Predicting the distributional shift of the Japanese pika under climate change

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Introduction
- Shifts in species distribution have been observed globally as a response to recent climate change
  ➔ Predicting suitable habitat of climatically sensitive species is a pressing need to maximize conservation outcomes
- Species distribution model (SDM) is used to understand relationships between distribution and environment
  ➔ Suitable area in the future can be predicted by using future climate data
- Japanese pika (*Ochotona hyperborea yesoensis*)
  ➔ Pikas belong to Lagomorpha (order of rabbits, hares, and pikas)
  ➔ Occurs in rocky terrains in forests and alpines in central Hokkaido, Japan
  ➔ Designated as Near Threatened species under Japanese Red List
  ➔ Vulnerable to heat stress (activity lowers when temperature exceeds 20°C)

Objective: I aimed to understand how Japanese pika distribution will shift under climate change

Materials and Methods
1. Compilation of species distribution data
   I. Survey of literature reporting distribution points on maps
   II. Organization of reported information (year, methods, etc.)
   III. Georeference (data digitization) of distribution points using GIS

2. SDM analysis (Preliminary analysis)
   ➔ Historical distribution data: n=261 (identified in step 1)
   ➔ SDM algorithm: maxlike
   ➔ Model selection: lowest AIC
   ➔ Evaluation of model performance: AUC*
   ➔ Binarization threshold for presence/absence: max TSS**
   ➔ Climate projection: MIROC-ESM

Historical (1970-2000) ➔ Future (2060-2080, RCP2.6 & 8.5)

* AUC: Area Under the Curve  ** TSS: True Skill Statistic

Results & Discussion

1. Compilation of species distribution data
   I. Literature survey
      ➔ 21 literature reported species distribution on maps
   II. Distribution information
      ➔ 302 observations ➔ 261 reliable presence data

Number of observations reported

<table>
<thead>
<tr>
<th>Occurrence status</th>
<th>Year and methods explained</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Presence</td>
<td>261</td>
<td>11</td>
</tr>
<tr>
<td>Absence</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>291</td>
<td>11</td>
</tr>
</tbody>
</table>

2. SDM analysis (Preliminary analysis)
   ➔ Global model was selected as best model
   ➔ Model performance was moderate: AUC=0.87

Effects of each predictor on distribution

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Historical</th>
<th>Future: RCP2.6</th>
<th>Future: RCP8.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean summer temp</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Annual precipitation</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Winter precipitation</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Slope angle</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Surface geology</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

For historical data, mountain summits and their margins are predicted as suitable area. In the future, the lower margins are predicted to become unsuitable.
➔ Habitat isolation is likely to occur
➔ It is necessary to conduct population monitoring

Environmental predictors*** Explanation
Mean summer temp (bio10) Species vulnerability to heat
Annual precipitation (bio12) Indicator for plant growth
Winter precipitation (bio19) Thermal insulation of snow
Slope angle Topography of rocky terrains
Surface geology Potential of rocky terrain

*** These variables are for the current preliminary analysis. More variables will be considered later in the research.

Methods used to identify the species presence*

<table>
<thead>
<tr>
<th>Year of surveys</th>
<th>Total</th>
<th>Sight</th>
<th>Hearing</th>
<th>Feces</th>
<th>Haypile</th>
<th>Eatmark</th>
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</thead>
<tbody>
<tr>
<td>1963-2008</td>
<td>261</td>
<td>78</td>
<td>202</td>
<td>37</td>
<td>48</td>
<td>9</td>
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<td></td>
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</tr>
</tbody>
</table>

*Lack of species distribution data precluded the prediction, so compilation of occurrence records is necessary.

Results & Discussion

For historical data, mountain summits and their margins are predicted as suitable area. In the future, the lower margins are predicted to become unsuitable.
➔ Habitat isolation is likely to occur
➔ It is necessary to conduct population monitoring