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Optimal Control of West Nile virus in mosquito, birds and humans with Season

In Canada the number of West Nile virus (WNv) infection of humans decreasing during the years of 2007-2010. However, it started increasing once more during last year 2011 despite the immense efforts exhibited by the specialized agencies to control the vector mosquitoes and the disease. In this study, we use mathematical models to study the behavior of the transmission of WNv in the mosquito-bird cycle and human (considering two kinds of birds: corvids and non-corvids). We study and compare the mathematical model of WNv without the effect of the seasonal variation and the modified model with seasonal variations. Firstly, we proved that the autonomous model undergoes a backward bifurcation. Secondly, we extended the model by adding three control functions: adulticide, larvicide and human protection. We simulated a set of possible control strategies and conclude that: (1) The feasibility of controlling WNv could be dependent on the initial sizes of the sub-population when we have a backward bifurcation. (2) Combining adulticide and larvicide is the most effective strategy to control an ongoing epidemic (in reducing disease cost). (3) The results further emphasized the importance to use the information about quantity of other animals infected and the percentage of the non-corvids bird at any region before applied the control strategies. (4) With impact of the seasonality identifying the ultimate time of adulticide and larvicide (individually and grouped) to achieve the best control strategy. Our findings emphasize the importance of carefully taking into account the impact of the seasonal variation when we applying the control.