Predator – Pray Model of Canadian Lynx and Snowshoe Hare

Abstract:

Problem Statement:

Predator-prey models are the building blocks of the bio and ecosystems as bio-masses are grown out of their resource masses. There are different Predator-prey models like a single specialist (basic model) and two specialists (LG and LC model) models are present for the solution but these are not able to provide complete quantitative information about the hare cycle. Due to lake of information, we are not able to investigate the problem.

Goal:

Improves the efforts of past modeling in two ways and builds a model for three specialists.

This model will provide the solution nearly to the predator and hare cycles according to the cycle period, hare, and predator distributions.

This model will also show the role each specialist of the model specialist plays in the hare cycle.

Purpose Method:

For this particular project, we will build a model for three specialists who will find that how the predators interact with the population of hares. The study of the Kluane in the Yukon Territory gives data about the lynx, the coyote and the great horned owl respond to varying hare densities as specialist predators. We will evaluate a model which able to empirical data through the investigation of three cycles (period cycle, prey and predator densities) for the prey, and each specialist predator. Our model will give the qualitative rather than quantitative behavior of the lynx-hare system which provides only a single specialist predator.

Used Method:

We have a method which used to fulfill our goals, which involve following steps:

Firstly, we calculate the population of hares in case of no lynx are present. Suppose that when there is no lynx present then the rate of reproduction of hares is proportional to their population and it will be increased exponentially. Thus the equation becomes which shows the rate change of hares population:

$$\frac{dH}{dt} = aH$$

Where H denoted hares population.

Secondly, we calculate the rate at which hares consumed. In the case of lynx prey to hares, the rate at which hares consumed by the predator proportional to the rate at which both lynx and hares interact. So, the above equation of rate change of hares population becomes as follow:

$$\frac{dH}{dt} = aH - bHL$$

In the above Equation, HL denoted the possible numbers of interactions between prey and predator (lynx and hares) population.

Thirdly, in case of no food present, the rate change of lynx population or rate of decline of lynx population is proportional to itself. The equation of rate change of lynx population is:

$$\frac{dL}{dt} = -cL$$

Where L is indicate the population of lynx.

Fourthly, we calculate the rate of growth of lynx population through the following equation:

$$\frac{dL}{dt} = -cL + dHL$$

And HL as the possible numbers of interactions of prey and predator in above equation.

The lynx received the hug benefit from the hares population. The born rate of lynx is proportional to the rate of numbers of hares eaten by the lynx, and this whole rate is proportional to the rate at which both hares and lynx are interact with each other.

Now, we have a system of linear equations which help us to analyze that how the prey and predator interacts with each other, how their rate change of their populations vary and their dependencies to each other.

Results and Discussions:-

In the presence of predators, many prey species change their behaviour due to predation risk and show a variety of anti-predator responses, which incorporates foraging activity, habitat alterations, vigilance and some physiological changes, etc. It is also observed that due to fear of predation risk, the reproduction rate of the scared prey decreases.

In this project we have observed that how the effect of one specie in predator prey model effects the population of each other. We observed this behavior on already available open source data of Hudson Bay Company about the population of Canadian lynx and the snowshoe hare from 1847 to 1903.

Our study shows that when there are less predators then the population of prey will be rise at a very high rate. Similarly, the rate at which predator prey on a particular specie is proportional to the population of the species interacting.

On the other hand, if food availability is less means that there is less amount of prey, then predator population will decline due to hunger. Also the rate at which a predator born is proportional to the amount of eating of the prey. These all hypothesis are modeled using differential equations.