Introduction:

The sex of reptiles, in particular the Pine Snakes, depend on the incubation temperature. In a study done by Burger and Zappalorti, it was concluded that there is a linear dependence between incubation temperature (Celsius) and the sex ratio (male/female). One question that arises is what might happen if there are rapid changes in environmental temperatures. For example, one prediction about climate change is that there will be larger variations in yearly temperatures.

The goal of this paper is to determine how climate change will affect a hypothetical pine snake population located in the state of Louisiana. The total snake population is modeled with exponential growth with an adjustment for a fixed survival rate. Then based on the male to female ratio, as well as the variation in temperature through the year, the populations of male and female Pine Snakes are plotted using Matlab.

Assumptions:

1. The pine snake population is located in Louisiana
2. Pine snakes are able to reproduce immediately after birth
3. The Initial male and female population are equivalent
4. Each pine snake has one mate and lays eggs once per year
5. The survival rate for male and female pine snakes is the same
6. The impact of evolutionary pressure is the same for male and female snakes

Pine Snake Population Model

To model the population of the Pine Snakes, four independent differential equation where used. The Pine Snake Population was modeled with exponential growth, Temperature was based on an estimated fluctuation with an increasing average annual trend. The two equations representing male and female population were derived from the assumption that the total population is equal to male snakes plus female snakes, as well as the assumption that $s$ is the ratio of male snakes to female snakes. These two equations were combined and then implicitly differentiated to find the rate of change for male and female pine snakes.
Pine Snake population Model continued

\[
\frac{dP}{dt} = (m + f)(b - a) \tag{1}
\]
\[
\frac{dm}{dt} = \frac{dp}{dt}s + \frac{ds}{dt}(f) \tag{2}
\]
\[
\frac{df}{dt} = \frac{dp}{dt} - \frac{ds}{dt}(f) \tag{3}
\]
\[
\frac{dT}{dt} = A\cos(2\pi t) + c \tag{4}
\]

- \(m\) represents male pine snakes, and \(f\) represents female pine snakes, the total snake population is represented by \(P\).
- \(b\) is the average amount of offspring pine snake couples make, \(a\) is the chance that the pine snake survives.
- \(s\) is the male to female ratio of the pine snakes, \(A\) is the average annual temperature (Celsius) variation and \(c\) is the average annual temperature (Celsius) increase, \(d\) is the change in survival rate. The change in survival rate is based on evolutionary pressure.

![Figure 1: Graph of model, the male snake population is increasing at a higher rate than the female snake population.](image)

**Conclusion**

Based on the results of our model of the pine snake population, there is a significant difference in male and female population starting around the 4 year mark. Therefore from this model we conclude that it will only take around four years for the male population of pine snakes to outgrow the female population. This change is based on an increasing average temperature.