4.1 - Ecosystems Unit, Packet 1

Score
□ Above & Beyond
□ Meets Expectations
□ Near Expectations
□ Incomplete – *fix the following pages:*

First & Last Name: _____ Period/Hour:_____

NOTE: Packets are due after completing Part 5. Check each page to be sure all blanks are completed.

Driving Question: Why do different places have different amounts of species?

Anchoring Phenomenon: Places like rainforests have abundant and diverse organisms, while places like mountain tops have fewer species & less variety. What determines the number of organisms and species an area can support? We'll explore this using species interactions at Isle Royale National Park.

Deeper Questions

1. How do living species interact with each other and their environment?
2. Why are there usually different amounts of herbivores and carnivores?
3. What happens if matter movement & energy flow is disrupted?

Schedule

Part 1: Introduction
- Initial Ideas & Data Dive - Wolf vs. Moose
- Discussion & Developing Explanations

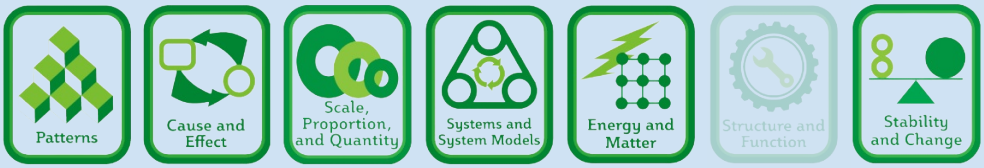
Part 2: Core Ideas
- Core Ideas
- Revisions of Part 1 Explanations

Part 3: Investigation
- A: Fox Meadow Simulation
- B: Tabletop Ecosystems

Part 4: Review & Assessment
- Ranking Your Readiness
- Formative Assessment & Mastery Check

Part 5: Life Connections
- Life Connections - Wolves & Woods

NGSS Standards (*PEs & CCCs are summarized below. SEPs are noted throughout the packet*).
HS-LS2-2. Modeling factors that affect biodiversity and populations in ecosystems at different scales. HS-LS2-4. Use mathematical representations to support claims that matter cycles and energy flows among organisms in an ecosystem. HS-LS2-5: Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.



Semester Schedule

1. Matter & Energy
1.1: What happens when something burns?
1.2: How does burning change matter & energy?
1.3: Unit Assessment

2. Animals
2.1: How do animal cells use food?
2.2: What happens to food when it is consumed?
2.3: How do cells acquire atoms from food?
2.4: Unit Assessment

3. Plants
3.1: How do plant cells differ from animal cells?
3.2: How do plant cells obtain matter and energy?
3.3: How can we investigate plant growth and function?
3.4: Unit Assessment

4. Ecosystems
4.1: Why do different places have different amounts of species?
4.2: How does human activity affect species?
4.3: Unit Assessment

Resource Links: Class Website; Core Ideas; Summary Video; Practice Test; Part 1 Video 1 & Video 2; Part 3A Meadow Simulation; Part 3B Video;

Part 1: Introduction – Isle Royale (4.1.1)

Overview: **Overview**: You will begin by discussing your initial ideas about what determines the number of species an area supports. You will then analyze data and work in teams to develop your initial explanations.

Initial Ideas - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Engaging in Argument from Evidence

1. Isle Royale is a US national park located in Lake Superior. It is largely untouched by human activity. Its isolation provides an ideal setting to examine the factors that determine predator and prey populations, such as wolves and moose on this island. Three students have differing opinions on what determines the sizes of wolf and moose populations on this island. **Do you agree or disagree with each student's claim**?
   - Mike: "There will be fewer moose than wolves because the wolves eat moose." *Agree / Disagree*
   - Lucia: "I think the population of moose and wolves should be about the same." *Agree / Disagree*
   - Oscar: "There should be more moose than wolves or there will be problems." *Agree / Disagree*

2. Work in your small groups to discuss your ideas. How are your ideas similar or different? Decide as a group whether each statement is correct (and why). Be prepared to present your ideas to the class.

Data Dive - *Read the directions below.* *SEP: Analyzing & Interpreting Data*

Next, watch the following videos individually or as a class (based on your teacher's instructions): Video 1 – Isle Royale Wolf & Moose Data; Video 2 - Isle Royale Wolf & Moose Researchers.

Next, look at the data comparing the sizes of the wolf and moose population, and how they fluctuate over time. Which population is larger? How does each population change over time? *(Data Source)*

Data Dive Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*

1. **Begin by individually attempting to make sense of this data**. What trends or patterns do you notice? How does this relate to any prior knowledge or experience that you have?
2. **Next, work in your teams to discuss your ideas**. Where do you agree? Where do you disagree? Can you use this data to reach an agreement? Do others have prior knowledge/experience that could help?
3. **Based on this data, what is one conclusion that would be supported by this data?** How is this conclusion supported by this data? What specifically suggests that your claim is accurate?
4. **Based on this data, what is a second conclusion that would be supported by this data?** How is this conclusion supported by this data? What specifically suggests that your claim is accurate?
5. **Does this data support or refute any of the initial claims on the previous page?** If so, explain.
6. **Why would there be differences in the number of wolves and moose the island can support?**

Discussion - *Record your ideas in the spaces below.* *SEP: Asking Questions & Defining Problems*

As a class, discuss your ideas about this data. What are the ideas that most agreed on? Where did your ideas differ as a class? Record your ideas in the spaces below.

We generally agree that…	***We disagreed or were unsure if…***

Initial Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Designing Solutions*

Why do different places have different amounts of species? Why would the number of carnivores differ from herbivores? Write down an initial explanation below. Don't worry if you aren't completely sure about this. You will revise this explanation as you gain more information during this unit.

_____

_____

_____

Throughout this packet, you will be updating this explanation as you gain more information and more experience. When you complete this packet, compare your initial explanation to your final version. You should see clear improvement with each revision.

Part 2: Core Ideas (4.1.2)

Overview: In this activity, you will use a short presentation to provide you with information that will help you improve and revise your initial ideas. Your instructor will decide on how to implement this portion. You will then work in small teams to address the questions listed below.

Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Developing & Using Models

1. What is an ecosystem? In what ways do living species depend on each other as well as the non-living components of their environments?
2. What is biomass? How does the biomass of organisms relate to glucose molecules and soil minerals?
3. What is the difference between producers and consumers?
4. How is a primary consumer different from a secondary consumer? How do these terms relate to trophic levels?
5. If a growing animal consumes 10 kg of plant biomass over the course of a week, how much mass would be added to the animal's body? Explain using the term 10% Rule.
6. True or false: the amount of plant, moose, and wolf biomass should be relatively equal in a stable ecosystem. Explain.
7. What is the carrying capacity of an ecosystem? How does carrying capacity relate to biomass production and to the 10% Rule?
8. What is biodiversity? How do levels of biodiversity relate to carrying capacity and biomass production?
9. Why does more biodiversity exist in rainforest ecosystems compared to most other regions?
10. What is ecosystem resilience? What is an ecosystem disturbance? How are these terms related?
11. How do changes to carrying capacity and biodiversity affect ecosystem resilience?
12. Tundra and alpine ecosystems are often quite fragile. Why might it take years or even decades for these ecosystems to recover after disturbances? Why aren't they more resilient?

Revising Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Developing Solutions*

Why do different places have different amounts of species? Why would the number of carnivores differ from herbivores? Based on this new information, how would you now respond to this question?

_____

_____

_____

Throughout this packet, you will be updating this explanation as you gain more information and more experience. When you complete this packet, compare your initial explanation to your final version. You should see clear improvement with each revision.

Part 3A: Fox Meadow Simulation (4.1.3a) *Adapted from materials by Carbon TIME*

Pre-Investigation Questions - *Work as a group to prepare verbal responses for these questions. When you think you are <u>all</u> ready to provide responses, raise your hand. Your instructor will listen to your explanations, provide feedback, and determine if you are ready to move on to the investigation.*
SEP: Developing & Using Models

1. What is the carrying capacity of an ecosystem? How does carrying capacity relate to biomass production and to the 10% Rule?
2. What is biodiversity? How do levels of biodiversity relate to carrying capacity and biomass production?
3. Tropical rainforests tend to have large numbers of different species per square mile. Why does more biodiversity exist in these ecosystems compared to most other regions of the planet?
4. What is ecosystem resilience? What is an ecosystem disturbance? How are these terms related?

This activity was completed _____ (*instructor signature*)

Overview: This activity requires you to use a computer simulation to explore how changing population sizes of grass, rabbits, and foxes affects the stability and carrying capacity of a simulated ecosystem. Your instructor may choose to demonstrate how this program works for the entire class before letting you work in your groups.

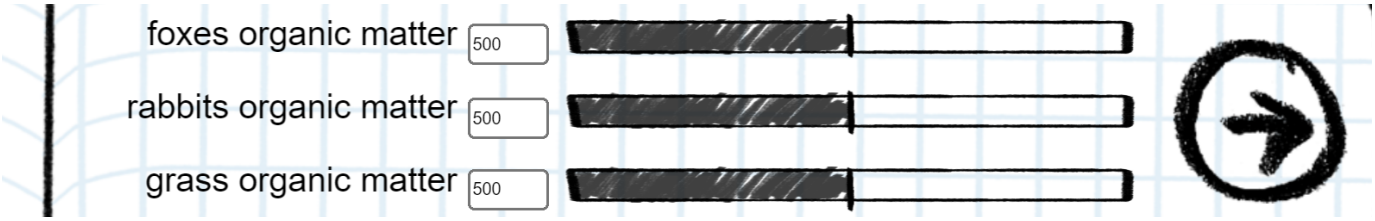
Fox Meadow Simulation - Trial 1. *SEP: Planning and Conducting an Investigation*

1. ☐ First, predict how the populations of grass, rabbits, and foxes will change over time if they all start at 500 units for each species. Will their units of biomass change over time? If so, how?

   I predict the following: _____

   _____

2. ☐ In an internet search engine, type Carbon TIME Meadow Simulation, or use the URL below: https://carbontime.create4stem.msu.edu/sites/default/files/simulations/eco-simulation/index.html
3. ☐ Set the initial mass for each species by dragging the sliders to 500 (*or by typing 500 in the boxes*).



4. ☐ Click the start arrow (top right) to run the simulation. Record your data in Results (next page).
5. ☐ On the simulation screen, use the buttons on the stopwatch at the bottom to pause the simulation (middle button), move ahead one year (right button), or to start a new run (left button)
6. ☐ Data is displayed on the left side of your screen. The upper line graph indicates how the biomass of grass, rabbits, and foxes changed during a 99-year period. If you click and drag on the line graph, the table in the lower right will provide detailed data for any chosen year. The lower bar graph illustrates the total biomass of grass, rabbits, and foxes at the end of the period.

Results - Trial 1. *SEP: Engaging in an Argument from Evidence. Analyzing & Interpreting Data*

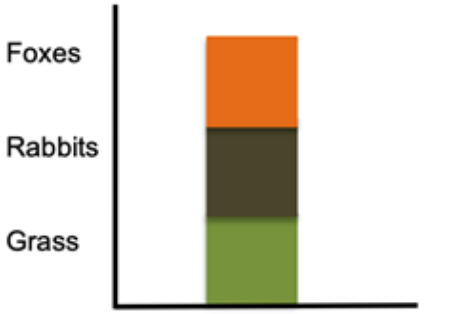
Trial 1 Data: Complete the table below after running the first simulation. Click on the line graph to move the line to the desired year. Its data will then be displayed in the data table in the lower left of your screen.

Fox Organic Mass: t = 0: *500* t ~ 50: _____ t = 99: _____

Rabbit Organic Mass: t = 0: *500* t ~ 50: _____ t = 99: _____

Grass Organic Mass: t = 0: *500* t ~ 50: _____ t = 99: _____

Sketch the final organic mass diagram for trial 1 in the blank graph below. *Note: the program's lab book records the data for each run. If needed, access this data by clicking the left button of the stopwatch.*



Initial Trial 1 organic mass
(as percent of ecosystem total)

Final Trial 1 organic mass
(as percent of ecosystem total)

How did grass, rabbit, and fox biomass change? Why did these outcomes occur? Explain your reasoning.

_____

_____

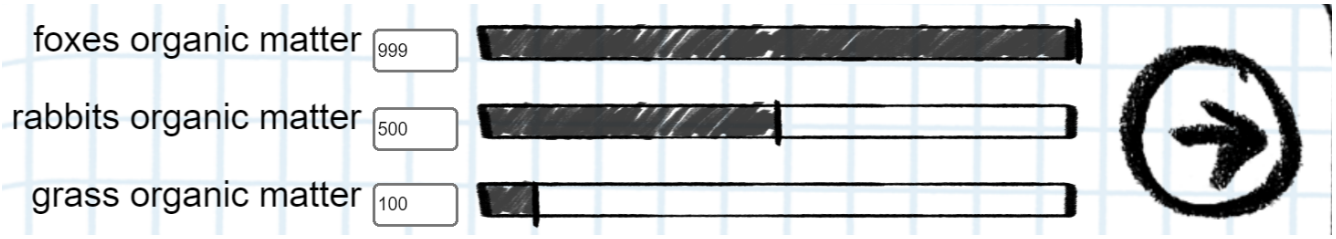
Fox Meadow Simulation - Trial 2. *SEP: Planning and Conducting an Investigation*

7. ☐ In this portion, we will adjust the values so that we start with 999 units of foxes, 500 units of rabbits, and 100 units of grass. Predict how units of biomass for these species will change over time:

   I predict the following: _____

   _____

8. ☐ Set the initial mass for each population by dragging the sliders to the values listed above. Then click the start arrow on the right hand side to restart the simulation under these conditions. .



9. ☐ Allow the simulation to completely run. Record your data in Results.

Results - Trial 2. *SEP: Engaging in an Argument from Evidence. Analyzing & Interpreting Data*

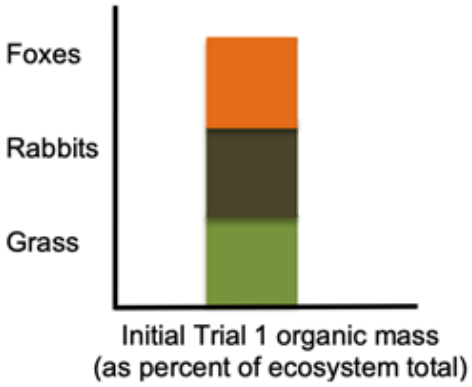
Trial 2 Data: Record your data for these conditions in the space below using the program's graphs and tables.

Fox Organic Mass: t = 0: *999* t ~ 50: _____ t = 99: _____

Rabbit Organic Mass: t = 0: *500* t ~ 50: _____ t = 99: _____

Grass Organic Mass: t = 0: *100* t ~ 50: _____ t = 99: _____

Sketch the final organic mass diagram for Trial 2 in the blank graph below. *Note: the program's lab book records the data for each run. If needed, access this data by clicking the left button of the stopwatch.*



Initial Trial 1 organic mass
(as percent of ecosystem total)

Final Trial 1 organic mass
(as percent of ecosystem total)

How did grass, rabbit, and fox biomass change? Why did these outcomes occur? Explain your reasoning.

_____

_____

Fox Meadow Simulation - Trial 3. *SEP: Planning and Conducting an Investigation*

10. ☐ In this portion, we will determine the maximum amount of fox units that this ecosystem can support for each species. Record your prediction in the space below:

    I predict the following: _____

    _____

11. ☐ Adjust the sliders to different values over four trials to determine the maximum organic mass of foxes that the meadow ecosystem can support. Record your data in Results (pages 7-8).

Results - Trial 3. *SEP: Engaging in an Argument from Evidence. Analyzing & Interpreting Data*

What were the maximum units of foxes that this ecosystem could sustain? _____

Why do you think this is the case?_____

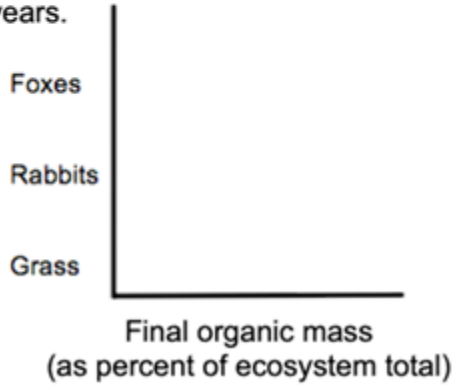
_____

Continues on next page

	Trial 1 Initial	Trial 1 Final	Trial 2 Initial	Trial 2 Final	Trial 3 Initial	Trial 3 Final	Trial 4 Initial	Trial 4 Final
Foxes								
Rabbits								
Grass								

8. Record the data and draw the organic mass diagram for the conditions that resulted in the highest organic mass in the fox population at the end of 100 years.

	Initial	Final
Foxes organic mass		
Rabbits organic mass		
Grass organic mass		



Part 3B Investigation: Tabletop Ecosystems (4.1.3b)

Overview: In this task, you'll explore tabletop ecosystems with three types of organisms. First, you'll notice tiny swimming animals called brine shrimp. There are also phytoplankton. These are tiny photosynthetic organisms that can make the water look green. Lastly, there are microscopic bacteria and fungi. These act as decomposers, breaking down dead shrimp, phytoplankton, and microbes. This provides plants with minerals and an extra source of CO_2 in addition to what is created by cellular respiration in the cells of the shrimp & phytoplankton. (Assembly directions & video)

Directions: Observe your tabletop ecosystem. Address the questions below using your observations to guide your thinking. Use a notebook, dry erase board, or scratch paper to record your ideas. When you think you are ready, raise your hand. Your instructor will listen to your verbal responses.

1. What kinds of energy transformations occur within the cells of these organisms?
2. How are inorganic molecules (like CO_2, H_2O, and minerals) being turned into the molecules found in cells? How are the molecules in cells being turned back into inorganic molecules?
3. These ecosystems are in sealed containers. Will this ecosystem run out of oxygen? Why or why not?
4. What is more important to the function of this ecosystem – the phytoplankton or the shrimp? Why?
5. Which should have greater biomass – the phytoplankton or the shrimp? Why?
6. Is your tabletop ecosystem very biodiverse? Explain.
7. What primarily determines the carrying capacity for shrimp within this ecosystem?
8. Do you think that this tabletop ecosystem is resilient? What factors determine resiliency in this case?

When you think you are ready, **raise your hand**. Your instructor will listen to your verbal responses.

This activity was completed _____ (*instructor signature*)

Part 4: Review & Assessment (4.1.4)

Step 1: Rank each Driving Question in Part 2 based on your comprehension (you can rank them as *1,2,3* or *green/yellow/red*, or any other method). Then work in teams to review anything that is still unclear.
Step 2: Identify any remaining areas of confusion or concern. Then review these topics with your instructor.
Step 3: Complete the Formative Assessment (*last page of the packet*). Your instructor will determine if you will work individually, in pairs, or in small groups. Then compare and evaluate your responses as a class.
Step 4: Individually complete a Mastery Check. If your performance indicates that additional support is needed, your instructor will determine how to help you move forward.

Part 5: Life Connections – Wolves & Woods (4.1.5)

Reading - *Complete the reading below. Use the space on the right to annotate the text by recording your ideas, highlighting important points, and recording questions as you are reading.*
SEP: Obtaining, Evaluating, and Communicating Information

Background: In the early 20th century, wolves were nearly wiped out by hunting. The Endangered Species Act prevented the wolves from going extinct in the Midwest. Wolves began returning to Wisconsin around the mid-1970s. The Wisconsin wolf population grew slowly initially, but then started growing rapidly in the following decades.

Since 1979, the Wisconsin DNR has mapped wolf pack territories every year. This data helps scientists study how wolf populations change over time. Scientists like Dr. Ramana Callan were uncertain how the presence of wolves affects both plant and animal biodiversity. Wolves in the Great Lakes region primarily hunt white-tailed deer. Deer are a main consumer of plant species in Wisconsin. Changes to the populations of wolves and deer can affect the rate at which plants are consumed.

Dr. Callan speculated that areas that were most frequently visited by wolf packs would have higher plant biodiversity compared to other areas. She reasoned that wolves would prey on whitetail deer, which consume plants. The more that wolves visit an area, the less that deer would consume plants. This would enable more plants and a wider variety of plants to exist in those areas.

To test this idea, Dr. Callan's team first mapped how frequently wolves visited different parts of northern Wisconsin. She then compared how levels of plant biodiversity differed between areas that are more visited by wolves compared to areas less visited by wolves.

Driving Questions:

1. **How can the presence of wolves change animal and plant biodiversity?**

2. **What was Dr. Callan's…** ***(underline and label each)***
- Research question (RQ)
- Hypothesis (HY)
- Rationale (RA)
- Independent Variable (IV)
- Dependent Variable (DV)

3. **How did Dr. Callan test her hypothesis?**

Questions - *Answer the following questions based on the reading on the previous page..*
SEP: Engaging in an Argument from Evidence. Constructing Explanations & Designing Solutions.

1. **Briefly summarize Dr. Callan's research question (RQ), hypothesis, and rationale:**

   RQ: _____

   Hypothesis: _____

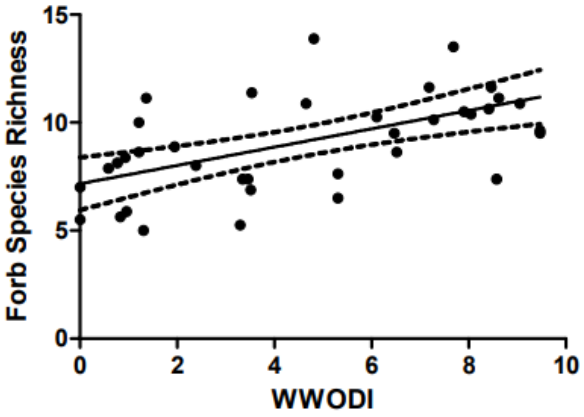
   Rationale: _____

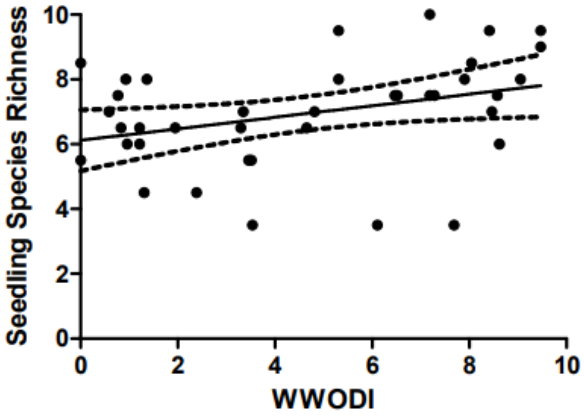
2. **What were Dr. Callan's independent and dependent variables in this experiment?**

   Ind. Var.: _____

   Dep. Var.: _____

Dr. Callan's data is shown below. "WWODI" refers to the "wolf duration index". This is a measure of how often wolves visited an area (larger numbers = more frequent visits). "Species richness" is a way to measure biodiversity. The greater the species richness, the more biodiversity for those species. "Forbs" are wildflowers, and "seedlings" refers to young trees. The dotted lines show the margin of error. *(Data Source)*





3. **Is Dr. Callan's hypothesis supported by this data? How do you know? Refer to specific parts of these graphs to support your claims (it is ok to draw arrows from your text to the graphs).**

   _____

   _____

   _____

4. **Based on this data, make a prediction about how the presence of wolves affects both the carrying capacity and resiliency of Wisconsin habits. Defend with evidence and reasoning.**

   _____

   _____

   _____

Ecosystems Packet 1 Formative Assessment (4.1.4)

Name: _____Hour____Date:_____Score:_____

Directions: A 3x5 notecard with *handwritten* notes can be used to guide your answers. Your instructor may allow you to work in assigned groups. If so, have a different person write each response while others assist.

1. The image at the right shows that in order to gain 1.5 lbs. of body mass per day, this animal has to consume roughly 15 lbs. of food. **Why does only a small percentage of the mass of the consumed food stay inside the animal's body?**

For a steer to gain 1.5 lbs. per day...

...it must consume 15 lbs. of food.

_____

_____

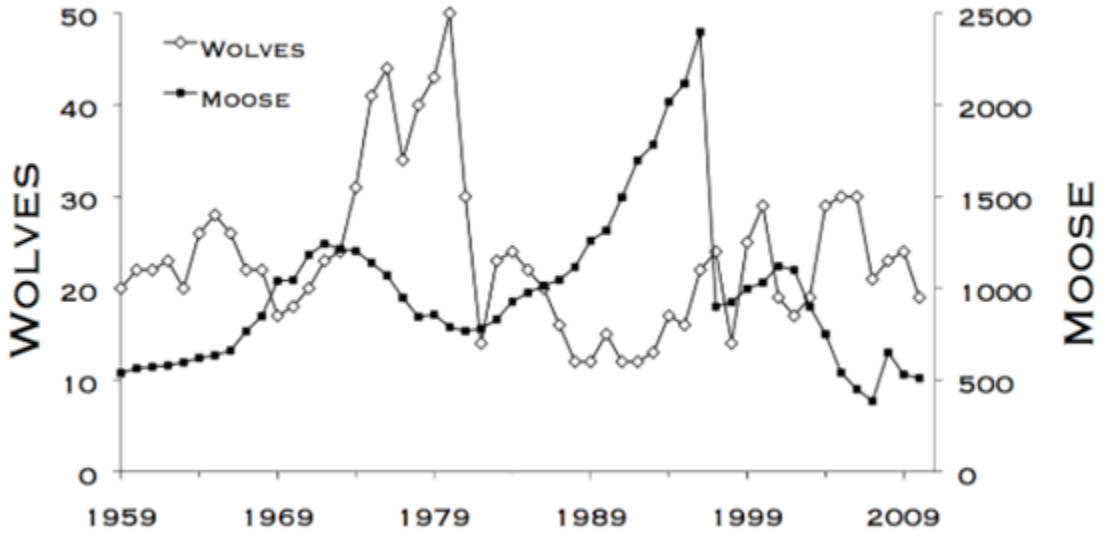
_____

_____

_____

_____

Writer's Name:



2. Three students make predictions before looking at data for Isle Royale's wolf and moose populations. **Circle "Agree" or "Disagree" for each of the three claims below based on the data above.**
   - Mike: "There will be more wolves because the wolves eat the moose." *Agree/ Disagree*
   - Lucia: "I think the population of moose and wolves should be about the same." *Agree / Disagree*
   - Oscar: "I think that there should usually be far more moose than wolves." *Agree / Disagree*

3. **How do trophic levels & the 10% Rule affect the number of moose & wolves this island supports?**

Writer's Name:

4. A study found that forests similar to those in Isle Royale contain an average of 135,000,000 g of plant biomass per hectare (*a hectare is roughly the size of 2.5 football fields*). **What is the maximum grams of a) primary consumer biomass and b) secondary consumer biomass that could be supported per hectare of Isle Royale forest? Explain your answers.** **(Source: Tang *et al.*, 2010).**

Writer's Name:

5. Tropical rainforests are more biodiverse, can support more species, and are more resilient compared to polar ecosystems. **Why does biodiversity, carrying capacity, and resiliency differ between these ecosystems?** Include & underline the following: *photosynthesis; biomass; 10% rule.*

Writer's Name:

6. Oil spills have occurred in both Alaska and in Louisiana, resulting in extensive ecological disruption. **Which ecosystems would recover more slowly, those in Alaska or those in Louisiana? Why?**

Writer's Name:

