Dynamics of Eastern Equine Encephalitis Infection Rates

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Parameters

Parameter	Description	Values
ψ_b	Birth rate of avians	$0.05 \frac{birds\ day^{-1}}{birds}$
a	Mosquito Biting Rate	0.8 day^{-1}
α_y	Exposure coefficient of YOY avians	0.8 day^{-1}
α_A	Exposure coefficient of adult avians	0.4 day^{-1}
γ_y & γ_a	Loss of Infectivity/Recovery Rate	$\frac{1}{3}$ day^{-1}
μ_y & μ_a & μ_m	Death rate of individuals within a population	0.002, $\frac{1}{547}$, & 0.1 day^{-1}
ν_y & ν_a	Disease induced death rate of avians	0.5 & 0.1 day^{-1}
ψ_m	Birth rate of mosquitos	3000 mosquitos day^{-1}
δ	Infectivity of avians	0.36
k	Incubation Period	$\frac{1}{3}$ $days^{-1}$
m_y	Maturation Rate of YOY avians	0.04 day^{-1}
N_B & N_M	Total Population of Avians/Mosquitos	Initial population of 1,000 birds and 1,500 mosquitos
c	Carrying Capacity of the Avians	50,000 birds

Differential Equation Model

$$S_y(t) = \psi_b S_y \left(1 - \frac{s_y}{c}\right) - a\,\alpha_y S_y \left(\frac{I_m}{N_m}\right) - (m_y + \mu_y) S_y$$

$$I_y(t) = a\,\alpha_y S_y \left(\frac{I_m}{N_m}\right) - (\gamma_y + \mu_y + \nu_y) I_y$$

$$R_y(t) = \gamma_y I_m - (m_y + \mu_y) R_y$$

$$S_a(t) = m_y S_y \left(1 - \frac{s_a}{c}\right) - a\,\alpha_a S_a \left(\frac{I_m}{N_m}\right) - \mu_a S_a$$

$$I_a(t) = a\,\alpha_a S_a \left(\frac{I_m}{N_m}\right) - (\gamma_a + \mu_a + \nu_a) I_a$$

$$R_a(t) = m_y R_y + \gamma_a I_a - \mu_a R_a$$

$$S_m(t) = \psi_m - a S_m \delta \left(\alpha_y \left(\frac{I_y}{N_B}\right) + \alpha_a \left(\frac{I_a}{N_B}\right)\right) - \mu_m S_m$$

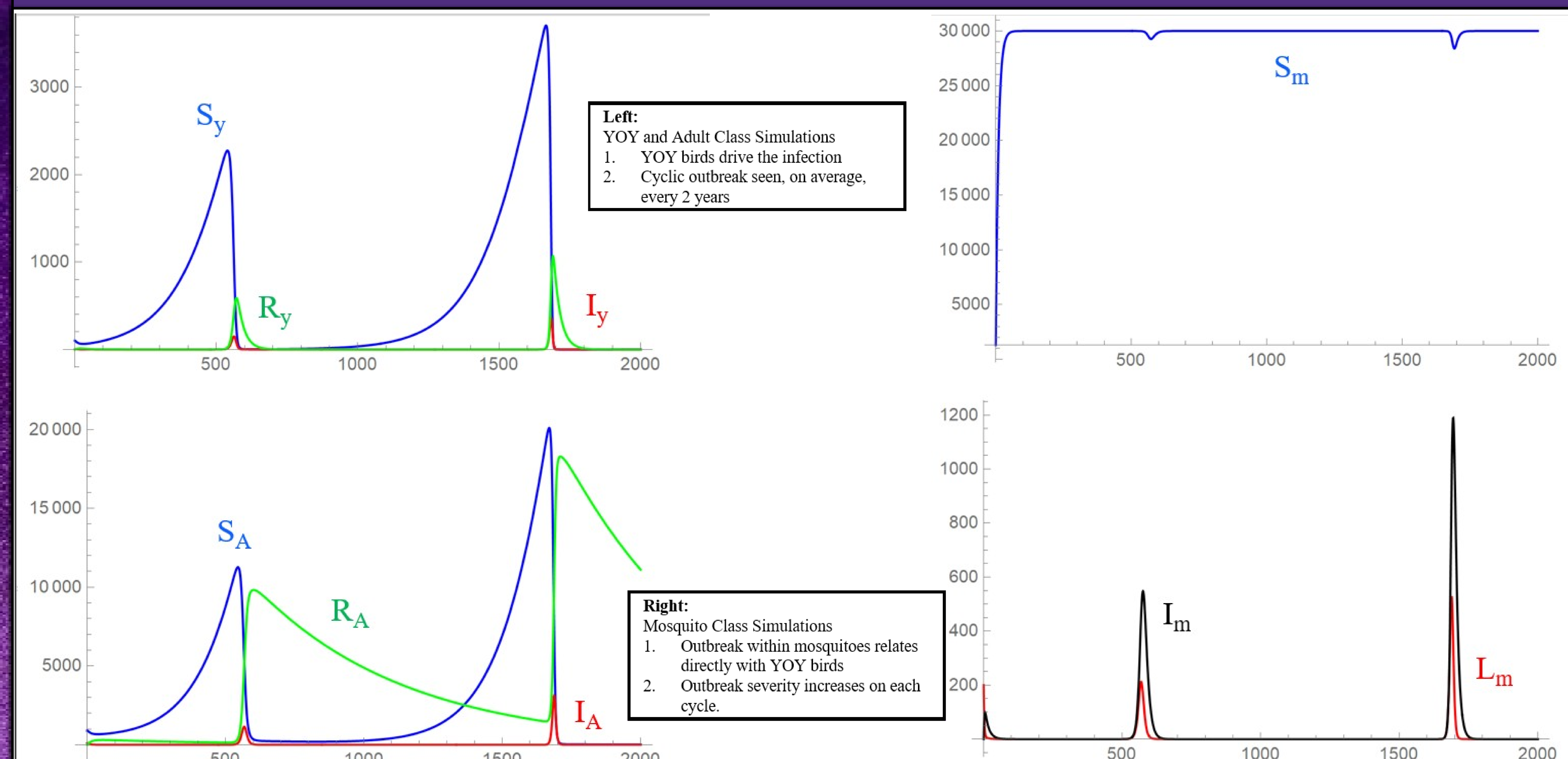
$$L_m(t) = a S_m \delta \left(\alpha_y \left(\frac{I_y}{N_B}\right) + \alpha_a \left(\frac{I_a}{N_B}\right)\right) - (k + \mu_m) L_m$$

$$I_m(t) = k L_m - \mu_m I_m$$

Background

- The EEE virus is maintained at endemic levels in an avian-mosquito cycle with the Black-Tailed Mosquito (*Culiseta melanura).* Death rates from the virus within humans are typically around 33%; however, of those who recover from EEE, many are left with mental/physical sequalae such as brain dysfunction and severe intellectual impairment.
- In our research, we focused on creating a vector-host transmission model between the mosquito and passerine avian species using a system of Ordinary Differential Equations (ODEs) to gain insight into the dynamics of the transmission of the virus.

Results



Conclusions

- - The reproduction number ($\mathscr{R}_0$) of the virus must be < 1 for the Disease-Free Equilibrium (DFE) to be locally asymptotically stable.
- - We found that the avian carrying capacity (c) is the most important parameter and if it becomes too high it has the potential of increasing the reproduction number.

Future Work

Future work includes, but is not limited to:

- - Look further into parameter values, be sure to check that the values make biological and mathematical sense.
- - Find data relating to the EEE virus so that a data fitting algorithm can be used to fit our model to the EEE data. This process is used to analyze the accuracy of our model to the data we choose to use.
  - Conduct more analysis on the Disease-Free Equilibrium (DFE) of the model.