Problem Statement

The effect of global climate change on the population dynamics of Pine snakes.
What is the deal with temperature and Pine snakes?

• Pine snakes are native to SE corridor of America with dense populations on the Pine Barrens of New Jersey
• These snakes are classified as threatened due to habitat loss
• Burger and Zappalorti published a study on the effect of temperature on the sex ratio of Pine snakes
  • \( \frac{M}{F} = 0.068(T) - 0.95 \)
Let’s get some things straight...

1. The carrying capacity \(N\) for the model is based on the data given by Burger and Zappalorti.

2. The growth rate for the male population is 33% and for the female population it is 25%.

3. The global temperature will raise 1.5-2°C by the end of this century and the 2017 global temperature was 14.7°C.
I dunno what’s the model with you?

\[ \frac{dM}{dt} = k_M P_M \left( 1 - \frac{P_M}{N} \right) + \alpha P_M P_F \]
\[ \frac{dF}{dt} = k_F P_F \left( 1 - \frac{P_F}{N} \right) + \beta P_M P_F \]

For when:

\( \frac{M}{F} > 1 \), \( \alpha = 1 \) \( \beta = -1 \)

\( \frac{M}{F} < 1 \), \( \alpha = -1 \) \( \beta = 1 \)

\( \frac{M}{F} = 1 \), \( \alpha = 1 \) \( \beta = 1 \)

\( \frac{M}{F} = 0 \), \( \alpha = -1 \) \( \beta = -1 \)
So who benefits?

<table>
<thead>
<tr>
<th>T(°C)</th>
<th>Sex Ratio</th>
<th>α</th>
<th>β</th>
<th>M:F Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>T&gt;28.7</td>
<td>( \frac{M}{F} &gt; 1 )</td>
<td>1</td>
<td>-1</td>
<td>( P_M ) Benefits</td>
</tr>
<tr>
<td>14&lt;T&lt;28.7</td>
<td>( 0 &lt; \frac{M}{F} &lt; 1 )</td>
<td>-1</td>
<td>1</td>
<td>( P_F ) Benefits</td>
</tr>
<tr>
<td>28.7</td>
<td>( \frac{M}{F} = 1 )</td>
<td>1</td>
<td>1</td>
<td>Equal</td>
</tr>
<tr>
<td>14</td>
<td>( \frac{M}{F} = 0 )</td>
<td>-1</td>
<td>-1</td>
<td>( P_M \ &amp; \ P_F ) Suffer</td>
</tr>
</tbody>
</table>
So what should we expect?

- Currently, we are within the $14^\circ<T<28.7^\circ\text{C}$ range of our model
- Generally we should see a demographic shift towards females
  - The female population will increase towards the carrying capacity for the system while the male population decreases towards zero
  - These trends are consistent throughout all our initial conditions
So what does this all mean?

1. Over the next centuries, Pine snakes will shift towards female-female competition for sexual selection.

2. Female Pine snakes will adapt traits to discourage other females or increase their ability to find males.

3. Male Pine snakes will adapt traits to either increase their chances of survival or increase their abilities to impregnate females.
What are some examples of advantageous adaptations?

• There are no examples of sexual dimorphism in Pine snakes

• Under the evolutionary pressures of climate change sexual dimorphism will develop in Pine snakes
  • Females will allocate a larger proportion of their bodies towards organs that help them store energy, fight other females, and pursue males
  • Males will allocate a larger proportion of their bodies towards organs that help them find females and increase sperm count
References


