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Mathematical Modeling
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Crane Population Dynamical System

Among the wildlife at a state park, a population of 100 cranes has been decreasing by 3.24 percent annually. In order to keep the crane population from dissolving, along with maintaining the revenue from visitors who enjoy the crane sightings, it is paramount that the park manager grow and release approximately eight chicks per year – the limit their resources will allow. Additionally, the carrying capacity of the park is 200 cranes. Two things will be investigated:

1. How quickly can a population of 200 cranes be reached?
2. What will it take for such a population to be maintained?

To answer the first problem, a model must be devised to calculate the crane population after each year.

$$X_{n+1} = (1 - r)X_n + C$$

This model suggests that each successive year, X_{n+1}, will be the difference of the previous year, X_n, and the rate of decay, r, in the crane population throughout the year rX_n, with the addition of any cranes hatched and released in captivity, C. The rate of decline will be held constant throughout the following models at 3.24 percent.

Should the park decide not to raise any cranes in captivity and release them through the year, the crane population will dip below 50 by the 22nd year. However, using the park's resources fully, raising and releasing eight cranes per year, the population can increase by approximately three cranes per year for the next 34 years, reaching the carrying capacity of 200.

Thus, at the 35th year, the park will be at carrying capacity for cranes, so the model will have to be modified in order to keep the population from increasing to an intolerable weight. In order to calculate this, the model above is adjusted for solving of the constant of cranes to be hatched, C.

$$C = X_{n+1} - (1 - r)X_n$$

With the desired outcome of a crane population totaling 200, the equation above would yield approximately 6.48 cranes. Being that it is impossible to hatch 6.48 cranes in a year, the model was adjusted to hatch six and seven cranes in alternating fashion. So, six cranes in the 36th year (even), seven cranes in the 37th year (odd), six cranes in the 38th year, and so on. With this model, there would be approximately 200 cranes in the 35th and 200th year.