Fire risk and responses of tortoises to burned habitat in the Northeastern Mojave Desert

Kenneth E. Nussear, Todd Esque, Lesley DeFalco, Kristina Drake, Peter Van Linn, Rich Inman

Western Ecological Research Center, Las Vegas Field Station
U.S. Geological Survey
Southern Nevada Fire Complex

- 739,037 acres
- 403,000 acres
- Desert Tortoise habitat
- 32,000 acres
- Critical Habitat
Quantifying Fire Risk

- Perennial Vegetation
- Annual Vegetation
- Fuel Moisture
- Lightning Strike Frequency
- Human Access/Use

Fuel Load

Ignition Sources

Fire Potential
Measuring Fuel Loads

Measured 1, 10, 100, 1000 hr fuel loadings
Modeling Fuel Load – Remote Sensing

\[ R^2 = 0.3 \]

Nussear et al. 2011
Diverse Vegetation
Ignition Risk - Lightning

Van Linn et al. 2013
Ignition Risk - Roads

Nussear et al. 2011
Fire Risk Model Selection

118 Models considered

**Table Fire 2.** Fire Risk Models – AIC rankings of models of 2005 Fire risk prediction. Average $\Delta$AIC (smaller is better), and model weight is given for 100 model runs, of random data sets of 1000 sampled points. $R =$ Distance to roads, $L =$ Summer lightning density, $SM =$ Fuel Moisture Content at Spring Maximum Temperature, $Sm =$ Fuel Moisture Content at Spring Minimum Temperature, $V =$ Vegetation Type, $F =$ Estimated 1-100hr Fuel Loading, and * indicates term entered as an interaction.

<table>
<thead>
<tr>
<th>Model</th>
<th>Average $\Delta$AIC</th>
<th>Average Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. R, L, SM, F, V, F*V</td>
<td>24.46</td>
<td>0.004</td>
</tr>
<tr>
<td>4. R, SM, F, V, F<em>V, SM</em>F, SM*V</td>
<td>27.86</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>5. L, SM, F, V, F<em>V, SM</em>F, SM*V</td>
<td>46.82</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>6. R, L, SM, Sm, F, V</td>
<td>50.23</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>7. R, L, SM, F, V</td>
<td>59.41</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>8. R, L, Sm, F, V</td>
<td>60.08</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>9. L, V</td>
<td>326.10</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>10. V</td>
<td>353.00</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>11. R</td>
<td>400.00</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>12. L</td>
<td>429.00</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>13. Sm</td>
<td>429.00</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>14. SM</td>
<td>429.10</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>15. F</td>
<td>458.60</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>
Risk Model - 2005

A. Fuel Load
B. Fuel Moisture
C. Ignition and Risk Model

Van Linn et al. 2013
Repeatable?

Validate!

AUC for training and testing 0.83

Van Linn et al. 2013
Fire in the Mojave Desert: Understanding Desert Tortoise Use of Burned Habitat

Kristina Drake, Todd Esque, Kenneth Nussear, Lesley DeFalco, Andrew Modlin, Sarah Scoles-Sciulla, Philip Medica

US Geological Survey
Western Ecological Research Center
Henderson, Nevada
The Desert Tortoise...

- Mojave Desert Population
  - Threatened 1990
- Designated Critical Habitat
  - Physical & Biological Needs
- Survival Challenged by
  - Predators
  - Disease
  - Habitat Loss...
- Wildfire driven by exotic grasses

(Photos by L. DeFalco, T. Esque)
Impacts From Wildfires in Southern Nevada

- Loss of perennial plants
- Shifts in vegetation (Native -> Invasive Grasses)
- Death and Emigration of tortoises
- Potential for slower growth and decreased fecundity

(Courtesy N. Sikula, L. DeFalco)

USGS

July 2005

May 2006
Study
Tortoises responses to wildfire

- Habitat Characteristics
  - Vegetation
  - Tortoise Density

- Possible Differences in
  - Spatial Habitat Use
  - Movement Patterns
  - Behavior
  - Shelter Selection

- Study Animals (2006-Present)
  - 25 Tortoises
 Annual Plant Biomass

- Native species higher in Unburned habitat in years of higher rainfall
- Sustained increases in invasive species biomass immediately following the fire

Drake et al. In Review
Perennial Vegetation Cover
Shelter/Thermal Protection

Drake et al. In Review
Perennial Vegetation Cover
Shelter/Thermal Protection

- Lower use of Vegetation in Burned habitat as expected
- Recent dissertation found no differences in temperature (Snyder 2014)
## Habitat Use

<table>
<thead>
<tr>
<th>Year</th>
<th>Obs.</th>
<th>Burn</th>
<th>Unburn</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>122</td>
<td>20%</td>
<td>80%</td>
</tr>
<tr>
<td>2007</td>
<td>2,647</td>
<td>43%</td>
<td>57%</td>
</tr>
<tr>
<td>2008</td>
<td>3,888</td>
<td>57%</td>
<td>43%</td>
</tr>
<tr>
<td>2009</td>
<td>1,669</td>
<td>60%</td>
<td>40%</td>
</tr>
<tr>
<td>2010</td>
<td>3,081</td>
<td>39%</td>
<td>61%</td>
</tr>
<tr>
<td>Total</td>
<td>11,407</td>
<td>49%</td>
<td>51%</td>
</tr>
</tbody>
</table>

Photo Courtesy R. Inman
Behavior

Burn

- Basking
- Moving
- Eating

Unburn

- Basking
- Moving
- Eating

Summary: What We Learned Post-Fire ...

1. Substantial vegetation changes occurred
   Shifts in vegetation (Native Shrubs -> Alien Grasses)
   Potentially altering shelter sites and dietary composition

2. At least 5 years post-fire, tortoises are still using burned critical habitat.
   - Out of ~11,000 observations, ~52% were in burned habitat
   - Post-fire estimations indicate that ~45% of tortoise home-ranges had been burned during the 2005 fire.

3. Tortoises moved further into the burn each year until temporary shade resources were reduced (Loss of Sphaeralcea)

4. Tortoise behavioral and microhabitat selection differences were noted between habitat types.
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