MIGRATION PATTERNS OF ADULT FEMALE MULE DEER IN RESPONSE TO NATURAL-GAS DEVELOPMENT

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Mule Deer Migration

Temperate regions

- Low-elevation winter ranges
- High-elevation summer ranges

Spring
- Winter to summer range

Autumn
- Summer to winter range
 Traditional routes
- Used for many generations
- Seasonally and yearly

 Travel great distances
- Average 35-55 km

~ 60 km
Objectives

► Map spring migration routes from 2008 to 2010

► Determine timing and synchrony
  ▪ Departure and arrival

► Resource selection
  ▪ Environmental and landscape alterations
$n = 205$ adult female mule deer
Number pads/home range

North Ridge
North Magnolia
Ryan Gulch
South Magnolia
Timing of migration...
Factors Influencing Migration Timing

- Snow depth
- Spring green-up
  - varied among years
  - highly synchronous across study areas within years
- Deer in better condition departed winter range earlier.
Resource-selection Functions

► Use vs. availability
  ▪ GPS locations vs. random locations

► Step length
  ▪ Distance between 2 consecutive locations

► Turning angle
  ▪ Angle between steps

► Conditional logistic regression
Resource Selection

Environmental
- Elevation
- Slope
- Aspect
- Terrain ruggedness
- Vegetation type

Landscape Alterations
- Roads
- Well pads
- Pipelines
Migration Summary

► Mule deer moved more quickly through the most developed areas

► Selected habitats with increased cover.

► Avoided roads except in the most developed area
  - High road densities may preclude avoidance

► Selected areas close to well pads
  - Predator avoidance? elk competition? foraging opportunities?
Conclusion

Deer may avoid disturbance where feasible or increase their rate of travel through highly developed landscapes where the energetic cost of avoidance may be too high.
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- Dr. Chuck Anderson - CPW
- Dr. John Kie - ISU
- Dr. Jonathan Jenks - SDSU

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**Funding**

<p>| Variables and Study area | Used locations | | | Random locations | | |
|-------------------------|----------------|--------|--------|------------------|--------|
|                         | $\bar{x}$ | SD  | Min.  | Max.  | $\bar{x}$ | SD  | Min.  | Max.  |
| Elevation (m)           |             |       |       |       |             |       |       |       |
| North Ridge             | 2,158.94    | 184.20| 1,764.38| 2,795.23| 2,261.61   | 266.30| 1,721.67| 3,344.86|
| North Magnolia          | 2,297.23    | 148.20| 1,912.75| 2,838.41| 2,300.51   | 253.50| 1,757.44| 3,428.61|
| Ryan Gulch              | 2,269.04    | 172.40| 1,871.76| 2,799.31| 2,255.67   | 207.70| 1,511.37| 3,075.65|
| South Magnolia          | 2,314.25    | 169.90| 1,915.48| 2,745.73| 2,269.74   | 214.00| 1,520.88| 2,812.14|
| Slope (%)               |             |       |       |       |             |       |       |       |
| North Ridge             | 11.21       | 6.80  | 0.09  | 39.38 | 12.66      | 8.10  | 0.00  | 50.50 |
| North Magnolia          | 11.86       | 7.30  | 0.13  | 40.22 | 13.18      | 8.30  | 0.00  | 62.58 |
| Ryan Gulch              | 10.91       | 6.90  | 0.03  | 36.63 | 14.04      | 8.90  | 0.00  | 63.26 |
| South Magnolia          | 11.96       | 6.80  | 0.01  | 34.67 | 15.45      | 9.50  | 0.00  | 69.88 |
| Terrain ruggedness      |             |       |       |       |             |       |       |       |
| North Ridge             | 0.07        | 0.13  | 0.00  | 0.88  | 0.07       | 0.13  | 0.00  | 0.97  |
| North Magnolia          | 0.08        | 0.14  | 0.00  | 0.96  | 0.08       | 0.14  | 0.00  | 0.96  |
| Ryan Gulch              | 0.09        | 0.10  | 0.00  | 0.87  | 0.10       | 0.15  | 0.00  | 0.93  |
| South Magnolia          | 0.09        | 0.10  | 0.00  | 0.84  | 0.10       | 0.15  | 0.00  | 0.97  |</p>
<table>
<thead>
<tr>
<th>Study area</th>
<th>Values (Used locations)</th>
<th>Values (Random locations)</th>
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<tr>
<td></td>
<td>$\bar{x}$</td>
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<td>Distance to well pads (m)</td>
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