The Ecosystem and Energy Development in Wyoming and the Intermountain West

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Overview

- Focus on **ecological impacts** from natural gas development

- Calibrate rangeland **food web** to Atlantic Rim Natural Gas (ARNG) region

- Introduce natural **gas development** and predict impacts on rangeland species

Introduction

- Rapid growth of **energy development** in Wyoming

- **Unexpected consequences** of human activity on Biodiversity

- **Ecosystem Services**: Hunting and Cattle Grazing

Atlantic Rim Natural Gas Development

- ARNG region is 109,297 hectares

- ARNG will contain 2,000 **natural gas wells**

- ARNG will produce 1.35 Tcf of natural gas (heat 1.93 million homes for one year)

- ARNG is home to many **rangeland species**

- **Disturbance area** (Buffer Zones) of 1,000 meters

Atlantic Rim Natural Gas Development, WY
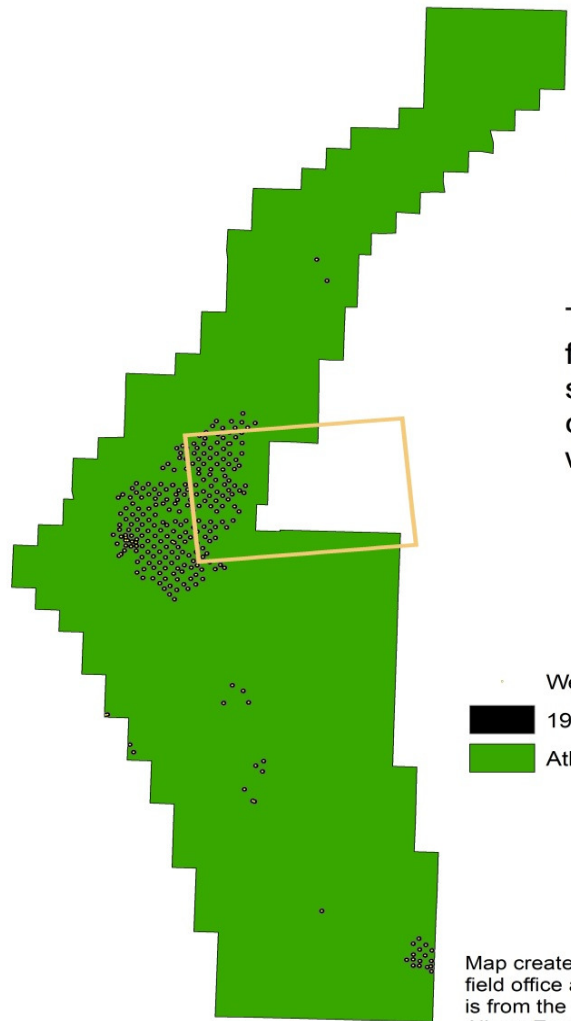
Natural Gas Wells within Atlantic Rim
Natural Gas Development Area
(wells active in 2010)

The November 2006 Environmental Impact Statement (EIS)
for the Atlantic Rim Natural Gas Field Development Project
sets a limit of 3,078 hectares of habitat disruption. This limit
corresponds approximately to a 193 meter buffer around each
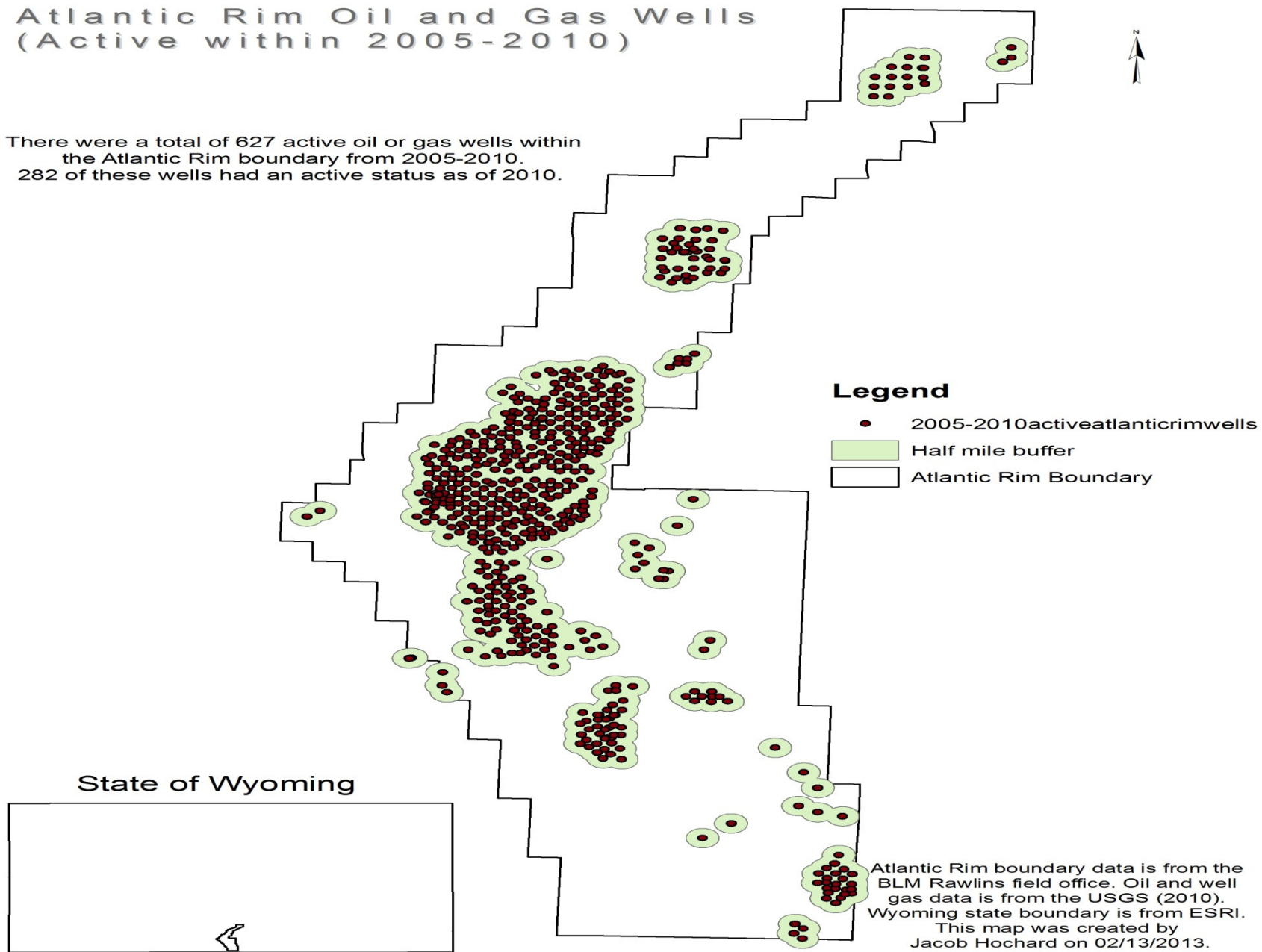well that was active in 2010.

Wells active in 2010

193 meter buffer

Atlantic Rim CBNG Project Boundary

193
meter
radius
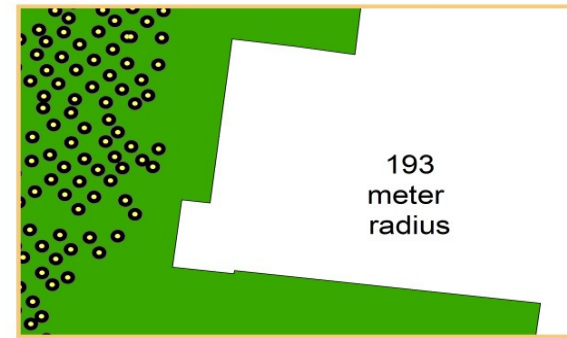
Map created on (4-28-2013) by Jacob Hochard. The Atlantic Rim boundary data is from the Rawlins, Wyoming BLM
field office and is valid for 2007. County data is from the Wyoming BLM and is valid for 1999. Natural gas well data
is from the U.S. Geological Survey (USGS) and is valid for 2010. Area calculated using USA Contiguous
Albers Equal Area projection.

# Atlantic Rim Oil and Gas Wells (Active within 2005-2010)

There were a total of 627 active oil or gas wells within the Atlantic Rim boundary from 2005-2010. 282 of these wells had an active status as of 2010.

Legend

- • 2005-2010activeatlanticrimwells
- Half mile buffer
- Atlantic Rim Boundary

State of Wyoming

Atlantic Rim boundary data is from the BLM Rawlins field office. Oil and well gas data is from the USGS (2010). Wyoming state boundary is from ESRI. This map was created by Jacob Hochard on 02/13/2013.
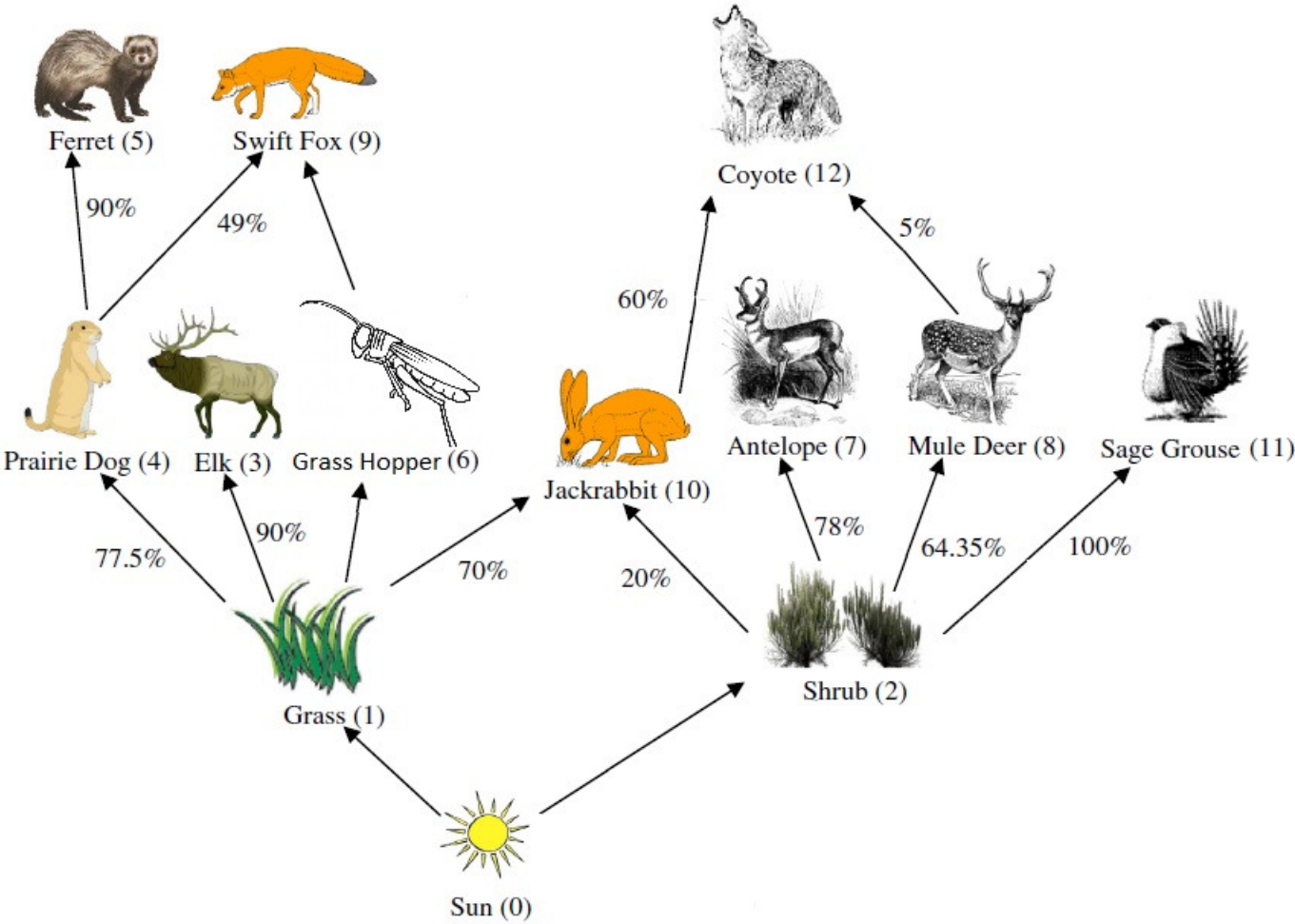
Rangeland Ecosystem and GEEM

- Ecosystem contains many species (elk, deer, sage grouse, grasshoppers, prairie dogs, etc.)

- General Equilibrium Ecosystem Model (GEEM)
  - Tschirhart (*Journal of Theoretical Biology*, 2000)

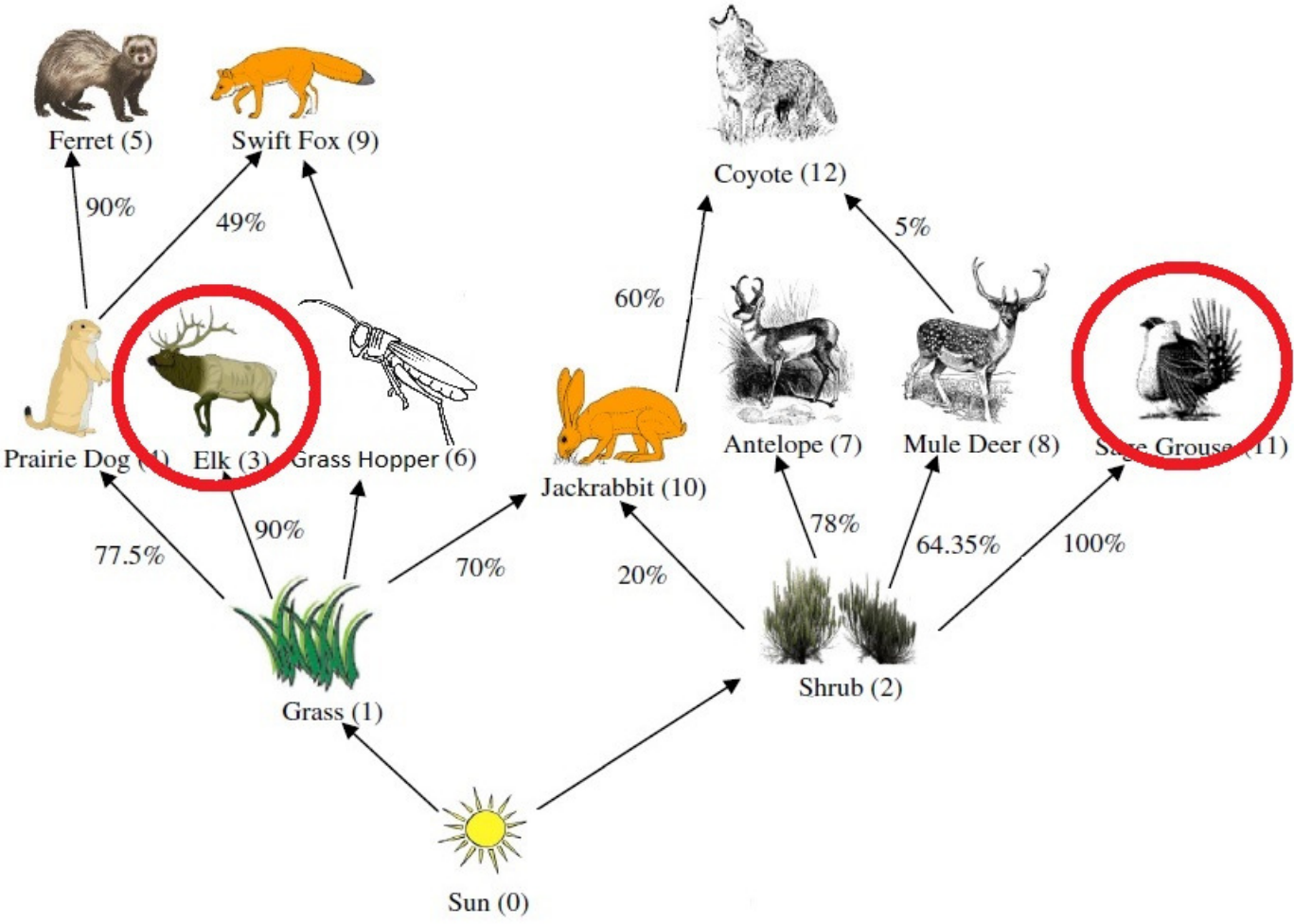- GEEM is calibrated to ARNG region

Rangeland Food Web & Natural Gas Development
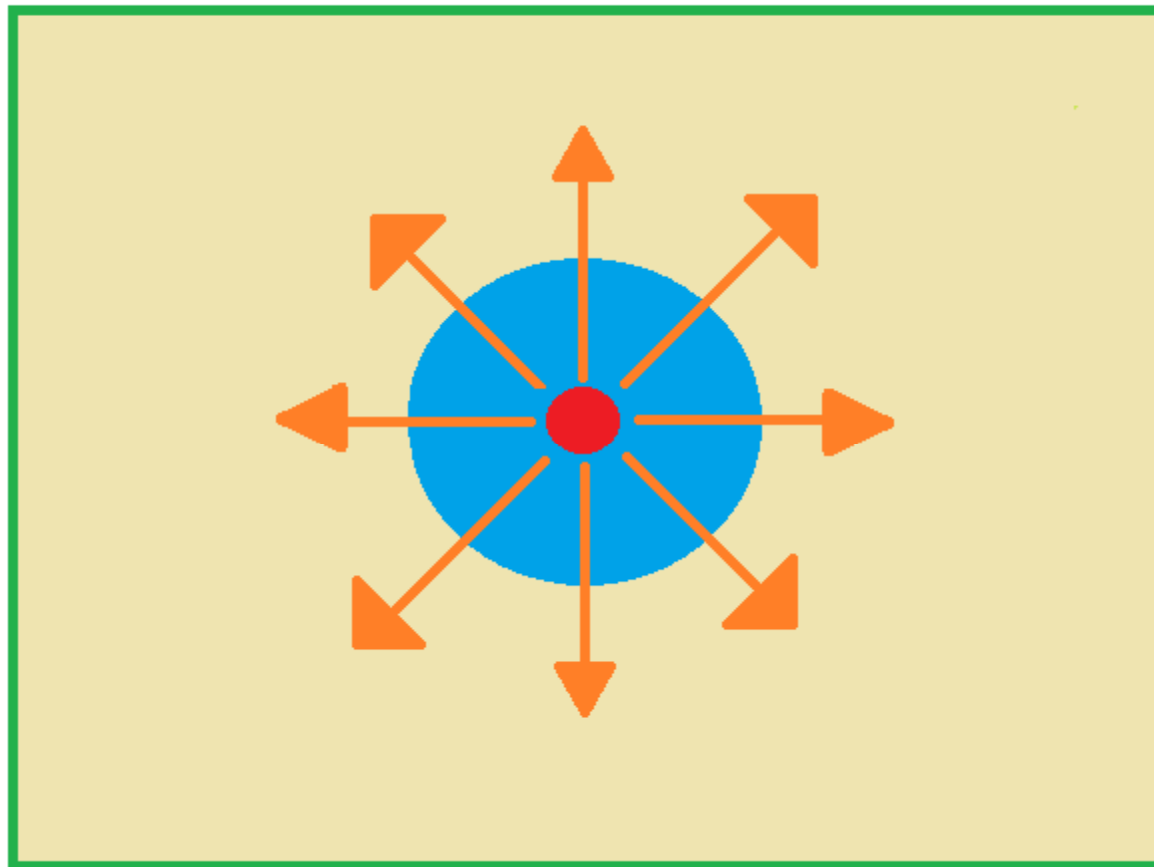
Rangeland Food Web & Natural Gas Development

Rangeland Food Web & Natural Gas Development

General Equilibrium Ecosystem Model

- Plants & Animals act as if they were rational agents that maximize the net energy of Biomass Consumption (Hunting or Grazing)
- Benefits: Energy content in Biomass
- Grazing & Hunting Cost: Energy Expenditure Price
- Variable Cost: Respiration, Feces, Locomotion & Reproduction
- Energy content in Biomass vs Exposing to Predators & Respiration Cost

Net Energy Equation

$$R_y = \overbrace{[e_0 - e^p] \cdot x_y}^{\text{Net Benefit}} \quad \underbrace{-r_y(x_y)}_{\text{Respiration}} \quad \underbrace{-\beta_y}_{\text{Basal Met.}} \quad \underbrace{-e_y \cdot [1 + t(e)] \cdot g(x_y)}_{\text{Predation \& Avoidance}}$$
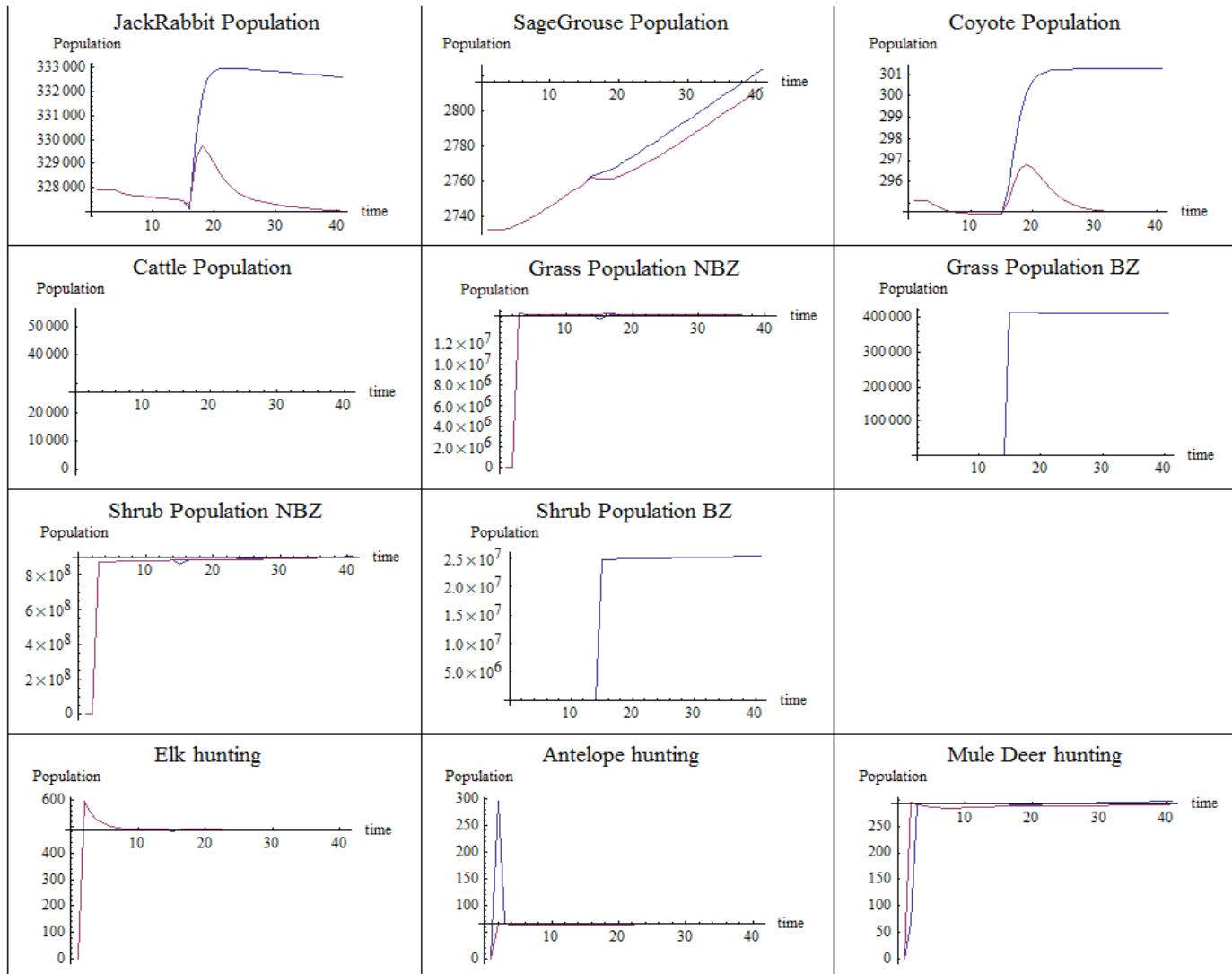
Hunting

Optimal Management

- We use GEEM and *Mathematica* v 9.0 to predict:

  ◦ Impact on species populations of energy development activities

  ◦ Change in benefits for ecosystem services

- We consider two scenarios:

  1. Hunting & Cattle Grazing

  2. Hunting & Cattle Grazing + Buffer Zones

Population simulations using GEEM
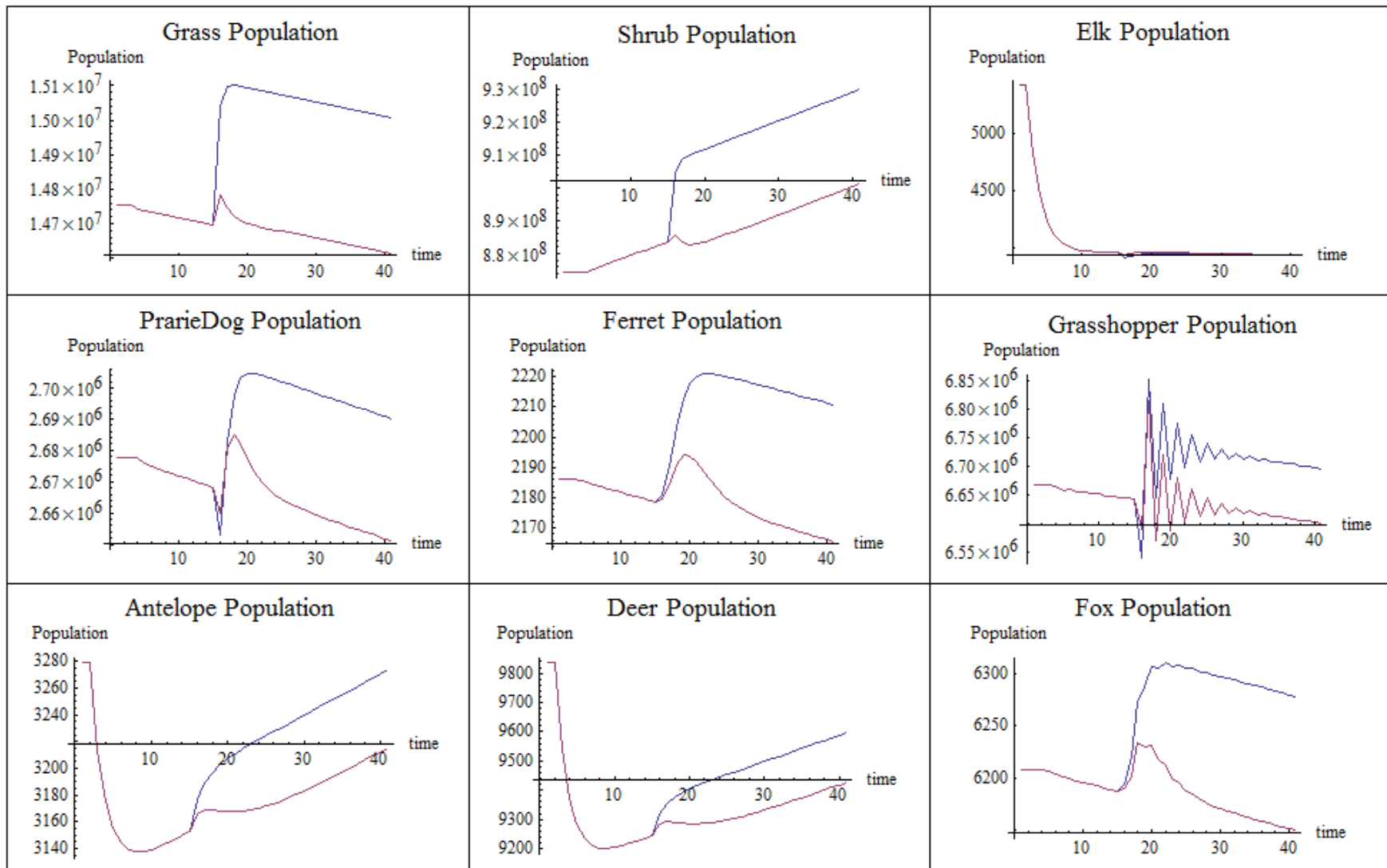
Population simulations using GEEM

Where are we now?

- Write manuscript for publication

- Add **other ecosystem externalities** (e.g., land degradation from cattle grazing)

- Using GEEM to solve for "natural" steady state

- Adding migration corridors & **spatial component**

- Finding **optimum extraction levels**: hunting & cattle grazing