**Appendix A**

**Wolf-Moose Predator-Prey Relationship Modeling Worksheet and Teacher Key**

**Student Name:**

**Background:** The wolves and moose of Isle Royale National Park have been tracked and studied for over six decades making it one of the longest continuous predator-prey studies in the world. Recent changes to the wolf population size had called into question what representatives of the National Park Service and scientists should do to the mostly isolated populations of moose and wolves on the island. Visit [isleroyalewolf.org](file:///C%3A%5CUsers%5Camandagronczi%5CDownloads%5Creupdatedarticleandtodolist%5Cisleroyalewolf.org) to learn more about the research that is being conducted on the island. Explore the links for **About the Project: Overview**, and **Educational: Population Dynamics** to learn more about the wolves and moose of the island.

**Directions:** You will create a basic computational model of the interaction of the wolf and moose populations on Isle Royale. Because Isle Royale is isolated from the mainland of the United States and Canada by Lake Superior, the population interactions are generally considered to exist in a *closed-system* where moose and wolves don’t generally enter into the populations of the island very easily. This makes studying and modeling this system interesting to scientists, because it limits some of the parameters (variables internal to the model which were estimated from data) which affect other predator-prey relationships.

Begin your work by creating a conceptual model of the factors which will influence the moose and wolf population sizes (*stocks*). Wolves and moose are born and die (*flows*) at rates (*variables*) which can be calculated from research data. While wolves have no natural predators on the island, moose are preyed on by wolves, and the size of the wolf populations influences the number of moose which die (*links between populations*).

See the template below to start your conceptual model. Add labels and show links between stocks, flows, and possible variables. Use the data found on the website and on the additional websites to build a working model of the moose and wolf population. Use your model output to answer the final three question.

Moose

Wolves

Identify Values for starting conditions for your model.

Moose: Wolves:

Moose birth rate: Wolf birth rate:

Moose death rate: Wolf death rate:

 Other variable(s): Other variable(s):

**Questions**

1. What are three limitations of your model and why are each of these limitations?
2. Use your data to describe how the wolf and moose populations change and provide an explanation for the observed pattern

**Web links for Wolf-Moose Model**

1. Wolf & Moose of Isle Royale Website <https://isleroyalewolf.org/>
2. Wolf & Moose of Isle Royale Annual Reports (1959 – today) <https://isleroyalewolf.org/wolfhome/ann_rep.html>
3. The Population Biology of Isle Royale Wolves and Moose: An Overview <https://isleroyalewolf.org/http%3A//www.cpc.ncep.noaa.gov/products/precip/CWlink/pna/nao.shtml>
4. Wolf-Moose data set (Excel Spreadsheet)

<https://isleroyalewolf.org/sites/default/files/documents/Data_wolves_moose_Isle_Royale_June2019.xlsx>

(note: this link will change with new reports. Find the most recent link here under Wolf-Moose Data:

<https://isleroyalewolf.org/data/data/home.html>

1. Example Insight Maker Model of Wolf-Moose Populations <https://insightmaker.com/insight/152543/Wolf-Moose-Model-1>

**NAME: KEY**

Moose deaths

Moose

Wolves

Moose births

Wolf births

Wolf deaths

Identify Values for starting conditions for your model.

Moose: 538 Wolves: 20

Moose birth rate: 0.25 Wolf birth rate: [Moose]\*[Wolf birth rate value]

Moose death rate: [Wolves]\*[Moose death rate value] Wolf death rate: 0.25

 Other variable(s): Moose death rate value = 0.0081 Other variable(s): Wolf birth rate value = 0.0002

Notes:

**Wolf-Moose Population Interaction Model instruction for Insightmaker.com**

1. Build a model with the following primitives
	1. Moose **STOCK**
	2. Wolves **STOCK**
	3. Moose births **FLOW** (flowing into Moose **STOCK)**
	4. Moose deaths **FLOW** (flowing out of Moose **STOCK**)
	5. Wolf births **FLOW** (flowing into Wolves **STOCK**)
	6. Wolf deaths **FLOW** (flowing out of Wolves **STOCK)**
	7. Moose birth rate **VARIABLE**
	8. Moose death rate **VARIABLE**
	9. Moose death rate value **VARIABLE**
	10. Wolf birth rate **VARIABLE**
	11. Wolf birth rate value **VARIABLE**
	12. Wolf death rate **VARIABLE**
2. Link the following primitives
	1. Moose **STOCK** to Wolf birth rate **VARIABLE**
	2. Wolves **STOCK** to Moose death rate **VARIABLE**
	3. Moose birth rate **VARIABLE** to Moose births **FLOW**
	4. Moose death rate **VARIABLE** to Moose deaths **FLOW**
	5. Moose death rate value **VARIABLE** to Moose death rate **VARIABLE**
	6. Wolf birth rate **VARIABLE** to Wolf Births **FLOW**
	7. Wolf birth rate value **VARIABLE** to Wolf birth rate **VARIABLE**
	8. Wolf death rate **VARIABLE** to Wolf deaths **FLOW**
3. Use the following initial values for your primates
	1. Moose **STOCK** = 538
	2. Wolves **STOCK** = 20
	3. Moose births **FLOW** = [Moose **STOCK**]\*[Moose birth rate **VARIABLE**]
	4. Moose deaths **FLOW** = [Wolves **STOCK**]\*[Moose death rate **VARIABLE**]
	5. Wolf births **FLOW** = [Wolves **STOCK**]\*[Wolf birth rate **VARIABLE**]
	6. Wolf deaths **FLOW** = [Wolves **STOCK**]\*[Wolf death rate **VARIABLE**]
	7. Moose birth rate **VARIABLE** = 0.25
	8. Moose death rate **VARIABLE** = [Wolves **STOCK**]\*[Moose death rate value **VARIABLE**]
	9. Moose death rate value **VARIABLE** = 0.0081
	10. Wolf birth rate **VARIABLE** = [Moose **STOCK**]\*[Wolf birth rate **VARIABLE**]
	11. Wolf birth rate value **VARIABLE** = 0.0002
	12. Wolf death rate **VARIABLE** = 0.25
4. Under **SETTINGS** set **SIMULATION START** = 1959 (starting year) and **SIMULATION LENGTH** = 100 (years).
5. Under **SETTINGS** set **ANALYSIS ALGORITHUM** to **Accurate (RK4).**
6. Under the **CONFIGURE** menu in the **SIMULATION** make the following changes:
	1. Under **TIME SERIES** change **TITLE** to *Wolf-Moose Populations of Isle Royale*
	2. Under **TIME SERIES** change **DATA** to *Moose*
	3. Under **X-AXIS** change label to **TIME (%u), MIN = 1959, MAX = 2059**
	4. Under **Y-AXIS** change label to *Moose*
	5. Under **SECONDARY Y-AXIS** change **DATA** to *wolves,* and **LABEL** to *wolves*