Tiger Salamander (*Ambystoma mavortium*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Tiger Salamander (AAAA01140) 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: 0.277
- 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: Tue Apr 13 15:32:41 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: 10 percentile training presence
• Binary Threshold Value: 0.2314270
• High-Probability Threshold Value: 0.5422827
• Low-Probability Threshold Value: 0.0506449

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: 0.717
Regularized Training Gain: 0.338

Cross-Validation Statistics
• Average Test AUC: 0.715 ± 0.043
• Upper Bound on Test AUC: 0.723
• Average Test Gain: 0.329 ± 0.141
• Omission Error (fraction of test points omitted during 10-fold cross validation): 0.35 ± 0.12
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 829
- Number of Occurrences used to create distribution model: 228
- Average Point Quality Index (highest quality is 12.00): 9.55 ± 2.94
- Most recent occurrence used: 2008
- Oldest occurrence used: 1899
- Occurrence File: DRAFT_3_SAGE_WATER_RERUNS.csv

Comments
This species is ubiquitous in Wyoming and occurs within a variety of habitat types. It is therefore difficult to develop an uniformly-accurate environmental niche model that can be effectively applied across the state. 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>Annual number of Frost Days</td>
<td>65</td>
</tr>
<tr>
<td>Distance to Permanent Water</td>
<td>31</td>
</tr>
<tr>
<td>Mean diurnal temperature range</td>
<td>4</td>
</tr>
<tr>
<td>Elevation</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

Distance to Permanent Water

Mean diurnal temperature range

Elevation
Boreal Toad (Anaxyrus boreas boreas)
Range Map and Distribution Model Summary
August 20, 2010

This report presents range and distribution of Boreal Toad (AAABB01031) 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: 0.406
• 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 08:05:42 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: 0.2772690
  - High-Probability Threshold Value: 0.5574093
  - Low-Probability Threshold Value: 0.0024045

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

Model Evaluation Statistics
- Final Model Statistics
  - Training AUC: 0.916
  - Regularized Training Gain: 1.477

Cross-Validation Statistics
- Average Test AUC: 0.909 ± 0.016
- Upper Bound on Test AUC: 0.913
- Average Test Gain: 1.430 ± 0.219
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.03± 0.03
Occurrence Data for Distribution Model

Occurrence Summary Statistics

- Number of Occurrences in AWVED master dataset: 1,690
- Number of Occurrences used to create distribution model: 256
- Average Point Quality Index (highest quality is 12.00): 8.97 ± 3.00
- Most recent occurrence used: 2008
- Oldest occurrence used: 1940
- Occurrence File: LOCAL_SAMPLE_POINTS_W__PD0G_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>Warmest quarter mean temperature</td>
<td>41</td>
</tr>
<tr>
<td>Wettest quarter mean temperature</td>
<td>35</td>
</tr>
<tr>
<td>Distance to Permanent Water</td>
<td>7</td>
</tr>
<tr>
<td>Annual Relative Humidity Range</td>
<td>7</td>
</tr>
<tr>
<td>Precipitation of the driest month</td>
<td>6</td>
</tr>
<tr>
<td>Precipitation of the coldest quarter</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).

[Graphs of response curves for various predictor variables]
Great Plains Toad (*Anaxyrus cognatus*)
Range Map and Distribution Model Summary
August 20, 2010

This report presents range and distribution of Great Plains Toad (AAABB01050) 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: 0.049
- 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, Quadratic, Hinge
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.1931160
- High-Probability Threshold Value: 0.6607317
- Low-Probability Threshold Value: 0.0900393

Model Quality Summary

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

Model Evaluation Statistics

Final Model Statistics
Training AUC: 0.968
Regularized Training Gain: 2.031

Cross-Validation Statistics
- Average Test AUC: 0.949 ± 0.053
- Upper Bound on Test AUC: 0.950
- Average Test Gain: 1.990 ± 1.128
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.15 ± 0.24
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 55
- Number of Occurrences used to create distribution model: 20
- Average Point Quality Index (highest quality is 12.00): 9.65 ± 2.83
- Most recent occurrence used: 2008
- Oldest occurrence used: 1949
- Occurrence File: LOCAL_SAMPLE_POINTS.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>Elevation</td>
<td>29</td>
</tr>
<tr>
<td>Herbaceous Cover Index</td>
<td>25</td>
</tr>
<tr>
<td>Pinon-Juniper Index</td>
<td>17</td>
</tr>
<tr>
<td>Radiation of the lightest month</td>
<td>11</td>
</tr>
<tr>
<td>Variation in monthly radiation</td>
<td>9</td>
</tr>
<tr>
<td>Hottest month mean maximum temperature</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).

- **Elevation**
- **Herbaceous Cover Index**
- **Pinon-Juniper Index**
- **Radiation of the lightest month**
- **Variation in monthly radiation**
- **Hottest month mean maximum temperature**
Rocky Mountain Toad (*Anaxyrus woodhousii woodhousii*)
Range Map and Distribution Model Summary
August 20, 2010

This report presents range and distribution of Rocky Mountain Toad (AAABB01180) 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: 0.141
- 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 Dec 04 22:03:17 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, Product, Quadratic, Hinge, Threshold
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.3089790
- High-Probability Threshold Value: 0.6768350
- Low-Probability Threshold Value: 0.0158477

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: High

Model Evaluation Statistics
Final Model Statistics
Training AUC: 0.942
Regularized Training Gain: 1.613

Cross-Validation Statistics
- Average Test AUC: 0.914 ± 0.033
- Upper Bound on Test AUC: 0.918
- Average Test Gain: 1.541 ± 0.370
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.14 ± 0.10
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 671
- Number of Occurrences used to create distribution model: 106
- Average Point Quality Index (highest quality is 12.00): 10.36 ± 2.87
- Most recent occurrence used: 2008
- Oldest occurrence used: 1910
- Occurrence File: LOCAL_SAMPLE_POINTS.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>Warmest quarter mean temperature</td>
<td>25</td>
</tr>
<tr>
<td>Variation in monthly radiation</td>
<td>18</td>
</tr>
<tr>
<td>Elevation</td>
<td>18</td>
</tr>
<tr>
<td>Cottonwood Index</td>
<td>15</td>
</tr>
<tr>
<td>Variation of monthly precipitation</td>
<td>13</td>
</tr>
<tr>
<td>Precipitation of the coldest quarter</td>
<td>11</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).

- **Warmest quarter mean temperature**
- **Variation in monthly radiation**
- **Elevation**
- **Cottonwood Index**
- **Variation of monthly precipitation**
- **Precipitation of the coldest quarter**
Wyoming Toad (*Anaxyrus baxteri*)
Range Map and Distribution Model Summary
August 20, 2010

This report presents range and distribution of Wyoming Toad (AAABB01220) 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: 0.750
- 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 02:27:23 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
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.2238890
- High-Probability Threshold Value: 0.6466638
- Low-Probability Threshold Value: 0.2238890

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

Model Evaluation Statistics
Final Model Statistics
Training AUC: 0.998
Regularized Training Gain: 4.631

Cross-Validation Statistics
- Average Test AUC: 0.993 ± 0.016
- Upper Bound on Test AUC: 0.994
- Average Test Gain: 4.325 ± 2.282
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.20 ± 0.42
Occurrence Data for Distribution Model

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 133
- Number of Occurrences used to create distribution model: 10
- Average Point Quality Index (highest quality is 12.00): 6.10 ± 2.56
- Most recent occurrence used: 1990
- Oldest occurrence used: 1946
- Occurrence File: LOCAL_SAMPLE_POINTS.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>Standard deviation of monthly temperature</td>
<td>43</td>
</tr>
<tr>
<td>Interannual variation in annual frost days</td>
<td>17</td>
</tr>
<tr>
<td>Vector Ruggedness Measure</td>
<td>15</td>
</tr>
<tr>
<td>Degree Slope</td>
<td>11</td>
</tr>
<tr>
<td>Conifer Index</td>
<td>9</td>
</tr>
<tr>
<td>Distance to Water Shoreline</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).

![Standard deviation of monthly temperature](image1)
![Interannual variation in annual frost days](image2)
![Vector Ruggedness Measure](image3)
![Degree Slope](image4)
![Conifer Index](image5)
![Distance to Water Shoreline](image6)
Boreal Chorus Frog (*Pseudacris maculata*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Boreal Chorus Frog (AAABC05130) 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: 0.298
- 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://uwadmweb.uwyo.edu/wyndd/).

**Doug Keinath**, Senior Zoologist

**Mark Andersen**, GIS Specialist

© 2010, WYNDD
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: 0.4407440
- High-Probability Threshold Value: 0.5880334
- Low-Probability Threshold Value: 0.1500802

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

Model Evaluation Statistics
Final Model Statistics
Training AUC: 0.822
Regularized Training Gain: 0.400

Cross-Validation Statistics
- Average Test AUC: 0.699 ± 0.055
- Upper Bound on Test AUC: 0.742
- Average Test Gain: 0.230 ± 0.165
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.42± 0.19
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 353
- Number of Occurrences used to create distribution model: 97
- Average Point Quality Index (highest quality is 12.00): 7.88 ± 2.78
- Most recent occurrence used: 2008
- Oldest occurrence used: 1950
- Occurrence File: DRAFT_3_SAGE_WATER_RERUNS.csv

Comments
This species is ubiquitous in Wyoming and occurs within a variety of habitat types. It is therefore difficult to develop an uniformly-accurate environmental niche model that can be effectively applied across the state. 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>Forest Cover Index</td>
<td>32</td>
</tr>
<tr>
<td>Variation in monthly radiation</td>
<td>18</td>
</tr>
<tr>
<td>Coldest month mean minimum temperature</td>
<td>18</td>
</tr>
<tr>
<td>Distance to Permanent Water</td>
<td>16</td>
</tr>
<tr>
<td>Elevation</td>
<td>12</td>
</tr>
<tr>
<td>Annual precipitation range (P3 – P2)</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).
Plains Spadefoot (*Spea bombifrons*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Plains Spadefoot (AAABF02010) 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: 0.085
- 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

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: 0.3328540
- High-Probability Threshold Value: 0.5650452
- Low-Probability Threshold Value: 0.1037380

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: Medium

Model Evaluation Statistics

Final Model Statistics
Training AUC: 0.804
Regularized Training Gain: 0.596

Cross-Validation Statistics
- Average Test AUC: 0.766 ± 0.085
- Upper Bound on Test AUC: 0.787
- Average Test Gain: 0.371 ± 0.580
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.29 ± 0.15
Occurrence Data for Distribution Model

Occurrence Summary Statistics

- Number of Occurrences in AWVED master dataset: 79
- Number of Occurrences used to create distribution model: 37
- Average Point Quality Index (highest quality is 12.00): 7.84 ± 2.73
- Most recent occurrence used: 2008
- Oldest occurrence used: 1949
- Occurrence File: LOCAL_SAMPLE_POINTS.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. 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>Elevation</td>
<td>52</td>
</tr>
<tr>
<td>Percent Forest Cover</td>
<td>21</td>
</tr>
<tr>
<td>Radiation of the lightest month</td>
<td>16</td>
</tr>
<tr>
<td>Standard deviation of monthly temperature</td>
<td>6</td>
</tr>
<tr>
<td>Soil texture</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).

- **Elevation**
- **Percent Forest Cover**
- **Radiation of the lightest month**
- **Standard deviation of monthly temperature**
- **Soil texture**
Great Basin Spadefoot (*Spea intermontana*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Great Basin Spadefoot (AAABF02030) 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: 0.151
- 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

© 2010, WYNDD
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: 0.1534280
- High-Probability Threshold Value: 0.5893315
- Low-Probability Threshold Value: 0.1534277

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

Model Evaluation Statistics
- Final Model Statistics
  - Training AUC: 0.903
  - Regularized Training Gain: 1.245

Cross-Validation Statistics
- Average Test AUC: 0.882 ± 0.070
- Upper Bound on Test AUC: 0.889
- Average Test Gain: 1.238 ± 0.726
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.12± 0.19
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics

- Number of Occurrences in AWVED master dataset: 63
- Number of Occurrences used to create distribution model: 27
- Average Point Quality Index (highest quality is 12.00): 7.96 ± 2.36
- Most recent occurrence used: 2005
- Oldest occurrence used: 1950
- 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>Precipitation of the warmest quarter</td>
<td>68</td>
</tr>
<tr>
<td>Conifer Index</td>
<td>13</td>
</tr>
<tr>
<td>Soil - Fraction Sand</td>
<td>7</td>
</tr>
<tr>
<td>Depth to Shallowest Restrictive Layer</td>
<td>7</td>
</tr>
<tr>
<td>Distance to Permanent Water</td>
<td>3</td>
</tr>
<tr>
<td>Contagion Index</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).

- **Precipitation of the warmest quarter**
  - Minimum: 44
  - Maximum: 222

- **Conifer Index**
  - Minimum: 0
  - Maximum: 0.15

- **Soil - Fraction Sand**
  - Minimum: 0
  - Maximum: 0.37

- **Depth to Shallowest Restrictive Layer**
  - Minimum: 0
  - Maximum: 261

- **Distance to Permanent Water**
  - Minimum: 0
  - Maximum: 12659.076

- **Contagion Index**
  - Minimum: 4
  - Maximum: 100
American Bullfrog (*Lithobates catesbieanus*)
Range Map and Distribution Model Summary
August 20, 2010

This report presents range and distribution of American Bullfrog (AAABH01070) 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: 0.286
- 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
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.5363030
- High-Probability Threshold Value: 0.6150528
- Low-Probability Threshold Value: 0.5363030

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: 0.999
Regularized Training Gain: 4.643

Cross-Validation Statistics
- Average Test AUC: 0.296 ± 0.476
- Upper Bound on Test AUC: 0.996
- Average Test Gain: -0.483 ± 3.993
- Omission Error (fraction of test points omitted during 3-fold cross validation): 0.67± 0.58
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: 3
- Average Point Quality Index (highest quality is 12.00): 4.67 ± 0.58
- Most recent occurrence used: 1987
- Oldest occurrence used: 1985
- 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. 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>Distance to Water</td>
<td>42</td>
</tr>
<tr>
<td>Warmest quarter mean temperature</td>
<td>19</td>
</tr>
<tr>
<td>Depth to Shallowest Restrictive Layer</td>
<td>13</td>
</tr>
<tr>
<td>Radiation Load</td>
<td>11</td>
</tr>
<tr>
<td>Degree Slope</td>
<td>10</td>
</tr>
<tr>
<td>Elevation</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).

- **Distance to Water**

- **Warmest quarter mean temperature**

- **Depth to Shallowest Restrictive Layer**

- **Radiation Load**

- **Degree Slope**

- **Elevation**
Northern Leopard Frog (*Lithobates pipiens*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Northern Leopard Frog (AAABH01170) 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: 0.458
- 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: 0.4196310
- High-Probability Threshold Value: 0.5416970
- Low-Probability Threshold Value: 0.0122484

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: 0.819
Regularized Training Gain: 0.728

Cross-Validation Statistics
- Average Test AUC: 0.812 ± 0.062
- Upper Bound on Test AUC: 0.806
- Average Test Gain: 0.677 ± 0.376
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.29± 0.13
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 1,099
- Number of Occurrences used to create distribution model: 225
- Average Point Quality Index (highest quality is 12.00): 9.80 ± 2.84
- Most recent occurrence used: 2008
- Oldest occurrence used: 1950
- 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>Distance to Permanent Water</td>
<td>36</td>
</tr>
<tr>
<td>Deciduous Forest Index</td>
<td>18</td>
</tr>
<tr>
<td>Precipitation of the coldest quarter</td>
<td>16</td>
</tr>
<tr>
<td>Variation in monthly radiation</td>
<td>16</td>
</tr>
<tr>
<td>Annual Radiation range</td>
<td>13</td>
</tr>
<tr>
<td>Forest Cover Index</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).
Wood Frog (*Lithobates sylvaticus*)
Range Map and Distribution Model Summary
August 20, 2010

This report presents range and distribution of Wood Frog (AAABH01200) 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: 0.375
- 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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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: 0.0461280
- High-Probability Threshold Value: 0.5653131
- Low-Probability Threshold Value: 0.0461280

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

Model Evaluation Statistics
**Final Model Statistics**
Training AUC: 0.985
Regularized Training Gain: 3.059

Cross-Validation Statistics
- Average Test AUC: 0.977 ± 0.023
- Upper Bound on Test AUC: 0.982
- Average Test Gain: 2.855 ± 0.792
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.05 ± 0.08
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 405
- Number of Occurrences used to create distribution model: 62
- Average Point Quality Index (highest quality is 12.00): 10.32 ± 2.02
- Most recent occurrence used: 2003
- Oldest occurrence used: 1963
- 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. 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>55</td>
</tr>
<tr>
<td>Wettest quarter mean temperature</td>
<td>21</td>
</tr>
<tr>
<td>Sagebrush Index</td>
<td>8</td>
</tr>
<tr>
<td>Forest Cover Index</td>
<td>7</td>
</tr>
<tr>
<td>Deciduous Forest Index</td>
<td>6</td>
</tr>
<tr>
<td>Distance to Permanent Water</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).

Conifer Index

Wettest quarter mean temperature

Sagebrush Index

Forest Cover Index

Deciduous Forest Index

Distance to Permanent Water
Columbia Spotted Frog (*Rana luteiventris*)
Range Map and Distribution Model Summary

August 20, 2010

This report presents range and distribution of Columbia Spotted Frog (AAABH01290Q) 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: 0.515
- 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 10:36:27 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, Product, Quadratic, Hinge, Threshold
- Binary Threshold Rule: Maximum training sensitivity plus specificity
- Binary Threshold Value: 0.2362600
- High-Probability Threshold Value: 0.5391309
- Low-Probability Threshold Value: 0.0013363

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: Very High
Test AUC and Model Gain: High

Model Evaluation Statistics

Final Model Statistics
Training AUC: 0.949
Regularized Training Gain: 1.941

Cross-Validation Statistics
- Average Test AUC: 0.943 ± 0.010
- Upper Bound on Test AUC: 0.945
- Average Test Gain: 1.920 ± 0.198
- Omission Error (fraction of test points omitted during 10-fold cross validation): 0.02± 0.01
Occurrence Data for Distribution Model

Occurrence Map

Occurrence Summary Statistics
- Number of Occurrences in AWVED master dataset: 2,219
- Number of Occurrences used to create distribution model: 291
- Average Point Quality Index (highest quality is 12.00): 10.33 ± 2.26
- Most recent occurrence used: 2008
- Oldest occurrence used: 1950
- Occurrence File: LOCAL_SAMPLE_POINTS.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>Precipitation of the driest quarter</td>
<td>69</td>
</tr>
<tr>
<td>Variation in monthly radiation</td>
<td>14</td>
</tr>
<tr>
<td>Precipitation of the driest month</td>
<td>9</td>
</tr>
<tr>
<td>Elevation</td>
<td>3</td>
</tr>
<tr>
<td>Variation of monthly precipitation</td>
<td>2</td>
</tr>
<tr>
<td>Degree Slope</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 driest quarter**
- **Variation in monthly radiation**
- **Precipitation of the driest month**
- **Elevation**
- **Variation of monthly precipitation**
- **Degree Slope**