Deer Ticks: A Model of Their Lifecycle Using STELLA

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Deer Ticks- Introduction

▪*Ixodes scapularis*, or "deer tick", is a vector for the pathogen, *Borrelia burgdorfert*, which is responsible for Lyme disease in humans (Guerra et al., 2002). This makes deer ticks and their lifecycle an important area of study.

▪There are three stages of a deer tick's lifecycle. During stage one, the tick is a larva. During stage two, the tick is a nymph. Stage three is when the tick is an adult. Each stage of a deer tick's lifecycle starts once they molt after a blood meal (Deer Tick Ecology, 2010).

▪A tick cannot transmit Lyme disease upon being hatching from the egg. The tick must first feed on a host that is already infected with the pathogen before it can transmit it to a host (Deer Tick Ecology, 2010).

▪Understanding the lifecycle of a tick and how it can transmit Lyme disease is crucial when it comes to prevention of this disease. This project aims to illustrate the lifecycle using a computer program called STELLA.

Life Cycle Parameters			
Status of Tick	**Stock/Flow**	**Transient Time (Days)**	**Initial Value Individuals (Input)**
Egg	Stock	500	100
Hatch	Flow	500	NA
Larvae	Stock	60	10
Eat 1	Flow	60	NA
Blood Meal 1	Stock	3	0
Molt 1	Flow	3	NA
Nymph	Stock	60	10
Eat 2	Flow	60	NA
Blood Meal 2	Stock	3	0
Molt 2	Flow	3	NA
Adult	Stock	60	10 *
Eat 3	Flow	60	NA
Blood Meal 3	Stock	3	0
Develop Eggs	Flow	3	NA
Egg Laying Females	Stock	3	0
Egg Laying	Flow	3	NA

Figure 1: Life Cycle parameters used in the STELLA model. * The initial value of adult ticks is fifty percent male and fifty percent female.

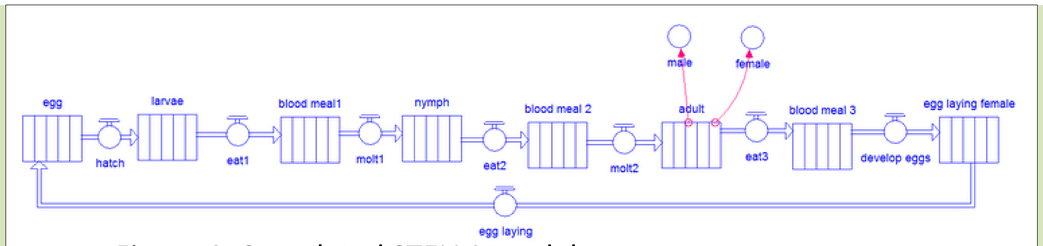

Figure 4: Completed STELLA model.

Methods

▪Reviewed literature for information and perimeters that could be used in the Stella model.

▪Referenced literature for potential modeling efforts on tick life cycle

▪ Using STELLA, a model was created to illustrate the two-year life cycle of a deer tick. Data was used from literature to best represent the reality of the cycle.

▪Conveyors were used to represent each stage in the life cycle.

▪Parametrized model using values found in the literature

▪Ran model and examined the output by comparing with previous modeling efforts

▪Suggested improvements and future areas of data needs.

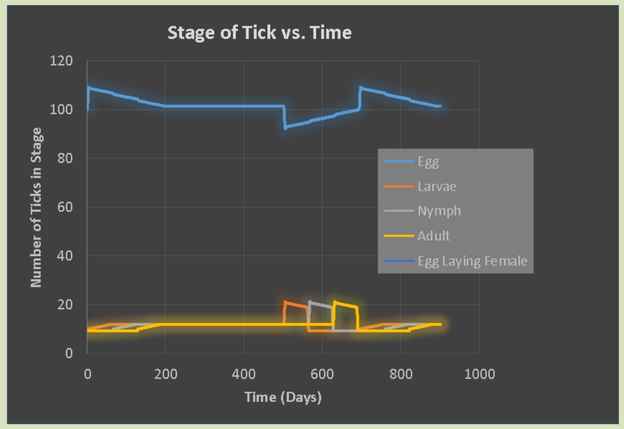

Figure 3: A graph of a deer tick's lifecycle using values from the STELLA model.

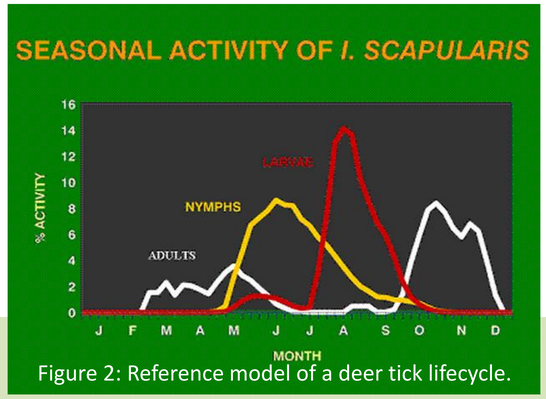

Figure 2: Reference model of a deer tick lifecycle.

Conclusion

▪The finalized model was similar to the reference model, but is lacking detail (i.e., accurate parameters).

▪More data needs to be found in order to make the data more accurate.

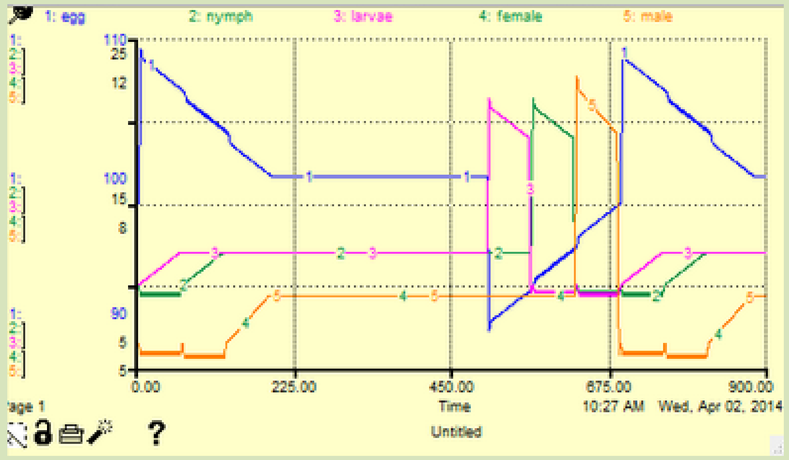

Figure 5: STELLA graph of tick life cycle.

References:

Guerra, M., Walker, E., Jones, C., Paskewitz, S., Cortinas, M. R., Stancil, A., Beck, Bobo, M., & Kitron Uriel. (2002, March). Predicting the Risk of Lyme Disease: Habitat Suitability of Ixodes scapularis in the North Central United States. *PubMed*, *8*(3), 289-297. Retrieved April 13, 2014, from http://www.ncbi.nlm.nih.gov/pubmed/11927027

Paskewitz, S. (2014). Ixodes scapularis (blacklegged or "deer" tick). In *Wisconsin Ticks and Tick-borne Diseases*. Retrieved April 13, 2014, from http://labs.russell.wisc.edu/wisconsin-ticks/

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Deer Tick Ecology. (2010, January 5). In *American Lyme Disease Foundation*. Retrieved April 12, 2014, from http://www.aldf.com/deerTickEcology.shtml

Diagram: Two-Year Life Cycle of the Blacklegged Tick (Ixodes scapularis, also known as the Deer Tick or Bear Tick). (2011, January 14). In *Minnesota Department of Health*. Retrieved April 14, 2014, from