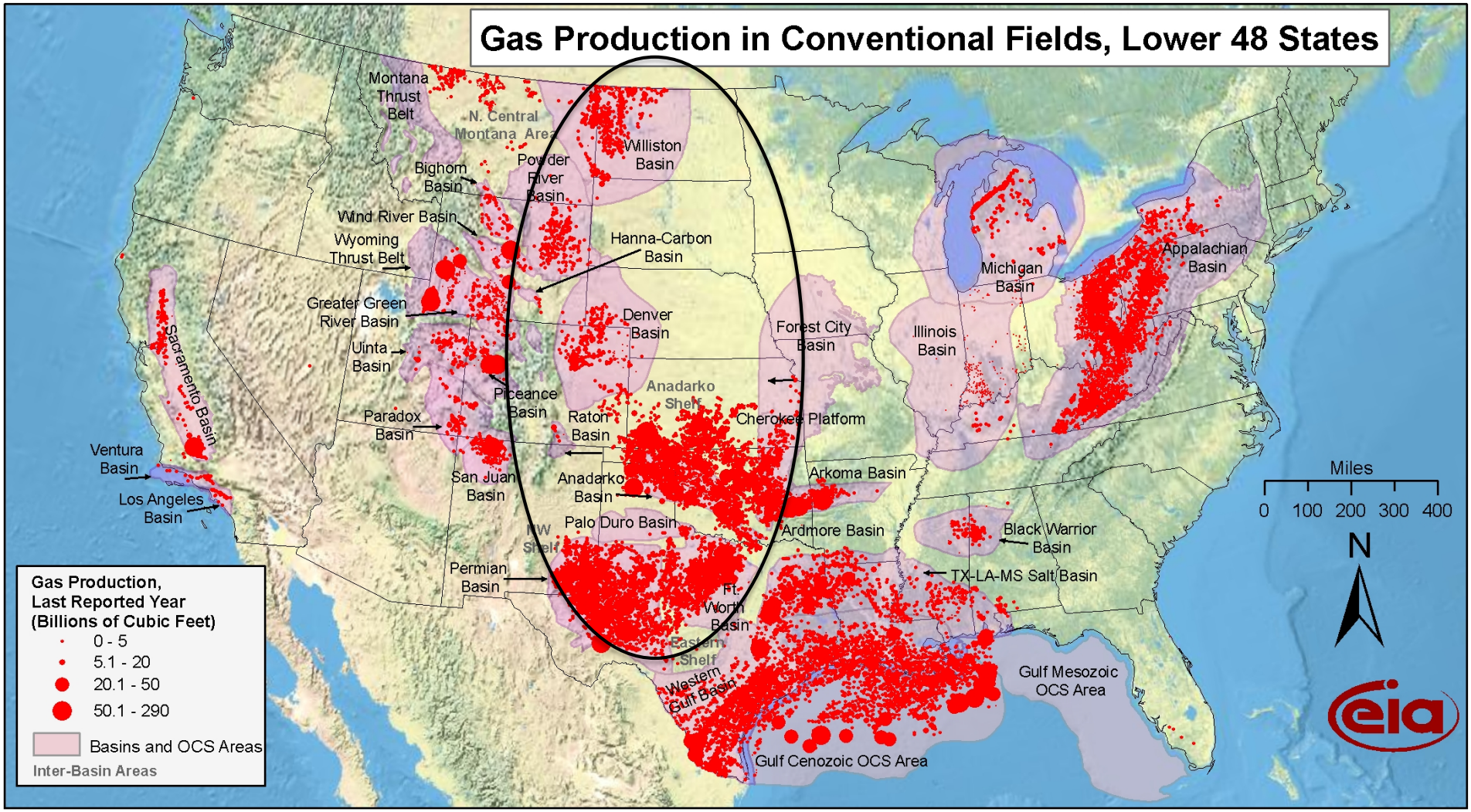
EIA 2018

Energy Resources on our Grasslands: Coal



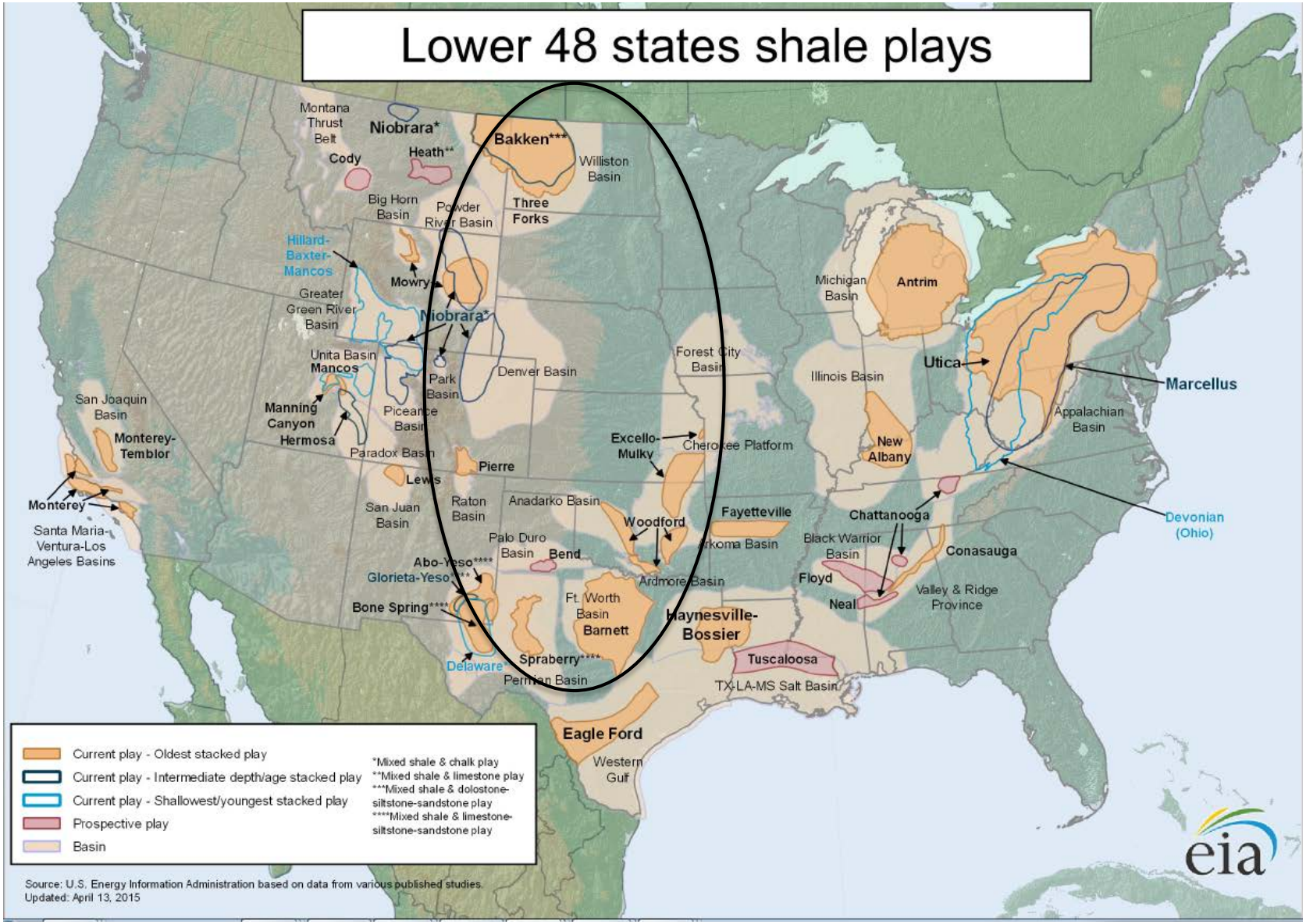
Source: Energy Information Administration based on data from USGS and various published studies
Updated: April 8, 2009

Energy Resources on our Grasslands: Conventional Oil and Gas

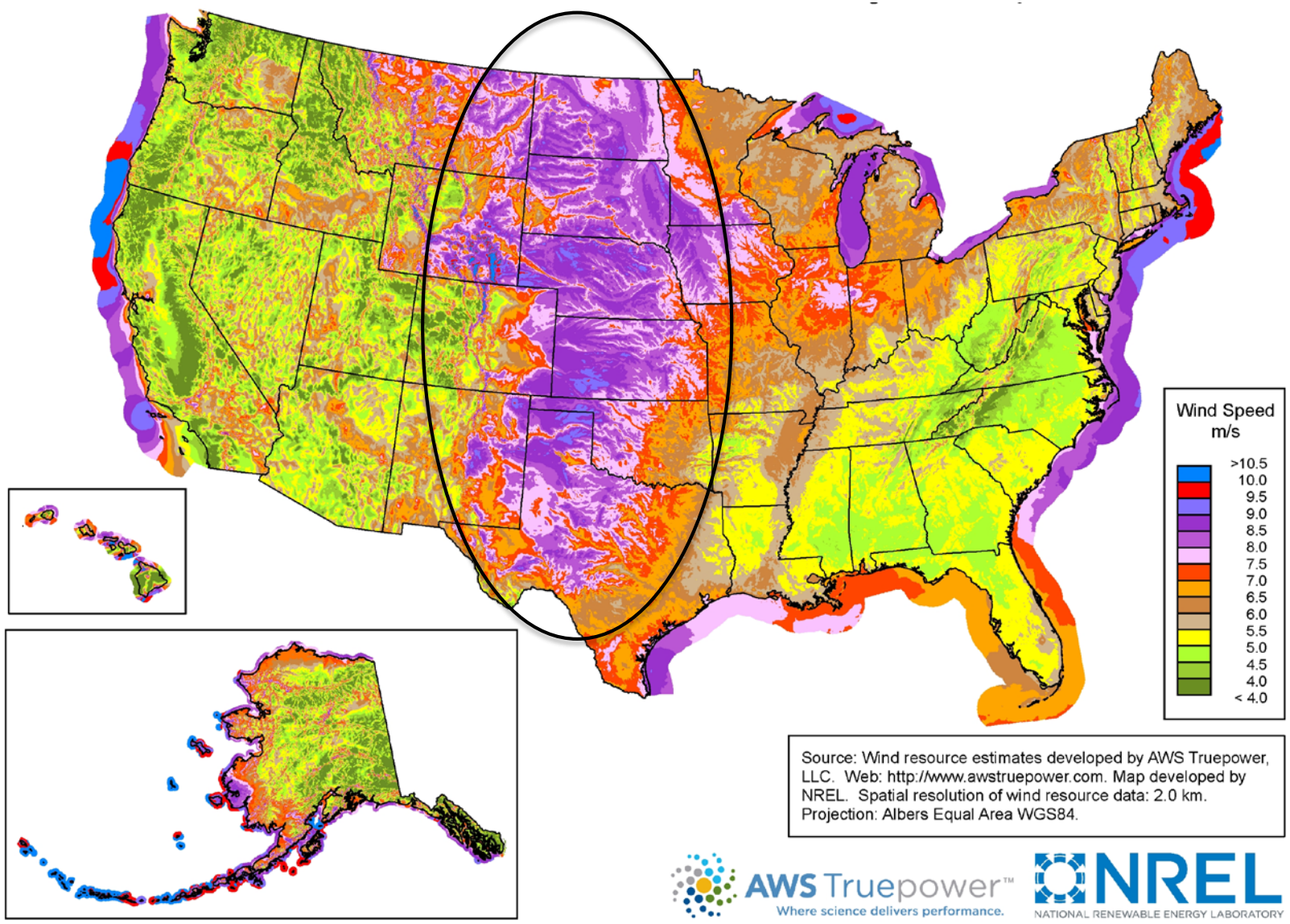


Source: Energy Information Administration based on data from HPDI, IN Geological Survey, USGS
Updated: April 8, 2009

Energy Resources on our Grasslands: Unconventional O&G



Energy Resources on our Grasslands: Wind



Energy Production: Consumption Ratios

US	CO	KS	MT	NE	NM	ND	OK	SD	TX	WY
0.9	2.2	0.8	2.8	0.5	4.0	3.0	2.4	0.6	1.4	17.3

> 1 exporting energy

< 1 importing energy

EIA 2018

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EIA 2018, Pipeline Safety Trust

Energy Resources on our Grasslands

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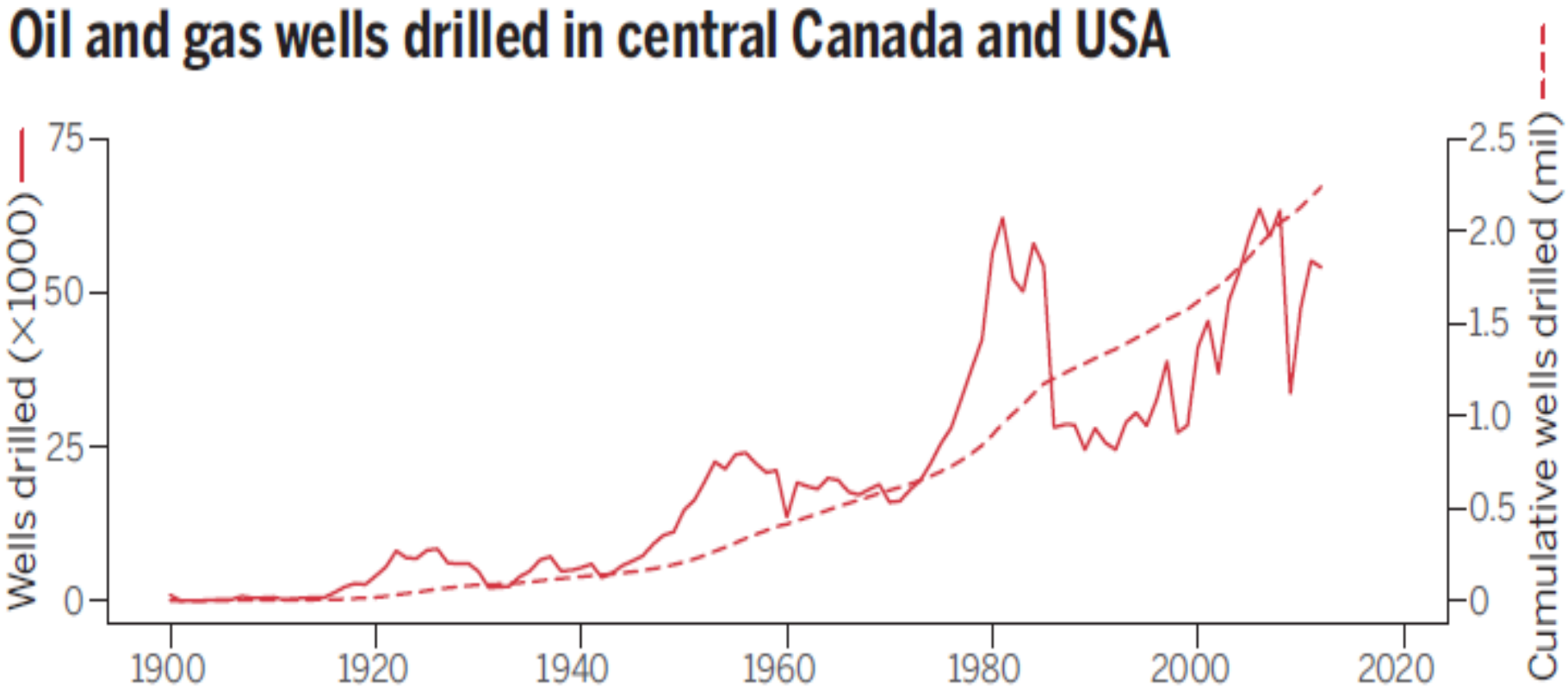
Oil and Gas Pipeline Mileage (%)

	CO	KS	MT	NE	NM	ND	OK	SD	TX	WY
	2.8	2.7	0.8	1.2	1.5	1.9	3.0	0.4	12.8	1.0

1.8 million miles of O&G pipeline in the US
28% occurs in our grassland states

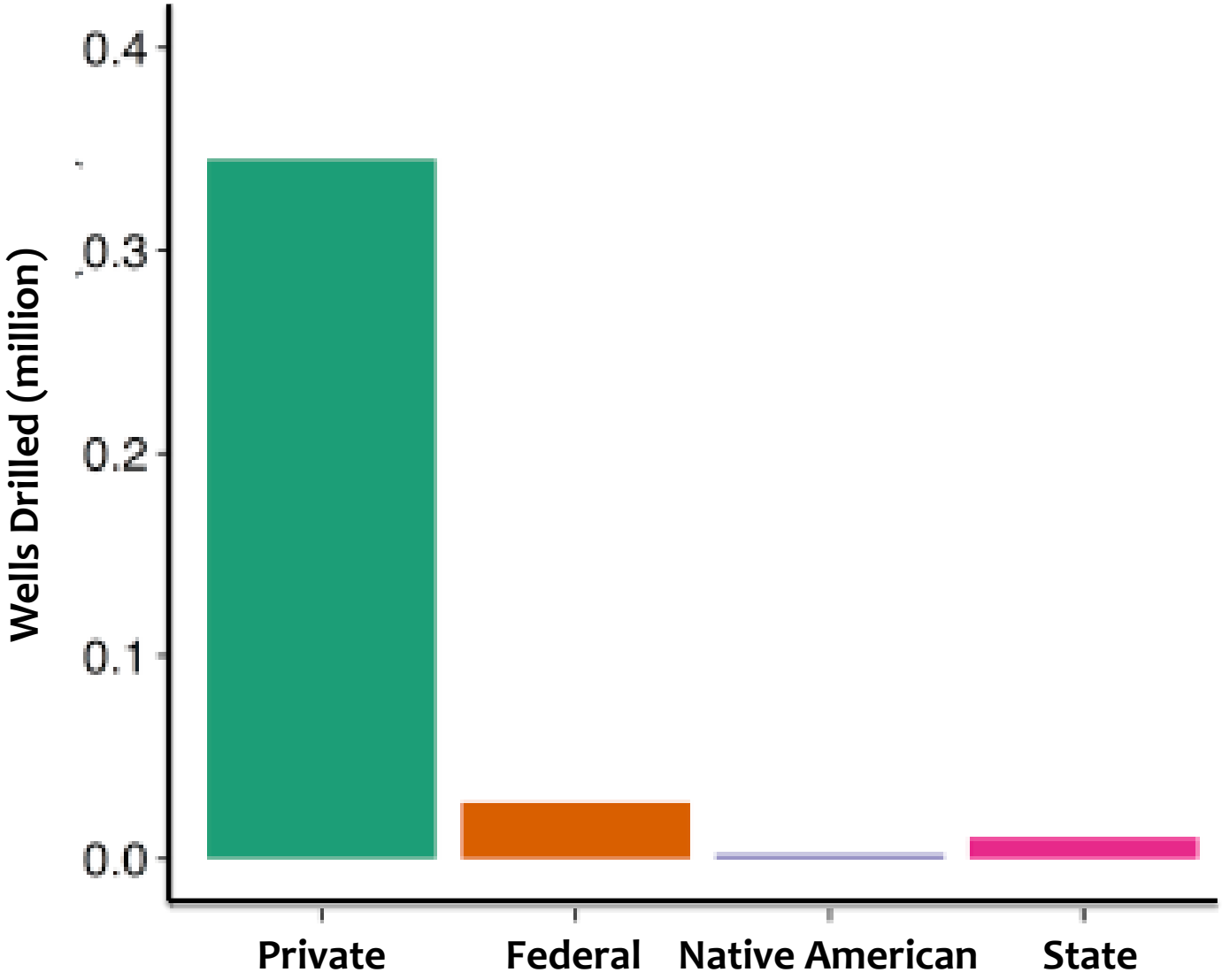
EIA 2018, Pipeline Safety Trust

Ongoing and Increasing Energy Harvest



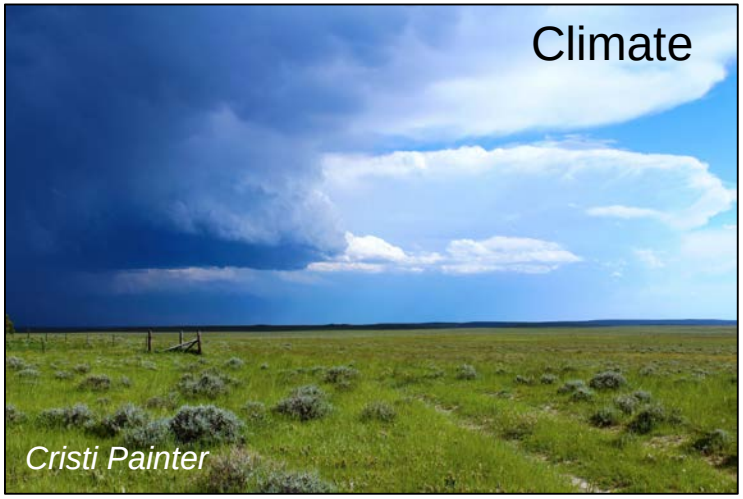
Allred et al. 2015

Energy Production and Land Ownership



Allred et al. 2015

Impacts of Energy Development: Historical Disturbances



Comparing Energy Development to Historical Disturbances

Historical Disturbances

- Small to mid-sized soil disturbance
- Removal of aboveground vegetation
- Disturbance timing driven by biology/phenology
- Creates local and landscape scale habitat heterogeneity

Energy Development

- Mid-sized to large and deep soil disturbance
- Removal of aboveground and belowground vegetation
- Disturbance timing driven by economics
- Heterogeneity in infrastructure density
- Alters vertical structure
- Introduces new substances

Potential Impacts and Opportunties of Energy Development

I. **Potential Impacts**
    1. **Atmosphere**
    2. **Water**
    3. **Soils and Vegetation**
    4. **Wildlife**
    5. **Social**

II. **Opportunities**

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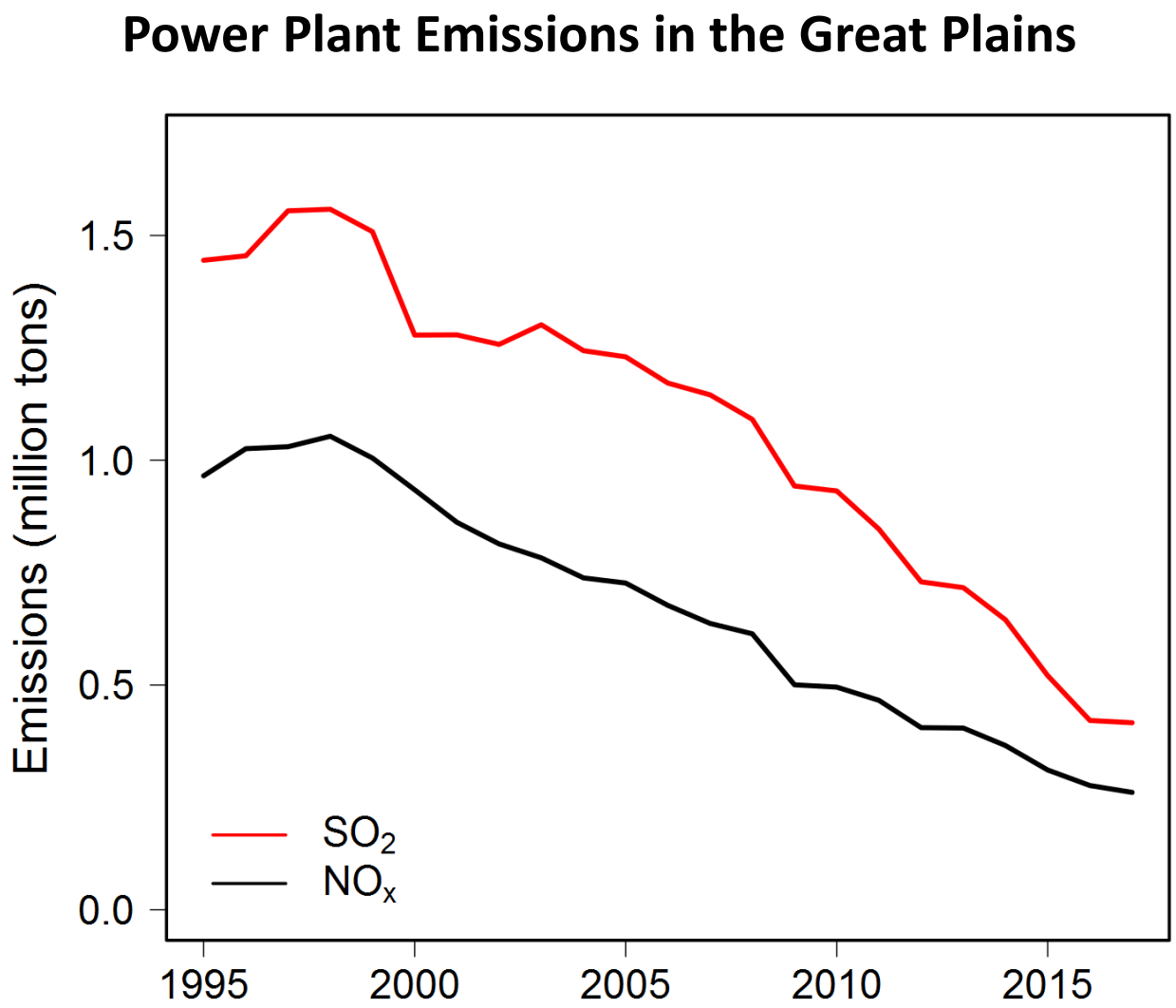
Potential Impacts of Energy Development: Atmosphere



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Potential Impacts of Energy Development: Atmosphere

- Emissions (VOCs, NO_x, SO_2, BC)
  - Venting
  - Flaring
  - Equipment Leaks

Potential Impacts of Energy Development: Atmosphere

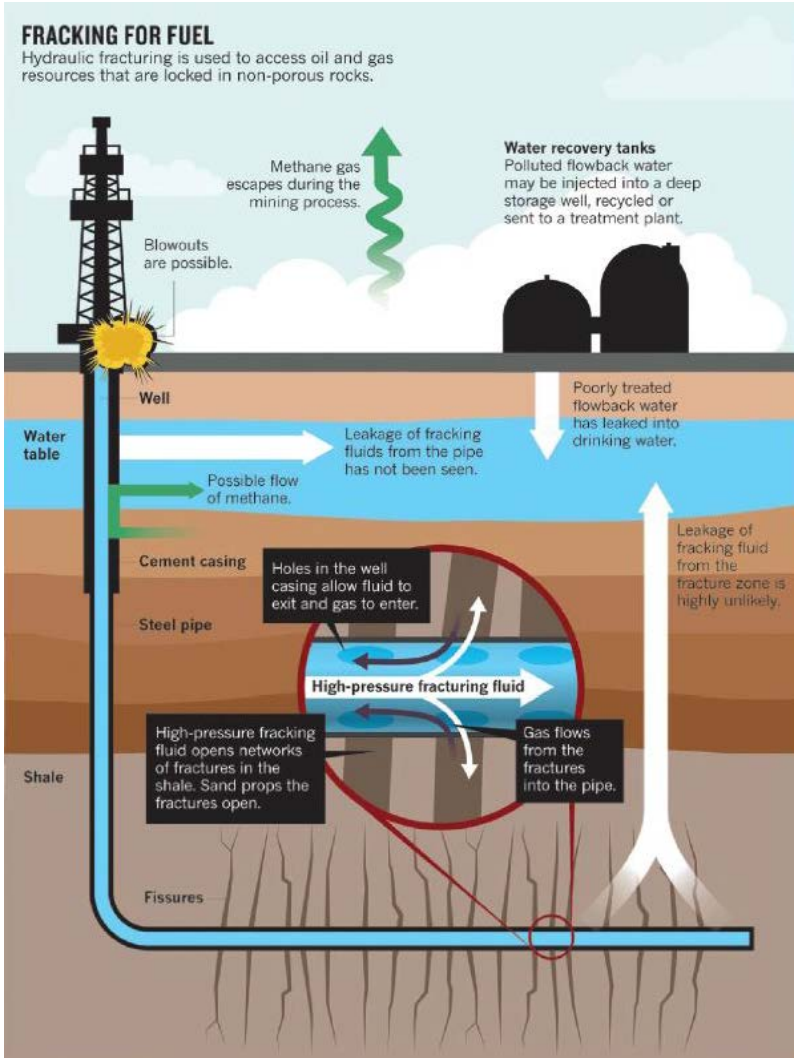
- Emissions (VOCs, NO_x, SO_2, BC)
  - Venting
  - Flaring
  - Equipment Leaks
- Local climate change

Local warming effect of 0.724°C per decade in TX (Zhou et al 2012)

EPA 2018

Potential Impacts of Energy Development: Water

- Competing water use



Potential Impacts of Energy Development: Water

- Competing water use
- Surface water contamination
  - Reserve pits are no longer legal in many states
  - Reinject into the wells
  - Still opportunities for spills

Potential Impacts of Energy Development: Soil and Vegetation

- Soil disturbance during construction and harvesting

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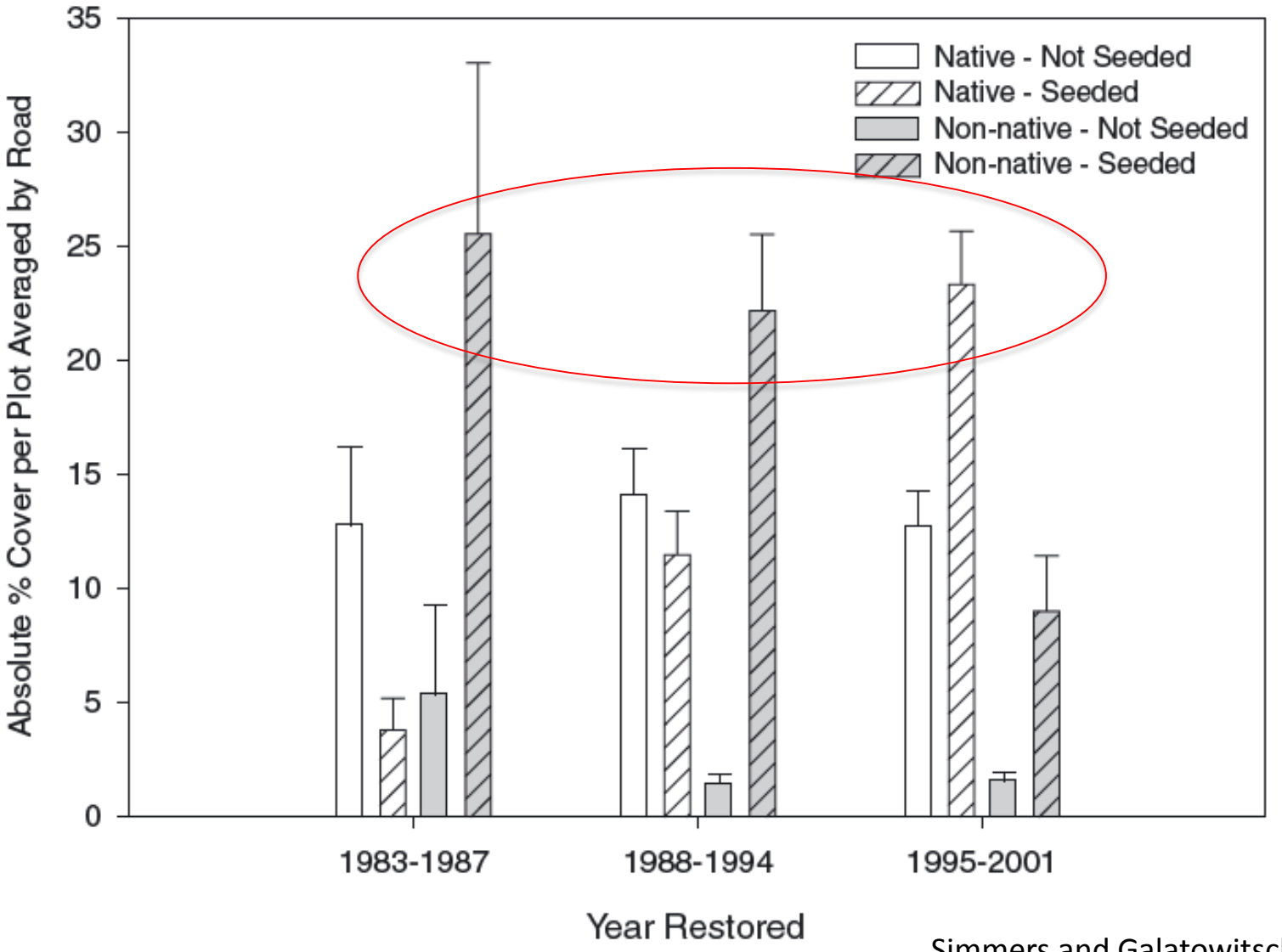
- Soil disturbance during construction and harvesting
- Soil compaction and erosion
- Soil alterations
  - Mixing horizons
  - Changes in microbial and soil seed bank during long-term storage
  - Opportunities for invasive species

Potential Impacts of Energy Development: Soil and Vegetation

Non-native species

- Soil disturbance creates open niches for weeds
- Movement of equipment can transport their seeds
- Linear developments (Roads, pipelines, and transmission lines) create opportunities for weed movement

Potential Impacts of Energy Development: Soil and Vegetation



Simmers and Galatowitsch 2010

Potential Impacts of Energy Development: Soil and Vegetation

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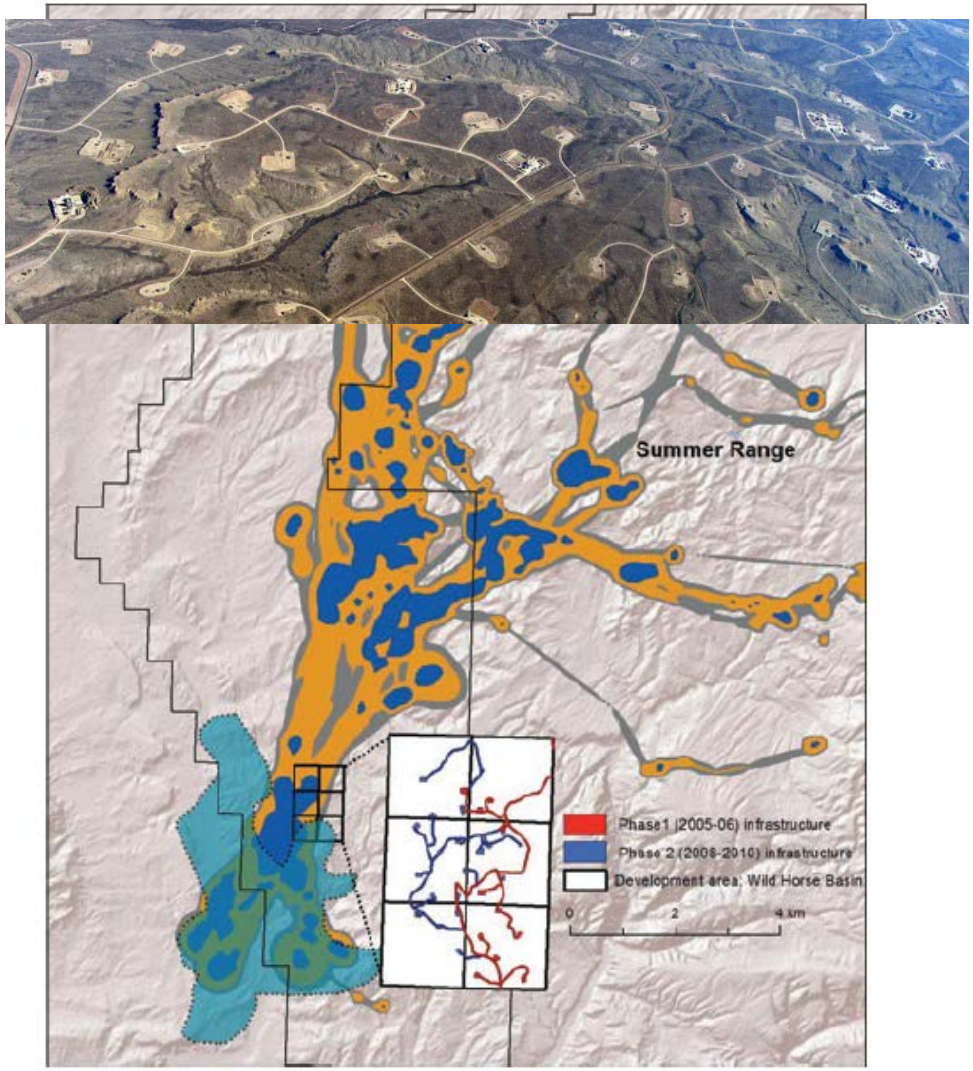
- Invasive species
- Fugitive dust
- Contamination from spills

Potential Impacts of Energy Development: Wildlife

- Increased mortality

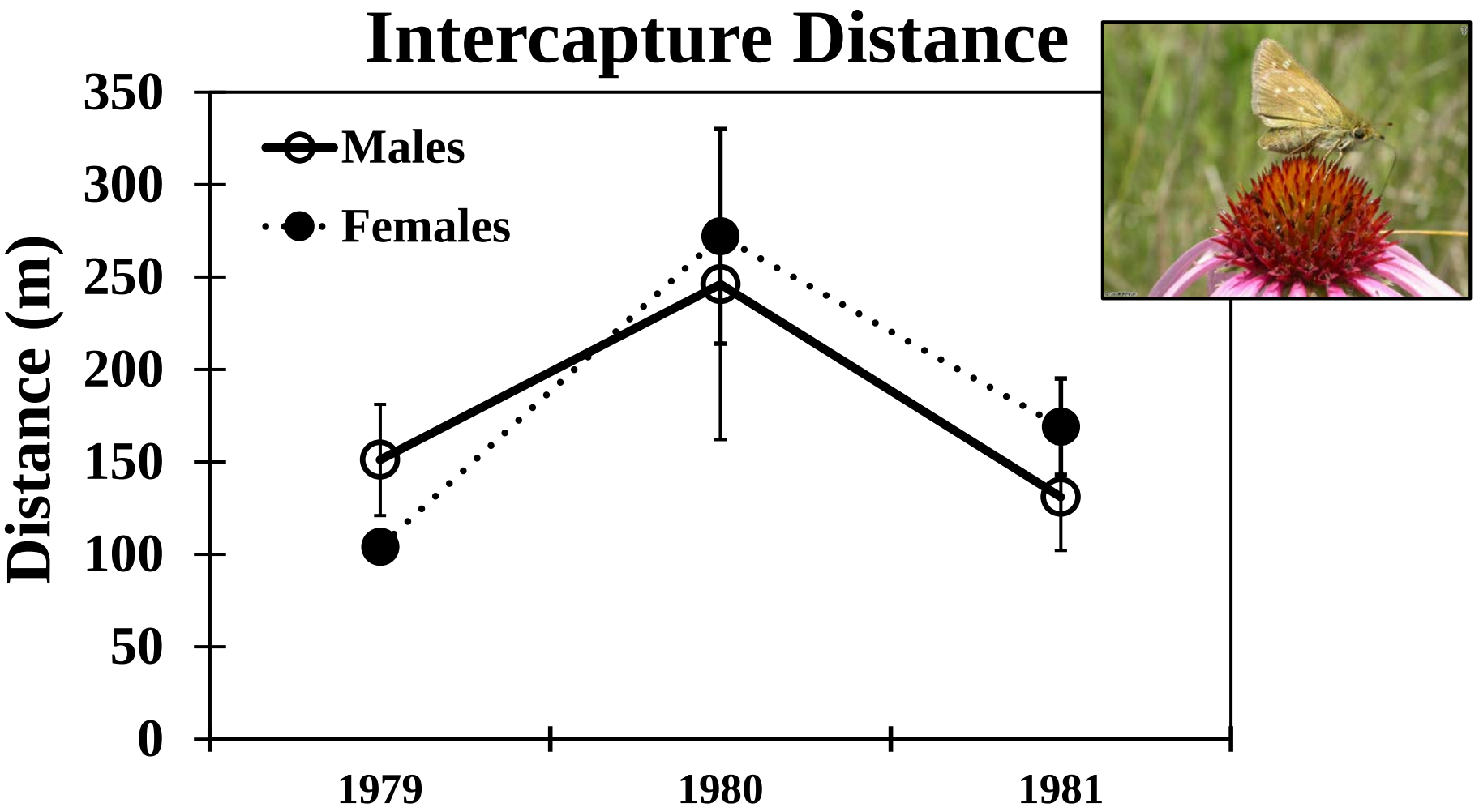
Potential Impacts of Energy Development: Wildlife

- Increased mortality
- Habitat fragmentation and reduction
  - Attraction or avoidance of infrastructure
  - Affect migration routes and stopover sites
  - Noise
  - Altered behavior/movement
  - Life history timing



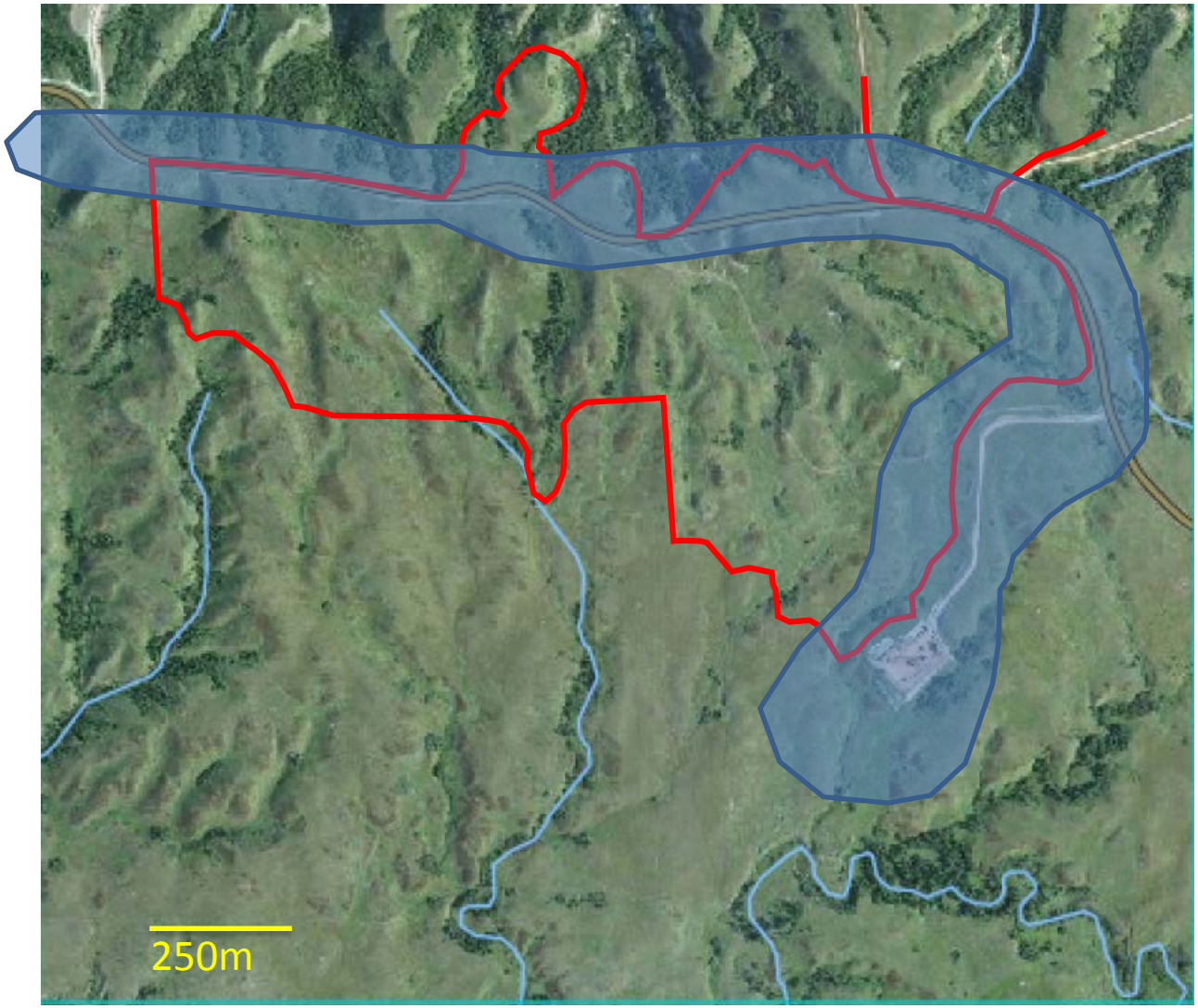
Sawyer et al. 2013

Potential Impacts of Energy Development: Wildlife



Dana 1991

Potential Impacts of Energy Development: Wildlife



Butler et al. In press.

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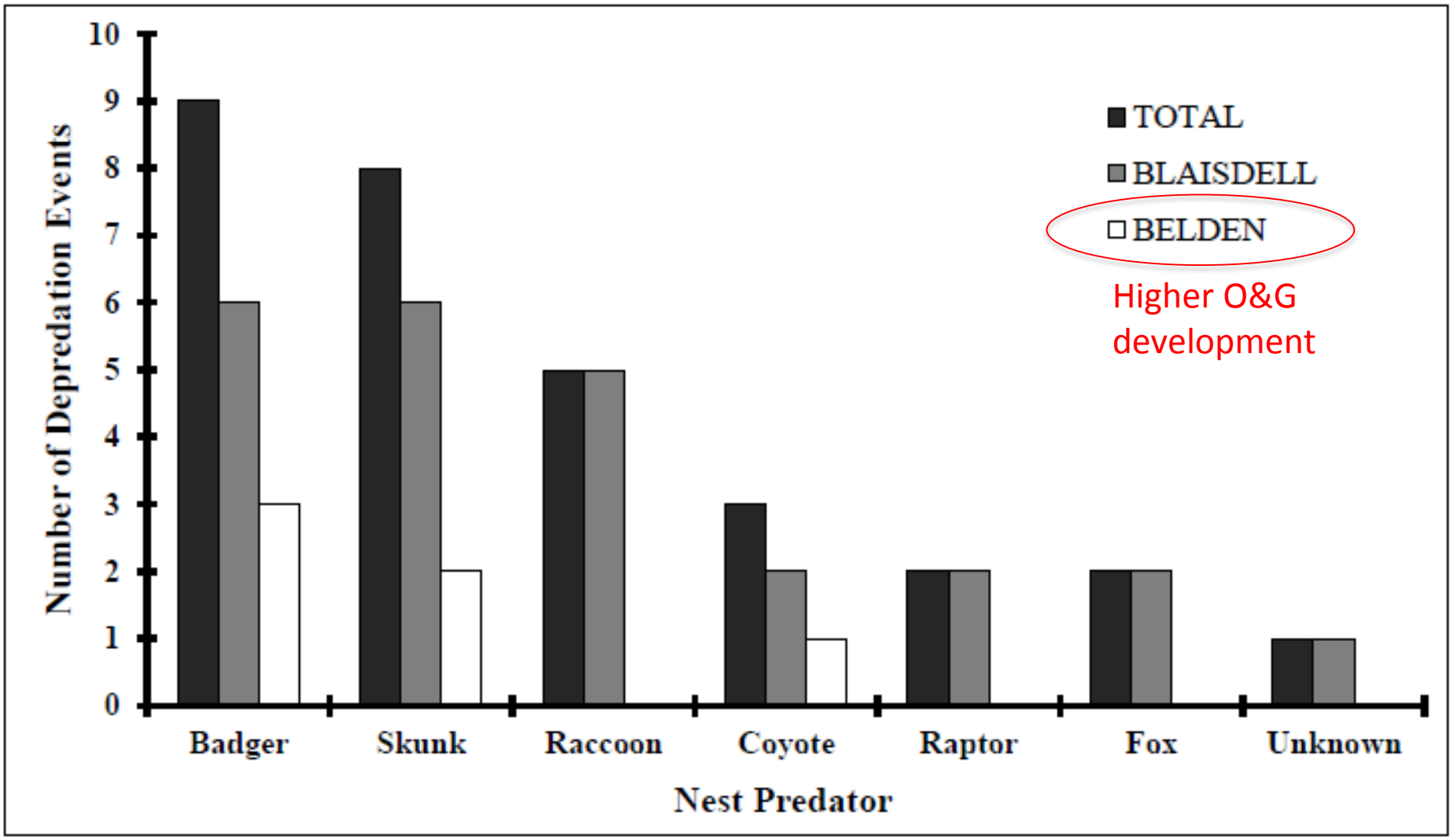

Burr 2014

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<u>Principles</u>

- Species specific
- Site Specific
- Scale
- Trophic Levels
- Time period of study

Potential Impacts of Energy Development: Social

- Boom-Bust Cycles in rural locations
  - Stress on community resources and investment on the grasslands
  - Increased grassland use
- Shadow flicker and noise

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   3. Soils and Vegetation
   4. Wildlife
   5. Social

II. Opportunities

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Opportunities to avoid and minimize impacts: Atmosphere

Current opportunities

- Build pipelines or develop storage capabilities for natural gas production to reduce the need for flaring

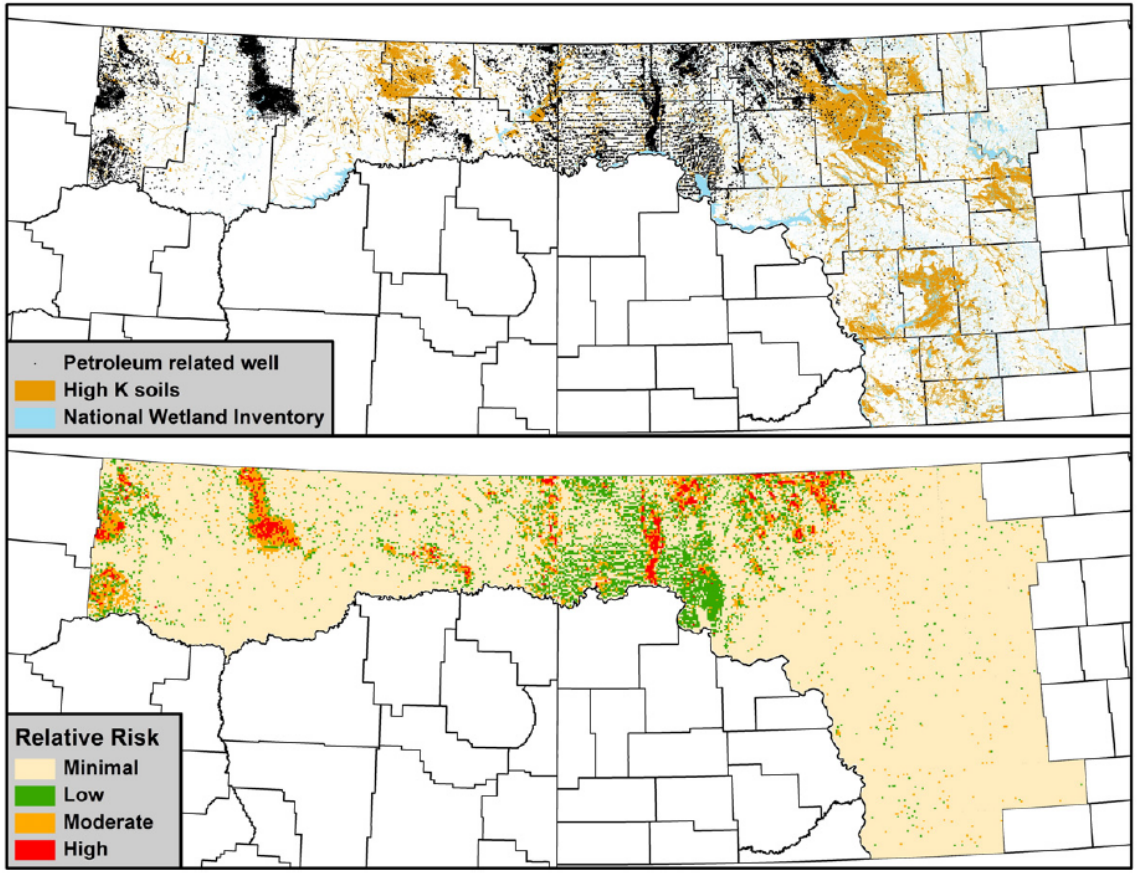
Needed research

- Determine the critical loads and monitoring needs of the various emissions

Opportunities to avoid and minimize impacts: Water

Current opportunities

- Develop and use risk assessments for areas with oil and gas activity to focus monitoring efforts



Preston et al. 2015

Opportunities to avoid and minimize impacts: Water

Current opportunities

- Develop and use risk assessments for areas with oil and gas activity to focus monitoring efforts

Research needs

- More knowledge on the effects of using surface vs groundwater for unconventional oil and gas development

Opportunities to avoid and minimize impacts: Soil and Vegetation

Current opportunities

- Have in mind reclamation and restoration plans from the beginning of the project
  - Eliminate weed populations prior to disturbance
  - Collect seeds from native ecotypes prior to development
  - Use high numbers of native plant species
  - Minimize disturbance

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- Lessons from other disciplines (O&G learn from coal and CRP)
- Project siting
  - Overlap with existing development
  - Locate in areas that need vegetation improvement
  - Colocation available due to horizontal drilling

Opportunities to avoid and minimize impacts: Soil and Vegetation

Needed research/technology

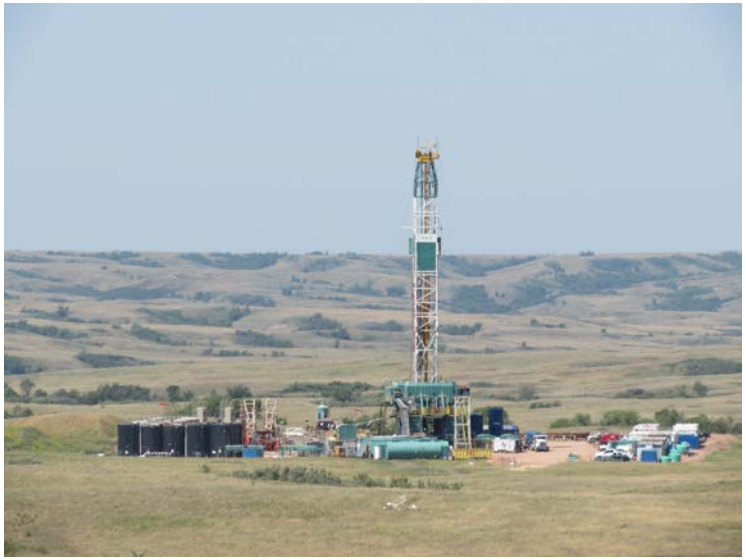
- Opportunities with future linear developments (focus on new restoration techniques)
- Better understanding of the biological processes occurring in stockpiled and salvaged topsoil (e.g. microbial responses) to produce new technology and improve methods for storing topsoil for long periods of time
- Determine methods that favor succession from weedy species to perennial natives
- Link aboveground and belowground restoration
- Seed provenance
    - Find or develop reasonably priced seed supplies of native species (especially forbs)
    - How far can we move seed?

Opportunities to avoid and minimize impacts: Wildlife

<u>Current opportunities</u>

Goals: Reduce noise, road traffic, fragmentation, vertical structure, and direct mortality

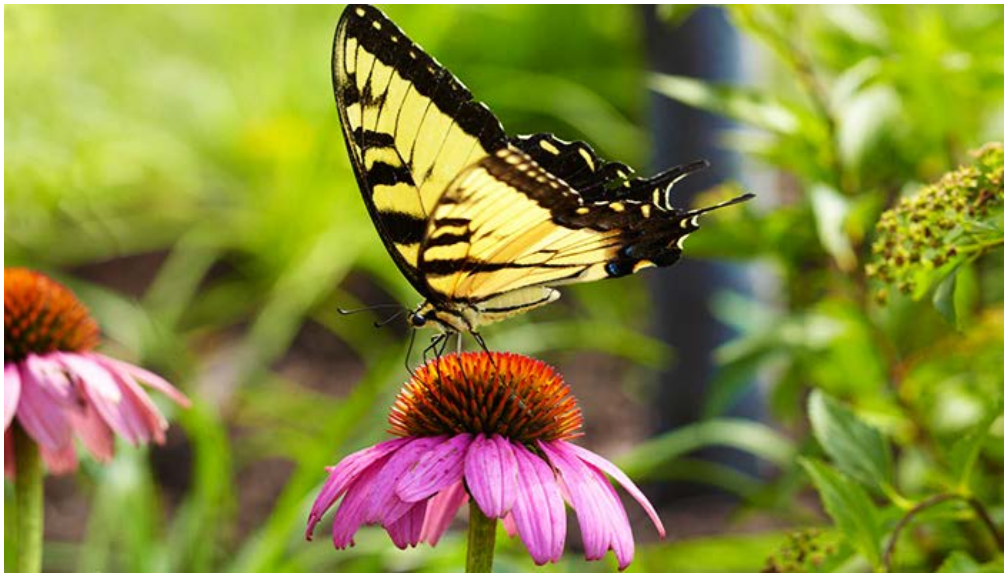
- Enlarge blades to lower rotational speeds of wind turbines
- Paint patterns on turbines to increase visibility/ Acoustical deterrents
- Project siting
  - Colocation (multiple wells on a single pad, battery tanks near roads)
  - Map key areas of wildlife use and group infrastructure leaving wildlife corridors
- Timing restrictions (minimize disturbance during key life history periods of certain species)
- Training reduction (consolidate visits to energy development sites)



Opportunities to avoid and minimize impacts: Wildlife

Needed research/technology

- Improve technology for running quieter operations (blade design, pump design)
- Conduct research that is species and site specific, takes in multiple geographic scales, looks at both the short and long term effects while considering effects on various trophic levels
- Knowledge of effects on pollinators and amphibians



Opportunities to avoid and minimize impacts: Social

Current opportunities

- Use socio-economic analyses to develop strategic investments to aid communities in the boom and bust cycles of energy development

Research needs

- Examine how human perceptions of oil and gas development are formed

Acknowledgements

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