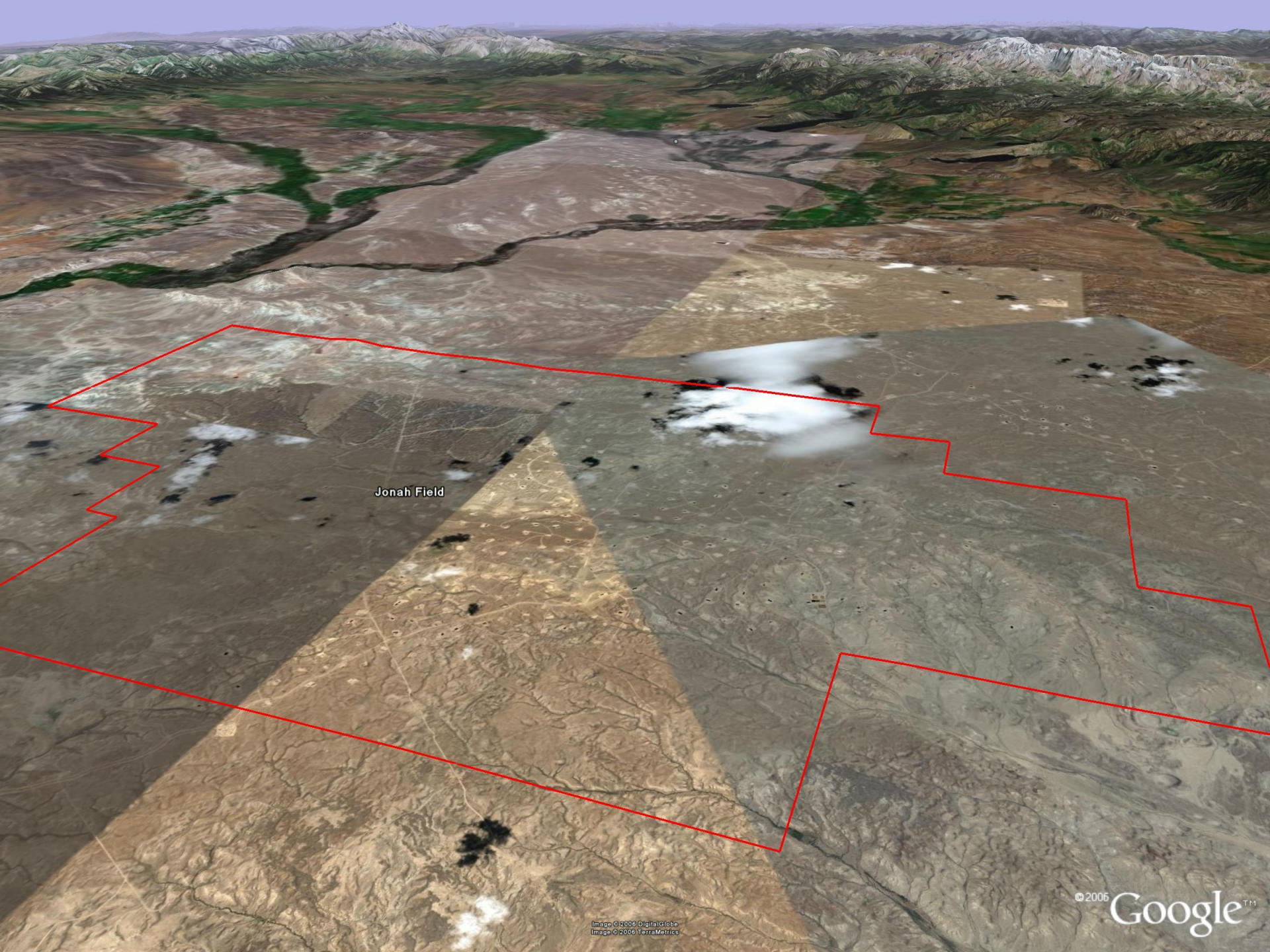
Joseph Kiesecker Ph.D.
Lead Scientist

DEVELOPMENT by DESIGN: Harnessing the Power of Landscape Level Conservation Planning to Evaluate Cumulative Impacts

The Nature Conservancy
Protecting nature. Preserving life.™


Jonah Field
Image © 2006 DigitalGlobe
Image © 2006 TerraMetrics
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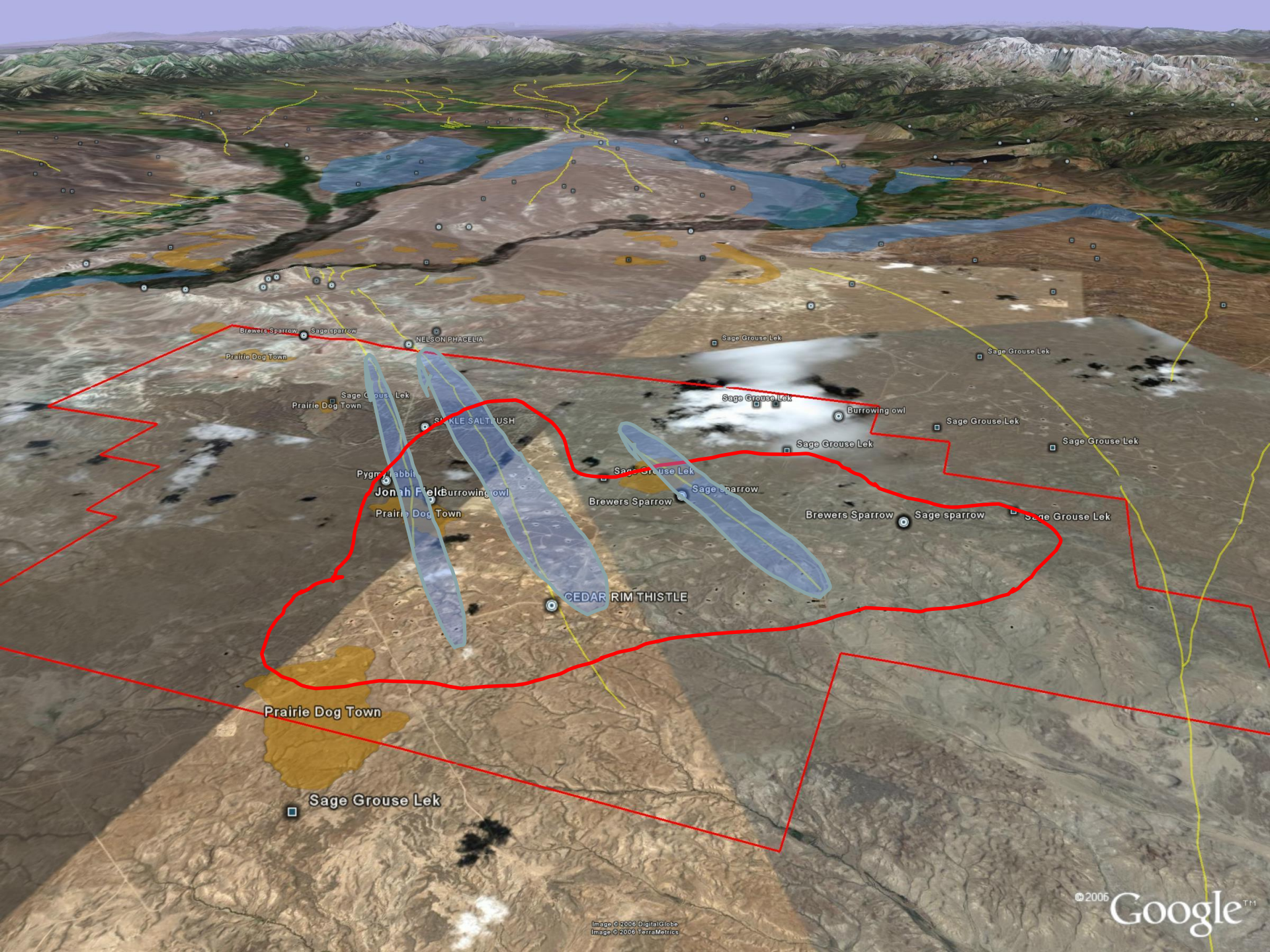
Brewers Sparrow
Sage sparrow
NELSON PHACELIA
Prairie Dog Town
Sage Grouse Lek
Sage Grouse Lek
Sage Grouse Lek
Prairie Dog Town
Sage Grouse Lek
Burrowing owl
Sage Grouse Lek
Sage Grouse Lek
Sage Grouse Lek
Sage Grouse Lek
Jonah Field
Burrowing owl
Brewers Sparrow
Brewers Sparrow
Sage sparrow
CEDAR RIM THISTLE
Prairie Dog Town
Sage Grouse Lek
Image © 2006 DigitalGlobe
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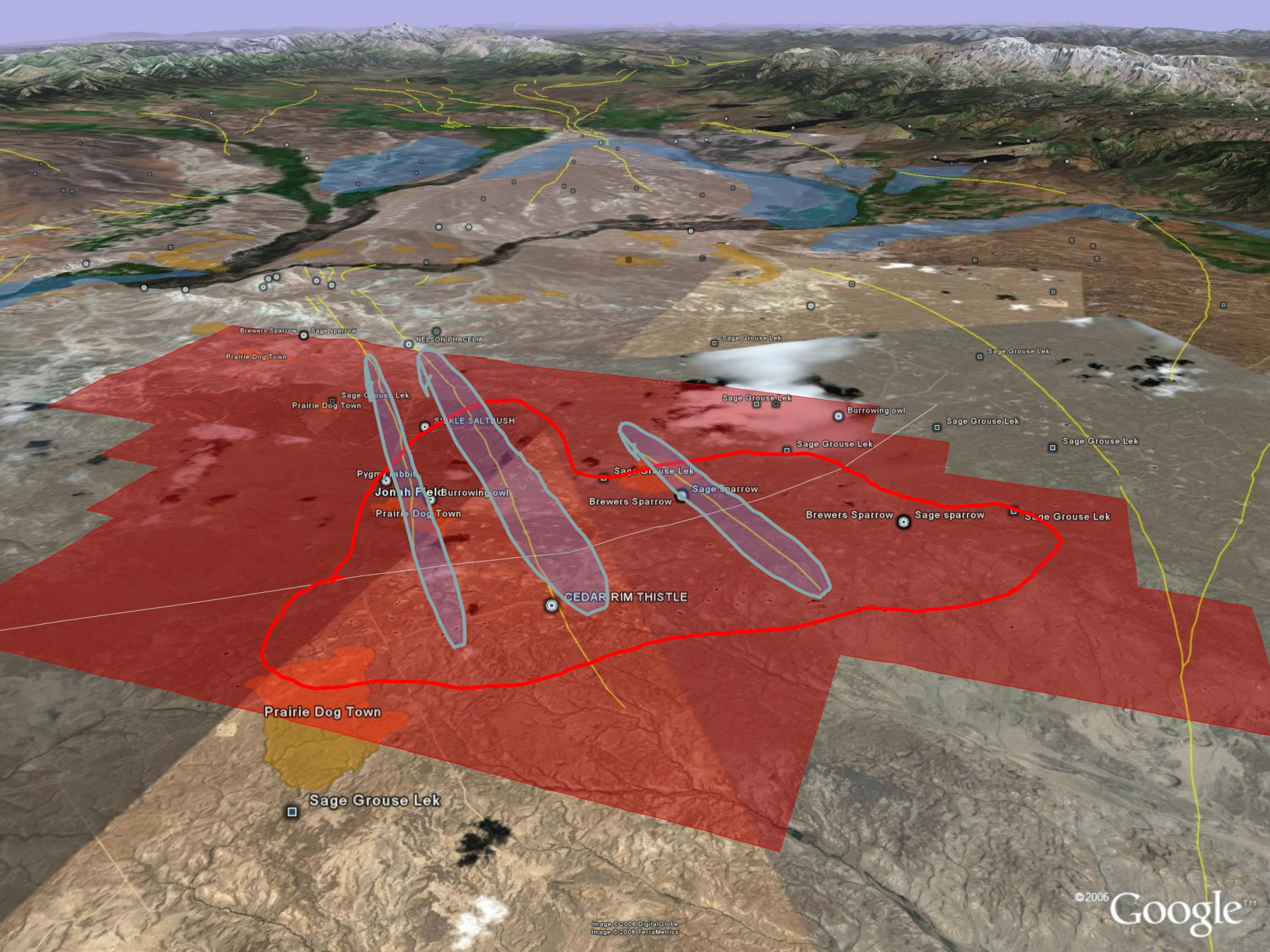
Brewers Sparrow
Sage sparrow
NELSON PHACELIA
Prairie Dog Town
Sage Grouse Lek
Prairie Dog Town
Sage Grouse Lek
Sage Grouse Lek
Burrowing owl
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Brewers Sparrow
Sage sparrow
Brewers Sparrow
Sage sparrow
CEDAR RIM THISTLE
Prairie Dog Town
Sage Grouse Lek
Image © 2006 DigitalGlobe
Image © 2006 TerraMetrics
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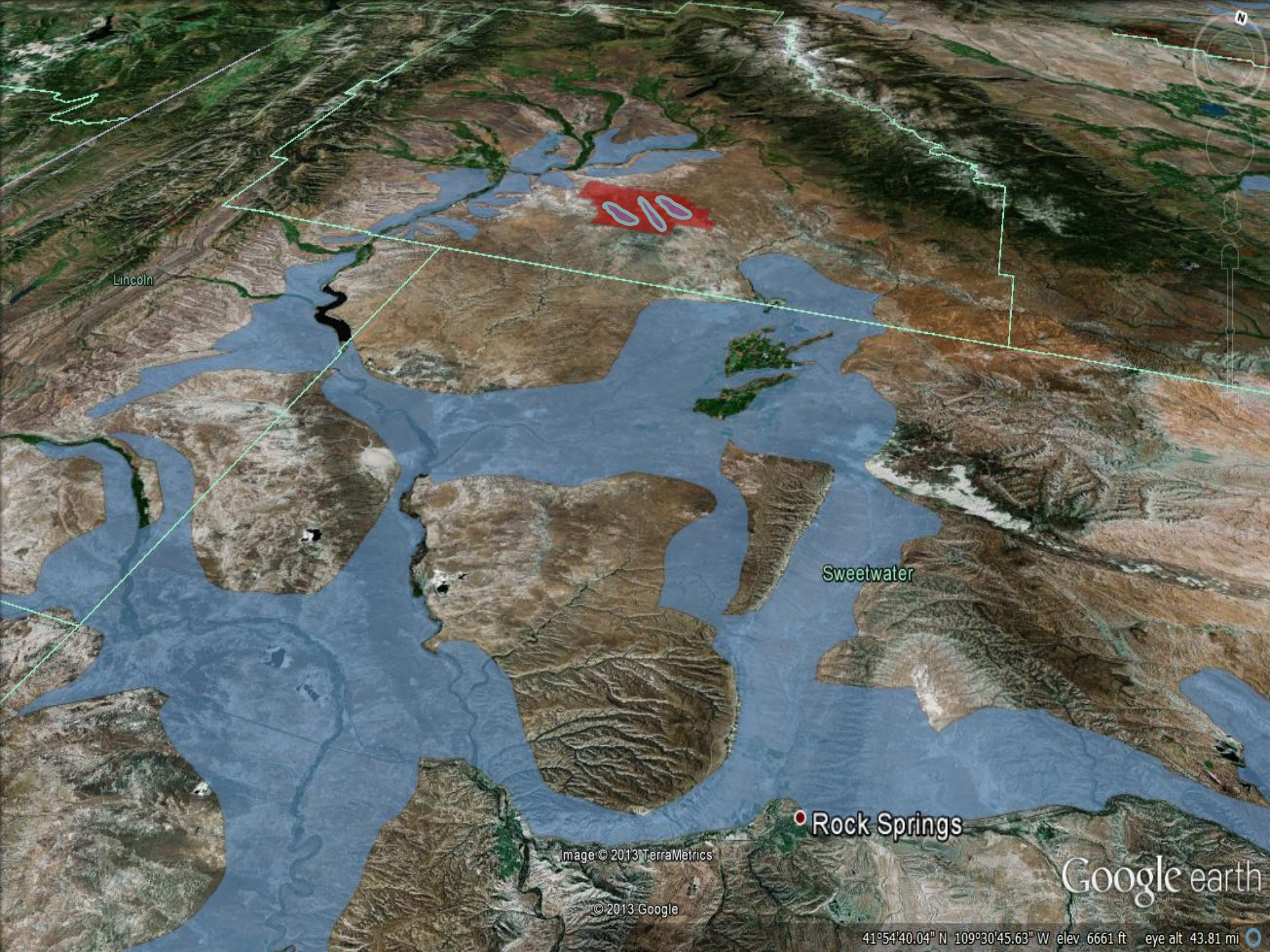
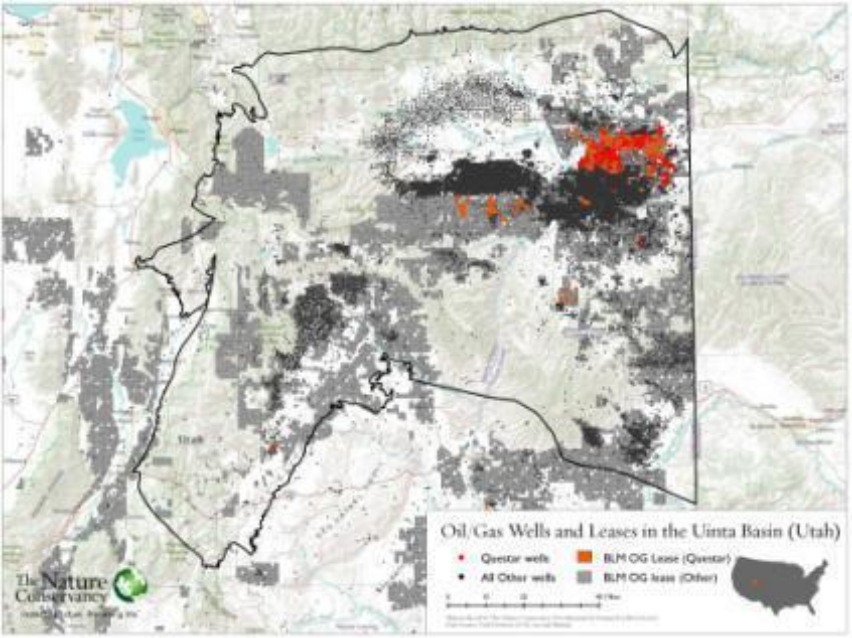
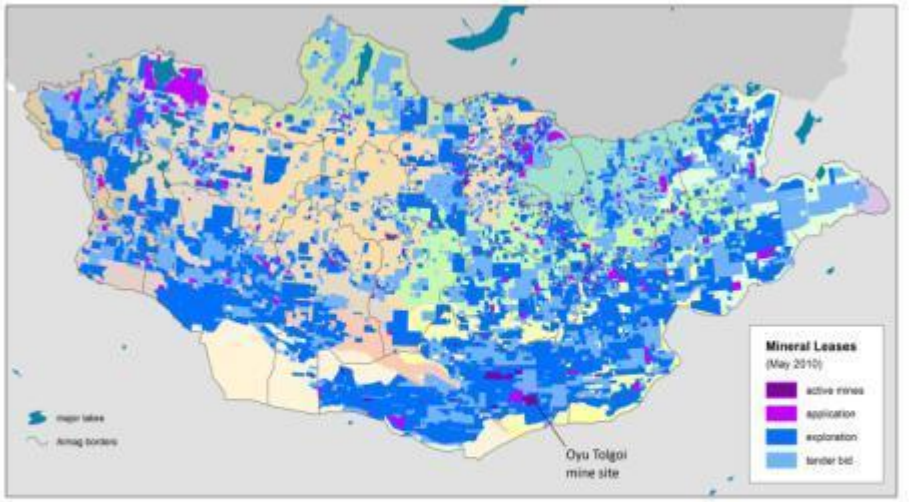
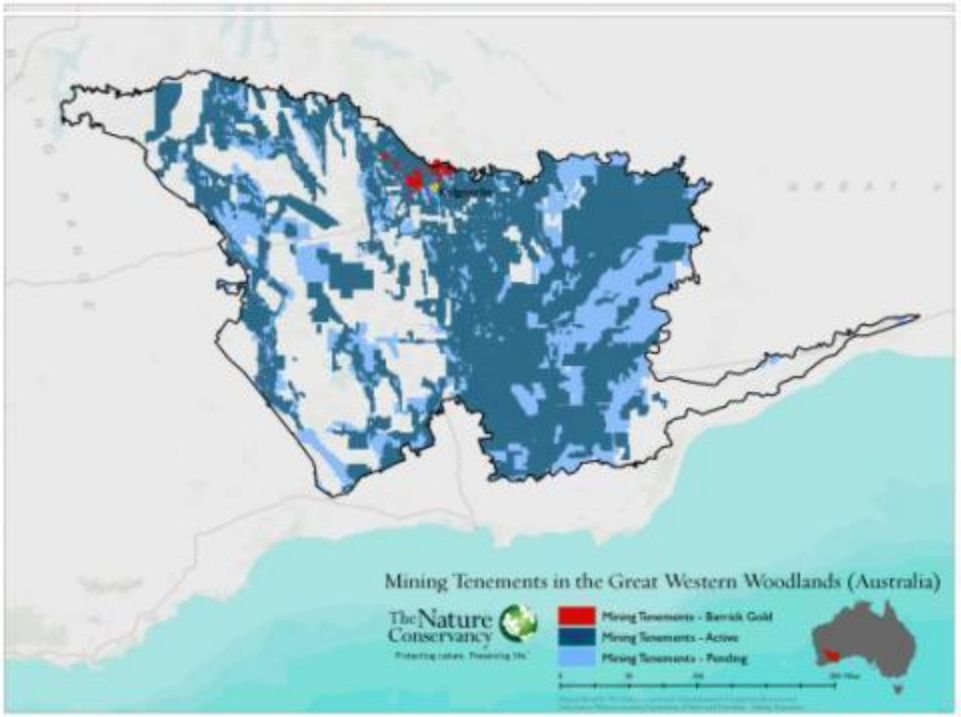

Lincoln
Sweetwater
Rock Springs
Image © 2013 TerraMetrics
© 2013 Google
Google earth
41°54'40.04" N 109°30'45.63" W elev 6661 ft eye alt 43.81 mi


Lincoln
Sweetwater
Rock Springs
Image © 2013 TerraMetrics
© 2013 Google
Google earth
41°54'40.04" N 109°30'45.63" W elev 6661 ft eye alt 43.81 mi


Lincoln
Sweetwater
Rock Springs
Image © 2013 TerraMetrics
© 2013 Google
Google earth
41°54'40.04" N 109°30'45.63" W elev 6661 ft eye alt 43.81 mi

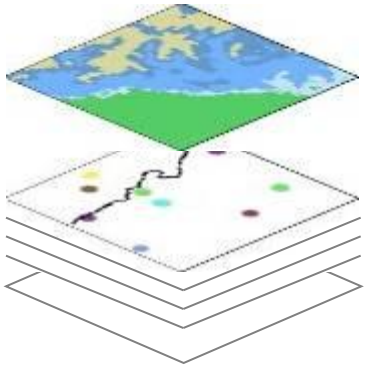

Oil/Gas Wells and Leases in the Uinta Basin (Utah)
Questar wells
All Other wells
BLM OG Lease (Questar)
BLM OG lease (Other)
The Nature Conservancy


Mineral Leases
(May 2010)
active mines
application
exploration
tender bid
major lakes
Aimag borders
Oyu Tolgoi
mine site


Mining Tenements in the Great Western Woodlands (Australia)
The Nature Conservancy
Mining Tenements - Barrick Gold
Mining Tenements - Active
Mining Tenements - Pending

Development by Design Process

Select BIODIVERSITY ELEMENTS



COARSE FILTER
Vegetation Types

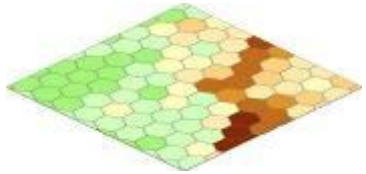
FINE FILTER
Species

Set GOALS

(X) Acres of habitat needed to maintain viability

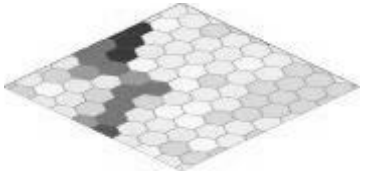
(Y) Acres of habitat or point locations (i.e. nests) needed to maintain viability

assess ECOLOGICAL CONDITION



Cost / Suitability Index

- Road & RR Density
- Population Density
- Converted Land Cover
- Irrigated Land Cover
- Housing density

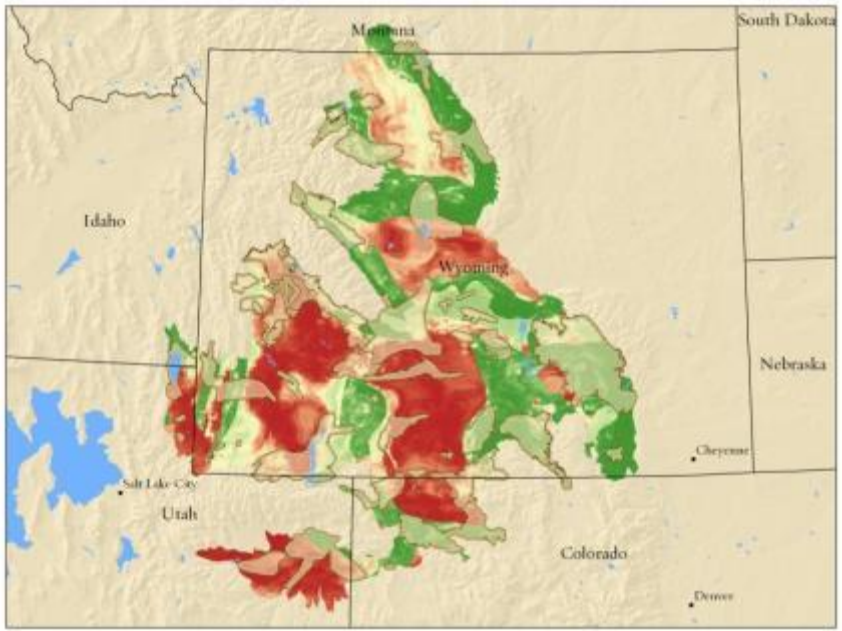


Future development pressure

(Z) Amount of production

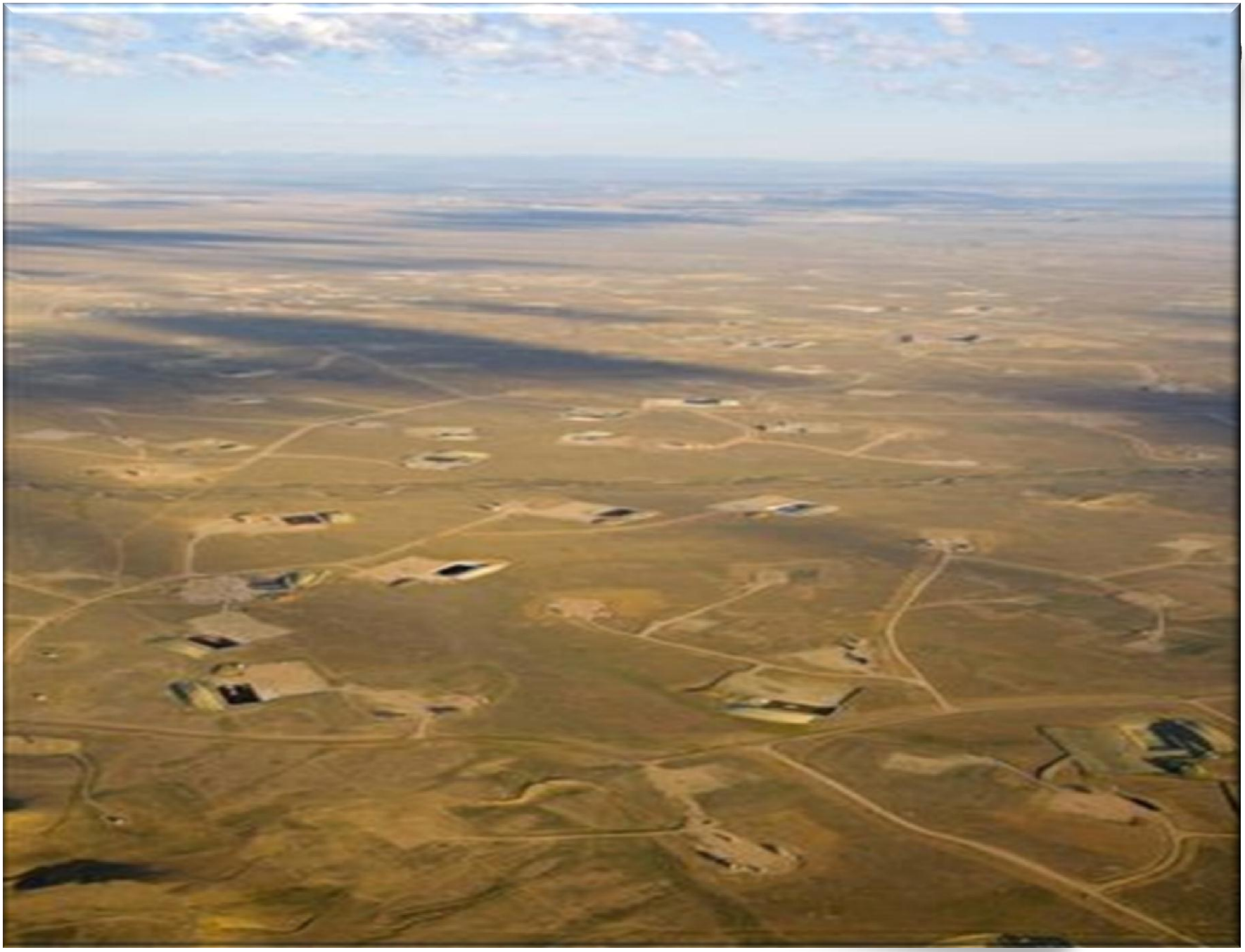
Conservation Portfolio Design:
Development Portfolio Design:

automated site selection (MARXAN with ZONES)

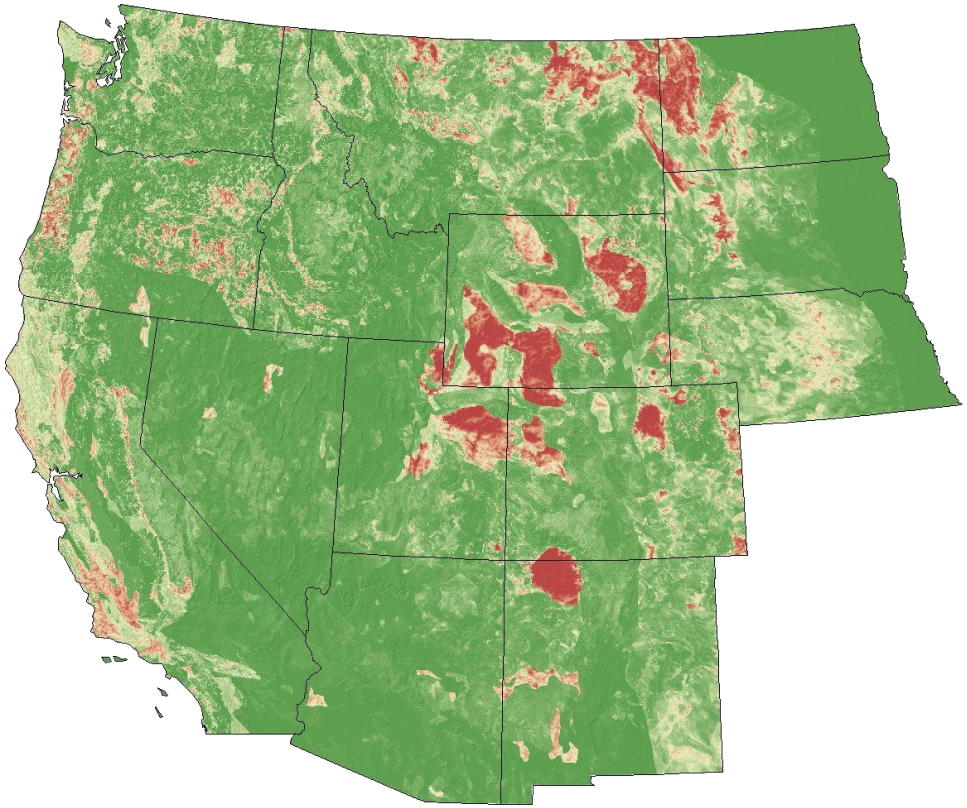


Oil and Gas Wells in the Wyoming Basins Ecoregion

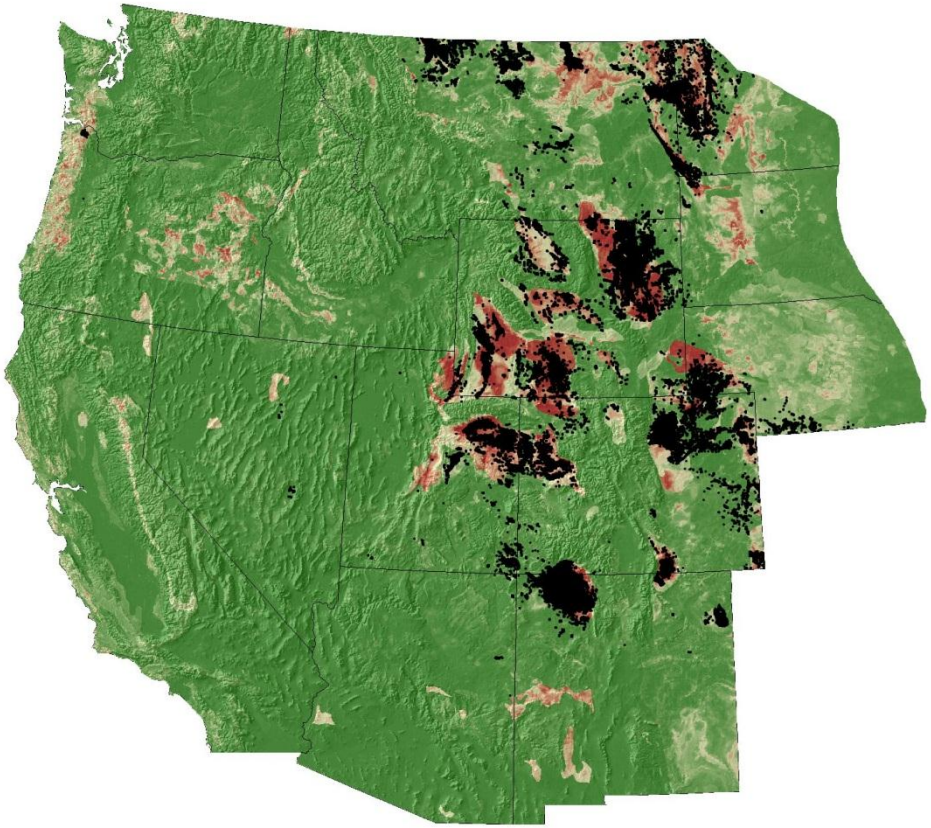
2011

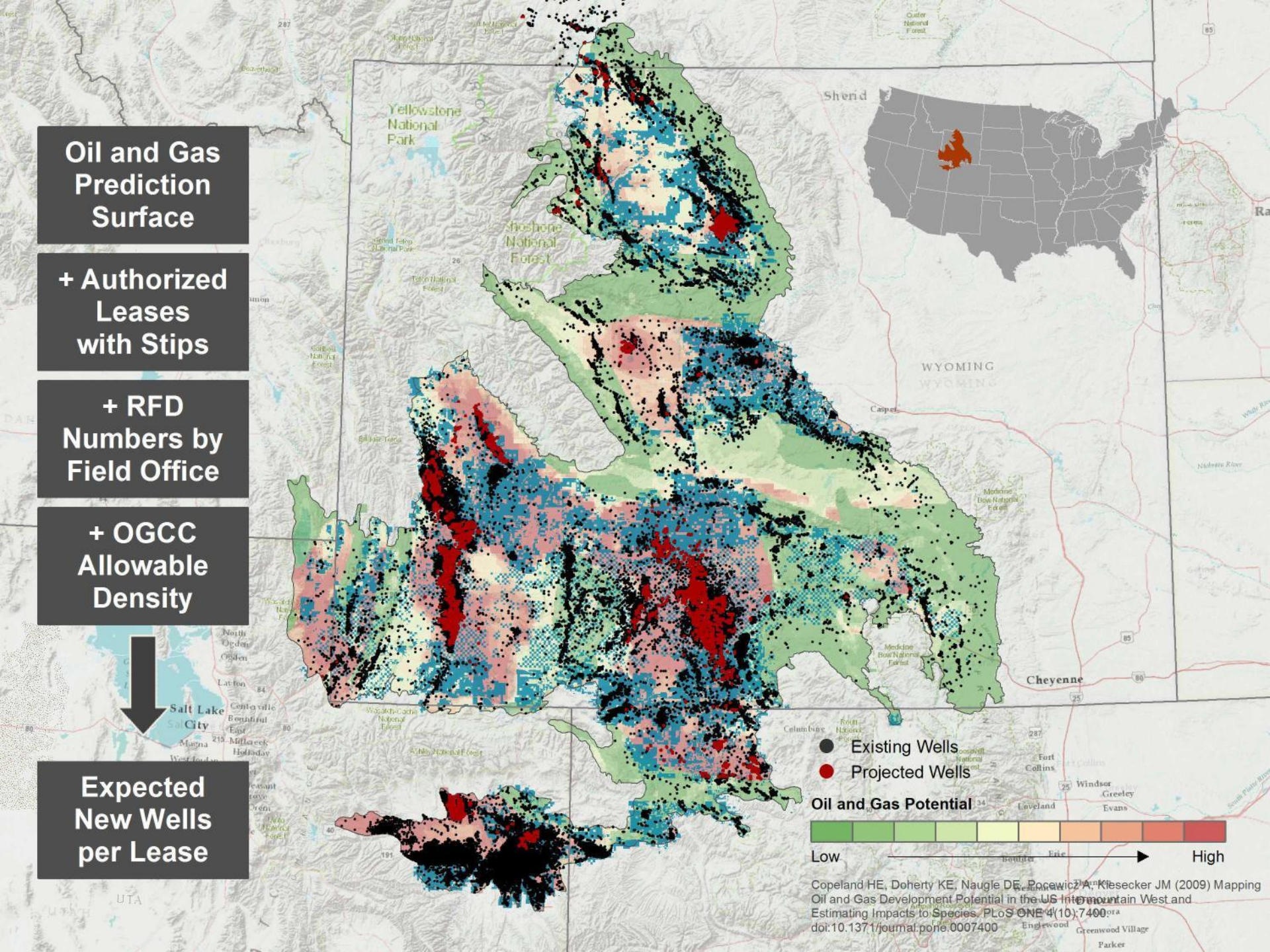


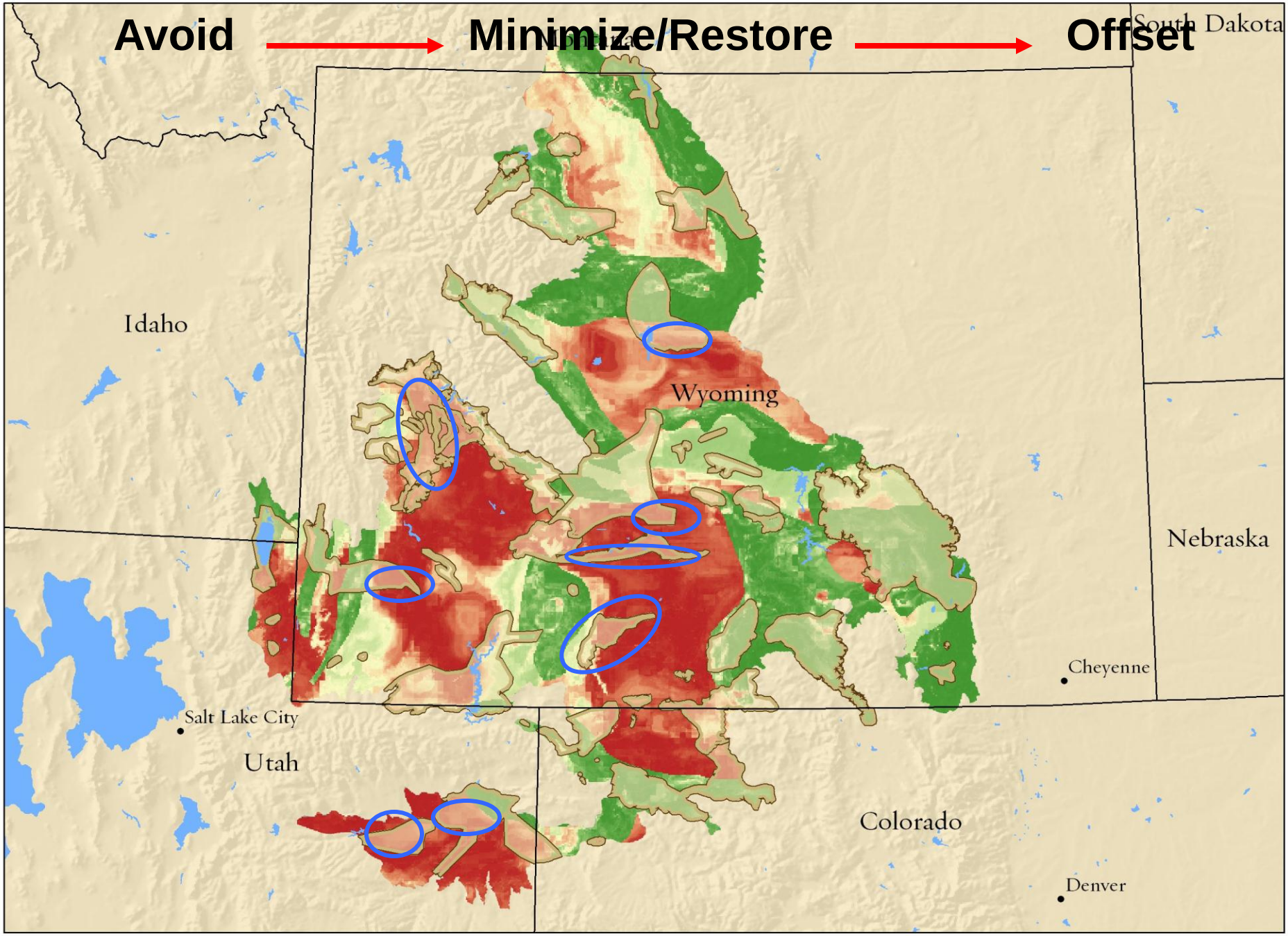
Pre-1985 Model Build

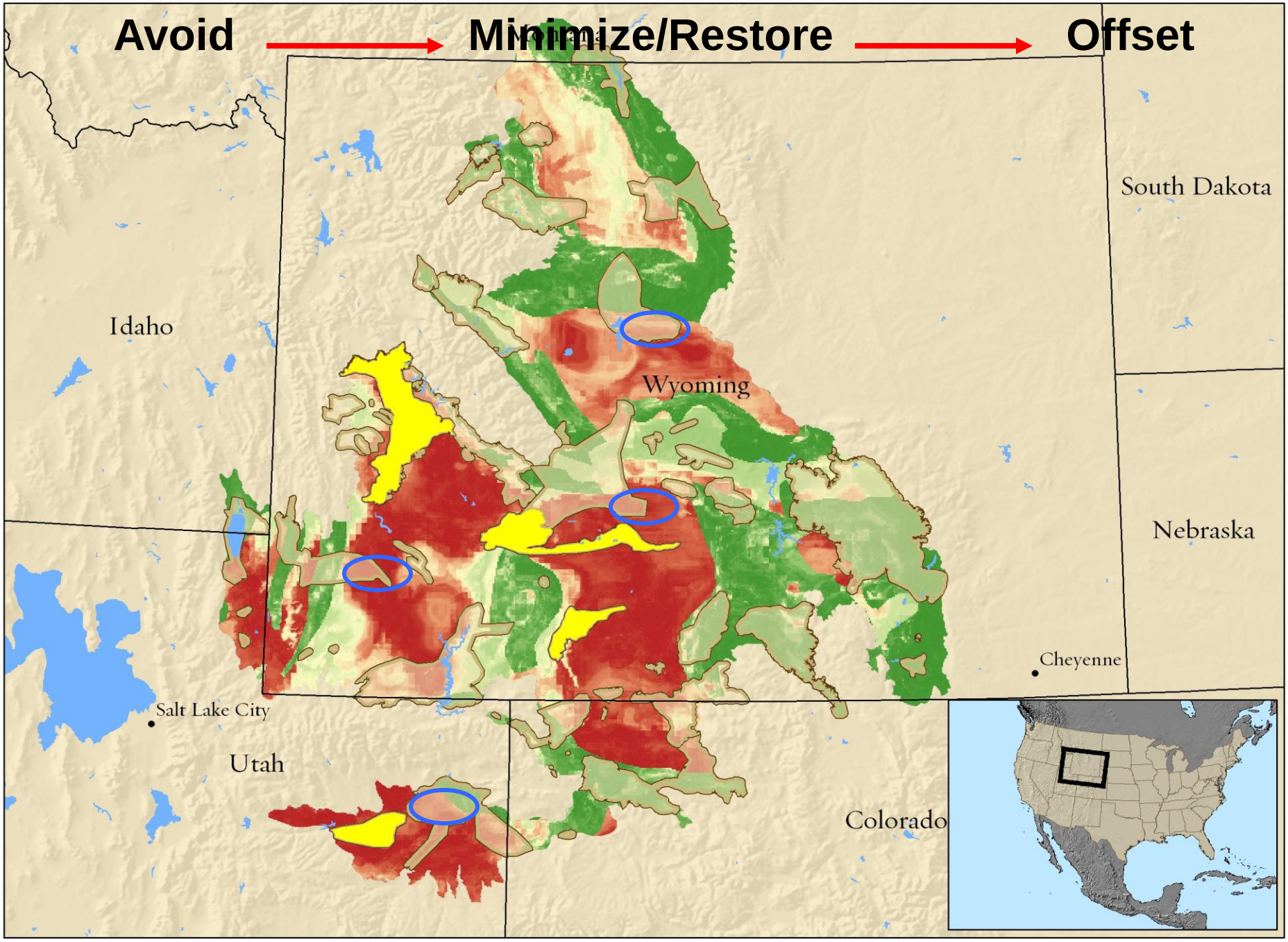


Pre-1985 Model Build (current wells)

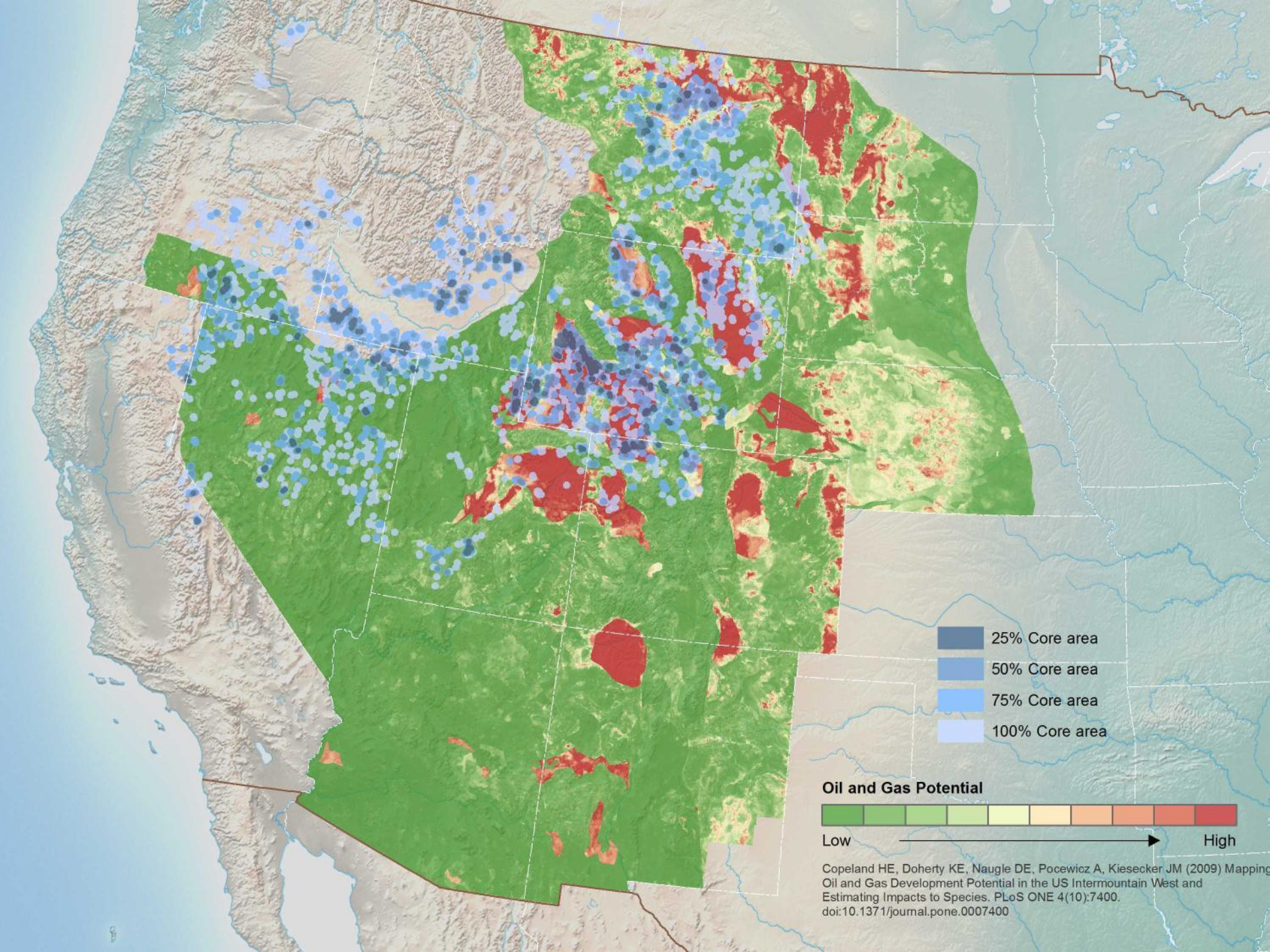



Oil and Gas Prediction Surface
+ Authorized Leases with Stips
+ RFD Numbers by Field Office
+ OGCC Allowable Density
Expected New Wells per Lease
Yellowstone National Park
Shoshone National Forest
WYOMING
Cheyenne
Casper
Salt Lake City
Existing Wells
Projected Wells
Oil and Gas Potential
Low
High
Copeland HE, Doherty KE, Naugle DE, Pocewicz A, Kiesecker JM (2009) Mapping Oil and Gas Development Potential in the US Intermountain West and Estimating Impacts to Species. PLoS ONE 4(10):7400. doi:10.1371/journal.pone.0007400

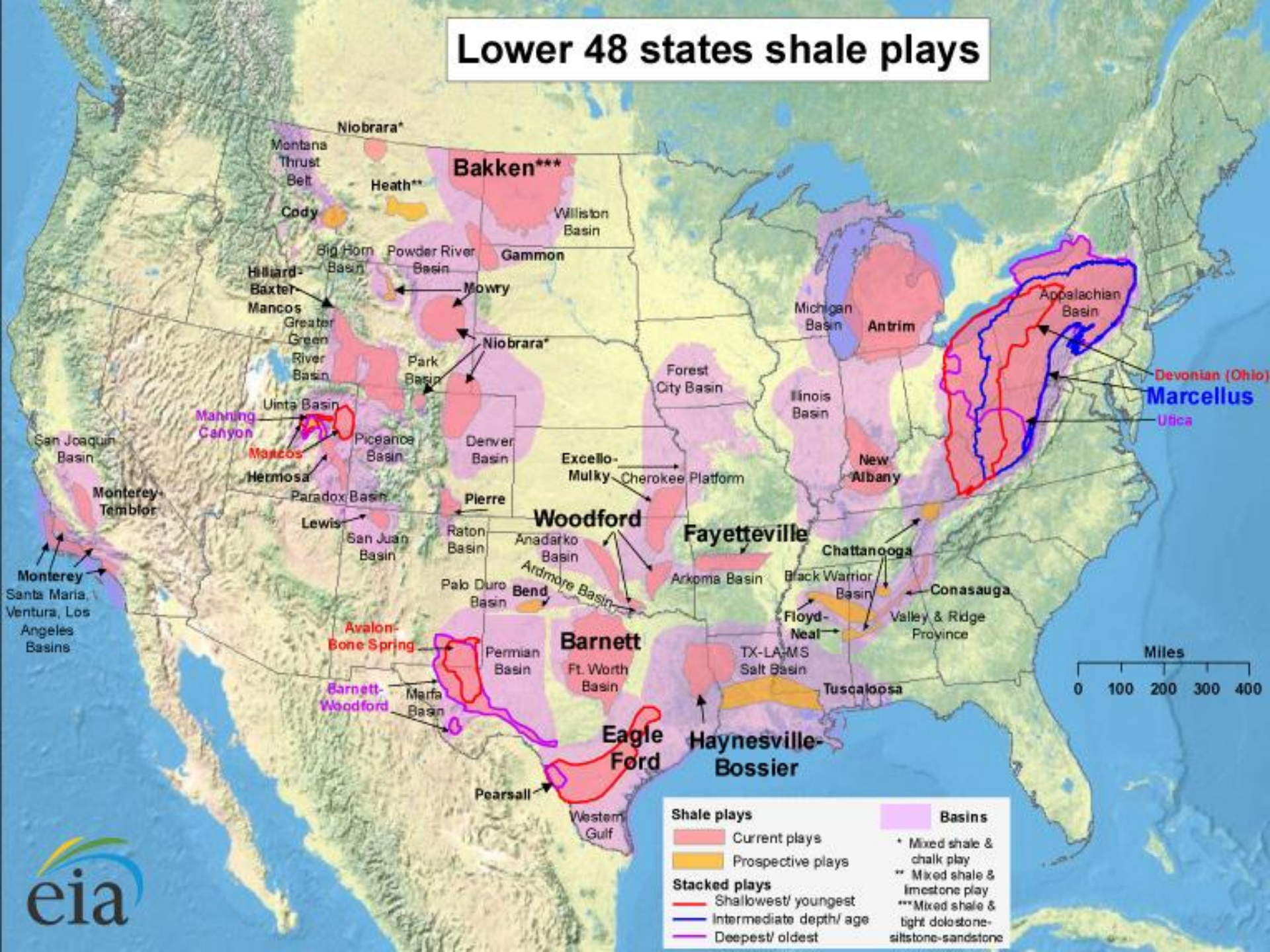

Avoid
Minimize/Restore
Offset
Montana
South Dakota
Idaho
Wyoming
Nebraska
Cheyenne
Salt Lake City
Utah
Colorado
Denver

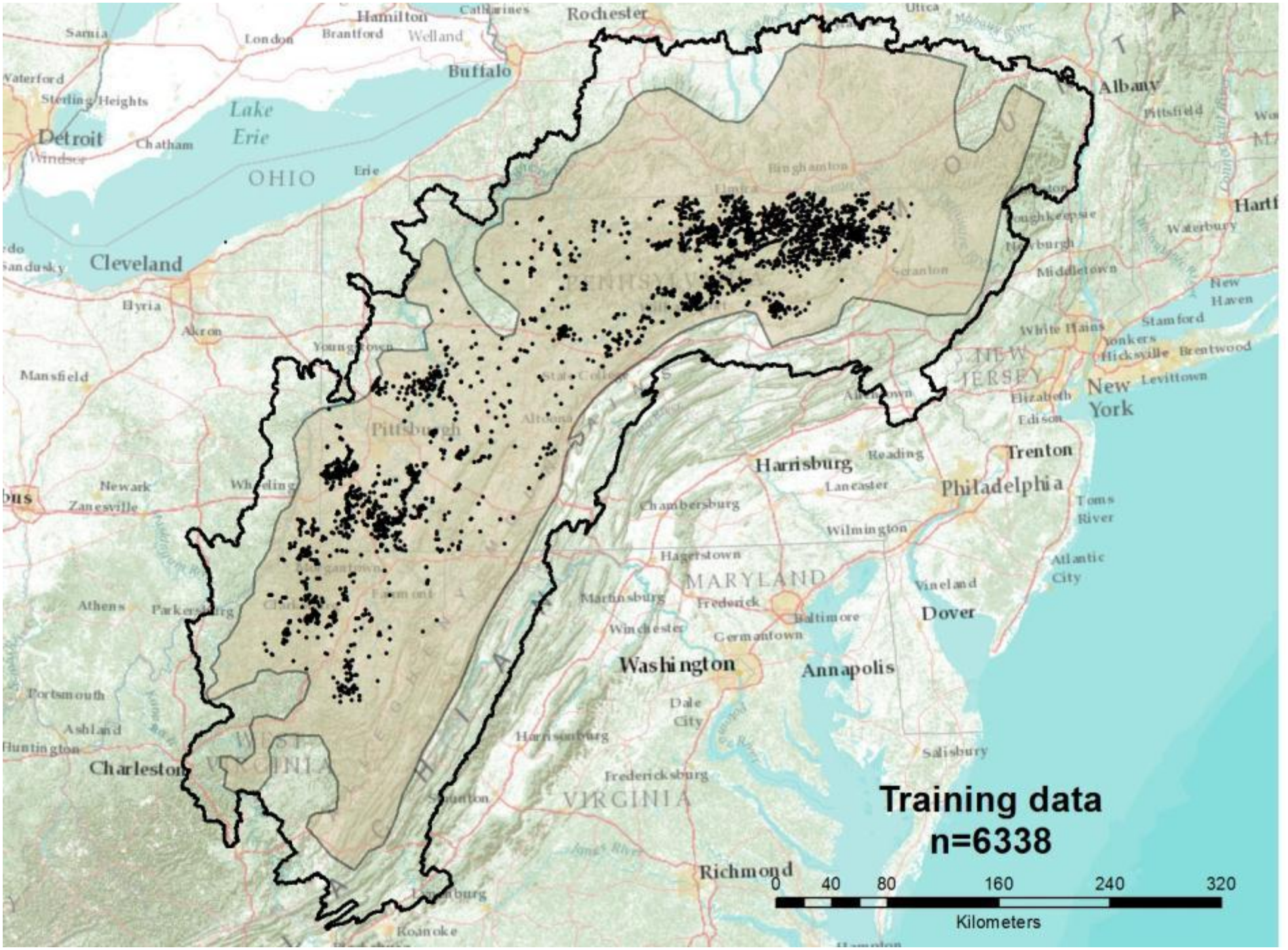

Avoid
Minimize/Restore
Offset
Montana
South Dakota
Idaho
Wyoming
Nebraska
Cheyenne
Salt Lake City
Utah
Colorado

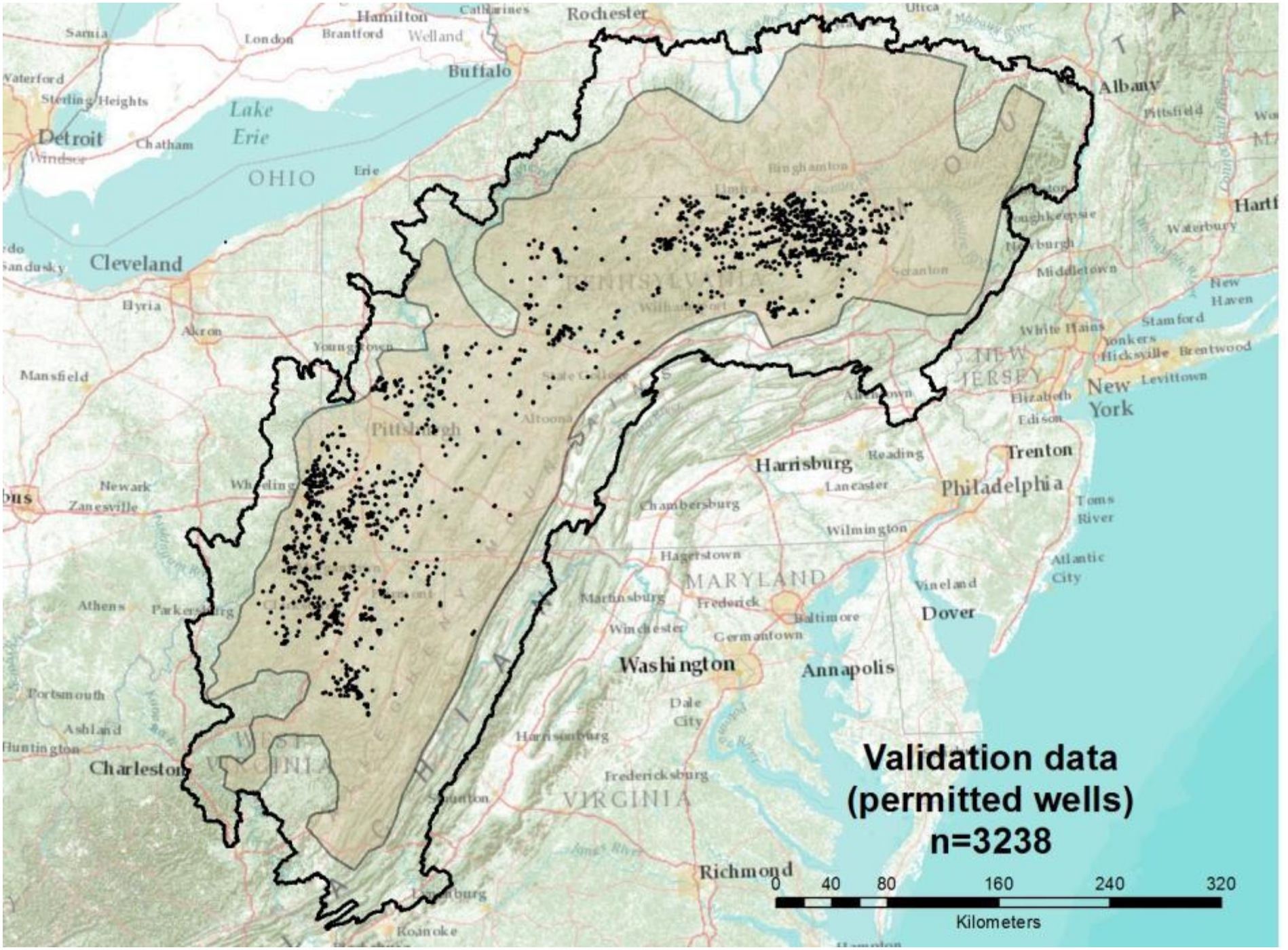
Wyoming Basins Ecoregion:
Pronghorn (Crucial habitat)



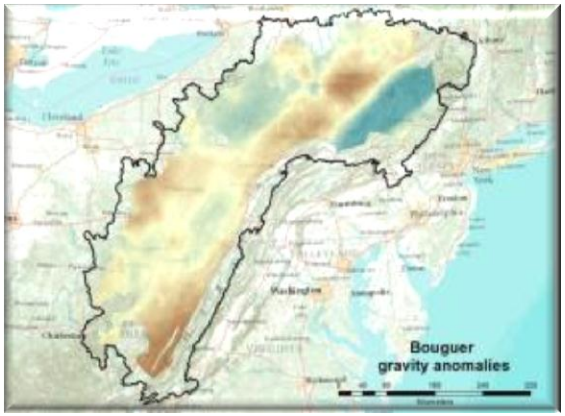
Copeland HE, Doherty KE, Naugle DE, Pocewicz A, Kiesecker JM (2009) Mapping Oil and Gas Development Potential in the US Intermountain West and Estimating Impacts to Species. PLoS ONE 4(10):7400. doi:10.1371/journal.pone.0007400

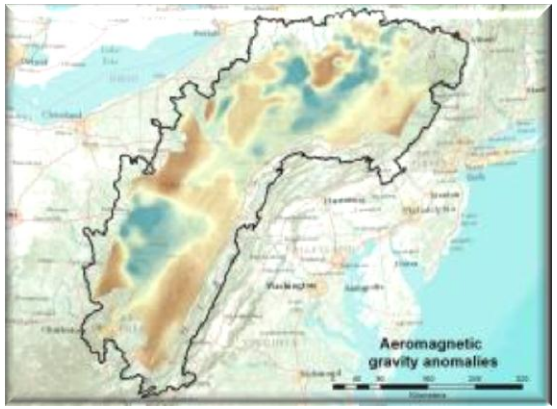

Lower 48 states shale plays
Niobrara*
Montana Thrust Belt
Heath**
Bakken***
Cody
Williston Basin
Big Horn Basin
Powder River Basin
Gammon
Hilliard-Baxter-Mancos
Mowry
Greater Green River Basin
Niobrara*
Park Basin
Forest City Basin
Michigan Basin
Antrim
Appalachian Basin
Devonian (Ohio)
Marcellus
Utica
Illinois Basin
Uinta Basin
Mahogany Canyon
Mancos
Hermosa
Piceance Basin
Denver Basin
San Joaquin Basin
Monterey-Temblor
Paradox Basin
Excello-Mulky
Cherokee Platform
New Albany
Pierre
Lewis
Woodford
Fayetteville
Chattanooga
San Juan Basin
Raton Basin
Anadarko Basin
Ardmore Basin
Arkoma Basin
Black Warrior Basin
Conasauga
Monterey
Santa Maria, Ventura, Los Angeles Basins
Palo Duro Basin
Bend
Floyd-Neal
Valley & Ridge Province
Avalon-Bone Spring
Permian Basin
Barnett
Ft. Worth Basin
TX-LA-MS Salt Basin
Barnett-Woodford
Marfa Basin
Tuscaloosa
Eagle Ford
Haynesville-Bossier
Pearsall
Western Gulf
Miles
0 100 200 300 400
Shale plays
Current plays
Prospective plays
Stacked plays
Shallowest/ youngest
Intermediate depth/ age
Deepest/ oldest
Basins
* Mixed shale & chalk play
** Mixed shale & limestone play
*** Mixed shale & tight dolostone-siltstone-sandstone
eia

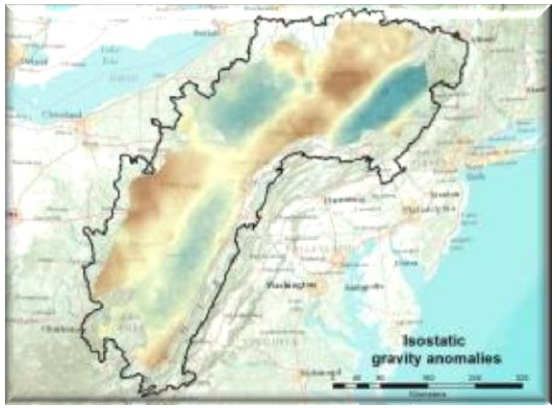

Training data
n=6338
0 40 80 160 240 320
Kilometers
Rochester
Buffalo
Albany
Detroit
Cleveland
Pittsburgh
Harrisburg
Philadelphia
Trenton
New York
Washington
Annapolis
Dover
Charleston
Richmond
Lake Erie
OHIO
MARYLAND
VIRGINIA


Validation data
(permitted wells)
n=3238
0 40 80 160 240 320
Kilometers

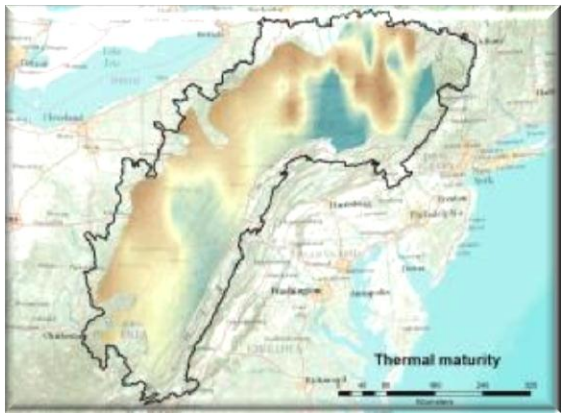
Selected independent variables

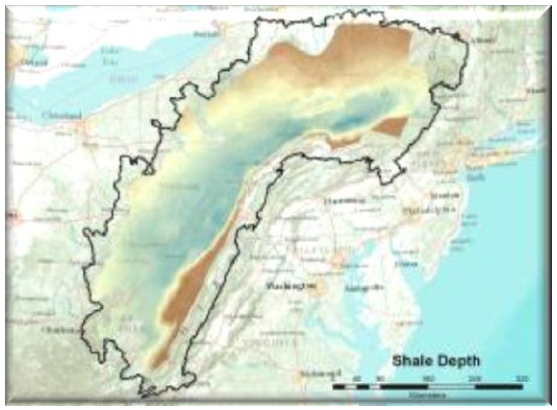




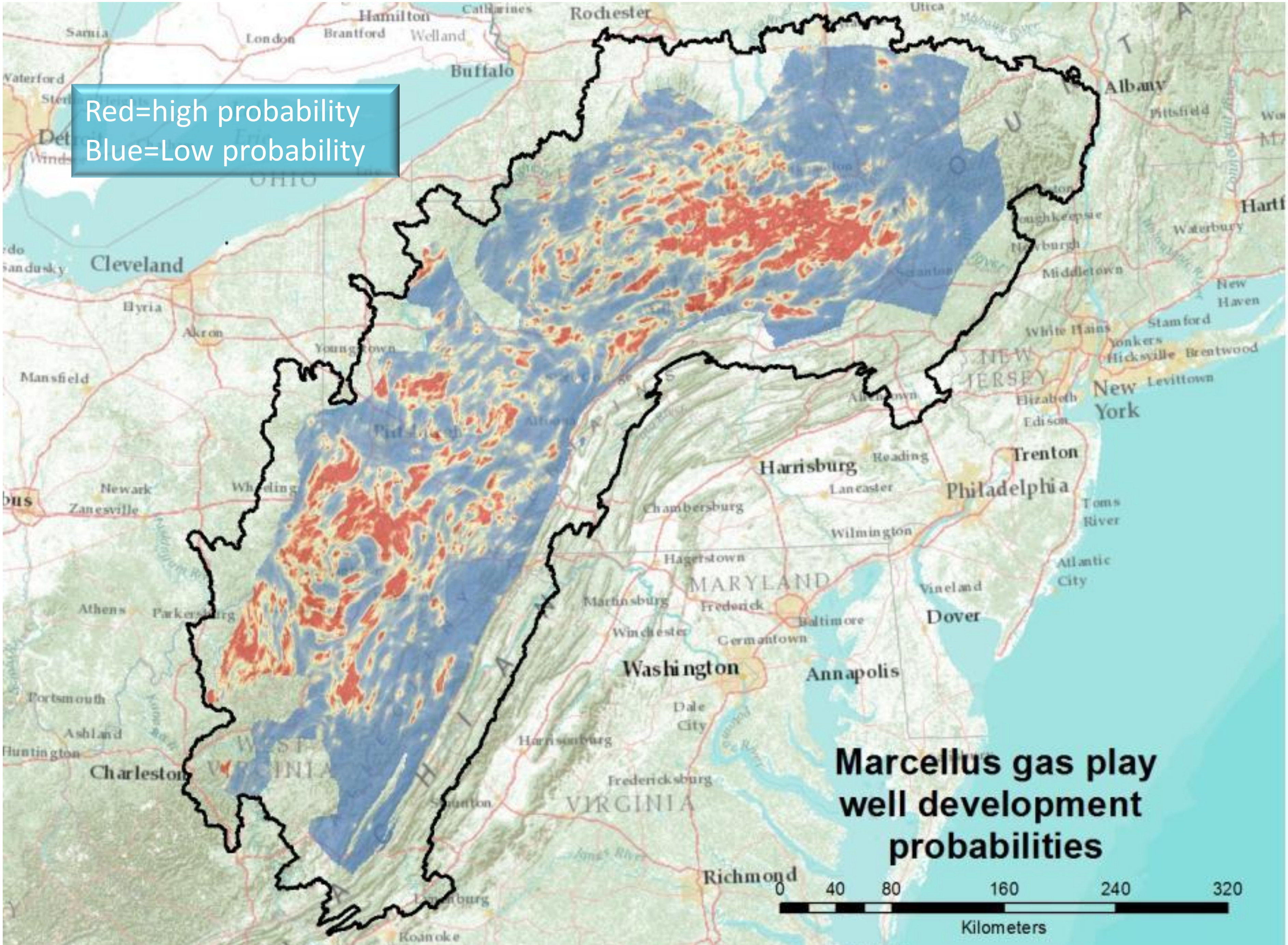


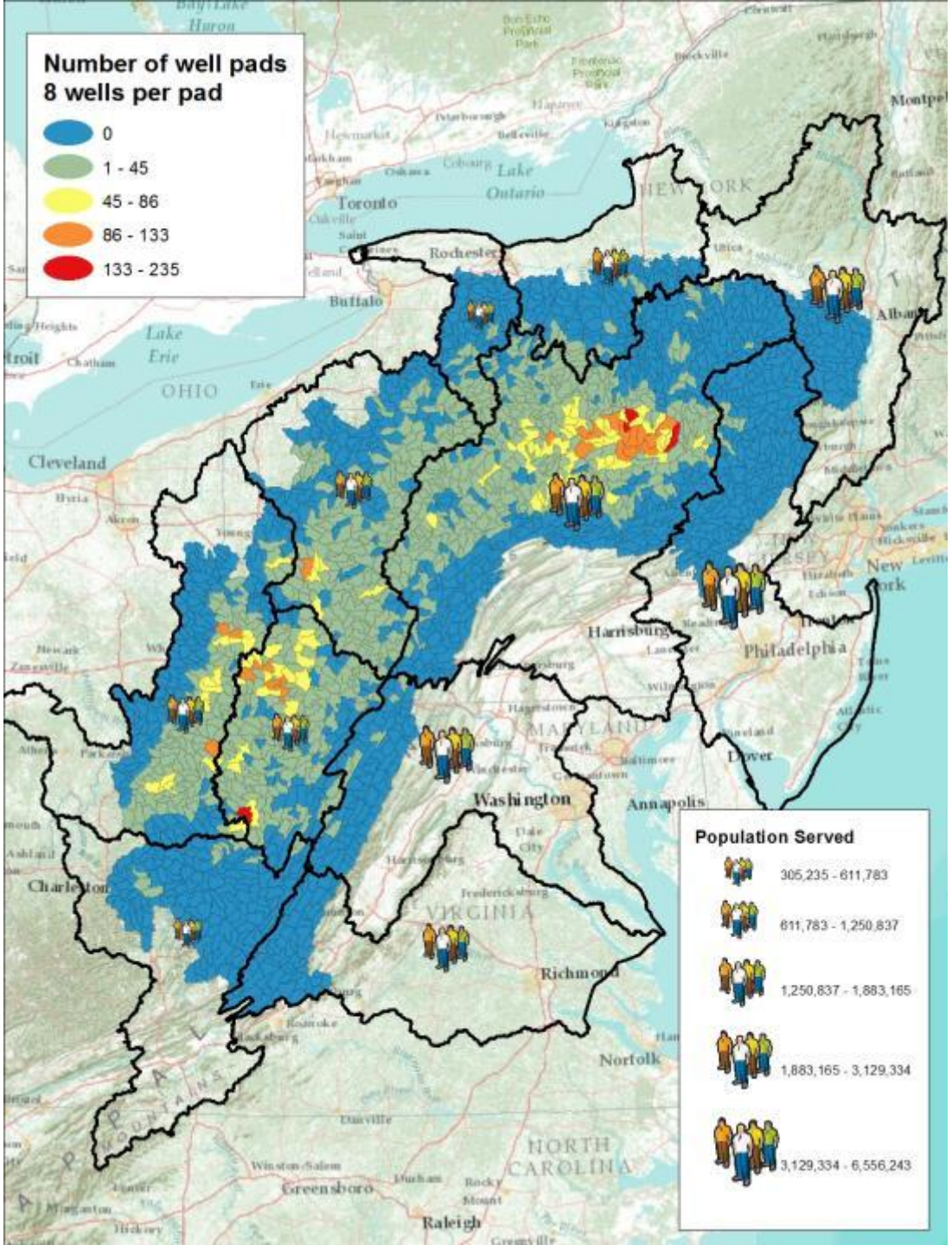
USGS gravitational anomaly data





Kriging models derived from USGS study and well monitoring data

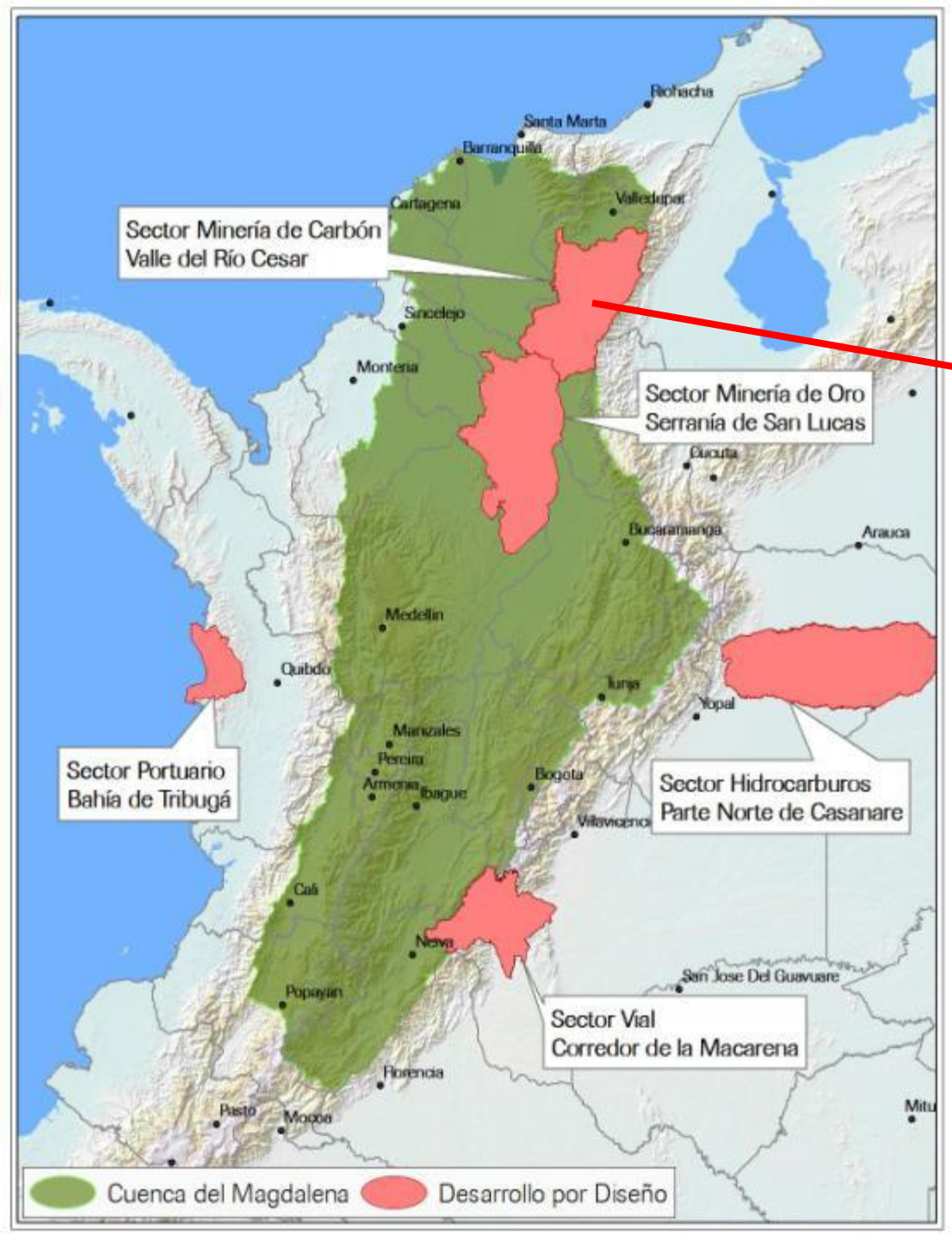

Red=high probability
Blue=Low probability
Marcellus gas play
well development
probabilities
0
40
80
160
240
320
Kilometers
Rochester
Buffalo
Hamilton
London
Brantford
Welland
Sarnia
Albany
Cleveland
Elyria
Akron
Mansfield
Newark
Zanesville
Athens
Parkersburg
Portsmouth
Ashland
Charleston
Harrisburg
Lancaster
Reading
Chambersburg
Wilmington
Trenton
Philadelphia
New York
Hagerstown
MARYLAND
Frederick
Martinsburg
Winchester
Germantown
Baltimore
Washington
Annapolis
Dover
Vineland
Atlantic City
Fredericksburg
VIRGINIA
Harrisonburg
Richmond
Roanoke
New Haven
Stamford
Waterbury
White Plains
Yonkers
Hicksville
Brentwood
Levittown
Elizabeth
Edison
Middletown
Toms River
Dale City

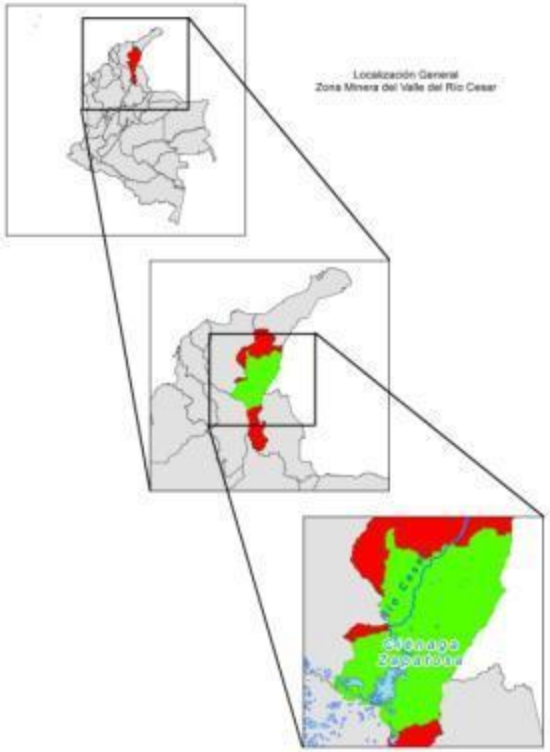

Number of well pads
8 wells per pad
0
1 - 45
45 - 86
86 - 133
133 - 235
Population Served
305,235 - 611,783
611,783 - 1,250,837
1,250,837 - 1,883,165
1,883,165 - 3,129,334
3,129,334 - 6,556,243
Toronto
Buffalo
Rochester
Cleveland
Harrisburg
Philadelphia
Washington
Annapolis
Richmond
Norfolk
Raleigh
Greensboro
Charleston
Lake Ontario
Lake Erie
OHIO
MARYLAND
VIRGINIA
NORTH CAROLINA

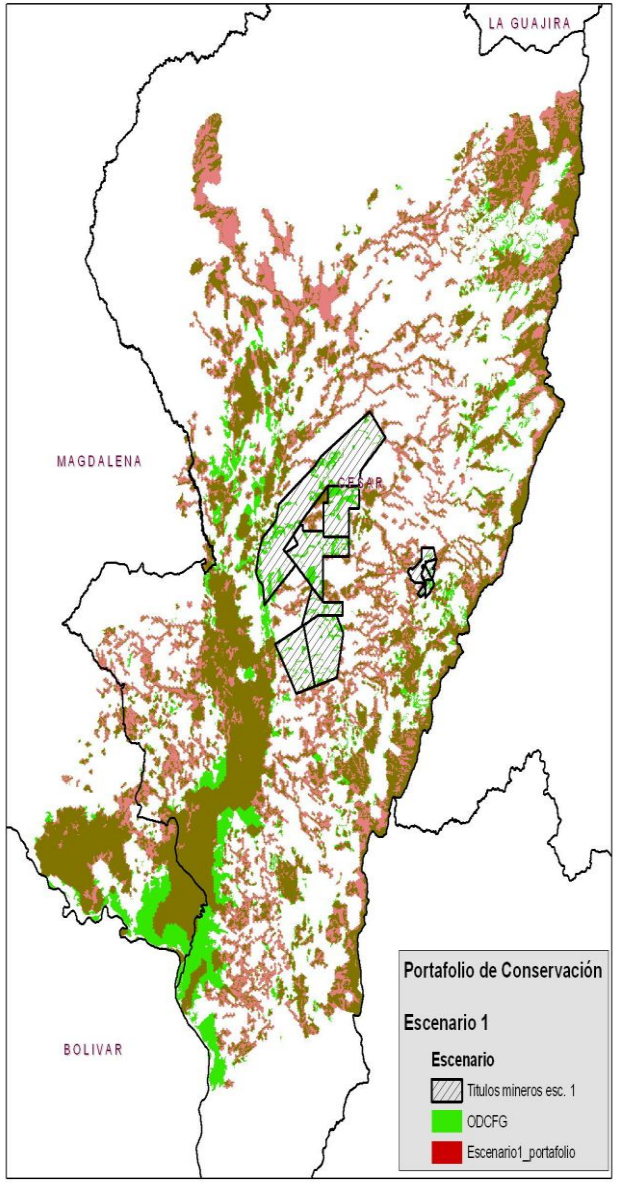
Coal Mining in the Cesar Valley of Colombia

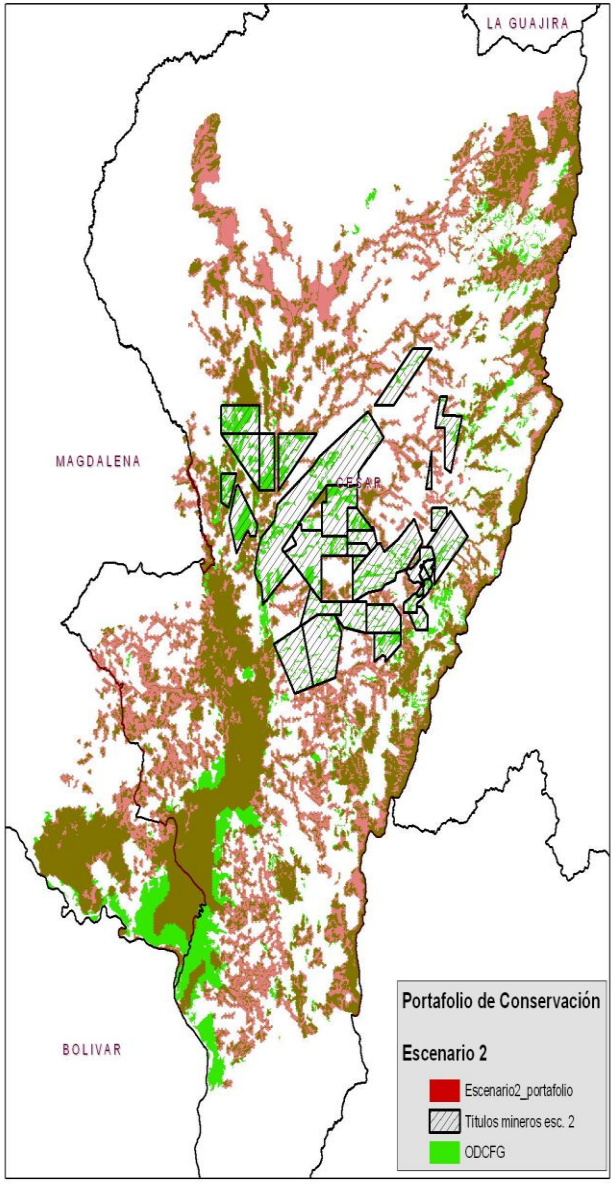
Casos Piloto Colombia

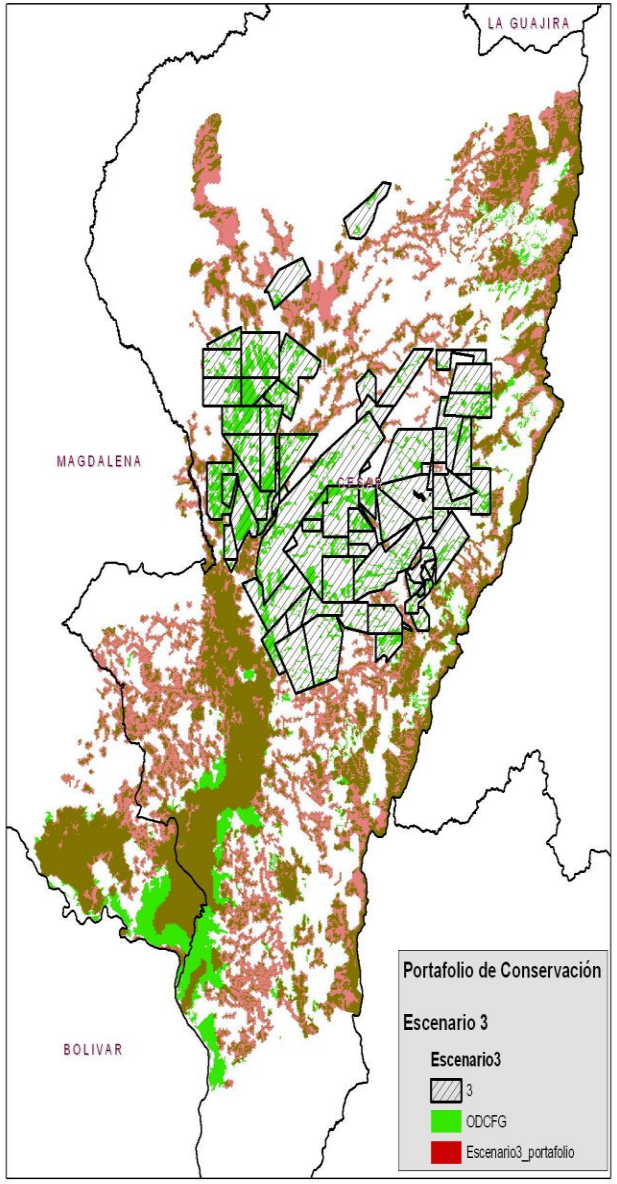
Convenio MAVDT- TNC



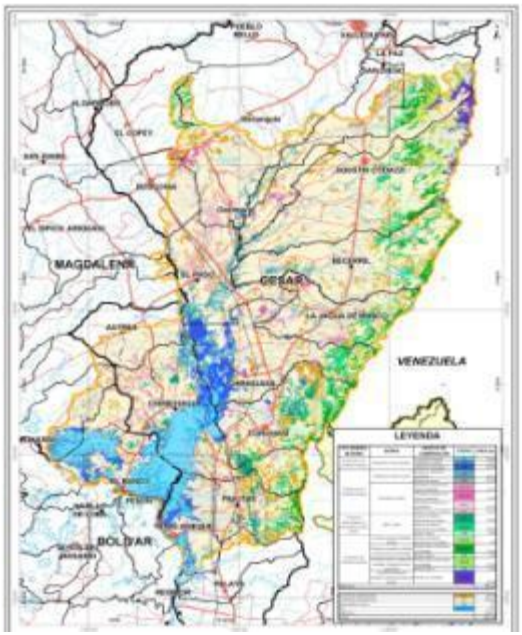




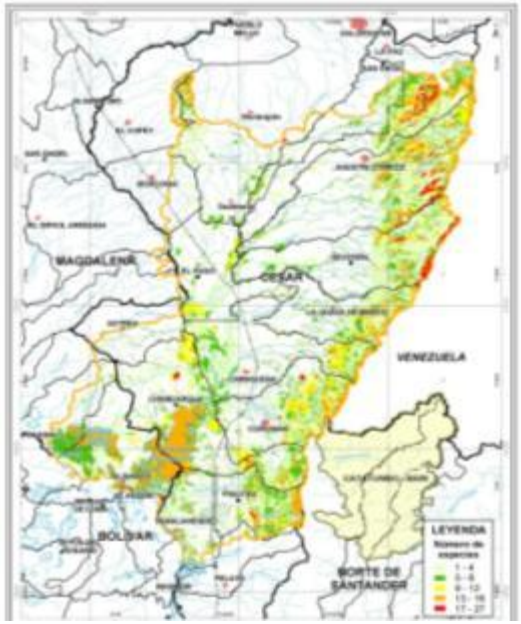




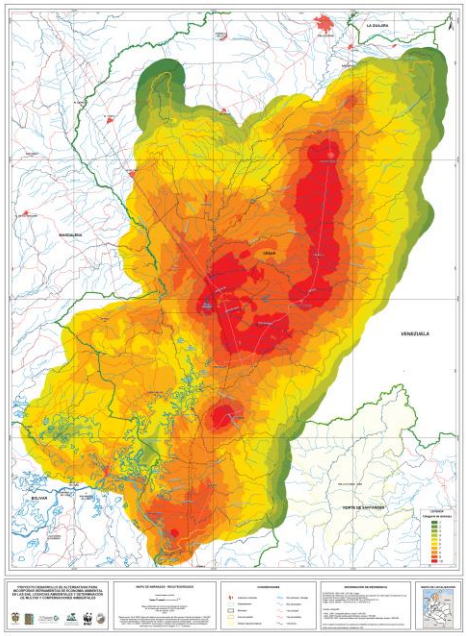
Possible Development Scenarios



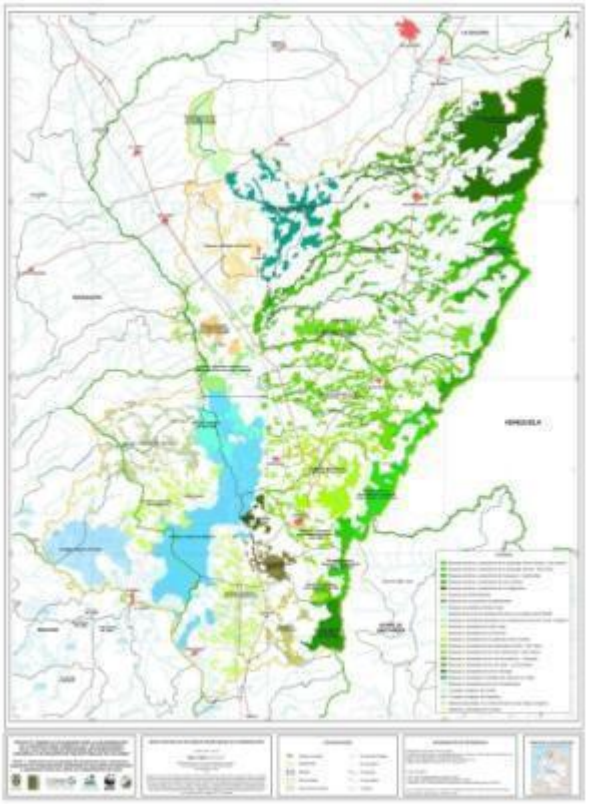
Habitat Data



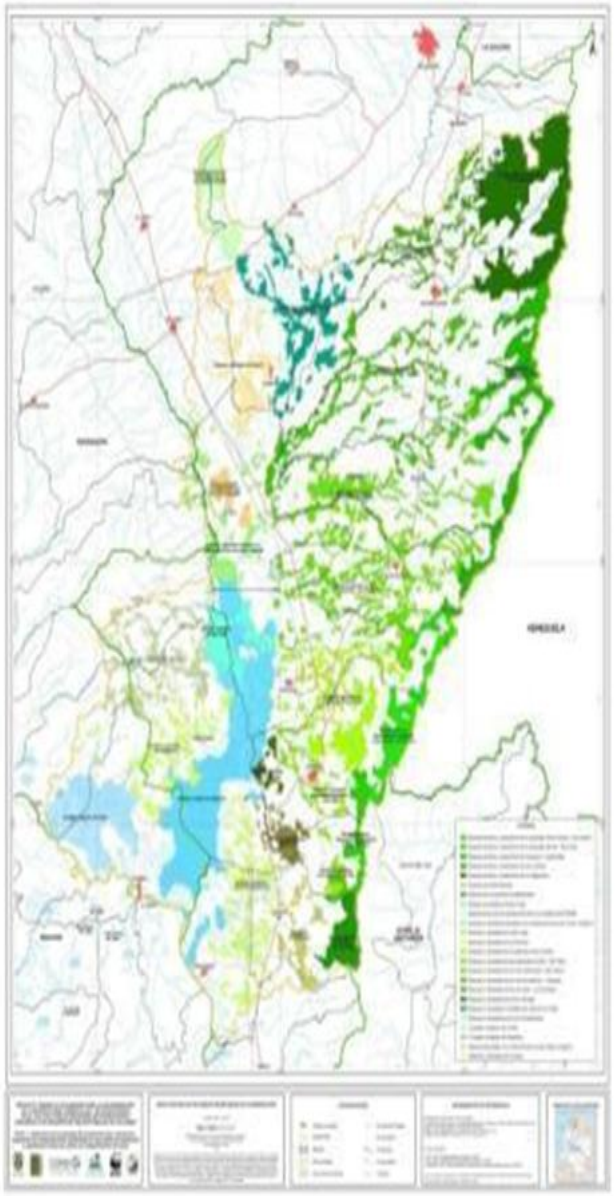
SpeciesData



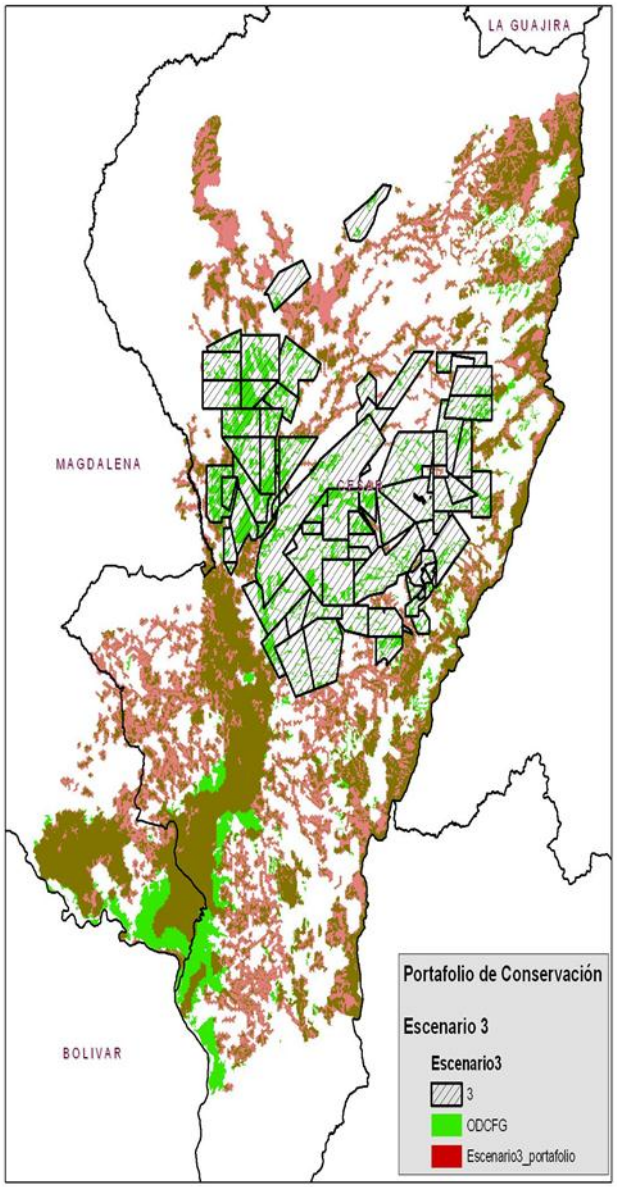
Current Impacts



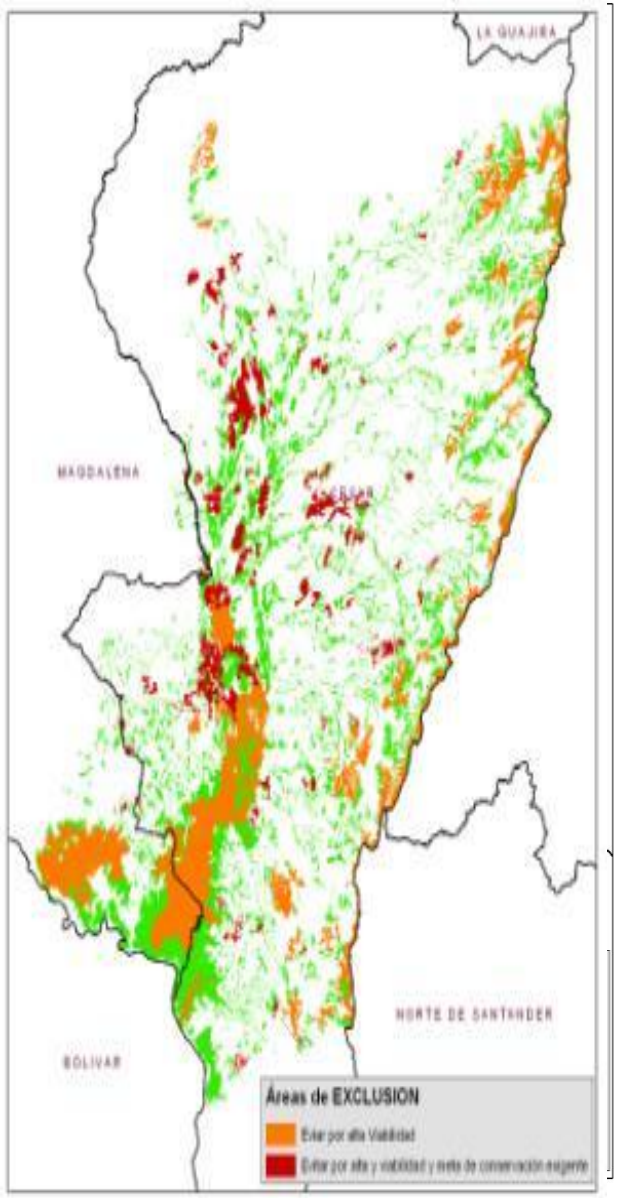
Conservation Portfolio



Conservation Goals & Priority Areas



Possible Development Scenario



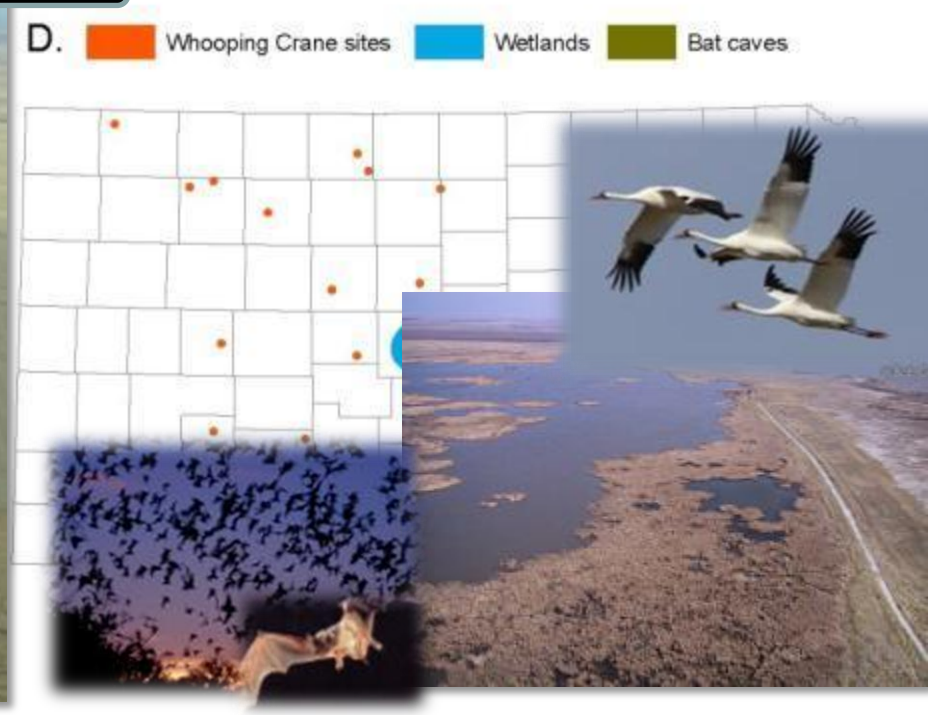
Areas Incompatible with Goals

Development by Design: Mitigating Wind Development's Impacts on Wildlife in Kansas

Brian Obermeyer[1], Robert Manes[2], Joseph Kiesecker[3], Joseph Fargione[4]*, Kei Sochi[5]

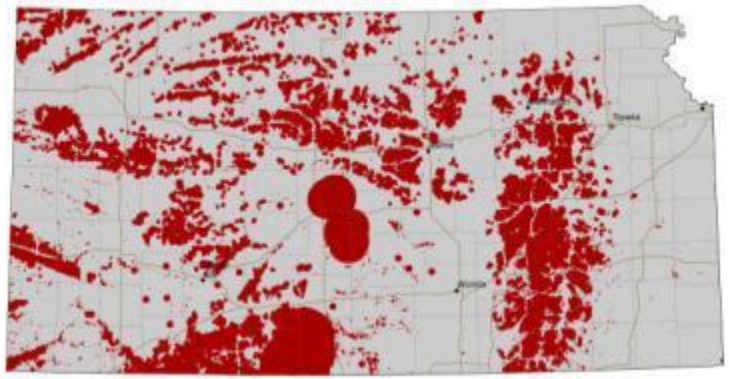
1 The Nature Conservancy, Cottonwood Falls, Kansas, United States of America, 2 The Nature Conservancy, Topeka, Kansas, United States of America, 3 The Nature Conservancy, Fort Collins, Colorado, United States of America, 4 The Nature Conservancy, Minneapolis, Minnesota, United States of America, 5 The Nature Conservancy, Boulder, Colorado, United States of America

Key Habitats

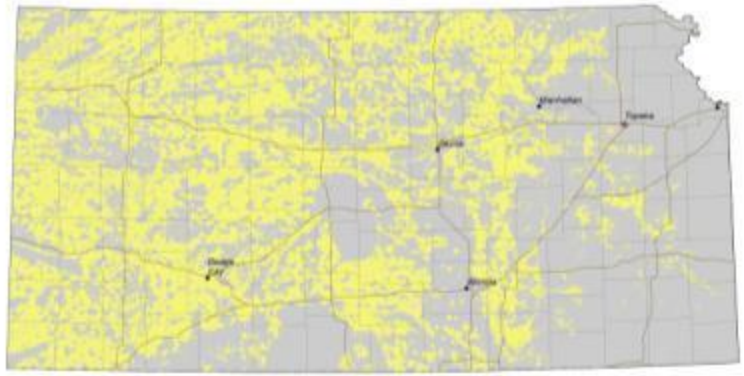


Development by Design for Wind

The Nature Conservancy
Protecting nature. Preserving life.™



AVOID



OFFSET

No Mitigation

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Mitigation Costs

Based on actual costs of restoring and protecting

Prairie chicken

Grassland

Playa lakes

Development by Design for Wind

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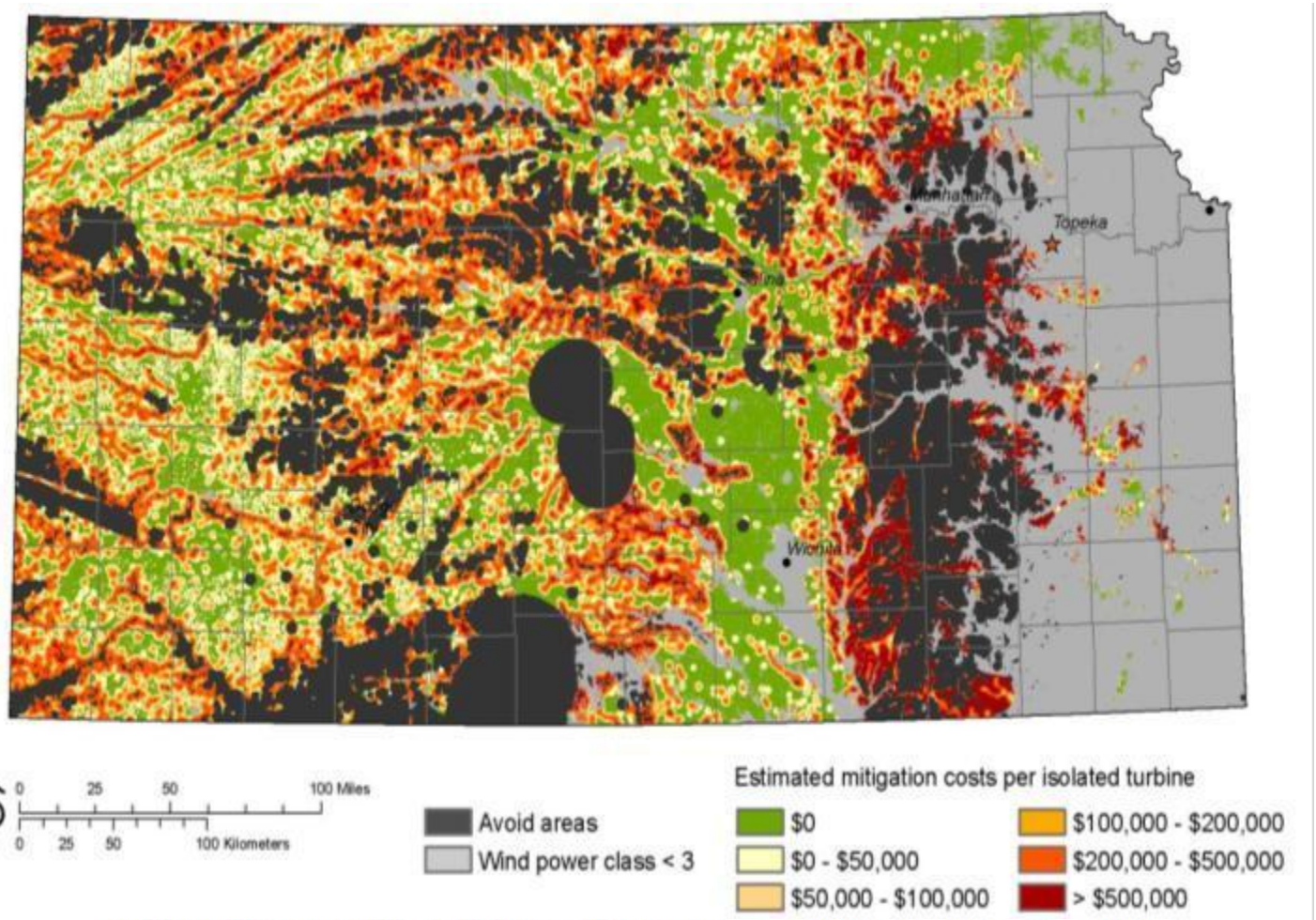
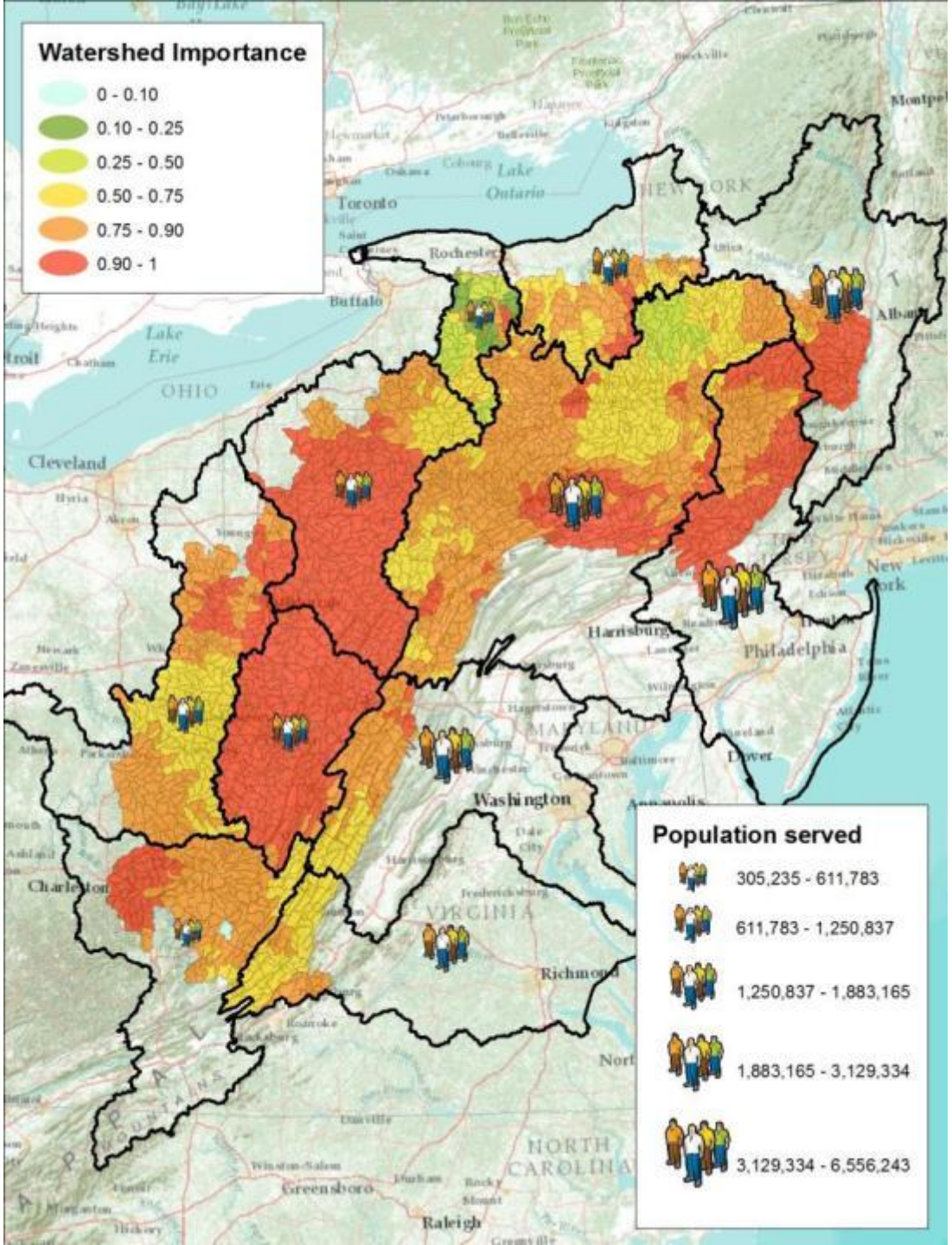
MITIGATION COSTS

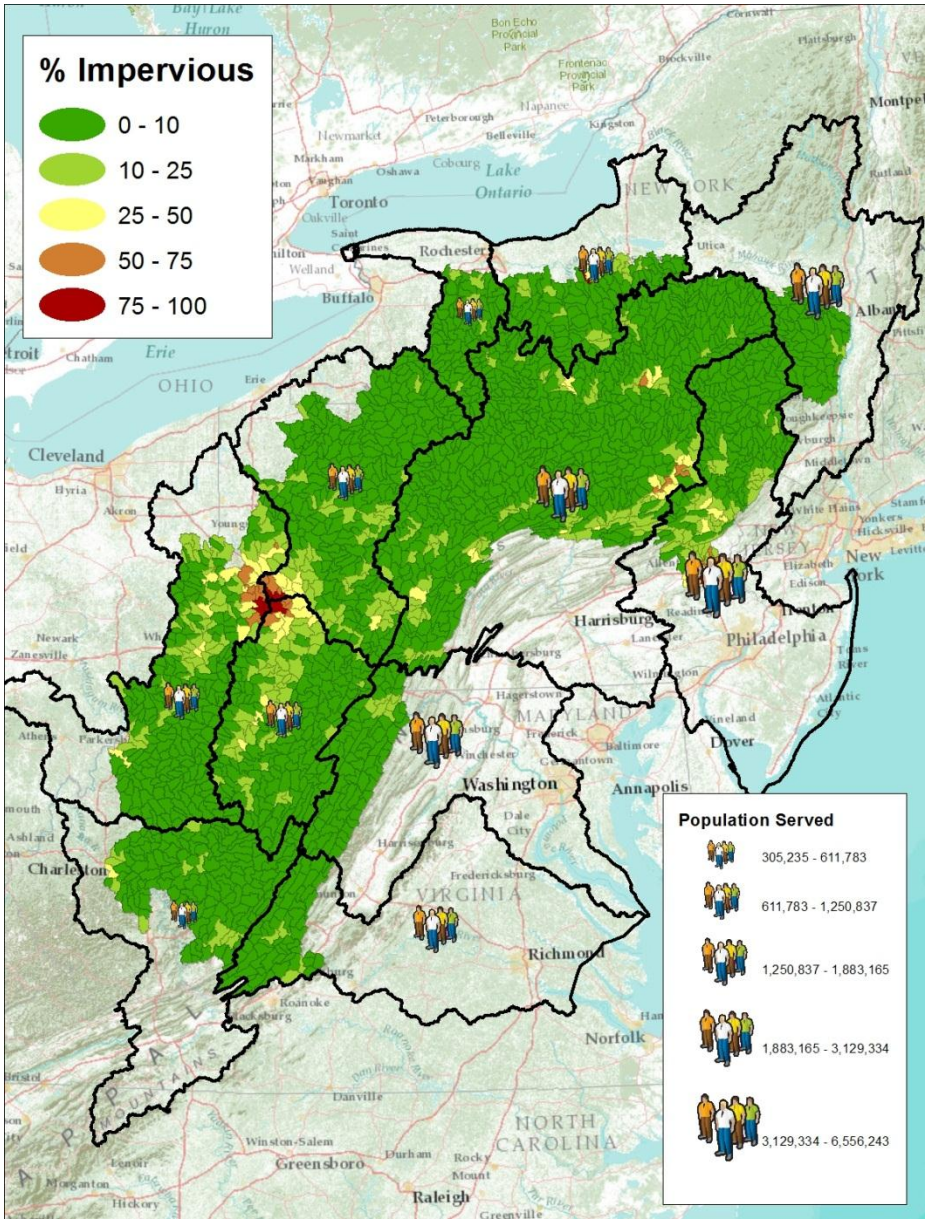


Development by Design: Mitigating Wind Development's Impacts on Wildlife in Kansas

Brian Obermeyer[1], Robert Manes[2], Joseph Kiesecker[3], Joseph Fargione[4]*, Kei Sochi[5]

1 The Nature Conservancy, Cottonwood Falls, Kansas, United States of America, 2 The Nature Conservancy, Topeka, Kansas, United States of America, 3 The Nature Conservancy, Fort Collins, Colorado, United States of America, 4 The Nature Conservancy, Minneapolis, Minnesota, United States of America, 5 The Nature Conservancy, Boulder, Colorado, United States of America


Watershed Importance
0 - 0.10
0.10 - 0.25
0.25 - 0.50
0.50 - 0.75
0.75 - 0.90
0.90 - 1
Population served
305,235 - 611,783
611,783 - 1,250,837
1,250,837 - 1,883,165
1,883,165 - 3,129,334
3,129,334 - 6,556,243
Toronto
Rochester
Buffalo
Lake Ontario
Lake Erie
OHIO
Cleveland
Harrisburg
Philadelphia
Washington
Richmond
Greensboro
Raleigh
MARYLAND
VIRGINIA
NORTH CAROLINA


% Impervious
0 - 10
10 - 25
25 - 50
50 - 75
75 - 100
Population Served
305,235 - 611,783
611,783 - 1,250,837
1,250,837 - 1,883,165
1,883,165 - 3,129,334
3,129,334 - 6,556,243
Toronto
Buffalo
Rochester
Cleveland
Harrisburg
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Greensboro
OHIO
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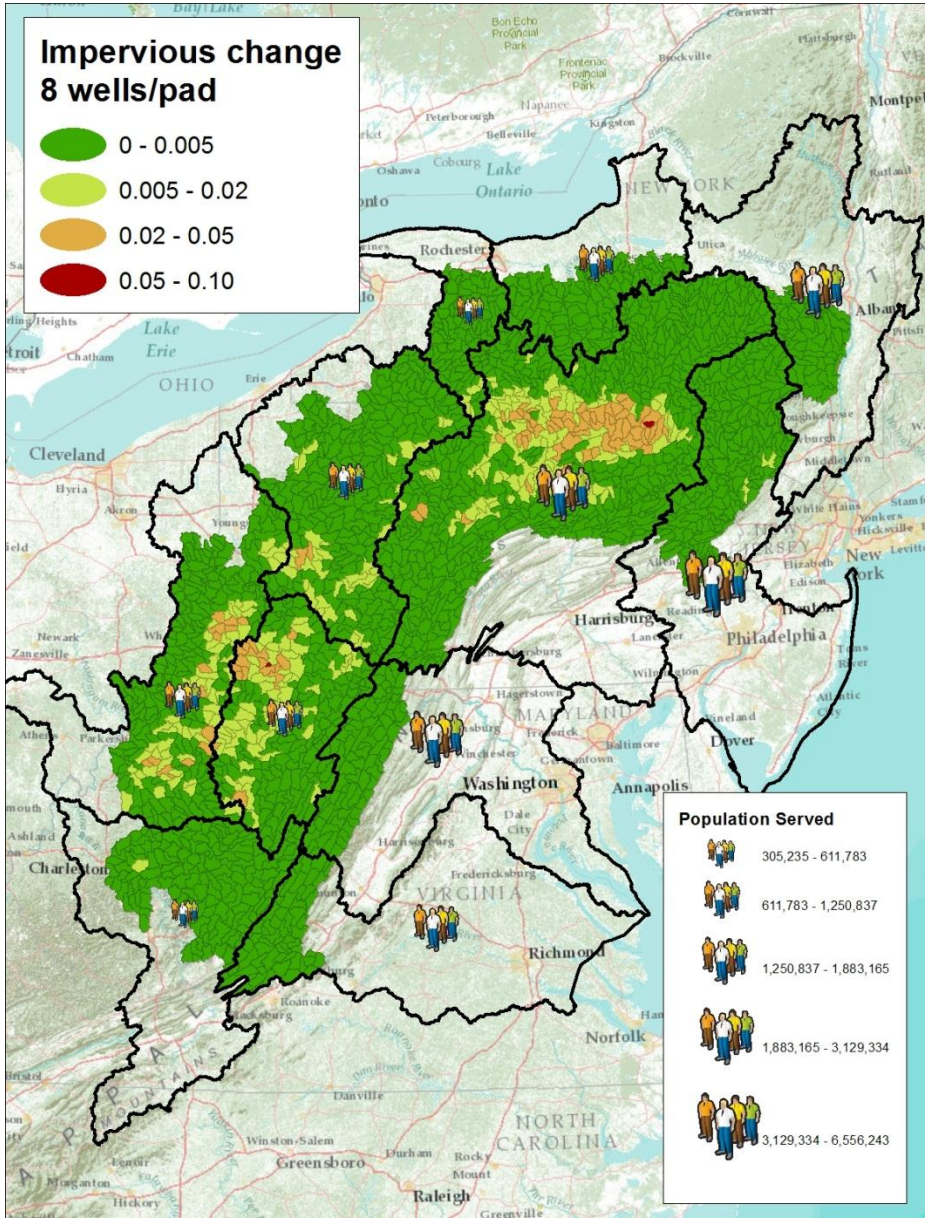
NORTH CAROLINA
MARYLAND


Impervious change
8 wells/pad
0 - 0.005
0.005 - 0.02
0.02 - 0.05
0.05 - 0.10
Population Served
305,235 - 611,783
611,783 - 1,250,837
1,250,837 - 1,883,165
1,883,165 - 3,129,334
3,129,334 - 6,556,243
Toronto
Buffalo
Rochester
Cleveland
Harrisburg
Philadelphia
Washington
Annapolis
Richmond
Norfolk
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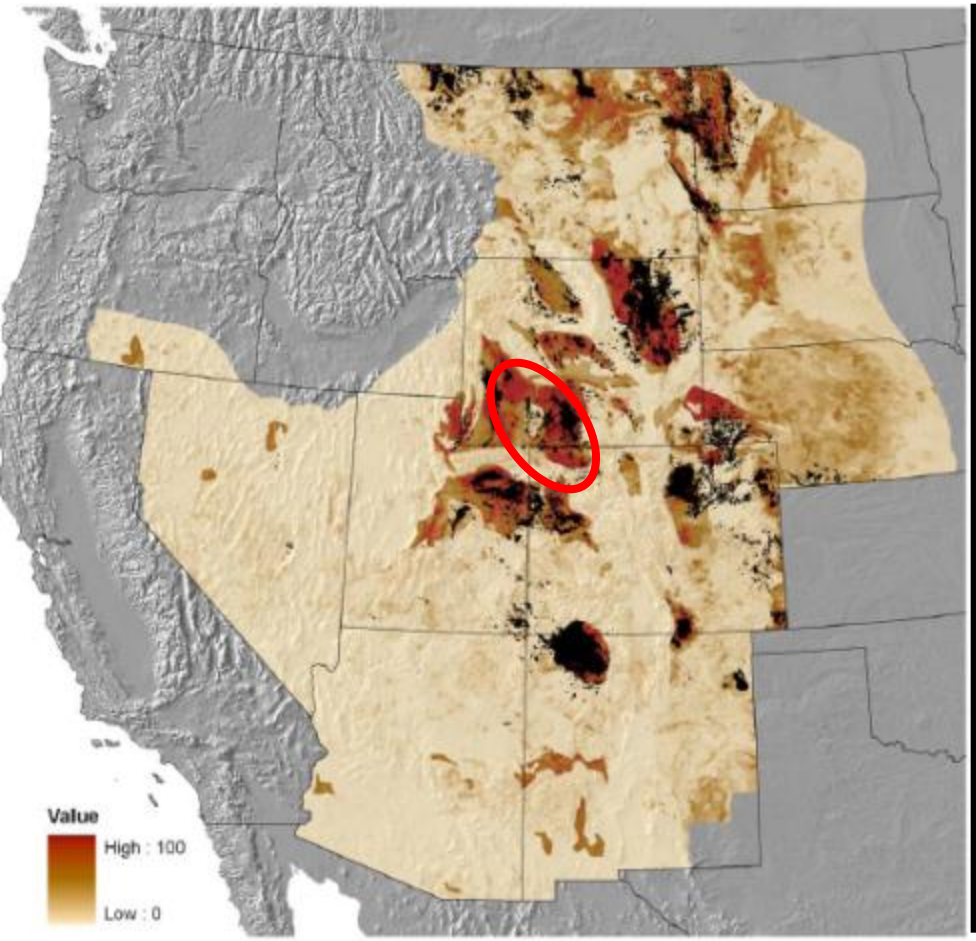
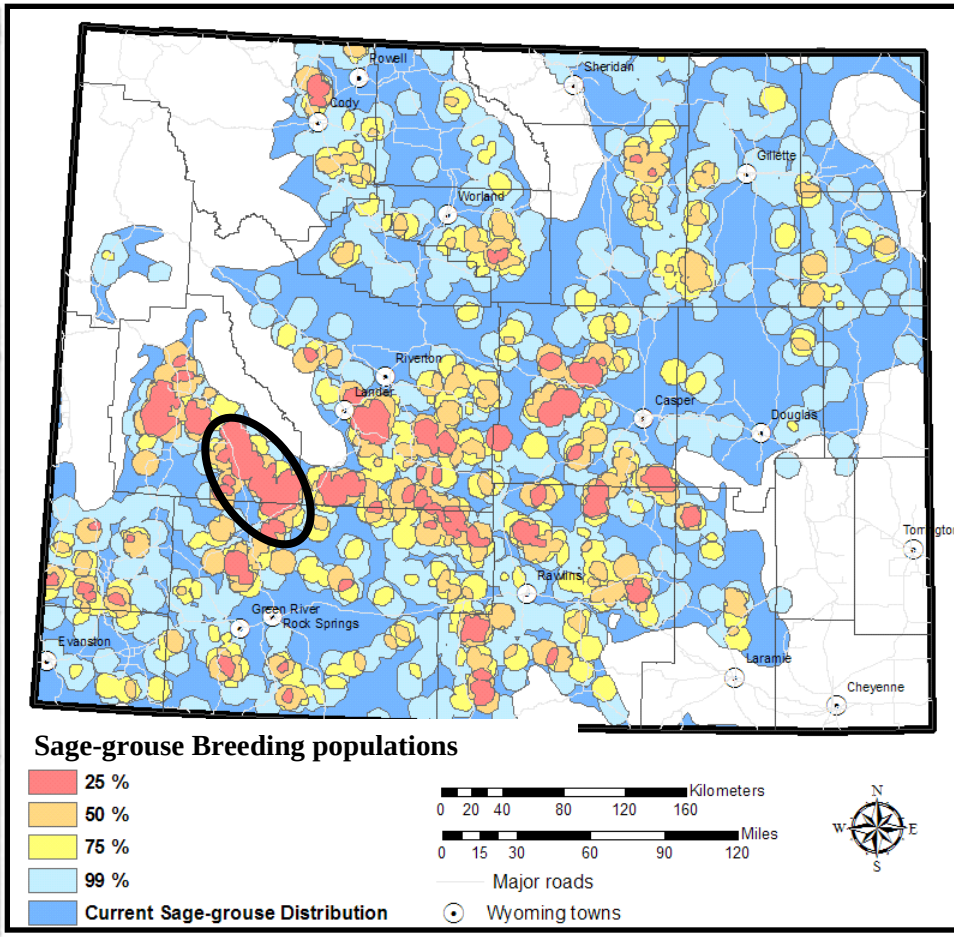
Raleigh
Greensboro
OHIO
VIRGINIA
NORTH CAROLINA
MARYLAND

Identify spatial overlap between energy development and core areas for sage-grouse.



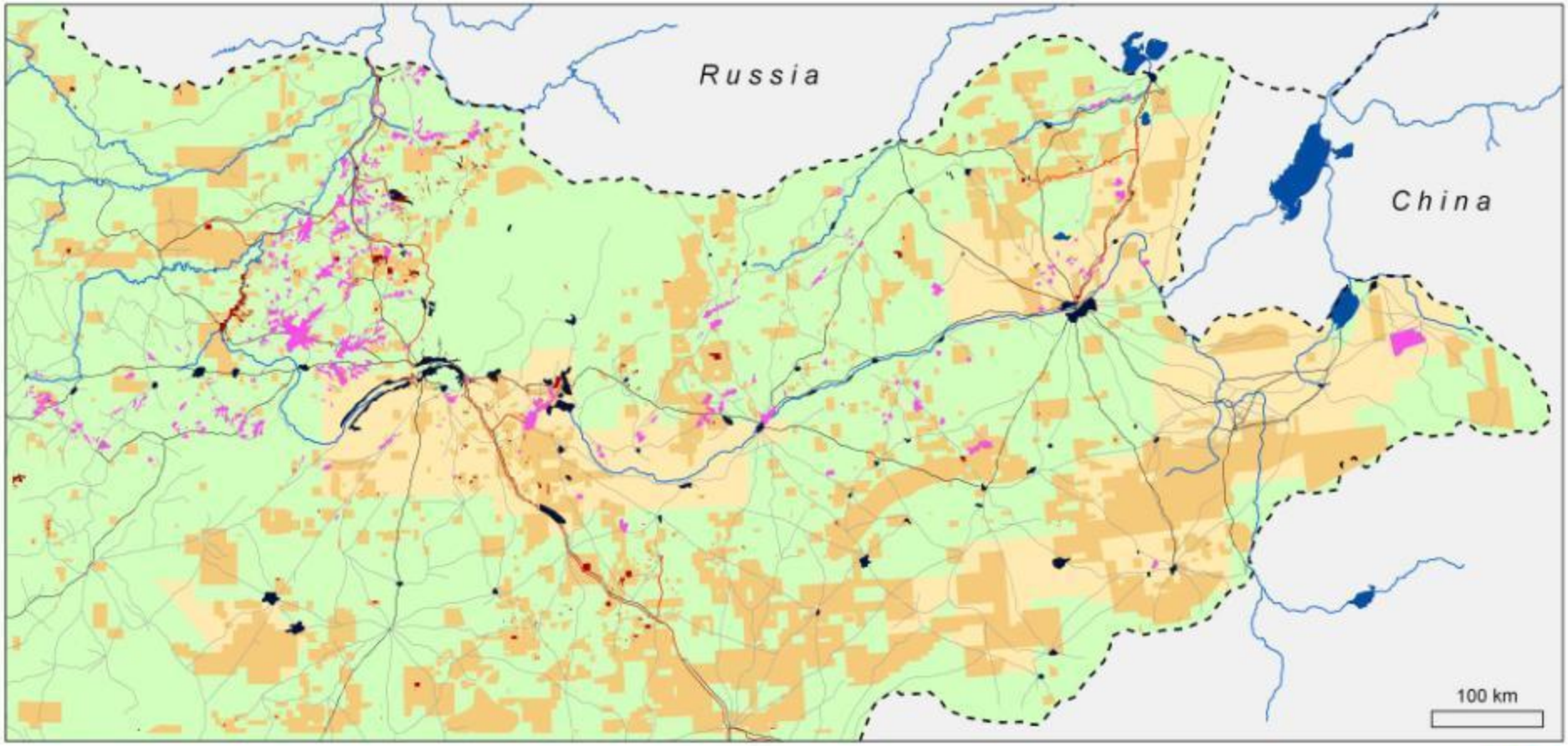


Shortcomings of Site Based Mitigation

Wetland mitigation site in Salem, Oregon

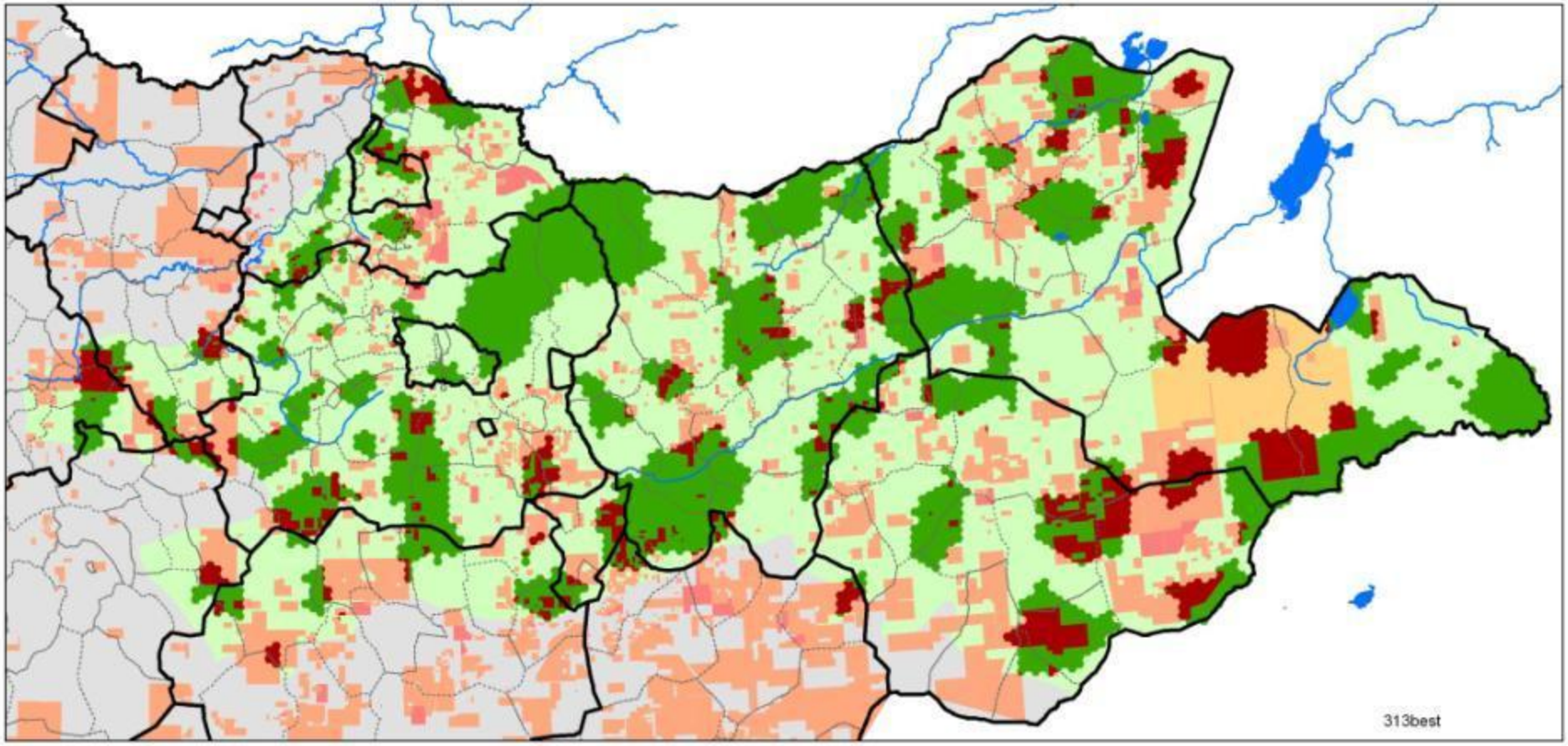
Infrastructure/Mining/Oil & Gas in Mongolia

Infrastructure & Mining in Mongolia's Eastern Steppe



Legend

- National borders
- major rivers
- large lakes
- primary roads
- secondary roads
- railway
- agriculture
- urban areas
- active mines
- mining licenses
- oil /gas license



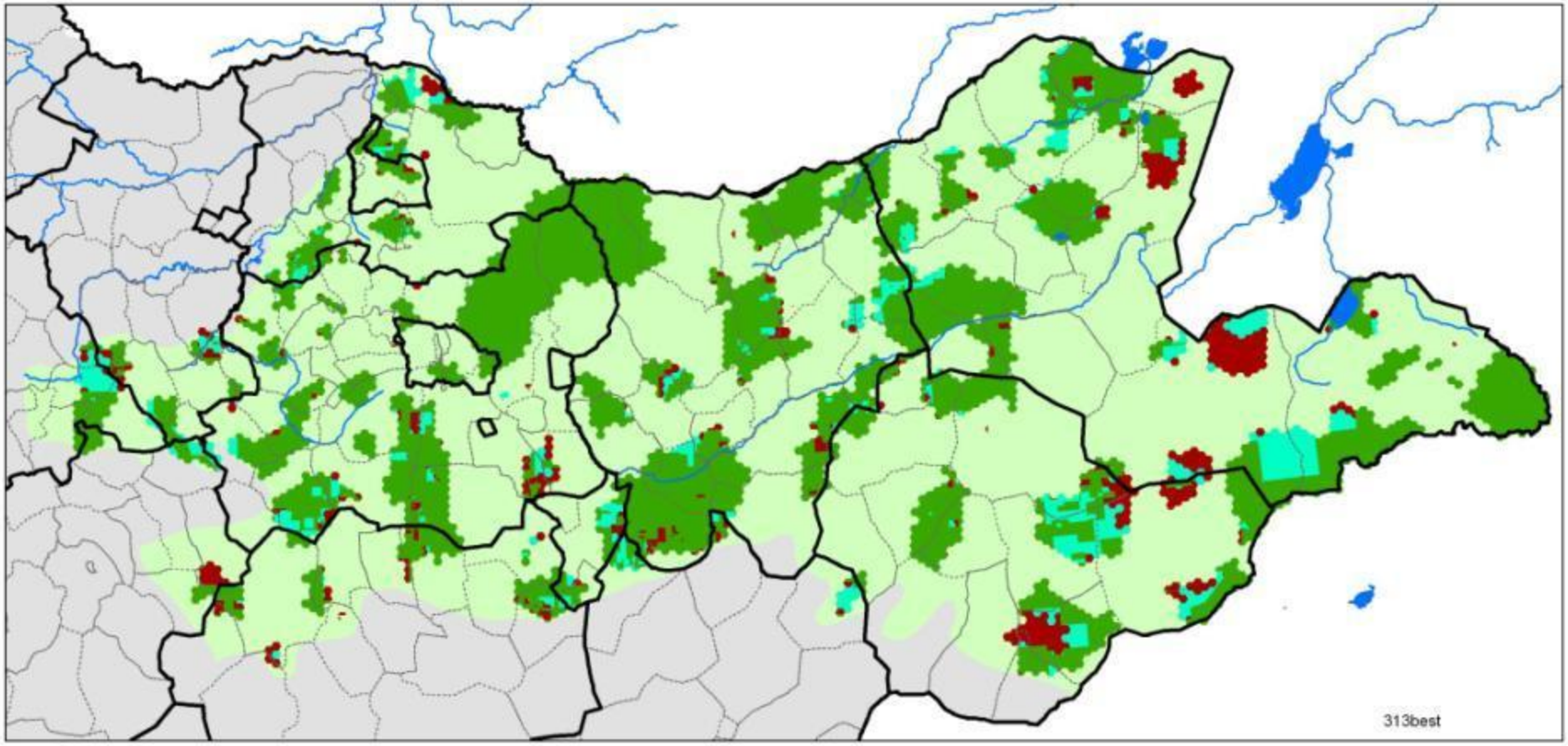
Conservation Priorities
30% goal

Ашигт малтмал болон газрын тосны лиценз

- application
- exploration
- petroleum

conflict areas

- major lakes
- major rivers
- Aimag borders
- Soum borders

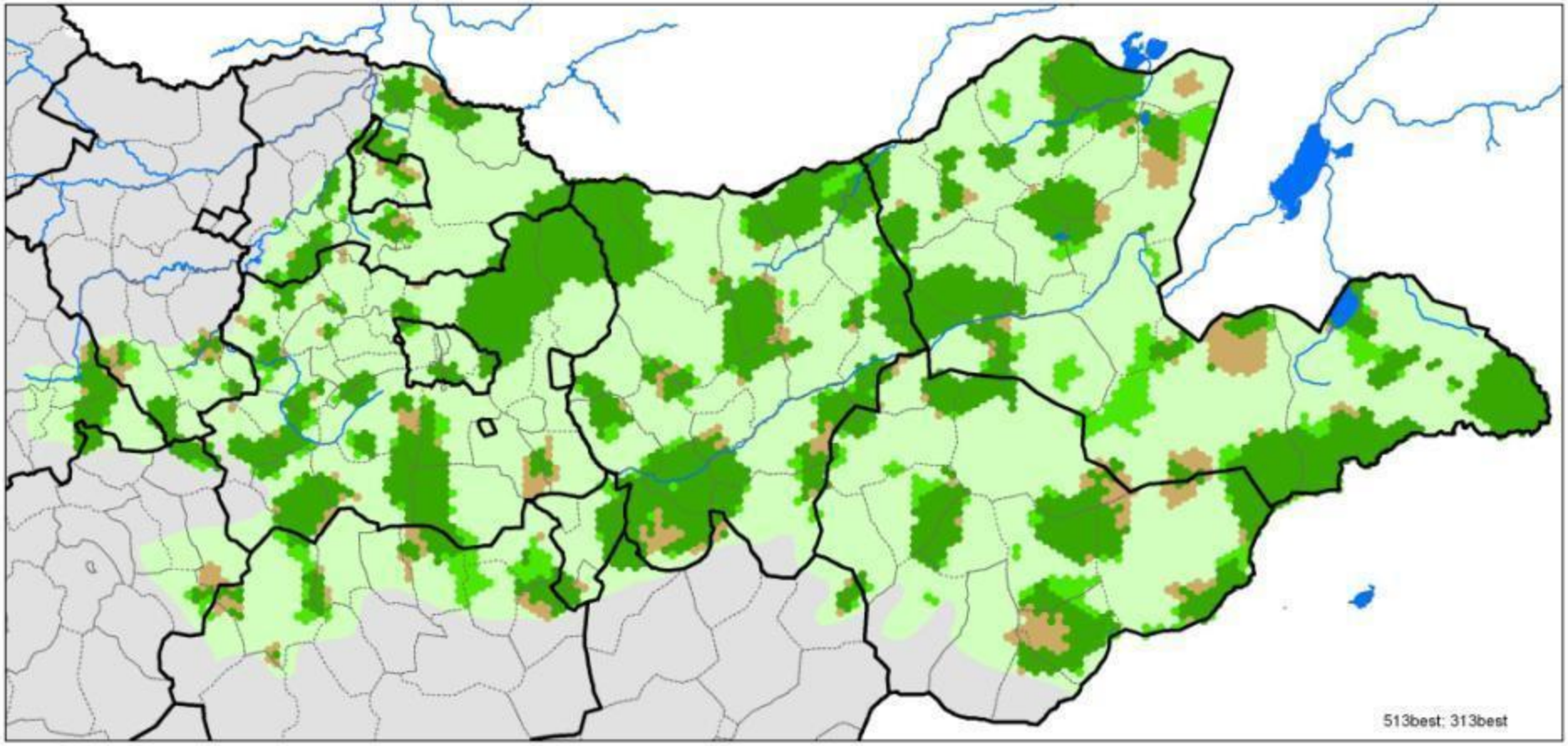


major lakes
major rivers
Aimag borders
Soum borders

Conservation Priorities
30% goal

Meet goals elsewhere

Avoid Impacts

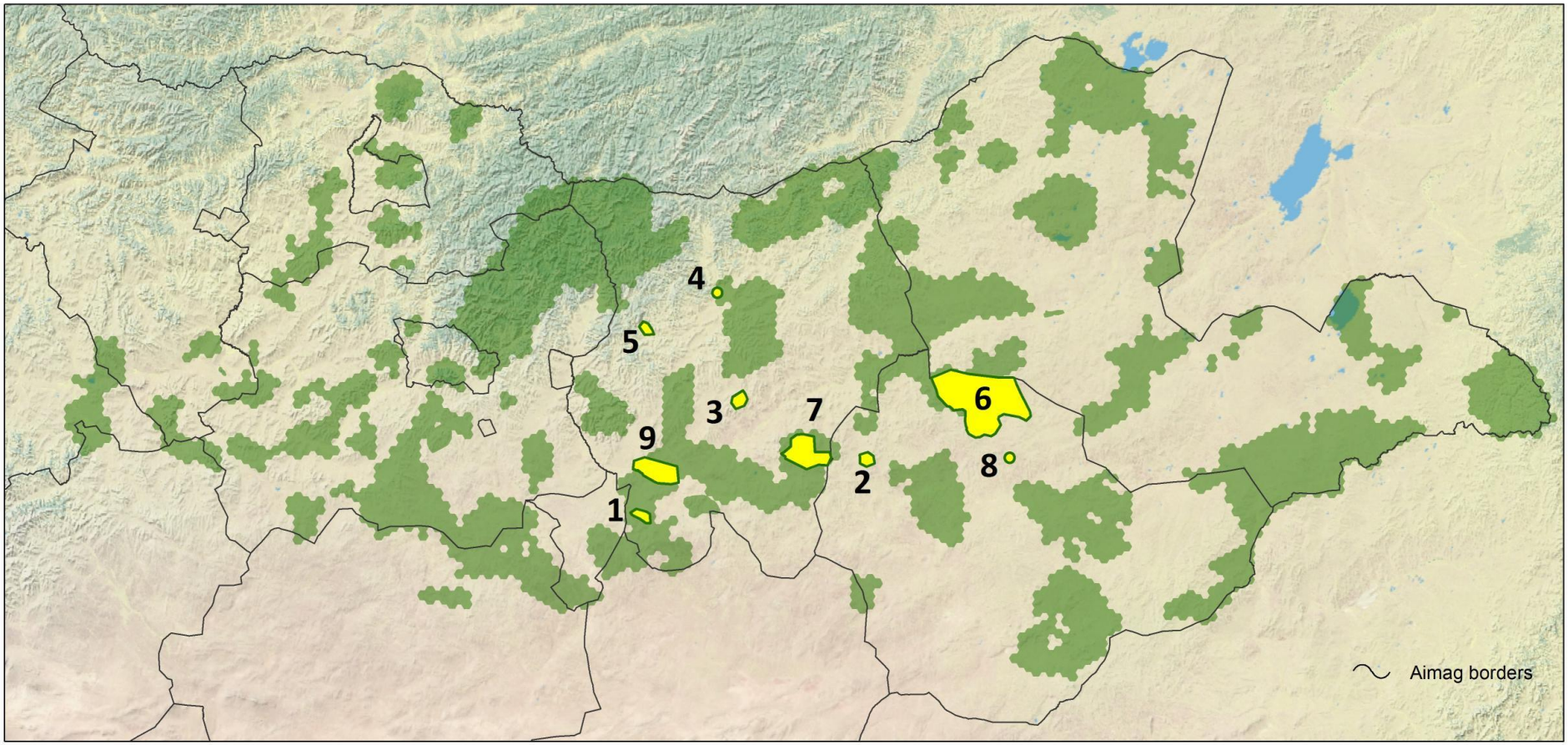


Conservation Priorities
30% goal

added

removed

major lakes
major rivers
Aimag borders
Soum borders



new protected areas

conservation portfolio

1 Darhan Uul
2 Munkhhaan Uul
3 Undur khaan Uul
4 Binder Ovoo
5 Khangal Nuur
6 Bayantsagaan Tal
7 Uvur Hundii
8 Dachaan Han Uul
9 Kherlen Toono Uul

Development by Design:
Uinta Basin (Utah)

Current Wells

QEP development area

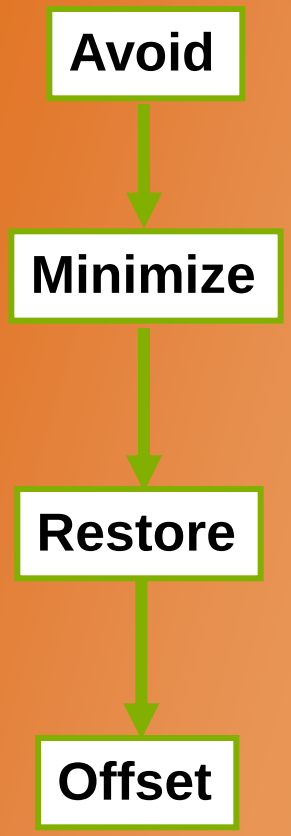
Pronghorn Crucial Habitat (source: UTDWR)

EIS boundaries

0 10 20 40 Miles

Reproduced by The Nature Conservancy

Cumulative Impacts in Environmental Impact Assessment



Problems

- Most significant Impacts to Biodiversity results from indirect and Cumulative Impacts
- Few EIA's even mention CI's
- When CI's are considered treated superficially
- Reactive piecemeal planning
- Improper ecological scale

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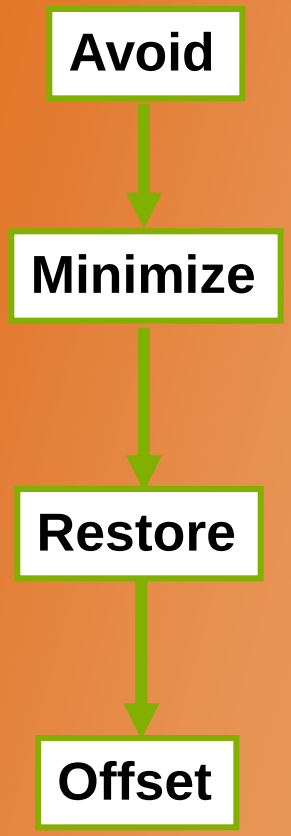
Cumulative Impacts in Environmental Impact Assessment



Issue of Scale

- Spatial Scale
- Temporal Scale

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