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# Probabilistic Integrated Resource Assessment Tool with Ecosystem Services: PIRATES

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Geosciences and Environmental Change Science Center

# Probabilistic Integrated Resource Assessment Tool with Ecosystem Services: PIRATES



## **Crew members**

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### **CERSC**

Cici Martinez  
Seth Haines

### **SDC**

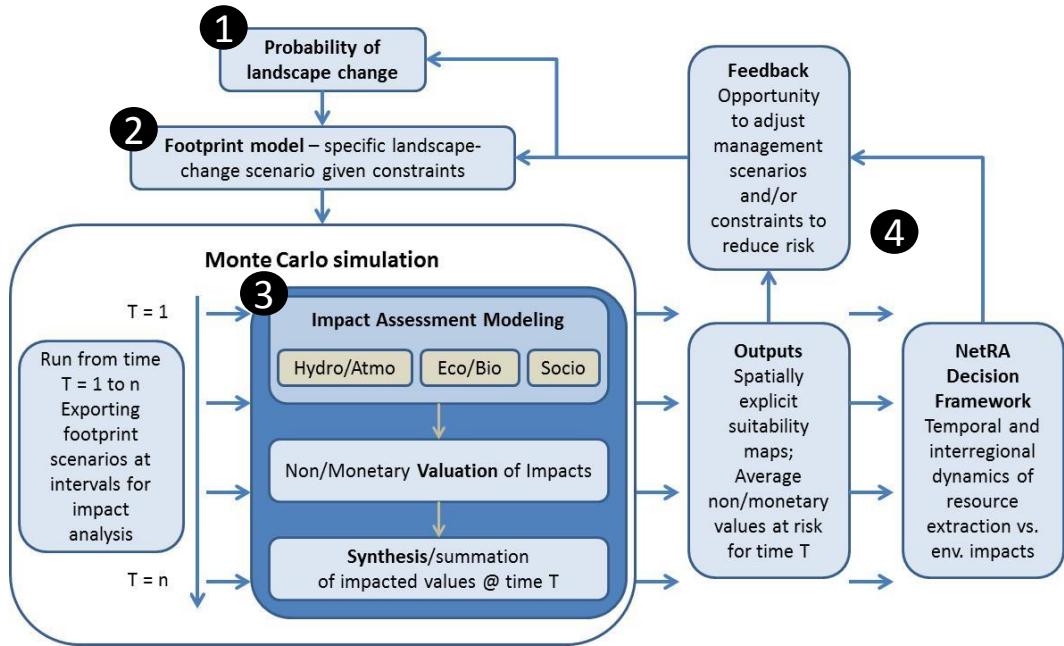
Karen Jenni

# PIRATES Conceptual Model

Integrated probabilistic modeling approach

Assess how future landscape changes may affect wildlife and ecosystem services

Account for uncertainty throughout the process





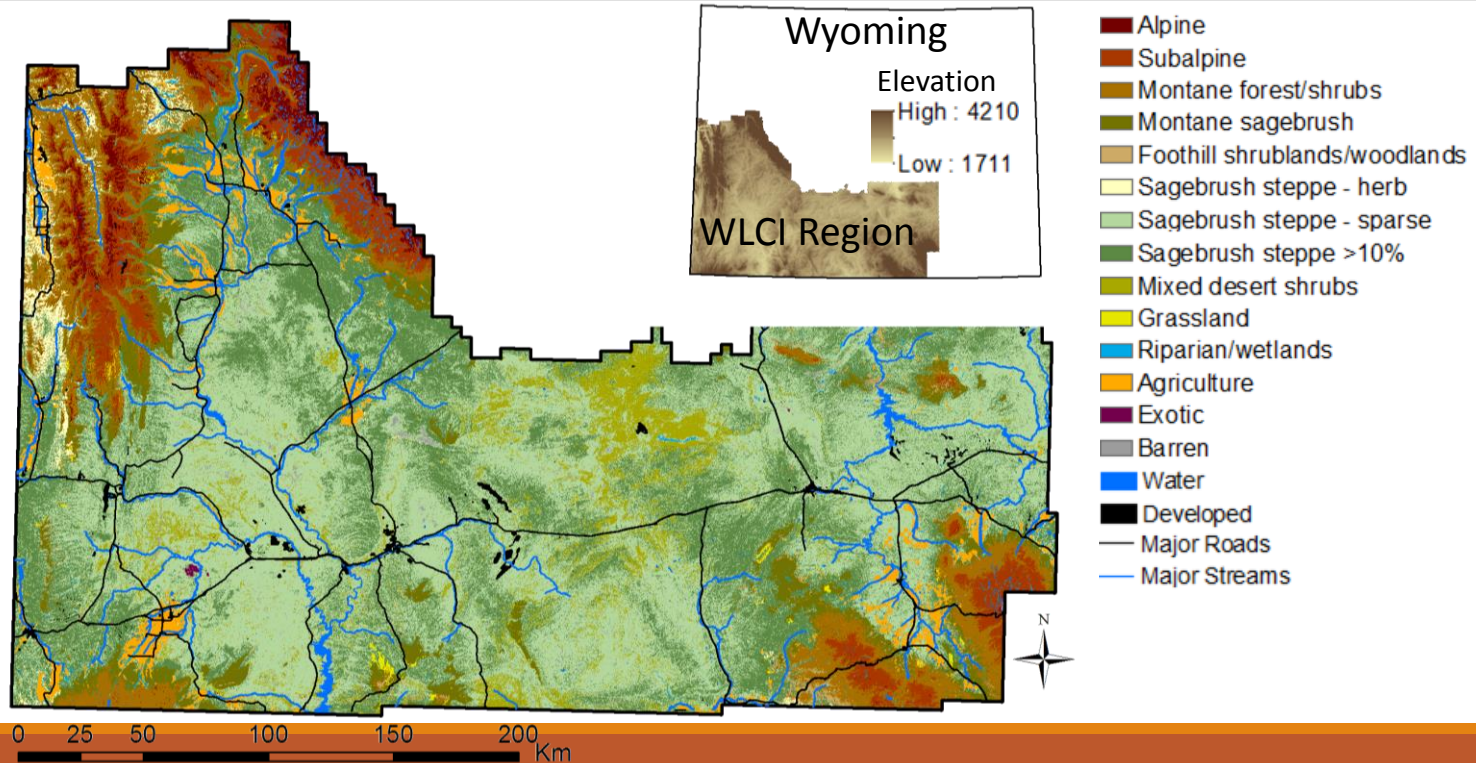
© 2015 Google

Google earth

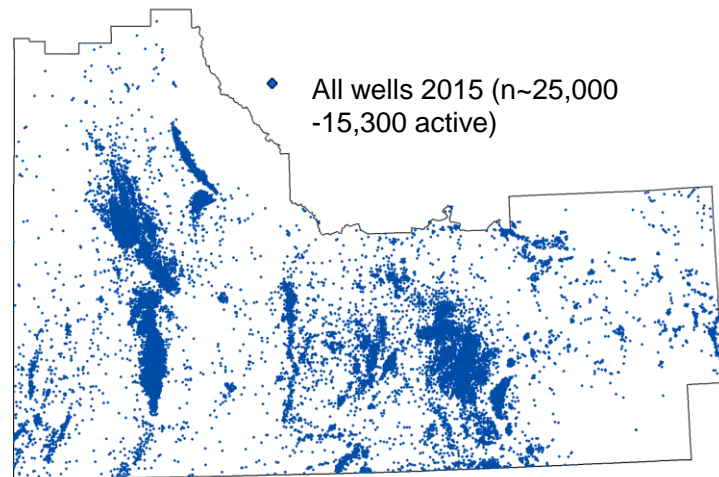
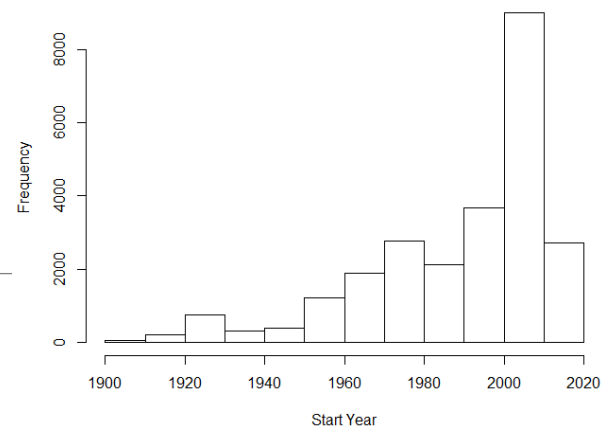




# Test Case: Southwest Wyoming



# Oil and gas development





# Wildlife and Ecosystem Services

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Photo by USDA NRCS

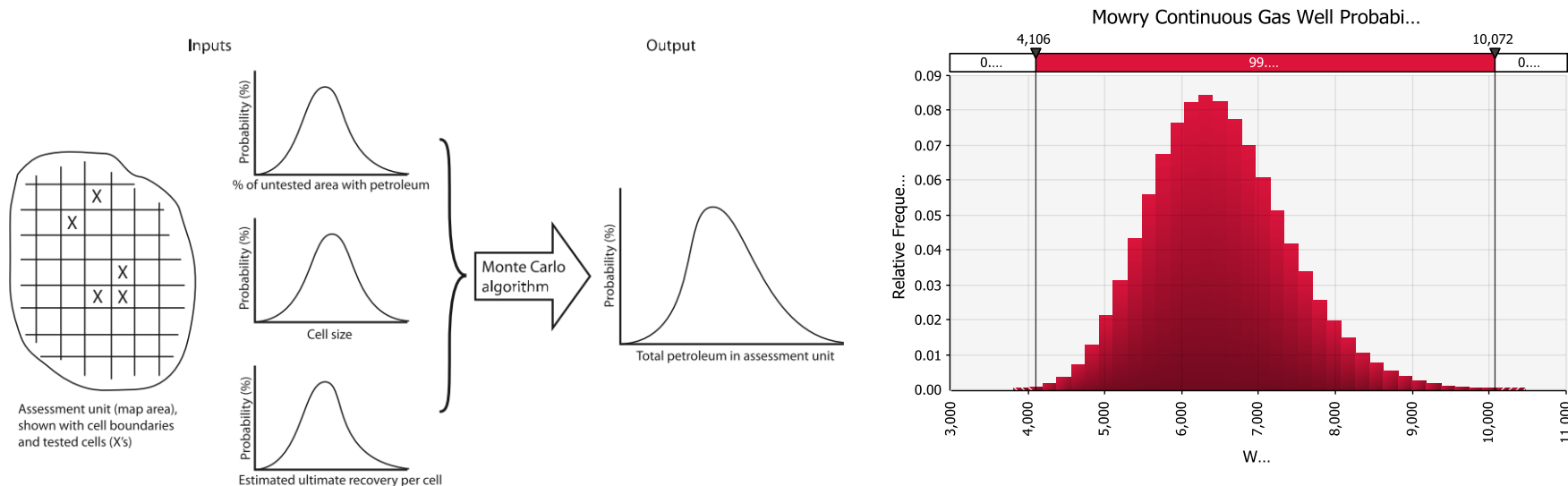


Photo by Larry Lamsa



Photo courtesy of WLCI

# 1 Probability of change

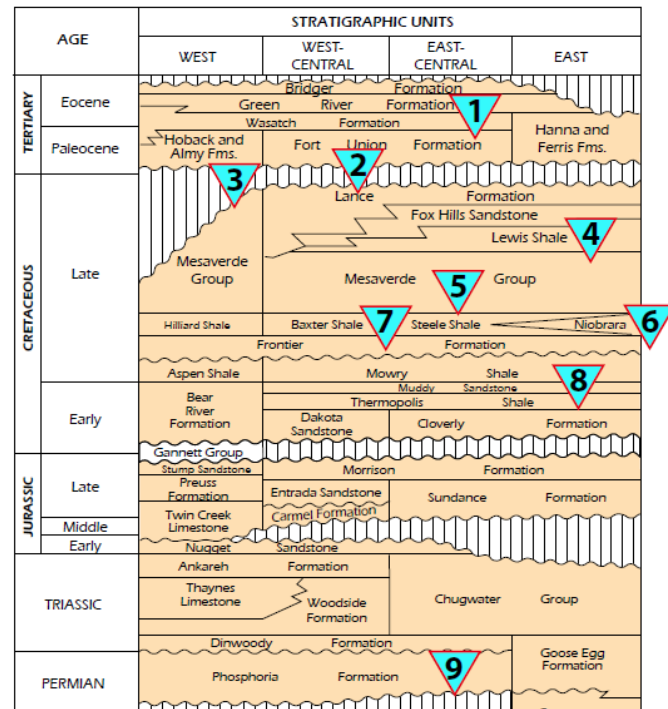


Haines et al. 2013. A framework for quantitative assessment of impacts related to energy and mineral resource development. *Natural Resources Research* 23: 3-17



# 1 Probability of change

**Petroleum Systems and Geologic Assessment of Oil and Gas in the Southwestern Wyoming Province, Wyoming, Colorado and Utah**  
 By: U.S. Geological Survey  
 Southwestern Wyoming Province Assessment Team  
 Date: 2005  
 Citation: DDS 69-D



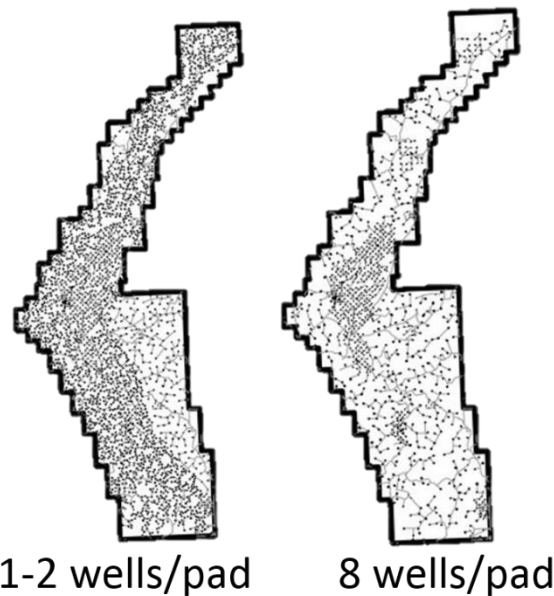
## ② Energy footprint simulator

Placement of well pads and associated roads  
across the landscape

Quantity: USGS assessments

Location: relatively unknown

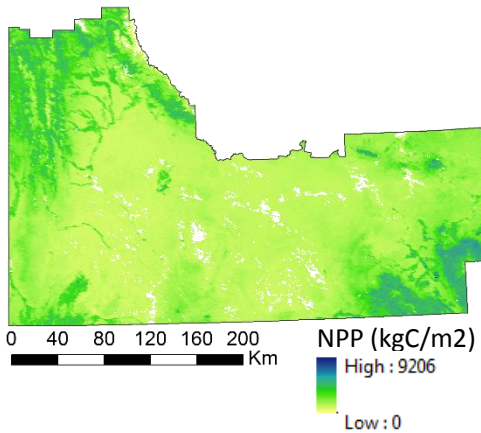
Multiple stochastic simulations implemented



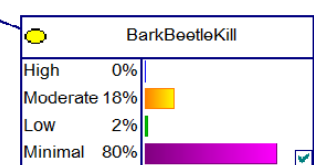
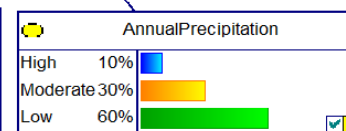
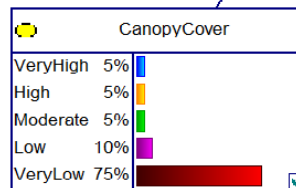
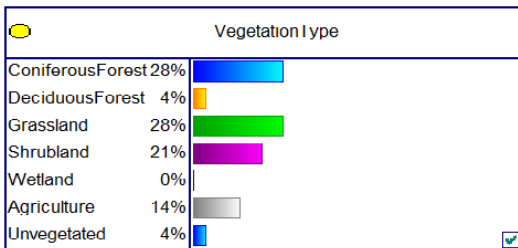
Simulation results for a single model run distributing 2000 wells

S. Garman. The Atlantic Rim Project Area, WY

### 3 Impact assessments

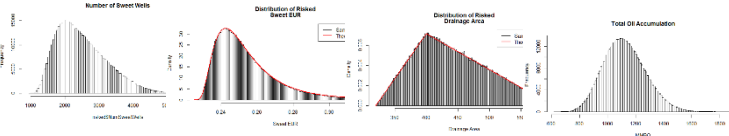


ARIES Carbon Model



# Approach 1: The full Monte

1

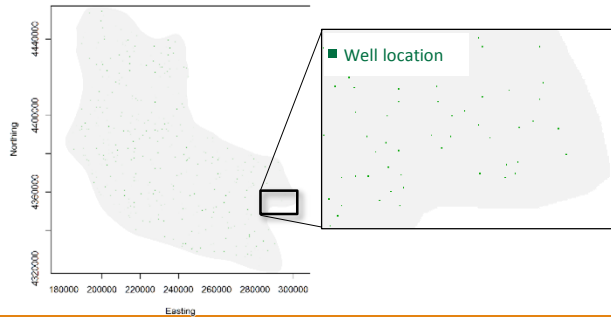


Continuous Oil & Gas Assessments

Sample (Monte Carlo)

Spatially  
Distribute

2 Potential Development

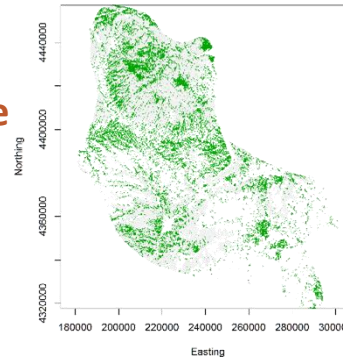


Outcome

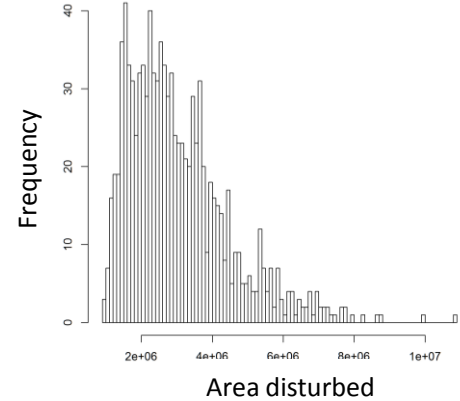
Repeat

3

Ecosystem Impact



Tally Potential  
Disturbance



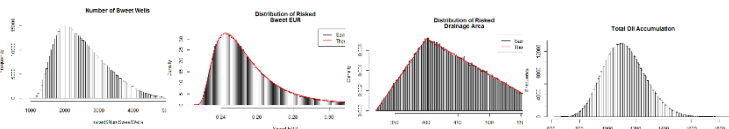
Cici Martinez  
CERSC





# Approach 2: Meta-model

1

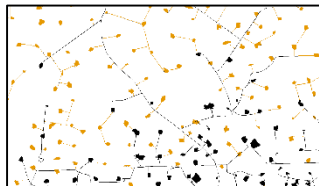
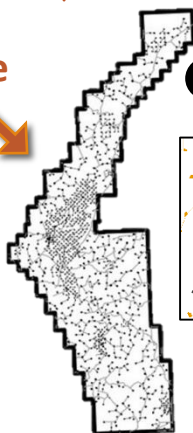


Continuous Oil & Gas Assessments

Sample (Latin-Hypercube)

Spatially  
Distribute

2 Potential Development



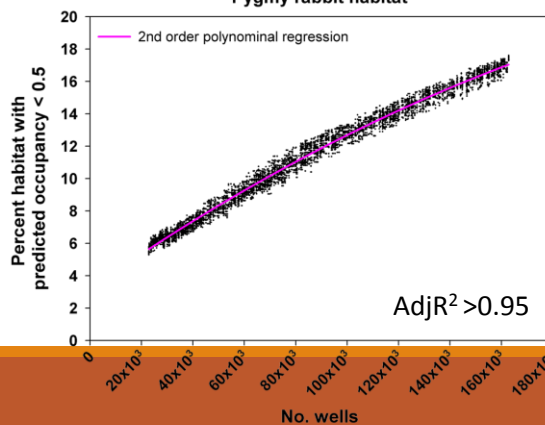
Outcome

Repeat

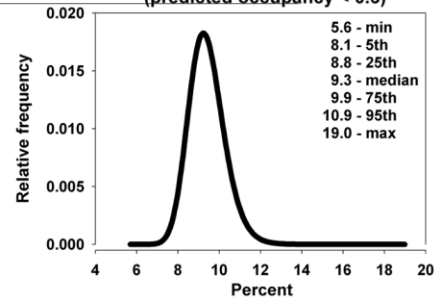
3

Ecosystem Impact

Pygmy rabbit habitat



Pygmy rabbit habitat  
(predicted occupancy < 0.5)



Tally Potential  
Disturbance

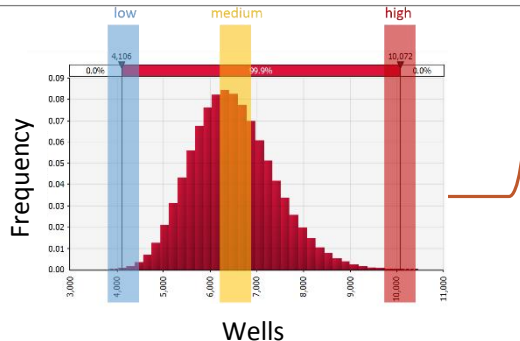
Steve Garman  
GECSC (now BLM)

# Approach 3: Scenarios

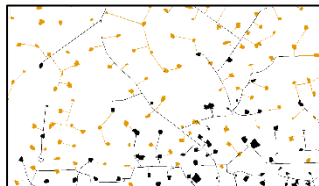
1

Continuous  
Oil & Gas  
Assessments

Sample



2 Potential Development

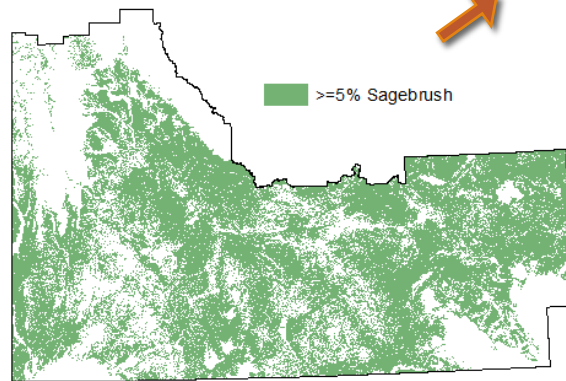


Outcome

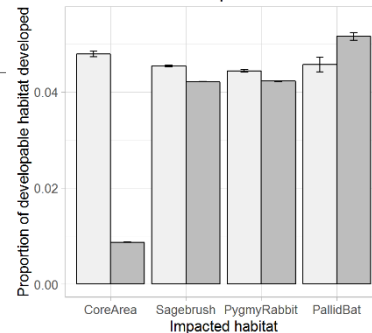


3

Ecosystem Impact



Tally Potential  
Disturbance



# PIRATES Scenarios: Assessing impacts of policy

The Sage-Grouse Umbrella: How do sage-grouse core area policies influence other species of conservation concern?

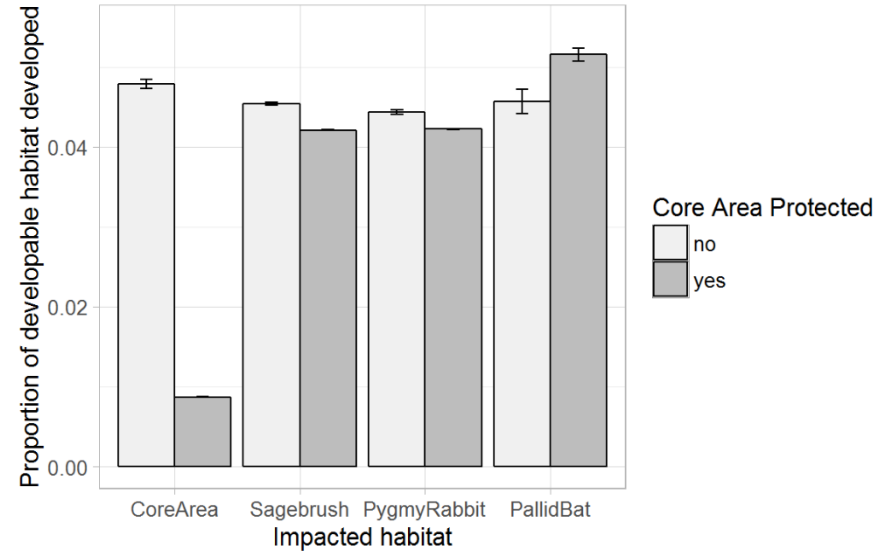
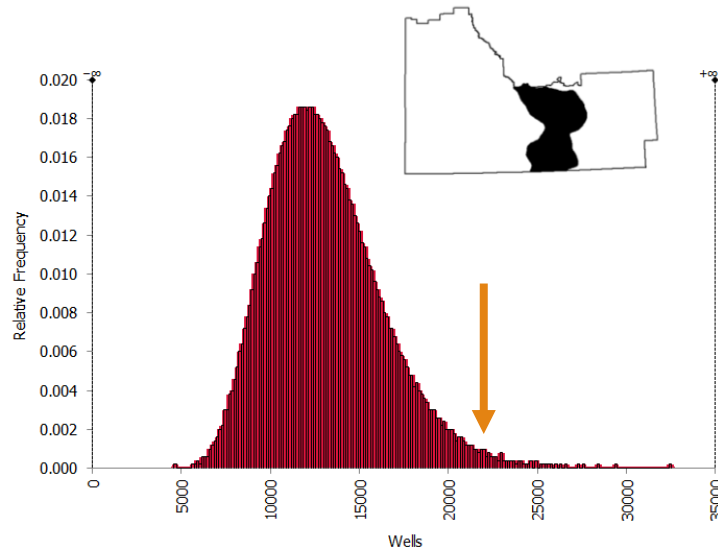
Use PIRATES framework to project how other species may be impacted by oil and gas development 1) with and 2) without the core area policy in place



Credit: Jaimel Blajszczak /WGF

Gamo et al. 2013. Greater Sage-Grouse in Wyoming: an umbrella species for sagebrush dependent wildlife. *The Wildlife Professional*

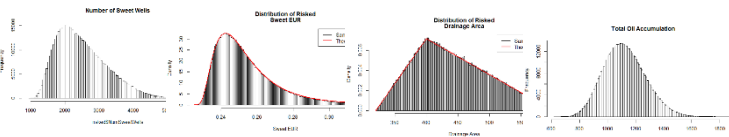
# Test results – single AU





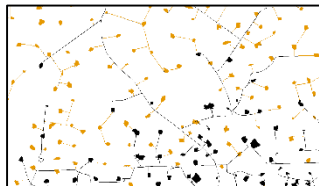
# ES Endpoints

## Continuous Oil & Gas Assessments



Sample

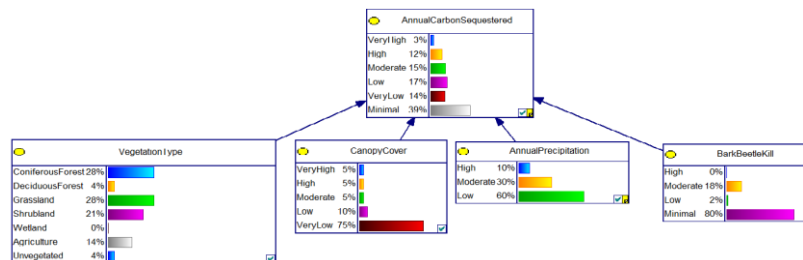
2 Potential Development



Outcome

Repeat

3 Ecosystem Impact



# Challenges assessing ES impacts in SW Wyoming

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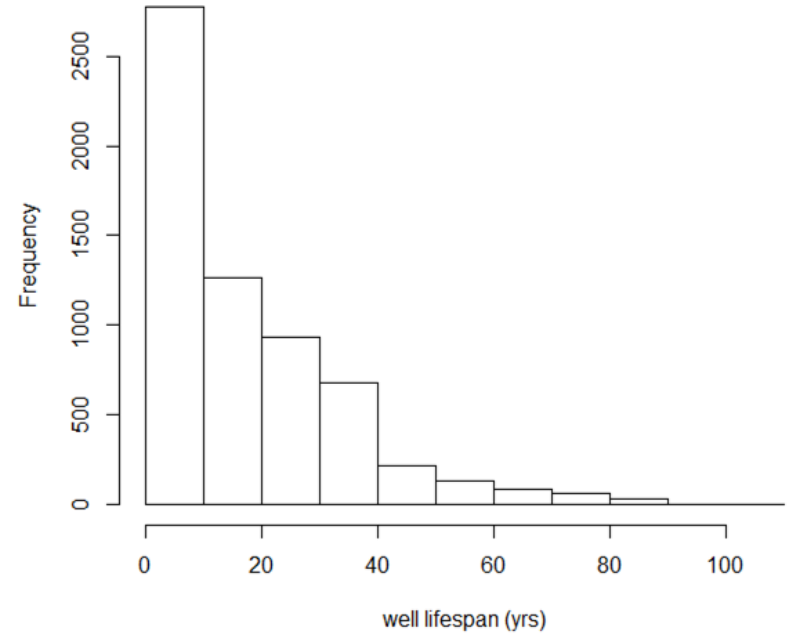
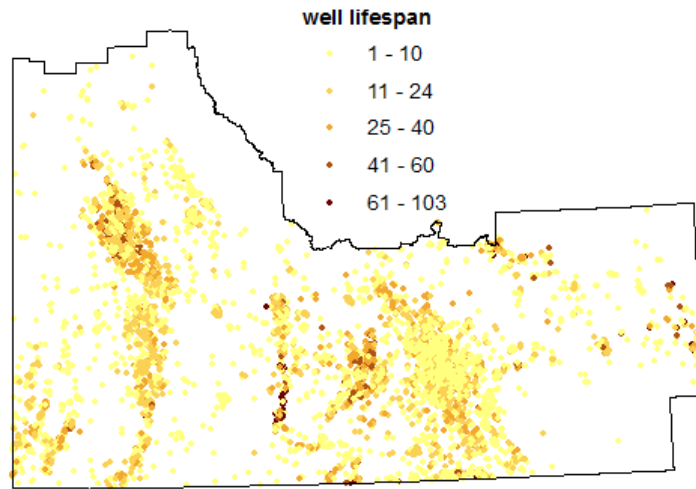
## 1. Data and empirical relationships



## 2. Impacts over time



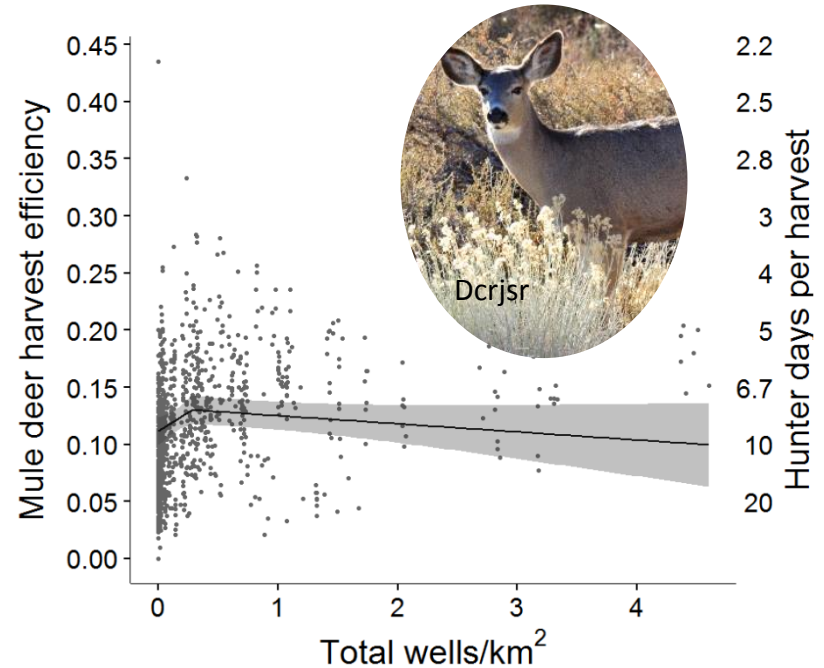
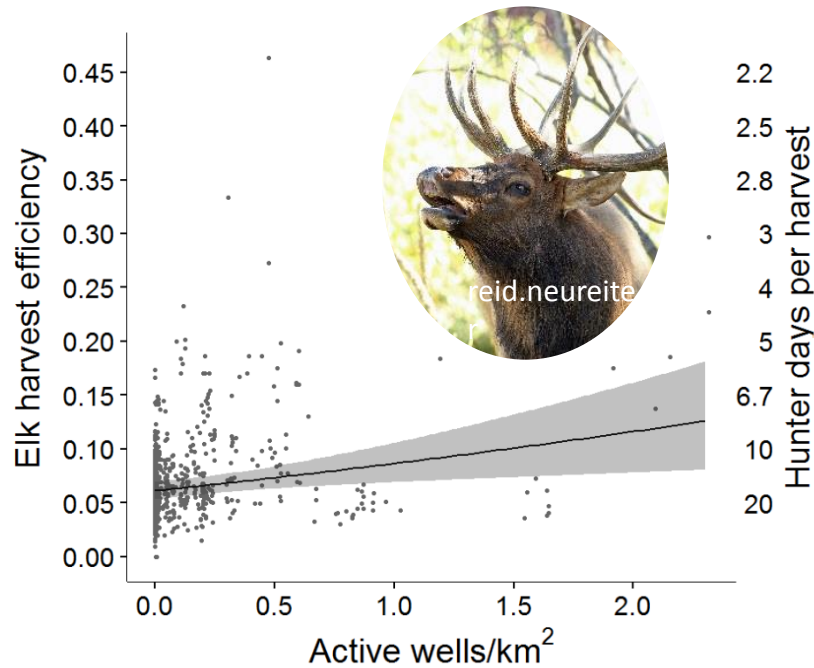
# Accounting for time: Well lifespans



# Empirical impacts to relevant ES

Oil and gas development influences big-game hunting in Wyoming

Dorning et al. In press. Journal of Wildlife Management





# The road ahead

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**Space:** Costs and benefits vary across local to global spatial scales

**Time:** Resource extraction and impacts vary over time. For example, energy production occurs over short time scales while impacts to sagebrush ecosystems can last decades

**Uncertainty:** Summarizing and communicating

**Data gaps:** Data are needed that document the impacts of development at broad scales

Photo: Dan Manier, USGS