A Synopsis of an 8 Year Evaluation of a Population of Mule Deer on the Mojave National Preserve, California USA.

Arid Environments in the United States

**Drying the Southwest**
Weather systems that bring rain are becoming more rare

Temperature increase (°F):

- 0.8
- 1
- 1.2
- 1.4
- 1.6
- 1.8
- 2

Percent change in precipitation per decade (1980-2010)

- -6.5
- -5.5
- -4.5
- -3.5
- -2.5
- -1.5
- -0.5
- 0.5
- 1.5
- 2.5
- 3.5
- 4.5
- 5.5
- 6.5

Palmer Drought Severity Index

- Wet
- Dry

Year

Mule Deer (*Odocoileus hemionus*)

- Widely distributed species in the western U.S.
- Recently declined in numbers
- Movement patterns typically tied to nutrition acquisition
- High and stable adult survival
  - ~86% Annually
- Neonate survival indicator of population health
Mule Deer

• Dependent on high quality forage
• “Bottom-up” influenced
• Maintain high nutritional plane

Diagram:

- High Plane
- Low Plane
- Time
- Fat and Happy
- Death

Note: The diagram illustrates the fluctuation in nutritional plane over time, with a bad season marked.
Gestation

Mating

Recovery

Parturition

Provision and Care for Young

Reproductive Life History
Mule Deer

- Current reproduction vs. future investment

**July**
1-2 Months of Provisioning
General Objectives

• Understand how landscape and environmental factors affect mule deer in an arid environment
  • Habitat use
  • Demographics
  • Ecological function
Chapters of the Mojave Mule Deer Project

• Difference in home ranges across habitat types
• Seasonal resource selection
• Adult survival
• Juvenile survival
• Parturition site selection
• Resource selection relative to reproductive timeframes
Methods: Adult capture

• Captured from 2008 to 2016

• In early spring, 10-12 adults in each study area were captured via net gun from helicopter

• Processing
  • Ultrasound
  • Morphometric measurements
  • GPS radio collar
  • Fixed with vaginal implant transmitter (VIT) during juvenile survival chapter
Neonate Capture

- Juveniles captured 2013 to 2016
- Parturition May 15\textsuperscript{th}-June 20\textsuperscript{th}
- Median parturition date June 2\textsuperscript{nd}
- Females checked every 1-3 days for VIT expulsion

Handling
- Sex
- Expandable VHF collar
- Morphometric Measurements
Chapters of the Mojave Mule Deer Project

- Difference in home ranges across habitat types
- Seasonal resource selection

Landscape use relative to environmental factors
Home Range Variation of Mule Deer in an Arid Environment
Home Range by Study Site

- Cima Dome $\text{(n = 24)}$
- Midhills $\text{(n = 40)}$
- New York Mtns. $\text{(n = 14)}$

Kernal density estimator (ha)

95% Utilization distribution

50% Core utilization distribution

McKee et al. 2015
Seasonal Resource Selection of Mule Deer in an Arid Environment
McKee et al. 2015
McKee et al. 2015

Probability of selection vs. Distance to water (m)

- Winter
- Spring
- Summer
- Autumn
Chapters of the Mojave Mule Deer Project

- Adult survival
- Juvenile survival

Factors influencing demographics of mule deer in an arid environment
Adult Survival
Juvenile Survival
Precipitation and NDVI on Mojave Preserve
Influence of Mid-Pregnancy NDVI and Juvenile Size

Probability of Survival to 120 Days

Relative Juvenile Size (PC1 Scores)

- Highest NDVI
- 1 SD Higher
- Mean NDVI
- 1 SD Lower
- Lowest NDVI

40%
Chapters of the Mojave Mule Deer Project

- Difference in home ranges across habitat types
- Seasonal resource selection
- Adult Survival
- Juvenile Survival
- Influence of perennial water access on body condition and reproductive output
- Parturition site selection
- Resource selection relative to reproductive timeframes

Landscape use relative to the reproductive life-history timeframe
Parturition Site Selection
Female Resource Selection Relative to Reproductive Stage
Reproductive Stage Resource Selection

### Univariate Predictors

<table>
<thead>
<tr>
<th>Pre-Parturition</th>
<th>R.I.</th>
<th>Provisioning Young</th>
<th>R.I.</th>
<th>Recovery</th>
<th>R.I.</th>
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<tr>
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<td>Ruggedness</td>
<td>1</td>
<td>Elevation</td>
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<td>Tree Cover</td>
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<td>Tree Cover</td>
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<td>% Slope</td>
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</tr>
</tbody>
</table>

R.I.=Relative Importance
Pre-Parturition

*Relative importance*

\[ \text{R.I.} = 0.05 \]

**Ranking** = 9th

**Selection** = >0.2 NDVI

Provisioning Young

*Relative importance*

\[ \text{R.I.} = 0.30 \]

**Ranking** = 5th

**Selection** = >0.2 NDVI

Post-Juvenile Mortality

*Relative importance*

\[ \text{R.I.} = 0.34 \]

**Ranking** = 4th

**Selection** = >0.1 NDVI
What did we learn?

• Difference in home ranges across habitat types
• Seasonal resource selection

Summary

• Home ranges largest in winter and spring
• Likely free sources of water and forage resulting from winter rainfall

• Selected distances closer to permanent water sources
• Utilized steeper slopes during the winter
What did we learn?

• Adult survival
• Juvenile survival

Summary
• Adult survival high and stable, influenced by drought measures
Juvenile Survival

- Forage quality directly linked to juvenile survival
- Higher nutrition = bigger neonate
What did we learn?

• Juveniles born from females with no access to quality forage have lower survival probability
• Lower nutrition = Smaller neonate
What did we learn?

Summary
• Selected parturition sites closer to water and higher in elevation
• Vigilance for predators
• Water requirements
• Selected higher shrub cover

• Parturition site selection
• Resource selection relative to reproductive timeframes
Resource Selection During Reproductive Time Periods

- Females tradeoff nutritional maintenance for juvenile safety
- Short term reversal of tradeoff
- Current investment
Resource Selection During Reproductive Time Periods

- Post-juvenile mortality the female is free to replenish energetic stores
- Future investment
Changing Climate

• Drought intensity and frequency increasing
• Likely affect spring rainfall patterns
• Adult survival affected by drought
• Reliance on forage pre-parturition
• Effects on population performance
• Important to consider for future management implications
Thank You!