

For office use only

Team Control Number

1924781

For office use only

T1 _____

F1 _____

T2 _____

F2 _____

T3 _____

F3 _____

T4 _____

F4 _____

Problem Chosen

A

2019

MCM/ICM

Summary Sheet

Here Be Dragons: The Ecology of Invasive Predators

Giant, fire-breathing dragons may exist in the *A Song of Ice and Fire* world created by George R. R. Martin, but how would they fare in our world? To answer this question, we sampled animal population data from representative regions around the world, fit a growth function to dragons based on data from the problem and from the *A Song of Ice and Fire* series, used modified allometric scaling laws, and Lotka-Volterra equations to build a model of how the dragons would interact with environments here on Earth.

Our model works well because it allows for the dragons to grow forever, but also limits their growth rate based on environmental factors in a meaningful way that is representative of real ecological pressures. Not only will dragons need different amounts of land in different climates, but they will also grow to different sizes based on the scarcity of prey. Also, our model allows for individual dragons to die off due to starvation which lets the remaining dragons have a better chance at survival. This flexibility in the model leads to some interesting results, such as one or more dragons surviving in a certain area, but if the area is tweaked slightly in either direction, the dragons die.

In a hot arid region, the dragons need 110,000 km² to survive and become stable at 86,000 kg each. In an arctic region, the dragons need 42,000 km² and reach 3,500,000kg, and in a temperate region, they need only 570km² and grow to 4,000,000 kg. As expected, the dragons' ability to survive is directly correlated with the availability and scarcity of prey.

While this three-dragon scenario is not likely to happen on earth, the beauty of this model is that it is dynamic enough to be highly generalizable. The hunting preference is robust enough that it can be applied to any animal in any position on the food chain. Based on the habits of any animal we can fit our model to imitate the hunting strategy it would take and apply it to novel scenarios to learn more about its behavior.

By slightly modifying the model used, we showed that we were able to model the growth of an invasive apex predator and see what will happen to the prey population given initial conditions. This could be used as a precaution to stop harmful invasive species from entering a sustainable and stable ecosystem.

Finally, using our analysis of dragons in different scenarios we recommended to George R. R. Martin that he not send Daenerys and Drogon to fight the white walkers in the North, as Drogon would not be able to meet his basal metabolic rate in such a sparse climate. We informed George that in order for Drogon to survive he must always stay in warm temperate regions where food is plentiful, and he can live sustainably within the ecosystem.

