Western Painted Turtle (*Chrysemys picta bellii*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Western Painted Turtle (ARAAD01010) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.131
- Details of range map creation noted in Keinath et al. (2010a).

**Range Map - Seasonality**

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

*Doug Keinath*, Senior Zoologist

*Mark Andersen*, GIS Specialist

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Distribution Model (Version: Tue Mar 16 16:58:16 MDT 2010)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Quadratic, Hinge
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.2444950
- High-Probability Threshold Value: 0.6528385
- Low-Probability Threshold Value: 0.0956548

Model Evaluation - ROC Plot

Model Quality Summary
Overall Assessment of Model Quality: MEDIUM
Expert Assessment: Low
Occurrence Sample Size: Medium
Quality of Occurrences: High
Positive Success Rate: High
Test AUC and Model Gain: High

Model Evaluation Statistics
Final Model Statistics
Training AUC: 0.960
Regularized Training Gain: 1.839

Cross-Validation Statistics
- Average Test AUC: 0.926 ± 0.057
- Upper Bound on Test AUC: 0.936
- Average Test Gain: 1.495 ± 0.959
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.20± 0.35
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 25
- Number of Occurrences used to create distribution model: 21
- Average Point Quality Index (highest quality is 12.00): 9.43 ± 2.48
- Most recent occurrence used: 2008
- Oldest occurrence used: 1982
- Occurrence File: LOCAL_SAMPLE_POINTS_W_PDOG_2.csv

Comments
This species uses aspects of wetlands (e.g., dense emergent vegetation) for which statewide data are not available or reliable. This often results in low model quality because key habitat features are not mappable across the state. Great improvements in our ability to model this species distribution could be obtained by improving wetland maps.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbaceous Cover Index</td>
<td>27</td>
</tr>
<tr>
<td>Elevation</td>
<td>19</td>
</tr>
<tr>
<td>Cottonwood Index</td>
<td>19</td>
</tr>
<tr>
<td>Variation of monthly precipitation</td>
<td>14</td>
</tr>
<tr>
<td>Conifer Index</td>
<td>14</td>
</tr>
<tr>
<td>Distance to Permanent Water</td>
<td>7</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

Herbaceous Cover Index

![Herbaceous Cover Index Graph]

Elevation

![Elevation Graph]

Cottonwood Index

![Cottonwood Index Graph]

Variation of monthly precipitation

![Variation Graph]

Conifer Index

![Conifer Index Graph]

Distance to Permanent Water

![Distance Graph]
Ornate Box Turtle (*Terrapene ornata ornata*)

Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Ornate Box Turtle (ARAAD08020) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

### Range Map - Occupancy

| Known | Suspected | Accidental | Historical |

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.000
- Details of range map creation noted in Keinath et al. (2010a).

### Range Map - Seasonality

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

**Doug Keinath**, Senior Zoologist  
**Mark Andersen**, GIS Specialist

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Comments
There were too few occurrence points to construct a distribution model for this species. Collection of additional, high-quality occurrence locations are necessary for assessment of potential distribution within Wyoming.

References
Western Spiny Softshell (*Apalone spinifera hartwegi*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Western Spiny Softshell (ARAAG01030) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.176
- Details of range map creation noted in Keinath et al. (2010a).

**Range Map - Seasonality**

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

**Doug Keinath**, Senior Zoologist
**Mark Andersen**, GIS Specialist

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Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Quadratic, Hinge
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.2861360
- High-Probability Threshold Value: 0.6534006
- Low-Probability Threshold Value: 0.1815232

Model Quality Summary
Overall Assessment of Model Quality: LOW
- Expert Assessment: Low
- Occurrence Sample Size: Low
- Quality of Occurrences: Medium
- Positive Success Rate: Medium
- Test AUC and Model Gain: Medium

Model Evaluation Statistics
Final Model Statistics
- Training AUC: 0.958
- Regularized Training Gain: 1.456

Cross-Validation Statistics
- Average Test AUC: 0.854 ± 0.159
- Upper Bound on Test AUC: 0.893
- Average Test Gain: 0.643 ± 2.249
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.25± 0.35
Occurrence Data for Distribution Model

Occurrence Map

<table>
<thead>
<tr>
<th>Year of Observation</th>
<th>Known and Suspected Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-1985</td>
<td></td>
</tr>
<tr>
<td>1985 or Later</td>
<td></td>
</tr>
</tbody>
</table>

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 23
- Number of Occurrences used to create distribution model: 19
- Average Point Quality Index (highest quality is 12.00): 7.42 ± 2.67
- Most recent occurrence used: 2006
- Oldest occurrence used: 1979
- Occurrence File: LOCAL_SAMPLE_POINTS_W_PDOG_2.csv

Comments
This species uses aspects of wetlands (e.g., dense emergent vegetation) for which statewide data are not available or reliable. This often results in low model quality because key habitat features are not mappable across the state. Great improvements in our ability to model this species distribution could be obtained by improving wetland maps.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cottonwood Index</td>
<td>33</td>
</tr>
<tr>
<td>Variation of monthly precipitation</td>
<td>18</td>
</tr>
<tr>
<td>Herbaceous Cover Index</td>
<td>16</td>
</tr>
<tr>
<td>Wettest quarter mean temperature</td>
<td>16</td>
</tr>
<tr>
<td>Sagebrush Index</td>
<td>10</td>
</tr>
<tr>
<td>Distance to Permanent Water</td>
<td>7</td>
</tr>
</tbody>
</table>

Response Curves
Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).
Great Plains Earless Lizard (*Holbrookia maculata*)
Range Map and Distribution Model Summary
August 20, 2010

This report presents range and distribution of Great Plains Earless Lizard (ARACF08020) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.125
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

**Doug Keinath**, Senior Zoologist
**Mark Andersen**, GIS Specialist

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Distribution Model (Version: Sat Dec 05 08:51:22 MST 2009)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.4525850
- High-Probability Threshold Value: 0.6520455
- Low-Probability Threshold Value: 0.4525850

Model Evaluation - ROC Plot

Model Quality Summary
**Overall Assessment of Model Quality:** LOW
Expert Assessment: Low
Occurrence Sample Size: Low
Quality of Occurrences: Low
Positive Success Rate: Low
Test AUC and Model Gain: Low

Model Evaluation Statistics
**Final Model Statistics**
Training AUC: 0.989
Regularized Training Gain: 2.535

Cross-Validation Statistics
- Average Test AUC: 0.687 ± 0.474
- Upper Bound on Test AUC: 0.961
- Average Test Gain: 1.904 ± 1.637
- Omission Error (fraction of test points omitted during 7-fold cross validation): 0.43 ± 0.53
Occurrence Data for Distribution Model

Occurrence Map

Points Used in Modeling, by Year of Observation
- Pre-1985
- 1985 or Later

Known and Suspected Range

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 11
- Number of Occurrences used to create distribution model: 7
- Average Point Quality Index (highest quality is 12.00): 5.43 ± 1.40
- Most recent occurrence used: 1987
- Oldest occurrence used: 1940
- Occurrence File: LOCAL_SAMPLE_POINTS.csv

Comments
The model for this species is based on a small sample size of occurrence locations, which often results in low model quality. Collection of additional, high-quality occurrence locations could greatly improve the modeled distribution for this species.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coldest quarter mean temperature</td>
<td>63</td>
</tr>
<tr>
<td>Variation in monthly radiation</td>
<td>15</td>
</tr>
<tr>
<td>Herbaceous Cover Index</td>
<td>13</td>
</tr>
<tr>
<td>Contagion Index</td>
<td>9</td>
</tr>
<tr>
<td>Radiation of the darkest month</td>
<td>0</td>
</tr>
<tr>
<td>Wettest quarter mean temperature</td>
<td>0</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).
Greater Short-horned Lizard (*Phrynosoma hernandesi*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Greater Short-horned Lizard (ARACF12080) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

- **Known**
- **Suspected**
- **Accidental**
- **Historical**

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.285
- Details of range map creation noted in Keinath et al. (2010a).

**Range Map - Seasonality**

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

**Doug Keinath**, Senior Zoologist
**Mark Andersen**, GIS Specialist

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Distribution Model (Version: Thu Apr 22 11:06:44 MDT 2010)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Product
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.3602060
- High-Probability Threshold Value: 0.5386674
- Low-Probability Threshold Value: 0.0295598

Model Evaluation - ROC Plot

Model Quality Summary
Overall Assessment of Model Quality: HIGH
- Expert Assessment: High
- Occurrence Sample Size: High
- Quality of Occurrences: High
- Positive Success Rate: High
- Test AUC and Model Gain: Medium

Model Evaluation Statistics
Final Model Statistics
- Training AUC: 0.829
- Regularized Training Gain: 0.729

Cross-Validation Statistics
- Average Test AUC: 0.808 ± 0.045
- Upper Bound on Test AUC: 0.817
- Average Test Gain: 0.605 ± 0.296
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.19± 0.13
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 184
- Number of Occurrences used to create distribution model: 148
- Average Point Quality Index (highest quality is 12.00): 8.11 ± 2.47
- Most recent occurrence used: 2008
- Oldest occurrence used: 1890
- Occurrence File: LOCAL_SAMPLE_POINTS_W_PDOG_2.csv

Comments
There are no additional comments specific to this species range map or distribution model.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare Ground Index</td>
<td>37</td>
</tr>
<tr>
<td>Precipitation of the warmest quarter</td>
<td>19</td>
</tr>
<tr>
<td>Sagebrush Index</td>
<td>19</td>
</tr>
<tr>
<td>Forest Cover Index</td>
<td>10</td>
</tr>
<tr>
<td>Distance to Permanent Standing Water</td>
<td>8</td>
</tr>
<tr>
<td>Variation in monthly Relative Humidity</td>
<td>6</td>
</tr>
</tbody>
</table>

Response Curves
Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

- **Bare Ground Index**
  - Suitability (vertical axis) vs. Bare Ground Index (horizontal axis)

- **Precipitation of the warmest quarter**
  - Suitability (vertical axis) vs. Precipitation of the warmest quarter (horizontal axis)

- **Sagebrush Index**
  - Suitability (vertical axis) vs. Sagebrush Index (horizontal axis)

- **Forest Cover Index**
  - Suitability (vertical axis) vs. Forest Cover Index (horizontal axis)

- **Distance to Permanent Standing Water**
  - Suitability (vertical axis) vs. Distance to Permanent Standing Water (horizontal axis)

- **Variation in monthly Relative Humidity**
  - Suitability (vertical axis) vs. Variation in monthly Relative Humidity (horizontal axis)
Northern Sagebrush Lizard (*Sceloporus graciosus graciosus*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Northern Sagebrush Lizard (ARACF14030) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

Range Map - Occupancy

Range Notes
• Version: 2010-01-19
• Proportion of range deemed known based on documented occurrences: 0.194
• Details of range map creation noted in Keinath et al. (2010a).

Range Map - Seasonality

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

**Doug Keinath**, Senior Zoologist

**Mark Andersen**, GIS Specialist

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Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Product, Quadratic, Hinge, Threshold
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.2881990
- High-Probability Threshold Value: 0.5325928
- Low-Probability Threshold Value: 0.0050249

Model Evaluation - ROC Plot

Model Quality Summary
Overall Assessment of Model Quality: HIGH
Expert Assessment: Medium
Occurrence Sample Size: High
Quality of Occurrences: High
Positive Success Rate: High
Test AUC and Model Gain: Medium

Model Evaluation Statistics
Final Model Statistics
Training AUC: 0.902
Regularized Training Gain: 1.163

Cross-Validation Statistics
- Average Test AUC: 0.861 ± 0.051
- Upper Bound on Test AUC: 0.870
- Average Test Gain: 0.974 ± 0.419
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.19± 0.13
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 263
- Number of Occurrences used to create distribution model: 112
- Average Point Quality Index (highest quality is 12.00): 9.54 ± 3.00
- Most recent occurrence used: 2008
- Oldest occurrence used: 1910
- Occurrence File: LOCAL_SAMPLE_POINTS_W_PDOG_2.csv

Comments
This is a sagebrush obligate species for which model quality would likely improve if an accurate statewide estimate of sagebrush structure (i.e., density and/or height) were available. Conclusive identification of this species is difficult unless the observer is experienced with the species. We suspect numerous occurrences could be in error, thus resulting in lower than expected model quality. The lack of supporting data provided with many occurrences (notably those from the Wildlife Observation System) makes it impossible to assess the accuracy of such observations. Supplementation/replacement of the existing data set with high-quality occurrence locations could greatly improve the modeled distribution for this species.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation of the wettest month</td>
<td>53</td>
</tr>
<tr>
<td>Vector Ruggedness Measure</td>
<td>21</td>
</tr>
<tr>
<td>Pinon-Juniper Index</td>
<td>12</td>
</tr>
<tr>
<td>Contagion Index</td>
<td>8</td>
</tr>
<tr>
<td>Annual temperature range (T3 – T4)</td>
<td>3</td>
</tr>
<tr>
<td>Warmest quarter mean temperature</td>
<td>2</td>
</tr>
</tbody>
</table>

Response Curves
Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

Precipitation of the wettest month

Vector Ruggedness Measure

Pinon-Juniper Index

Contagion Index

Annual temperature range (T3 – T4)

Warmest quarter mean temperature
Plateau Fence Lizard (*Sceloporus tristichus*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Plateau Fence Lizard (ARACF14130Q) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

![Range Map - Occupancy](image)

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.145
- Details of range map creation noted in Keinath et al. (2010a).

**Range Map - Seasonality**

![Range Map - Seasonality](image)

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

*Doug Keinath*, Senior Zoologist  
*Mark Andersen*, GIS Specialist

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Distribution Model (Version: Wed Dec 09 16:12:26 MST 2009)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Quadratic, Hinge
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.3227750
- High-Probability Threshold Value: 0.6046611
- Low-Probability Threshold Value: 0.0660673

Model Evaluation - ROC Plot

Model Quality Summary
**Overall Assessment of Model Quality: LOW**
- Expert Assessment: Low
- Occurrence Sample Size: Medium
- Quality of Occurrences: Medium
- Positive Success Rate: Medium
- Test AUC and Model Gain: High

Model Evaluation Statistics
**Final Model Statistics**
- Training AUC: 0.953
- Regularized Training Gain: 1.674

Cross-Validation Statistics
- Average Test AUC: 0.919 ± 0.036
- Upper Bound on Test AUC: 0.921
- Average Test Gain: 1.431 ± 0.434
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.29 ± 0.23
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 155
- Number of Occurrences used to create distribution model: 34
- Average Point Quality Index (highest quality is 12.00): 7.26 ± 3.60
- Most recent occurrence used: 2006
- Oldest occurrence used: 1907
- Occurrence File: LOCAL_SAMPLE_POINTS.csv

Comments
Qualitative expert review of this model suggests that the binary version may over-predict the distribution of this species in Wyoming. Conclusive identification of this species is difficult unless the observer is experienced with the species. We suspect numerous occurrences could be in error, thus resulting in lower than expected model quality. The lack of supporting data provided with many occurrences (notably those from the Wildlife Observation System) makes it impossible to assess the accuracy of such observations. Supplementation/replacement of the existing data set with high-quality occurrence locations could greatly improve the modeled distribution for this species.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinon-Juniper Index</td>
<td>38</td>
</tr>
<tr>
<td>Radiation of the darkest month</td>
<td>19</td>
</tr>
<tr>
<td>Annual precipitation range (P3 – P2)</td>
<td>14</td>
</tr>
<tr>
<td>Conifer Index</td>
<td>12</td>
</tr>
<tr>
<td>Contagion Index</td>
<td>8</td>
</tr>
<tr>
<td>Coldest month mean minimum temperature</td>
<td>8</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

Pinon-Juniper Index

![Pinon-Juniper Index Response Curve](image)

Radiation of the darkest month

![Radiation of the Darkest Month Response Curve](image)

Annual precipitation range (P3 – P2)

![Annual Precipitation Range Response Curve](image)

Conifer Index

![Conifer Index Response Curve](image)

Contagion Index

![Contagion Index Response Curve](image)

Coldest month mean minimum temperature

![Coldest Month Mean Minimum Temperature Response Curve](image)
This report presents range and distribution of Prairie Lizard (ARACF14135) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.114
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

**Doug Keinath**, Senior Zoologist  
**Mark Andersen**, GIS Specialist

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Distribution Model (Version: Sat Dec 05 23:16:55 MST 2009)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.3366590
- High-Probability Threshold Value: 0.8023145
- Low-Probability Threshold Value: 0.3366590

Model Quality Summary

**Overall Assessment of Model Quality:** LOW
Expert Assessment: Low
Occurrence Sample Size: Very Low
Quality of Occurrences: Medium
Positive Success Rate: Low
Test AUC and Model Gain: Low

Model Evaluation Statistics

**Final Model Statistics**
Training AUC: 0.995
Regularized Training Gain: 3.634

**Cross-Validation Statistics**
- Average Test AUC: 0.298 ± 0.480
- Upper Bound on Test AUC: 0.987
- Average Test Gain: 0.948 ± 1.918
- Omission Error (fraction of test points omitted during 3-fold cross validation): 0.33 ± 0.58
Occurrence Data for Distribution Model

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 5
- Number of Occurrences used to create distribution model: 3
- Average Point Quality Index (highest quality is 12.00): 7.00 ± 1.73
- Most recent occurrence used: 2000
- Oldest occurrence used: 1941
- Occurrence File: LOCAL_SAMPLE_POINTS.csv

Comments
The model for this species is based on a small sample size of occurrence locations, which often results in low model quality. Collection of additional, high-quality occurrence locations could greatly improve the modeled distribution for this species.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coldest quarter mean temperature</td>
<td>52</td>
</tr>
<tr>
<td>Isothermality (T2/T5)</td>
<td>16</td>
</tr>
<tr>
<td>Depth to Shallowest Restrictive Layer</td>
<td>13</td>
</tr>
<tr>
<td>Coldest month mean minimum temperature</td>
<td>10</td>
</tr>
<tr>
<td>Distance to Water</td>
<td>6</td>
</tr>
<tr>
<td>Vector Ruggedness Measure</td>
<td>4</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

Coldest quarter mean temperature

 depth to Shallowest Restrictive Layer

Distance to Water

Isothermality (T2/T5)

Coldest month mean minimum temperature

Vector Ruggedness Measure
Northern Tree Lizard (*Urosaurus ornatus wrighti*)
Range Map and Distribution Model Summary
August 20, 2010

This report presents range and distribution of Northern Tree Lizard (ARACF16030) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.375
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

**Doug Keinath**, Senior Zoologist

**Mark Andersen**, GIS Specialist

© 2010, WYNDD
Distribution Model (Version: Wed Mar 17 03:05:28 MDT 2010)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Quadratic
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.2181800
- High-Probability Threshold Value: 0.5923660
- Low-Probability Threshold Value: 0.2181796

Model Evaluation - ROC Plot

Model Quality Summary
Overall Assessment of Model Quality: MEDIUM
Expert Assessment: Medium
Occurrence Sample Size: Low
Quality of Occurrences: Medium
Positive Success Rate: Very High
Test AUC and Model Gain: High

Model Evaluation Statistics
Final Model Statistics
Training AUC: 0.988
Regularized Training Gain: 2.768

Cross-Validation Statistics
- Average Test AUC: 0.986 ± 0.015
- Upper Bound on Test AUC: 0.967
- Average Test Gain: 3.105 ± 0.986
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.05 ± 0.16
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 62
- Number of Occurrences used to create distribution model: 13
- Average Point Quality Index (highest quality is 12.00): 7.62 ± 3.25
- Most recent occurrence used: 2006
- Oldest occurrence used: 1939
- Occurrence File: LOCAL_SAMPLE_POINTS_W_PDOG_2.csv

Comments
Conclusive identification of this species is difficult unless the observer is experienced with the species. We suspect numerous occurrences could be in error, thus resulting in lower than expected model quality. The lack of supporting data provided with many occurrences (notably those from the Wildlife Observation System) makes it impossible to assess the accuracy of such observations. Supplementation/replacement of the existing data set with high-quality occurrence locations could greatly improve the modeled distribution for this species.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation of the darkest month</td>
<td>63</td>
</tr>
<tr>
<td>Relative Humidity of most humid month</td>
<td>14</td>
</tr>
<tr>
<td>Wettest quarter mean temperature</td>
<td>11</td>
</tr>
<tr>
<td>Pinon-Juniper Index</td>
<td>7</td>
</tr>
<tr>
<td>Annual mean temperature</td>
<td>5</td>
</tr>
<tr>
<td>Warmest quarter mean temperature</td>
<td>0</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).
This report presents range and distribution of Northern Many-lined Skink (ARACH01090) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

Range Notes
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.000
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

Doug Keinath, Senior Zoologist
Mark Andersen, GIS Specialist

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Distribution Model (Version: Sun Dec 06 05:53:44 MST 2009)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.5308380
- High-Probability Threshold Value: 0.5563779
- Low-Probability Threshold Value: 0.5308380

Model Quality Summary
- Overall Assessment of Model Quality: LOW
- Expert Assessment: Low
- Occurrence Sample Size: Low
- Quality of Occurrences: Low
- Positive Success Rate: Low
- Test AUC and Model Gain: High

Model Evaluation Statistics
- Final Model Statistics
  - Training AUC: 0.982
  - Regularized Training Gain: 2.660

Cross-Validation Statistics
- Average Test AUC: 0.973 ± 0.503
- Upper Bound on Test AUC: 0.974
- Average Test Gain: 1.600 ± 1.422
- Omission Error (fraction of test points omitted during 6-fold cross validation): 0.50 ± 0.55
Occurrence Data for Distribution Model

Occurrence Map

<table>
<thead>
<tr>
<th>Points Used in Modeling, by Year of Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pre-1985</td>
</tr>
<tr>
<td>• 1985 or Later</td>
</tr>
</tbody>
</table>

Known and Suspected Range

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 6
- Number of Occurrences used to create distribution model: 6
- Average Point Quality Index (highest quality is 12.00): 4.17 ± 0.41
- Most recent occurrence used: 1983
- Oldest occurrence used: 1940
- Occurrence File: LOCAL_SAMPLE_POINTS.csv

Comments
The model for this species is based on a small sample size of occurrence locations, which often results in low model quality. Collection of additional, high-quality occurrence locations could greatly improve the modeled distribution for this species.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wettest quarter mean temperature</td>
<td>41</td>
</tr>
<tr>
<td>Depth to Shallowest Restrictive Layer</td>
<td>22</td>
</tr>
<tr>
<td>Sagebrush Index</td>
<td>20</td>
</tr>
<tr>
<td>Variation in monthly radiation</td>
<td>13</td>
</tr>
<tr>
<td>Pinon-Juniper Index</td>
<td>4</td>
</tr>
<tr>
<td>Precipitation of the warmest quarter</td>
<td>0</td>
</tr>
</tbody>
</table>

Response Curves
Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

Wettest quarter mean temperature

Depth to Shallowest Restrictive Layer

Sagebrush Index

Variation in monthly radiation

Pinon-Juniper Index

Precipitation of the warmest quarter
Great Basin Skink (*Plestiodon skiltonianus utahensis*)

Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Great Basin Skink (ARACH01113) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

Range Notes
- Version: 2010-06-05
- Proportion of range deemed known based on documented occurrences: 0.286
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

*Doug Keinath*, Senior Zoologist

*Mark Andersen*, GIS Specialist

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Comments
This species was first discovered in Wyoming in June 2010. There were too few occurrence points to construct a distribution model. Collection of additional, high-quality occurrence locations are necessary for assessment of potential distribution within Wyoming.

References

Prairie Racerunner (*Aspidoscelis sexlineatus viridis*)
Range Map and Distribution Model Summary
August 20, 2010

This report presents range and distribution of Prairie Racerunner (ARACJ02110) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

### Range Map - Occupancy

#### Range Notes
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.077
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

**Doug Keinath**, Senior Zoologist

**Mark Andersen**, GIS Specialist

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Distribution Model (Version: Fri Dec 04 11:54:04 MST 2009)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
• Season Modeled: Year-Round
• Algorithm: Maxent version 3.3.1
• Feature Types: Linear
• Binary Threshold Rule: Maximum training sensitivity plus specificity
• Binary Threshold Value: 0.5061240
• High-Probability Threshold Value: 0.6158926
• Low-Probability Threshold Value: 0.5061240

Model Evaluation - ROC Plot

Model Quality Summary
Overall Assessment of Model Quality: LOW
Expert Assessment: Low
Occurrence Sample Size: Very Low
Quality of Occurrences: Low
Positive Success Rate: Low
Test AUC and Model Gain: Low

Model Evaluation Statistics
Final Model Statistics
Training AUC: 0.996
Regularized Training Gain: 3.749

Cross-Validation Statistics
• Average Test AUC: 0.396 ± 0.511
• Upper Bound on Test AUC: 0.990
• Average Test Gain: 1.241 ± 1.770
• Omission Error (fraction of test points omitted during 4-fold cross validation): 0.50 ± 0.58
Occurrence Data for Distribution Model

Occurrence Map

Points Used in Modeling, by Year of Observation
- Pre-1985
- 1985 or Later
- Known and Suspected Range

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 44
- Number of Occurrences used to create distribution model: 4
- Average Point Quality Index (highest quality is 12.00): 4.50 ± 1.00
- Most recent occurrence used: 1987
- Oldest occurrence used: 1941
- Occurrence File: LOCAL_SAMPLE_POINTS.csv

Comments

The model for this species is based on a small sample size of occurrence locations, which often results in low model quality. Collection of additional, high-quality occurrence locations could greatly improve the modeled distribution for this species.

References


Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coldest quarter mean temperature</td>
<td>72</td>
</tr>
<tr>
<td>Depth to Shallowest Restrictive Layer</td>
<td>12</td>
</tr>
<tr>
<td>Distance to Permanent Water</td>
<td>8</td>
</tr>
<tr>
<td>Isothermality (T2/T5)</td>
<td>3</td>
</tr>
<tr>
<td>Cottonwood Index</td>
<td>3</td>
</tr>
<tr>
<td>Coldest month mean minimum temperature</td>
<td>1</td>
</tr>
</tbody>
</table>

Response Curves
Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

Coldest quarter mean temperature

Depth to Shallowest Restrictive Layer

Distance to Permanent Water

Isothermality (T2/T5)

Cottonwood Index

Coldest month mean minimum temperature
Rubber Boa (*Charina bottae*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Rubber Boa (ARADA01010) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.375
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

**Doug Keinath**, Senior Zoologist
**Mark Andersen**, GIS Specialist

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Distribution Model (Version: Fri Dec 04 15:08:45 MST 2009)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Quadratic, Hinge
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.3208680
- High-Probability Threshold Value: 0.5875406
- Low-Probability Threshold Value: 0.1024961

Model Evaluation - ROC Plot

Model Quality Summary
**Overall Assessment of Model Quality:** MEDIUM
- Expert Assessment: Medium
- Occurrence Sample Size: Medium-High
- Quality of Occurrences: Medium
- Positive Success Rate: Medium
- Test AUC and Model Gain: High

Model Evaluation Statistics
**Final Model Statistics**
- Training AUC: 0.933
- Regularized Training Gain: 1.412

**Cross-Validation Statistics**
- Average Test AUC: 0.901 ± 0.044
- Upper Bound on Test AUC: 0.903
- Average Test Gain: 1.343 ± 0.458
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.25± 0.20
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics

- Number of Occurrences in AWVED master dataset: 80
- Number of Occurrences used to create distribution model: 51
- Average Point Quality Index (highest quality is 12.00): 6.90 ± 2.09
- Most recent occurrence used: 2002
- Oldest occurrence used: 1921
- Occurrence File: LOCAL_SAMPLE_POINTS.csv

Comments

The map of range seasonality for rubber boa is likely inaccurate. Despite the fact that this is the map that was approved by state experts, all hydraulic units within its range should probably be labeled "year-round". We have left the range as shown until formal review results in an official change to the approved map. Qualitative expert review of this model suggests that the binary version may over-predict the distribution of this species in Wyoming.

References


Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conifer Index</td>
<td>25</td>
</tr>
<tr>
<td>Precipitation of the coldest quarter</td>
<td>17</td>
</tr>
<tr>
<td>Wettest quarter mean temperature</td>
<td>16</td>
</tr>
<tr>
<td>Forest Cover Index</td>
<td>16</td>
</tr>
<tr>
<td>Vector Ruggedness Measure</td>
<td>14</td>
</tr>
<tr>
<td>Pinon-Juniper Index</td>
<td>12</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

Conifer Index

Precipitation of the coldest quarter

Wettest quarter mean temperature

Forest Cover Index

Vector Ruggedness Measure

Pinon-Juniper Index
Eastern Yellow-bellied Racer (*Coluber constrictor flaviventris*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Eastern Yellow-bellied Racer (ARADB07014) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

<table>
<thead>
<tr>
<th>Known</th>
<th>Suspected</th>
<th>Accidental</th>
<th>Historical</th>
</tr>
</thead>
</table>

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.176
- Details of range map creation noted in Keinath et al. (2010a).

**Range Map - Seasonality**

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database.
(http://uwadmnweb.uwyo.edu/wyndd/).

Doug Keinath, Senior Zoologist
Mark Andersen, GIS Specialist

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Detail of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Quadratic, Hinge
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.2922430
- High-Probability Threshold Value: 0.5871243
- Low-Probability Threshold Value: 0.1192337

Model Quality Summary

Overall Assessment of Model Quality: MEDIUM
- Expert Assessment: Medium
- Occurrence Sample Size: Medium-High
- Quality of Occurrences: Medium
- Positive Success Rate: High
- Test AUC and Model Gain: Medium

Model Evaluation Statistics

Final Model Statistics
- Training AUC: 0.886
- Regularized Training Gain: 1.017

Cross-Validation Statistics
- Average Test AUC: 0.856 ± 0.057
- Upper Bound on Test AUC: 0.865
- Average Test Gain: 0.912 ± 0.418
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.13 ± 0.15
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 83
- Number of Occurrences used to create distribution model: 60
- Average Point Quality Index (highest quality is 12.00): 7.63 ± 3.20
- Most recent occurrence used: 2008
- Oldest occurrence used: 1906
- Occurrence File: LOCAL_SAMPLE_POINTS.csv

Comments
Qualitative expert review of this model suggests that the binary version may over-predict the distribution of this species in Wyoming.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variation of monthly precipitation</td>
<td>49</td>
</tr>
<tr>
<td>Distance to Permanent Water</td>
<td>15</td>
</tr>
<tr>
<td>Elevation</td>
<td>12</td>
</tr>
<tr>
<td>Cottonwood Index</td>
<td>10</td>
</tr>
<tr>
<td>Precipitation of the wettest month</td>
<td>8</td>
</tr>
<tr>
<td>Herbaceous Cover Index</td>
<td>7</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).
Plains Hog-nosed Snake (*Heterodon nasicus*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Plains Hog-nosed Snake (ARADB17010) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.114
- Details of range map creation noted in Keinath et al. (2010a).

**Range Map - Seasonality**

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

*Doug Keinath*, Senior Zoologist  
*Mark Andersen*, GIS Specialist

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Distribution Model (Version: Thu Apr 22 09:39:12 MDT 2010)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Quadratic, Hinge
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.3387860
- High-Probability Threshold Value: 0.5649360
- Low-Probability Threshold Value: 0.2126335

Model Quality Summary
**Overall Assessment of Model Quality:**
**MEDIUM**
- Expert Assessment: Medium
- Occurrence Sample Size: Medium
- Quality of Occurrences: Medium
- Positive Success Rate: Very High
- Test AUC and Model Gain: Medium

Model Evaluation Statistics
**Final Model Statistics**
- Training AUC: 0.884
- Regularized Training Gain: 0.911

**Cross-Validation Statistics**
- Average Test AUC: 0.829 ± 0.133
- Upper Bound on Test AUC: 0.845
- Average Test Gain: 0.697 ± 1.029
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.00 ± 0.00
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 24
- Number of Occurrences used to create distribution model: 22
- Average Point Quality Index (highest quality is 12.00): 7.32 ± 3.05
- Most recent occurrence used: 2008
- Oldest occurrence used: 1980
- Occurrence File: LOCAL_SAMPLE_POINTS.csv

Comments
There are no additional comments specific to this species range map or distribution model.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variation of monthly precipitation</td>
<td>47</td>
</tr>
<tr>
<td>Elevation</td>
<td>31</td>
</tr>
<tr>
<td>Standard deviation of monthly temperature</td>
<td>14</td>
</tr>
<tr>
<td>Warmest quarter mean temperature</td>
<td>5</td>
</tr>
<tr>
<td>Percent Forest Cover</td>
<td>2</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al. 2010b for details).

- **Variation of monthly precipitation**
- **Elevation**
- **Standard deviation of monthly temperature**
- **Warmest quarter mean temperature**
- **Percent Forest Cover**
Pale Milksnake (*Lampropeltis triangulum multistriata*)

Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Pale Milksnake (ARADB19050) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

- **Version**: 2010-01-19
- **Proportion of range deemed known based on documented occurrences**: 0.057
- **Details of range map creation noted in Keinath et al. (2010a).**

**Range Map - Seasonality**

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

*Doug Keinath*, Senior Zoologist

*Mark Andersen*, GIS Specialist

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Details of distribution model creation are presented in Keinath et al. (2010b)

**Model Parameters**
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Quadratic, Hinge
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.3225460
- High-Probability Threshold Value: 0.6715417
- Low-Probability Threshold Value: 0.1259588

**Model Quality Summary**

**Overall Assessment of Model Quality:** LOW
- Expert Assessment: Low
- Occurrence Sample Size: Low
- Quality of Occurrences: Medium
- Positive Success Rate: Medium
- Test AUC and Model Gain: Medium

**Model Evaluation Statistics**

**Final Model Statistics**
- Training AUC: 0.950
- Regularized Training Gain: 1.427

**Cross-Validation Statistics**
- Average Test AUC: 0.898 ± 0.099
- Upper Bound on Test AUC: 0.880
- Average Test Gain: 1.502 ± 1.133
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.30 ± 0.26
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 21
- Number of Occurrences used to create distribution model: 19
- Average Point Quality Index (highest quality is 12.00): 6.26 ± 1.79
- Most recent occurrence used: 2006
- Oldest occurrence used: 1856
- Occurrence File: LOCAL_SAMPLE_POINTS.csv

Comments
There are no additional comments specific to this species range map or distribution model.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variation of monthly precipitation</td>
<td>44</td>
</tr>
<tr>
<td>Contagion Index</td>
<td>13</td>
</tr>
<tr>
<td>Herbaceous Cover Index</td>
<td>12</td>
</tr>
<tr>
<td>Coldest month mean minimum temperature</td>
<td>12</td>
</tr>
<tr>
<td>Conifer Index</td>
<td>11</td>
</tr>
<tr>
<td>Interannual variation in annual frost days</td>
<td>8</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

![Variation of monthly precipitation](image1)

![Contagion Index](image2)

![Herbaceous Cover Index](image3)

![Coldest month mean minimum temperature](image4)

![Conifer Index](image5)

![Interannual variation in annual frost days](image6)
Great Basin Gophersnake (*Pituophis catenifer deserticola*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Great Basin Gophersnake (ARADB26022) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.300
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

**Doug Keinath**, Senior Zoologist

**Mark Andersen**, GIS Specialist

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Distribution Model (Version: Tue Mar 16 21:09:06 MDT 2010)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Product
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.2571420
- High-Probability Threshold Value: 0.6456544
- Low-Probability Threshold Value: 0.1021669

Model Quality Summary

**Overall Assessment of Model Quality:** MEDIUM

Expert Assessment: Medium
Occurrence Sample Size: Low
Quality of Occurrences: Medium
Positive Success Rate: Very High
Test AUC and Model Gain: High

Model Evaluation Statistics

Final Model Statistics
Training AUC: 0.953
Regularized Training Gain: 1.644

Cross-Validation Statistics
- Average Test AUC: 0.944 ± 0.053
- Upper Bound on Test AUC: 0.926
- Average Test Gain: 1.854 ± 0.640
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.10 ± 0.21
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 28
- Number of Occurrences used to create distribution model: 15
- Average Point Quality Index (highest quality is 12.00): 6.93 ± 2.79
- Most recent occurrence used: 2006
- Oldest occurrence used: 1980
- Occurrence File: REVISED_SAMPLE POINTS_ALL_SPP.cs

Comments
There are no additional comments specific to this species range map or distribution model.

References

**Predictor Variables used in the Distribution Model**

**Percent Contribution (PC) to final model**

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation of the wettest month</td>
<td>53</td>
</tr>
<tr>
<td>Interannual variation in annual frost days</td>
<td>19</td>
</tr>
<tr>
<td>Potential for Rock Outcrop</td>
<td>14</td>
</tr>
<tr>
<td>Percent Forest Cover</td>
<td>13</td>
</tr>
<tr>
<td>Distance to Permanent Water</td>
<td>0</td>
</tr>
<tr>
<td>Pinon-Juniper Index</td>
<td>0</td>
</tr>
</tbody>
</table>

**Response Curves**

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).
Bullsnake (*Pituophis catenifer sayi*)  
Range Map and Distribution Model Summary  
August 20, 2010

This report presents range and distribution of Bullsnake (ARADB26024) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

### Range Map - Occupancy

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.369
- Details of range map creation noted in Keinath et al. (2010a).

### Range Map - Seasonality

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wynnd/).

**Doug Keinath,** Senior Zoologist  
**Mark Andersen,** GIS Specialist

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Distribution Model (Version: Thu Apr 01 15:03:04 MDT 2010)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Product, Quadratic, Hinge, Threshold
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.3167540
- High-Probability Threshold Value: 0.5373218
- Low-Probability Threshold Value: 0.1010481

Model Quality Summary

Overall Assessment of Model Quality: MEDIUM
Expert Assessment: Medium
Occurrence Sample Size: High
Quality of Occurrences: High
Positive Success Rate: Medium
Test AUC and Model Gain: Medium

Model Evaluation Statistics
Final Model Statistics
Training AUC: 0.867
Regularized Training Gain: 0.896

Cross-Validation Statistics
- Average Test AUC: 0.822 ± 0.028
- Upper Bound on Test AUC: 0.843
- Average Test Gain: 0.779 ± 0.179
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.21± 0.10
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 181
- Number of Occurrences used to create distribution model: 145
- Average Point Quality Index (highest quality is 12.00): 8.67 ± 2.82
- Most recent occurrence used: 2008
- Oldest occurrence used: 1981
- Occurrence File: REVISED_SAMPLE_POINTS_ALL_SPP.cs

Comments
There are no additional comments specific to this species range map or distribution model.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual number of Frost Days</td>
<td>41</td>
</tr>
<tr>
<td>Variation of monthly precipitation</td>
<td>27</td>
</tr>
<tr>
<td>Cottonwood Index</td>
<td>15</td>
</tr>
<tr>
<td>Warmest quarter mean temperature</td>
<td>12</td>
</tr>
<tr>
<td>Elevation</td>
<td>5</td>
</tr>
<tr>
<td>Annual Radiation range</td>
<td>0</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

![Annual number of Frost Days](image)

![Variation of monthly precipitation](image)

![Cottonwood Index](image)

![Warmest quarter mean temperature](image)

![Elevation](image)

![Annual Radiation range](image)
Black Hills Redbelly Snake (*Storeria occipitomaculata pahasapae*)

Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Black Hills Redbelly Snake (ARADB34030) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

Range Notes

- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.300
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

Doug Keinath, Senior Zoologist
Mark Andersen, GIS Specialist

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Distribution Model (Version: Sat Dec 05 15:26:01 MST 2009)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.0559810
- High-Probability Threshold Value: 0.7559857
- Low-Probability Threshold Value: 0.0559810

Model Quality Summary
Overall Assessment of Model Quality: LOW
Expert Assessment: Low
Occurrence Sample Size: Low
Quality of Occurrences: Medium
Positive Success Rate: High
Test AUC and Model Gain: Medium

Model Evaluation Statistics
Final Model Statistics
Training AUC: 0.983
Regularized Training Gain: 2.889

Cross-Validation Statistics
- Average Test AUC: 0.780 ± 0.415
- Upper Bound on Test AUC: 0.943
- Average Test Gain: 2.663 ± 2.336
- Omission Error (fraction of test points omitted during 8-fold cross validation): 0.13 ± 0.35
Occurrence Data for Distribution Model

Occurrence Map

<table>
<thead>
<tr>
<th>Points Used in Modeling, by Year of Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pre-1985</td>
</tr>
<tr>
<td>• 1985 or Later</td>
</tr>
</tbody>
</table>

Occurrence Summary Statistics

- Number of Occurrences in AWVED master dataset: 8
- Number of Occurrences used to create distribution model: 8
- Average Point Quality Index (highest quality is 12.00): $7.75 \pm 3.06$
- Most recent occurrence used: 1994
- Oldest occurrence used: 1962
- Occurrence File: LOCAL_SAMPLE_POINTS.csv

Comments

The model for this species is based on a small sample size of occurrence locations, which often results in low model quality. Collection of additional, high-quality occurrence locations could greatly improve the modeled distribution for this species.

References


Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deciduous Forest Index</td>
<td>77</td>
</tr>
<tr>
<td>Radiation of the lightest month</td>
<td>9</td>
</tr>
<tr>
<td>Potential for Rock Outcrop</td>
<td>7</td>
</tr>
<tr>
<td>Soil - Fraction Sand</td>
<td>3</td>
</tr>
<tr>
<td>Driest quarter mean temperature</td>
<td>3</td>
</tr>
<tr>
<td>Wettest quarter mean temperature</td>
<td>2</td>
</tr>
</tbody>
</table>

Response Curves
Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

- **Deciduous Forest Index**
- **Radiation of the lightest month**
- **Potential for Rock Outcrop**
- **Soil - Fraction Sand**
- **Driest quarter mean temperature**
- **Wettest quarter mean temperature**
Plains Black-headed Snake (*Tantilla nigriceps*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Plains Black-headed Snake (ARADB35050) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

[Map image]

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.158
- Details of range map creation noted in Keinath et al. (2010a).

**Range Map - Seasonality**

[Map image]

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database.
(http://uwadmnweb.uwyo.edu/wyndd/).

*Doug Keinath*, Senior Zoologist

*Mark Andersen*, GIS Specialist

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Comments
There were too few occurrence points to construct a distribution model for this species. Collection of additional, high-quality occurrence locations are necessary for assessment of potential distribution within Wyoming.

References

Wandering Gartersnake (*Thamnophis elegans vagrans*)
Range Map and Distribution Model Summary
August 20, 2010

This report presents range and distribution of Wandering Gartersnake (ARADB36050) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.280
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

**Doug Keinath,** Senior Zoologist

**Mark Andersen,** GIS Specialist

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Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Product
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.4359750
- High-Probability Threshold Value: 0.5259595
- Low-Probability Threshold Value: 0.0137789

Model Quality Summary
- Overall Assessment of Model Quality: LOW
  - Expert Assessment: Low
  - Occurrence Sample Size: High
  - Quality of Occurrences: High
  - Positive Success Rate: Low
  - Test AUC and Model Gain: Low

Model Evaluation Statistics
- Final Model Statistics
  - Training AUC: 0.737
  - Regularized Training Gain: 0.312

Cross-Validation Statistics
- Average Test AUC: 0.696 ± 0.075
- Upper Bound on Test AUC: 0.713
- Average Test Gain: 0.137 ± 0.393
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.36± 0.14
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 198
- Number of Occurrences used to create distribution model: 129
- Average Point Quality Index (highest quality is 12.00): 8.19 ± 3.08
- Most recent occurrence used: 2008
- Oldest occurrence used: 1934
- Occurrence File: LOCAL_SAMPLE_POINTS_W_PDOG_2.csv

Comments
This species uses aspects of wetlands (e.g., dense emergent vegetation) for which statewide data are not available or reliable. This often results in low model quality because key habitat features are not mappable across the state. Great improvements in our ability to model this species distribution could be obtained by improving wetland maps. Conclusive identification of this species is difficult unless the observer is experienced with the species. We suspect numerous occurrences could be in error, thus resulting in lower than expected model quality. The lack of supporting data provided with many occurrences (notably those from the Wildlife Observation System) makes it impossible to assess the accuracy of such observations. Supplementation/replacement of the existing data set with high-quality occurrence locations could greatly improve the modeled distribution for this species.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to Permanent Water</td>
<td>39</td>
</tr>
<tr>
<td>Annual mean relative humidity</td>
<td>36</td>
</tr>
<tr>
<td>Precipitation of the driest quarter</td>
<td>10</td>
</tr>
<tr>
<td>Forest Cover Index</td>
<td>7</td>
</tr>
<tr>
<td>Conifer Index</td>
<td>7</td>
</tr>
<tr>
<td>Deciduous Forest Index</td>
<td>1</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

- **Distance to Permanent Water**
- **Annual mean relative humidity**
- **Precipitation of the driest quarter**
- **Forest Cover Index**
- **Conifer Index**
- **Deciduous Forest Index**
Plains Gartersnake (*Thamnophis radix*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Plains Gartersnake (ARADB36100) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

Range Map - Occupancy

Range Notes
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.052
- Details of range map creation noted in Keinath et al. (2010a).

Range Map - Seasonality

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

*Doug Keinath*, Senior Zoologist

*Mark Andersen*, GIS Specialist

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Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Quadratic, Hinge
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.2583430
- High-Probability Threshold Value: 0.6876158
- Low-Probability Threshold Value: 0.2583428

Model Evaluation - ROC Plot

Model Quality Summary
- Overall Assessment of Model Quality: MEDIUM
- Expert Assessment: Medium
- Occurrence Sample Size: Low
- Quality of Occurrences: Medium
- Positive Success Rate: Low
- Test AUC and Model Gain: Medium

Model Evaluation Statistics
- Final Model Statistics
  - Training AUC: 0.934
  - Regularized Training Gain: 1.077

Cross-Validation Statistics
- Average Test AUC: 0.796 ± 0.201
- Upper Bound on Test AUC: 0.870
- Average Test Gain: 0.272 ± 1.876
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.35± 0.41
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 28
- Number of Occurrences used to create distribution model: 18
- Average Point Quality Index (highest quality is 12.00): 6.50 ± 2.92
- Most recent occurrence used: 2008
- Oldest occurrence used: 1906
- Occurrence File: LOCAL_SAMPLE_POINTS_W_PDOG_2.csv

Comments
This species uses aspects of wetlands (e.g., dense emergent vegetation) for which statewide data are not available or reliable. This often results in low model quality because key habitat features are not mappable across the state. Great improvements in our ability to model this species distribution could be obtained by improving wetland maps. Conclusive identification of this species is difficult unless the observer is experienced with the species. We suspect numerous occurrences could be in error, thus resulting in lower than expected model quality. The lack of supporting data provided with many occurrences (notably those from the Wildlife Observation System) makes it impossible to assess the accuracy of such observations. Supplementation/replacement of the existing data set with high-quality occurrence locations could greatly improve the modeled distribution for this species. Due to timing of range map edits, the distribution model for plains gartersnake was created before final edits were made to the range map. As a result, several datapoints used in the model fall outside the accepted range of the species. Future versions of the model should eliminate these occurrences, as they are likely mis-identified records of other gartersnakes.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conifer Index</td>
<td>29</td>
</tr>
<tr>
<td>Precipitation of the wettest quarter</td>
<td>18</td>
</tr>
<tr>
<td>Herbaceous Cover Index</td>
<td>17</td>
</tr>
<tr>
<td>Isothermality (T2/T5)</td>
<td>15</td>
</tr>
<tr>
<td>Cottonwood Index</td>
<td>13</td>
</tr>
<tr>
<td>Depth to Shallowest Restrictive Layer</td>
<td>8</td>
</tr>
</tbody>
</table>

Response Curves
Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

Conifer Index

Precipitation of the wettest quarter

Herbaceous Cover Index

Isothermality (T2/T5)

Cottonwood Index

Depth to Shallowest Restrictive Layer
Red-sided Gartersnake (*Thamnophis sirtalis parietalis*)

Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Red-sided Gartersnake (ARADB3613C) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.235
- Details of range map creation noted in Keinath et al. (2010a).

**Range Map - Seasonality**

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

*Doug Keinath*, Senior Zoologist  
*Mark Andersen*, GIS Specialist

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Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Quadratic, Hinge
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.3157210
- High-Probability Threshold Value: 0.6146828
- Low-Probability Threshold Value: 0.0806229

Model Quality Summary
Overall Assessment of Model Quality: MEDIUM
Expert Assessment: Medium
Occurrence Sample Size: Medium
Quality of Occurrences: Medium
Positive Success Rate: Medium
Test AUC and Model Gain: Medium

Model Evaluation Statistics
Final Model Statistics
Training AUC: 0.917
Regularized Training Gain: 1.172

Cross-Validation Statistics
- Average Test AUC: 0.847 ± 0.069
- Upper Bound on Test AUC: 0.879
- Average Test Gain: 0.868 ± 0.641
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.27 ± 0.22
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 39
- Number of Occurrences used to create distribution model: 32
- Average Point Quality Index (highest quality is 12.00): 7.78 ± 1.91
- Most recent occurrence used: 2008
- Oldest occurrence used: 1981
- Occurrence File: REVISED_SAMPLE_POINTS_ALL_SPP.cs

Comments
Conclusive identification of this species is difficult unless the observer is experienced with the species. We suspect numerous occurrences could be in error, thus resulting in lower than expected model quality. The lack of supporting data provided with many occurrences (notably those from the Wildlife Observation System) makes it impossible to assess the accuracy of such observations. Supplementation/replacement of the existing data set with high-quality occurrence locations could greatly improve the modeled distribution for this species.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation of the lightest month</td>
<td>49</td>
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<tr>
<td>Wettest quarter mean temperature</td>
<td>15</td>
</tr>
<tr>
<td>Annual temperature range (T3 – T4)</td>
<td>15</td>
</tr>
<tr>
<td>Pinon-Juniper Index</td>
<td>9</td>
</tr>
<tr>
<td>Deciduous Forest Index</td>
<td>7</td>
</tr>
<tr>
<td>Annual total radiation</td>
<td>5</td>
</tr>
</tbody>
</table>

Response Curves
Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).
Valley Gartersnake (*Thamnophis sirtalis fitchi*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Valley Gartersnake (ARADB3613X) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Map - Occupancy**

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.167
- Details of range map creation noted in Keinath et al. (2010a).

**Range Map - Seasonality**

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

*Doug Keinath*, Senior Zoologist
*Mark Andersen*, GIS Specialist

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Distribution Model (Version: Fri Apr 02 16:03:25 MDT 2010)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.5960850
- High-Probability Threshold Value: 0.6662462
- Low-Probability Threshold Value: 0.5960850

Model Quality Summary
**Overall Assessment of Model Quality: LOW**
Expert Assessment: Low
Occurrence Sample Size: Very Low
Quality of Occurrences: High
Positive Success Rate: Very High
Test AUC and Model Gain: Low

Model Evaluation Statistics
Final Model Statistics
Training AUC: 0.995
Regularized Training Gain: 3.415

Cross-Validation Statistics
- Average Test AUC: 0.100 ± 0.211
- Upper Bound on Test AUC: 0.986
- Average Test Gain: 0.000 ± 0.000
- Omission Error (fraction of test points omitted during 2-fold cross validation): 0.00 ± 0.00
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 5
- Number of Occurrences used to create distribution model: 2
- Average Point Quality Index (highest quality is 12.00): 9.00 ± 1.41
- Most recent occurrence used: 2006
- Oldest occurrence used: 2004
- Occurrence File: DRAFT_3_SAGE_WATER_RERUNS.csv

Comments
The model for this species is based on a small sample size of occurrence locations, which often results in low model quality. Collection of additional, high-quality occurrence locations could greatly improve the modeled distribution for this species. Conclusive identification of this species is difficult unless the observer is experienced with the species. We suspect numerous occurrences could be in error, thus resulting in lower than expected model quality. The lack of supporting data provided with many occurrences (notably those from the Wildlife Observation System) makes it impossible to assess the accuracy of such observations. Supplementation/replacement of the existing data set with high-quality occurrence locations could greatly improve the modeled distribution for this species.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wettest quarter mean temperature</td>
<td>48</td>
</tr>
<tr>
<td>Interannual variation in annual frost days</td>
<td>17</td>
</tr>
<tr>
<td>Percent Cover of sagebrush</td>
<td>14</td>
</tr>
<tr>
<td>Prevalence of Lakes/Large Rivers within 300 meters</td>
<td>14</td>
</tr>
<tr>
<td>Annual temperature range (T3 – T4)</td>
<td>3</td>
</tr>
<tr>
<td>Hottest month mean maximum temperature</td>
<td>3</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

![Wettest quarter mean temperature](image)

![Interannual variation in annual frost days](image)

![Percent Cover of sagebrush](image)

![Prevalence of Lakes/Large Rivers within 300 meters](image)

![Annual temperature range (T3 – T4)](image)

![Hottest month mean maximum temperature](image)
Smooth Green Snake (*Opheodrys vernalis*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Smooth Green Snake (ARADB47010) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.353
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

*Doug Keinath*, Senior Zoologist

*Mark Andersen*, GIS Specialist

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Distribution Model (Version: Sun Dec 06 20:16:29 MST 2009)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Quadratic, Hinge
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.1173890
- High-Probability Threshold Value: 0.7417376
- Low-Probability Threshold Value: 0.0276957

Model Quality Summary
Overall Assessment of Model Quality: MEDIUM
Expert Assessment: Medium
Occurrence Sample Size: Medium
Quality of Occurrences: Medium
Positive Success Rate: High
Test AUC and Model Gain: High

Model Evaluation Statistics
Final Model Statistics
Training AUC: 0.975
Regularized Training Gain: 2.349

Cross-Validation Statistics
- Average Test AUC: 0.921 ± 0.156
- Upper Bound on Test AUC: 0.946
- Average Test Gain: 1.933 ± 2.110
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.13 ± 0.32
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 34
- Number of Occurrences used to create distribution model: 24
- Average Point Quality Index (highest quality is 12.00): 7.50 ± 2.99
- Most recent occurrence used: 2006
- Oldest occurrence used: 1938
- Occurrence File: LOCAL_SAMPLE_POINTS.csv

Comments
There are no additional comments specific to this species range map or distribution model.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deciduous Forest Index</td>
<td>66</td>
</tr>
<tr>
<td>Wettest quarter mean temperature</td>
<td>10</td>
</tr>
<tr>
<td>Vector Ruggedness Measure</td>
<td>10</td>
</tr>
<tr>
<td>Precipitation of the wettest quarter</td>
<td>6</td>
</tr>
<tr>
<td>Pinon-Juniper Index</td>
<td>4</td>
</tr>
<tr>
<td>Conifer Index</td>
<td>4</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).
Prairie Rattlesnake (*Crotalus viridis*)
Range Map and Distribution Model Summary
August 20, 2010

This report presents range and distribution of Prairie Rattlesnake (ARADE02120) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

**Range Notes**
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.453
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

*Doug Keinath*, Senior Zoologist
*Mark Andersen*, GIS Specialist

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Distribution Model (Version: Tue Mar 16 17:04:14 MDT 2010)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Year-Round
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Product, Quadratic, Hinge, Threshold
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.3930900
- High-Probability Threshold Value: 0.5525965
- Low-Probability Threshold Value: 0.0351664

Model Quality Summary
**Overall Assessment of Model Quality:** MEDIUM
Expert Assessment: Medium
Occurrence Sample Size: High
Quality of Occurrences: Medium
Positive Success Rate: Low
Test AUC and Model Gain: Medium

Model Evaluation Statistics
**Final Model Statistics**
Training AUC: 0.816
Regularized Training Gain: 0.630

Cross-Validation Statistics
- Average Test AUC: 0.777 ± 0.028
- Upper Bound on Test AUC: 0.795
- Average Test Gain: 0.573 ± 0.134
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.36 ± 0.10
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 359
- Number of Occurrences used to create distribution model: 281
- Average Point Quality Index (highest quality is 12.00): 6.88 ± 2.07
- Most recent occurrence used: 2008
- Oldest occurrence used: 1935
- Occurrence File: LOCAL_SAMPLE_POINTS_W_PDOG_2.csv

Comments
There are no additional comments specific to this species range map or distribution model.

References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wettest quarter mean temperature</td>
<td>31</td>
</tr>
<tr>
<td>Coldest month mean minimum temperature</td>
<td>19</td>
</tr>
<tr>
<td>Annual number of Frost Days</td>
<td>17</td>
</tr>
<tr>
<td>Mean diurnal temperature range</td>
<td>13</td>
</tr>
<tr>
<td>Precipitation of the warmest quarter</td>
<td>11</td>
</tr>
<tr>
<td>Relative Humidity of most humid month</td>
<td>9</td>
</tr>
</tbody>
</table>

Response Curves
Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).

- **Wettest quarter mean temperature**
- **Coldest month mean minimum temperature**
- **Annual number of Frost Days**
- **Mean diurnal temperature range**
- **Precipitation of the warmest quarter**
- **Relative Humidity of most humid month**
Midget Faded Rattlesnake (*Crotalus oreganus concolor*)

Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Midget Faded Rattlesnake (ARADE02123) in Wyoming (see Keinath et al. 2010b). Similar reports were developed by the Wyoming Natural Diversity Database for terrestrial vertebrate species of conservation need in Wyoming’s State Wildlife Action Plan. This effort was supported by the Wyoming Game and Fish Department and the U.S. Geological Survey.

Range Notes
- Version: 2010-01-19
- Proportion of range deemed known based on documented occurrences: 0.583
- Details of range map creation noted in Keinath et al. (2010a).

Maps, models and report were created by and are available from the Wyoming Natural Diversity Database. (http://uwadmnweb.uwyo.edu/wyndd/).

*Doug Keinath*, Senior Zoologist

*Mark Andersen*, GIS Specialist

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Distribution Model (Version: Wed Mar 17 00:42:40 MDT 2010)
Details of distribution model creation are presented in Keinath et al. (2010b)

Model Parameters
- Season Modeled: Summer (1-May-30-Sep)
- Algorithm: Maxent version 3.3.1
- Feature Types: Linear, Product
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.1603490
- High-Probability Threshold Value: 0.5274099
- Low-Probability Threshold Value: 0.1603490

Model Evaluation - ROC Plot

Model Quality Summary
- Overall Assessment of Model Quality: HIGH
- Expert Assessment: Medium
- Occurrence Sample Size: Medium
- Quality of Occurrences: High
- Positive Success Rate: Very High
- Test AUC and Model Gain: High

Model Evaluation Statistics
- Final Model Statistics
  - Training AUC: 0.984
  - Regularized Training Gain: 2.886

Cross-Validation Statistics
- Average Test AUC: 0.973 ± 0.032
- Upper Bound on Test AUC: 0.978
- Average Test Gain: 2.572 ± 1.272
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.03 ± 0.11
## Occurrence Data for Distribution Model

### Occurrence Map

![Occurrence Map](image)

#### Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 315
- Number of Occurrences used to create distribution model: 35
- Average Point Quality Index (highest quality is 12.00): 9.60 ± 3.28
- Most recent occurrence used: 2006
- Oldest occurrence used: 1946
- Occurrence File: LOCAL_SAMPLE_POINTS_W_PDOG_2.csv

### Comments
There are no additional comments specific to this species range map or distribution model.

### References

Predictor Variables used in the Distribution Model

Percent Contribution (PC) to final model

<table>
<thead>
<tr>
<th>Environmental Variable</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Relative Humidity Range</td>
<td>47</td>
</tr>
<tr>
<td>Precipitation of the wettest month</td>
<td>46</td>
</tr>
<tr>
<td>Herbaceous Cover Index</td>
<td>5</td>
</tr>
<tr>
<td>Distance to Permanent Water</td>
<td>1</td>
</tr>
<tr>
<td>Vector Ruggedness Measure</td>
<td>1</td>
</tr>
<tr>
<td>Pinon-Juniper Index</td>
<td>0</td>
</tr>
</tbody>
</table>

Response Curves

Each curve shows dependence of predicted suitability on input values of a single predictor variable considering correlations with others. Suitability is on the vertical axis (units: probability). Variable values are on the horizontal axis (units based on inputs; see Keinath et al 2010b for details).