Effectiveness of Culling Conservation Strategy for Survival of Tasmanian Devils

Ralitza Mondal ‘19- (Sponsor:Professor Dana Bauer)

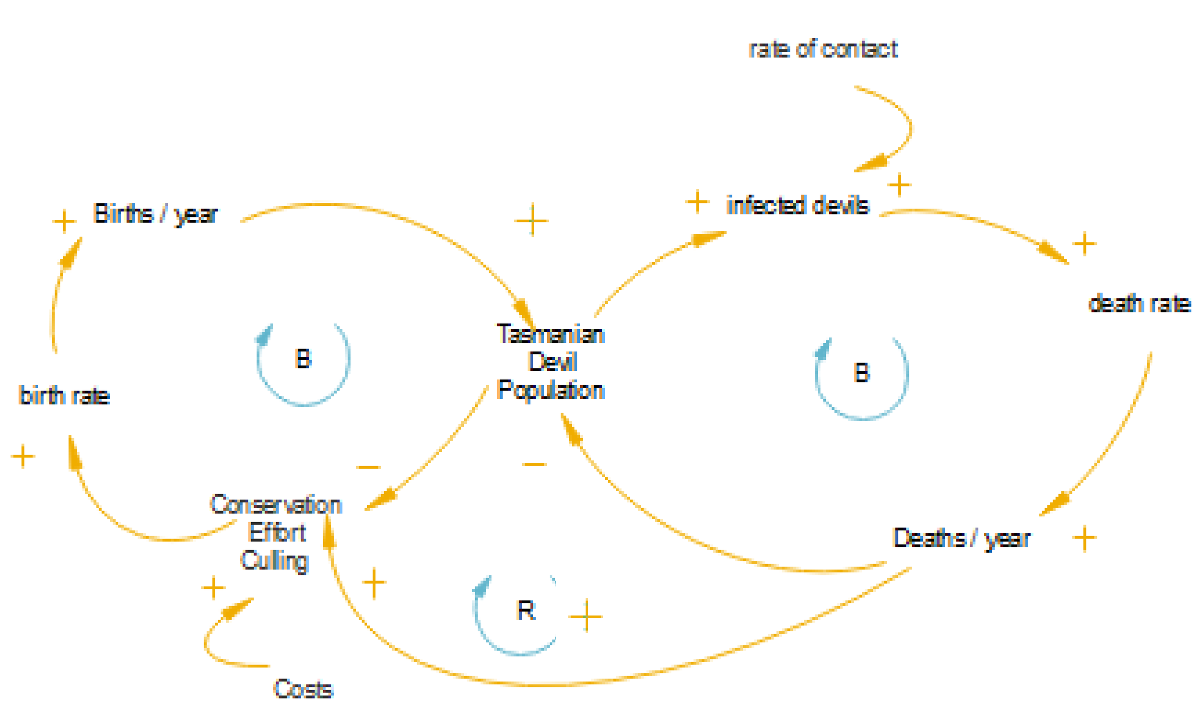
Introduction

The Tasmanian devil is a small carnivore which was once native to mainland Australia but is now only found in the wild on the island state of Tasmania. But since 1996, a widespread facial contagious cancerous disease ravaged the Tasmanian devil population. The disease spreads predominantly through biting as males are aggressive for territory and finding a mate. The stakeholders are the conservationists, policy makers and the Tasmanian devils.

Research Question

What is the impact of the culling strategy of devil facial tumor disease for the survival of the Tasmanian Devil?

Conceptual Model



Model

To determine how culling can be an effective strategy to control the survival rate of the Tasmanian population, I used a simple ordinary differential equation model. The Tasmanian Population was split into susceptible(s),exposed € and infectious(I). Using the three ordinary differential equations and the uncertainty of the latency time, a stochastic model is performed.

Equations:

$$\frac{dS}{dt} = bN(1-N) - \mu S - f(S; I; N)$$

$$\frac{dE}{dt} = f(S; I; N) - (k+\mu)E$$

$$\frac{dI}{dt} = kE - (\mu + \alpha + \rho)I$$

$$C = R * P$$

The total devil population is represented by *N*, where $N = S + E + I$. Here, *t* represents time in years, *b* is the birth rate per devil per year, μ is the mortality rate in the absence of disease, $k = 1/L$ models the latent period *L* of the disease, α is the disease-specific mortality rate, ρ represents the removal effort on infectious devils, and f(*S*; *I*; *N*) = β*SI*/*N* is the frequency-dependent transmission function. The carrying capacity is denoted by K and the intrinsic growth rate is also calculated by b- µ.
C is the total cost of removal, *R* are the individuals removed from exposed and infectious populations, and *P* is the price of removing an individual.

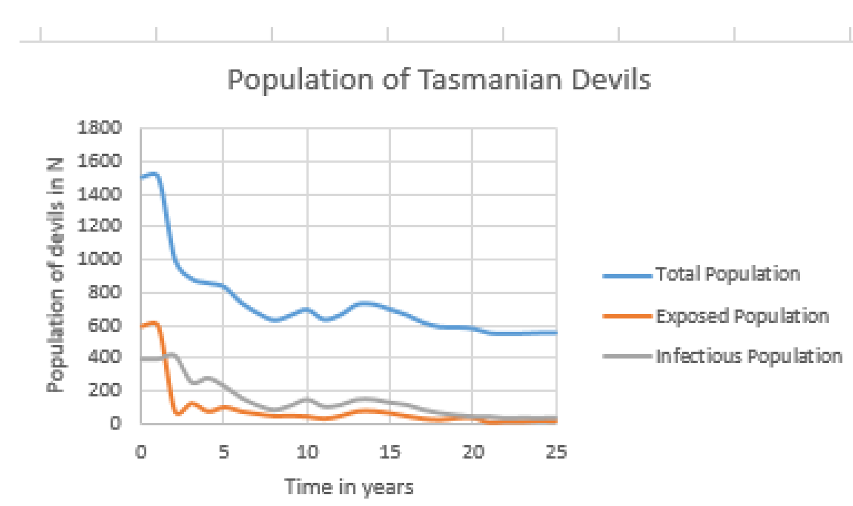
Assumptions

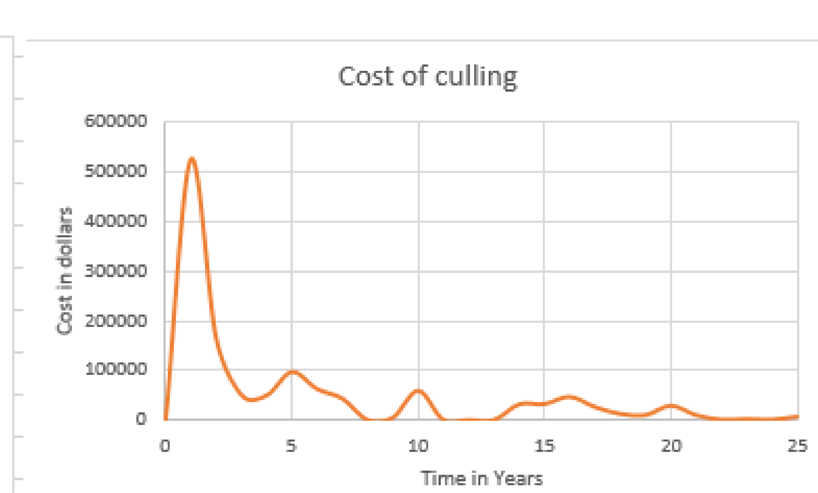
1.The model is made based on frequency-dependent transmission
2.The population of susceptible is always fixed since only the infectious and exposed are removed from the entire population.
3.The removal of infectious and exposed devils are continuous over the span of 25 years.
4.Removal of exposed and infectious devils cost the same.

Results

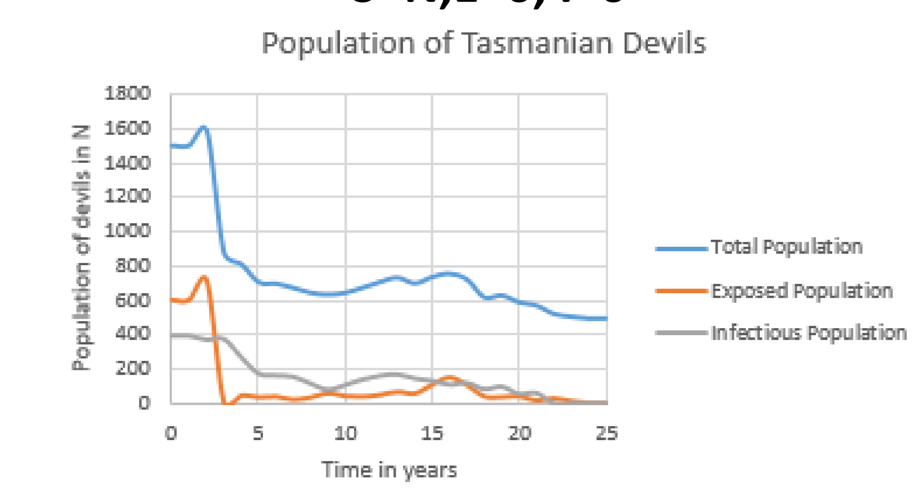
The stochastic model has yielded three equilibrium states:

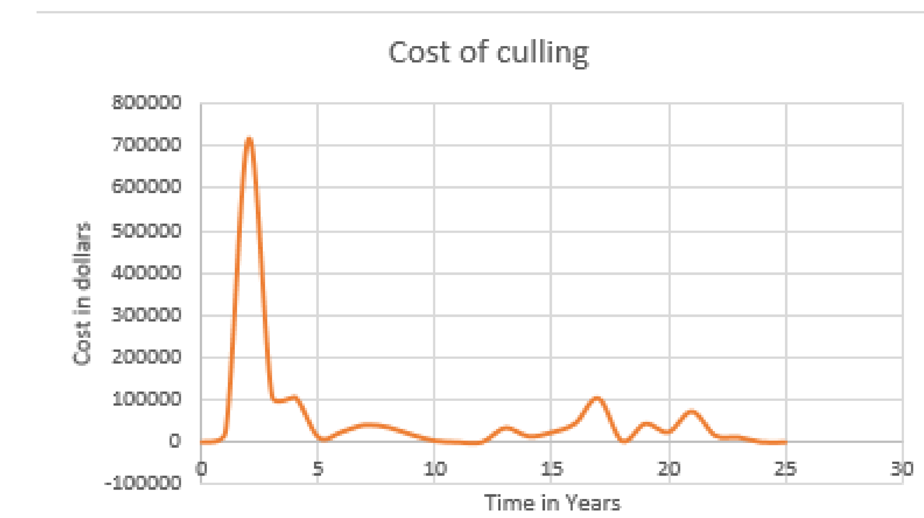
Disease-host coexistence



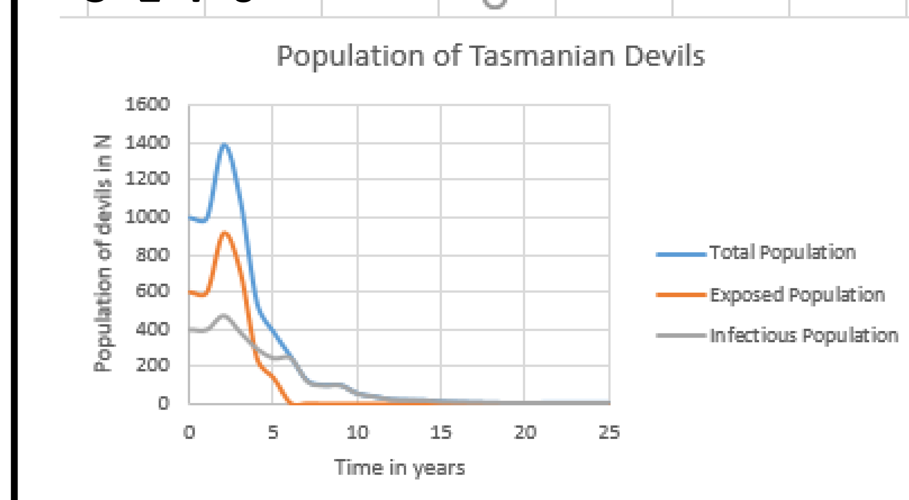


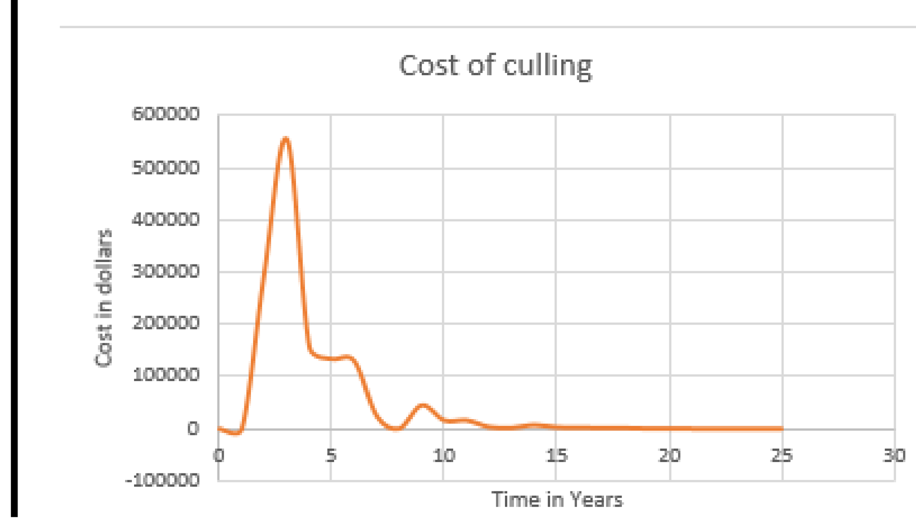
Disease eradication where S=N,E=0, I=0





Host extinction where, S=E=I=0





For all the equilibrium cases, the cost to maintain this strategy peaks in 5 years, after which when the population of the Tasmanian devil decreases rapidly there is less devils to remove and so the cost remains low. For disease eradication, the cost fluctuates the most compared to disease-host coexistence and host extinction because the rate of removal of exposed and infected Tasmanian devils fluctuates the most in disease eradication.

Conclusion and Discussion

Stochastic analysis proves that culling is not an effective strategy to prevent the extinction of the Tasmanian devil in 25 years. In most of the model runs, we see a disease-host coexistence meaning that the disease still prevails. The trivial case of host extinction is not viable as the host cannot be determined for sure. Disease eradication happens less than 2% of the time. To manage removal of infected individuals, resulted in decline of the population recovery. Primary objective of this modeling was to investigate constant removal rate with varying disease latency period. But, continuous removal is difficult requiring trapping teams to work continuously and also result in trap fatigue and lowered capture rates.

Resources:

Beeton, Nick, and Hamish McCallum. “Models Predict That Culling Is Not a Feasible Strategy to Prevent Extinction of Tasmanian Devils from Facial Tumour Disease: Modelling Removal of Diseased Devils.” *Journal of Applied Ecology*, vol. 48, no. 6, Dec. 2011, pp. 1315–23.