

Brief Project Descriptions

1 Badger Culling

Culling is the process of removing breeding animals from the population based on certain criteria. In the case of badgers, the culling is typically done in an effort to reduce the number of cows infected by bovine tuberculosis (*Mycobacterium bovis*). Badgers are a vector for this disease and farmers in England want to reduce the costs due to bovine TB since infected cattle are typically destroyed. There is strong opposition to badger culling since there are questions on whether culling is effective and what damage is done to the badger population. In this project, you will build a population model for the badgers and determine under what conditions bovine TB would be endemic to the population as well as predicting the effect of culling on the badger population.

2 Native vs. Invasive Species

The introduction of an invasive species into a new environment can have catastrophic consequences for the native species. Examples of non-native species that out compete native wildlife include asian carp, kudzu, and zebra mussels. In this project, you will develop a population model between two competitive species and determine under what conditions would one population dominate the other and when both populations would coexist. Additionally, you will examine how predation of one species will effect the population dynamics.

3 Harvesting

When harvesting from a population, it is important to understand the effect of removing members has on the stability of the population. This is important for both farm grown and wild populations since over-harvesting can be a big concern for many animals species. In this project, you will develop a population model subject to logistic growth with harvesting. How does different harvesting strategies effect the total population? Can harvesting collapse the population? What is the maximum number of members that can be removed from the population without collapsing the entire population?

4 Age-Based Predation

Populations exhibit age structures, where the population is segregated into different age groups. For example, immature animals are unable to reproduce but age into mature animals that are capable of reproducing. Additionally, predators prey more often upon the immature members of the population so predation can exhibit age based structures. In this project, you will develop an age-structured population model of immature and mature members subject to predation. How does the population evolve in the absence of predation? How does age based predation affect the stable population sizes?

5 Zombie Model with Vital Dynamics

In this project, you will develop a model of the interaction between a human population that exhibits logistic growth with a zombie outbreak. Under what conditions will a zombie outbreak occur and how does births/deaths affect the dynamics of the epidemic?

6 SIR Vaccination Model with Vital Dynamics

Vaccination of young children can be an effective measure against the outbreak of numerous diseases. Diseases like smallpox and polio have been effectively eradicated in the United States by the use of vaccines. In this problem, you will develop an SIR model with Vital Dynamics that models the vaccination of susceptible population. Using this model, you will try to determine the effect vaccination has on the disease and make suggestions on effective vaccination strategies.

7 Vertical Transmission in a SIR Model with Vital Dynamics

Vertical transmission is the infection of offspring at birth by the mother. Examples of this type of infection might be HIV infections (vertical transmission is not the primary mode of infection for HIV and AIDS) where a fraction of births by an HIV-positive mother are infected. How does vertical transmission affect the dynamics of the infection?

8 Chytridiomycosis Infections in Amphibians

Chytridiomycosis is a fungal disease in amphibians and is linked to dramatic declines and extinctions of various species. In this project, you will develop a basic model of a SIR-type infection in a logistic population. How does the infection affect the stable population size and under what conditions would the infection cause the population to go to zero?

9 Latent Infection SIS Model

For some diseases, there is a time period between the time the patient becomes infected and when they can infect others. This latent period can have effects on the dynamics of the infection. In this project, you will develop a SIS-type model that incorporates a latent period and compare it to a SIS model without a latent period. A SIS-type model is similar to a SIR model except that there is no acquired immunity after recovering from the infection.

10 SIS Quarantine Model

A possible control mechanism during an epidemic is quarantining infected individuals. In this project, you will develop a SIS-type model with an additional quarantined group. How does a quarantine program affect the epidemic? Could it prevent the infection from becoming an epidemic and/or an endemic infection?

11 Mathematical Model of Vector Infection (Malaria)

Malaria is a mosquito-borne infection of humans caused by a type of microorganism called a protist. In this project, you will develop and analyze a mathematical model that incorporates the following aspects of a malarial outbreak: external source of infection and partial recovery.

12 Coupled SIS Models

The epidemiological models that we have seen so far have involved a homogeneous, well-mixed population. We can also develop a model that incorporates the interaction between two distinct, homogeneous, well-mixed populations. An example of where this type of model might be a isolated population (say on an island) that is visited by a different population. In this project, you will develop a coupled SIS model for each population. If a disease is endemic in one population but not in the other, under what conditions would the coupling cause the non-endemic population to become endemic?

13 Model of a Stocked Pay Fishing Lake

A stocked pay fishing lake is a commercial enterprise where fishermen pay to fish at a lake that is stocked with attractive species of fish (catfish, carp, trout, bass, etc.). In this project, you will develop a basic model for the dynamics of both the fish population in the lake and the number of fishermen. Does the model predict a stable steady fish population? How does stocking fish change the dynamics?

14 Warring Species

Many social species exhibit warfare where members of one group battles with one or more opposing groups. This behavior is see in many different species of insects such as ants as well chimpanzees and, of course, humans. In this project, you will develop a basic model that describes the population dynamics of two warring populations when the war lasts longer than a single generation. Which side wins? Do both populations kill each other off? Can the war last perpetually?