# Predator-Prey System Dynamics Analysis

This graph represents a classic predator-prey system model, often referred to as the Lotka-Volterra model in ecology. The graph shows population dynamics over a 100-year period with two distinct population curves:

* **Red line**: Prey population
* **Blue line**: Predator population

## Key Dynamics Observed:

1. **Cyclical Pattern**: Both populations exhibit regular oscillatory behavior with a consistent period of approximately 30-33 years per cycle.
2. **Phase Shift**: The predator population peaks consistently lag behind prey population peaks by about 5-10 time units.
3. **Amplitude**: The prey population shows higher amplitude, fluctuating between near-zero and peaks of about 70-73 individuals, while predator population fluctuates between approximately 13-35 individuals.

## Causal Relationships and Feedback Loops:

### Primary Feedback Loops:

1. **Positive Feedback (R1: Prey Growth Loop)**:
   * In the absence of predators, prey would grow exponentially due to reproduction
   * This is a reinforcing loop driving prey population growth
2. **Negative Feedback (B1: Predation Loop)**:
   * As prey population increases, it provides more food for predators
   * More food leads to increased predator reproduction and population
   * More predators increase prey death rate
   * Prey population consequently decreases
   * This is a balancing loop controlling prey population
3. **Negative Feedback (B2: Predator Starvation Loop)**:
   * As prey population decreases, predators have less food
   * Predator death rate increases due to starvation
   * Predator population decreases
   * Predation pressure on prey reduces
   * This is a balancing loop controlling predator population

### Sequence of Events in Each Cycle:

1. Low predator population allows prey to increase rapidly
2. Abundant prey enables predator population growth
3. Growing predator population consumes prey at increasing rates
4. Prey population collapses due to high predation
5. Predator population subsequently crashes due to food shortage
6. Low predator numbers allow prey to recover, starting the cycle again

The sustained oscillations demonstrate a stable limit cycle, indicating that this ecosystem maintains dynamic equilibrium without reaching a steady state. This classic ecological model effectively demonstrates how coupled populations can create endogenous cyclical behavior through interlinked feedback mechanisms.