DYNAMIC POPULATIONS

OVERVIEW

This lesson will explore the phenomenon of the **moose-wolf population dynamics** on Isle Royale, as students learn about how one of our lesser-known national parks provides a firsthand opportunity to witness biology, ecology, and history in action. They will explore the dynamics of predator-prey relationships, conduct field observations about populations in their own area, and mathematically model the moose-wolf population biology over time.

LESSON OBJECTIVES

- **Know** how predator-prey interactions affect the populations of each over time
- **Understand** how the moose and wolf populations on Isle Royale have changed in recent decades
- **Be able to** mathematically model the populations of a predator and prey system

WHAT YOU'LL NEED

- Computer or mobile device with Internet access to view video and online resources
- Notebooks and pencils
- Chart paper
- Sticky notes
- Markers
- Lab supplies (see individual activities for a full list)
- Copies of the Student Handouts

INTRODUCTION

Isle Royale National Park is a place of astounding beauty and natural wonder. Yet beneath the tranquil appearance of this remarkable island lies a dynamic struggle for survival—a delicate dance between predator and prey—that has been playing out for generations. The island's largest herbivore, the majestic moose, has been locked into an ongoing relationship with the cunning wolves that hunt them. What happens on Isle Royale is not just the stuff of wilderness documentaries; it's a living laboratory of biology, ecology, and history, studied by scientists for years to reveal its predator-prey population dynamics.

This lesson includes multiple activities, including lab activities, that can span the course of several sessions or be adapted to fit the needs of your group's meeting format.

Some prior knowledge* with which students should be familiar includes:

- graphing
- collecting data
- food chains and food webs

NGSS CONNECTIONS

Phenomenon: Wolf-Moose Population

- **MS-LS2-1**
- **MS-LS2-2**
- **MS-LS2-3**
- **MS-LS2-4**
- **MS-ESS3-3**

- **SEP 2**
- **SEP 4**
- **SEP 5**
- **SEP 6**
- **SEP 8**

During the course of the lesson, students will progress through the following sequence** of activities:

- Class discussion to elicit and activate prior knowledge about the concept of **population**
- Close read a video about salmon population
- Teacher notes on **population dynamics**
- Watch a segment from *Great Lakes Now*
- Class discussion to debrief the video
- Read about the come back of the bald eagle
- Analyze and model the populations of wolves and moose on Isle Royale
- Research the populations of organisms in a local area

The lesson progresses through three major sections: **launch, activities, and closure.** After the launch of the lesson, you are ready to begin the lesson activities. Once finished with the activities, students will synthesize their learning in the closure. You can select the activities that are best suited for your learners and teaching goals, and then sequence them in a way that makes sense within your learning progression and the scaffolds of the lesson.

Follow this QR Code or hyperlink to the Episode Landing Page!

Check out our full collection of lessons for more activities related to topics like these.

***The sequence of these activities is flexible, and can be rearranged to fit your teaching needs.**

If you use this lesson or any of its activities with your learners, we'd love to hear about it!

Contact us with any feedback or questions at:
GreatLakesNow@DPTV.org

LESSON LAUNCH

A. Warm Up

The warm up is intended to be structured as teacher-facilitated, whole-group student discussion activities. It helps students to begin thinking about the topic at the center of the lesson.

1. Ask students to list out on a piece of paper five things that come to mind when thinking of **population**.
2. Have students pair up with a partner to share their five ideas with each other. If any ideas appear on both lists, have students circle those.
3. Then, engage students in a whole-group discussion to ask them to share any ideas that were circled.
4. Generate a list of the circled ideas.
5. Ask for volunteers to share any ideas that were not circled that they think are really important to include in this topic.
6. Generate a separate list of those ideas.
7. At the end of making the two lists, have students copy down one single list of all the circled ideas and important ideas in their notebooks or on their paper.
8. Ask students individually to rank the ideas in the list from most to least relevant.
9. Ask for some students to share which term should be most relevant and why they think that is. Engage the whole group in discussion to arrive at consensus about the most relevant idea related to **population** that they already know about or that came to mind during this exercise.

B. Bridge to Learning

Activate prior knowledge by having students research their school population over time. Obtain data ahead of time to provide students, and have them use graph paper to create graphs that illustrate the total school population (e.g., enrollment) over different periods of 10 years spans. Then, discuss the graphs they created.

C. Close Reading a Video

Play the video clip **Salmon Population Depleted** from PBS LearningMedia. The video offers the perspective of the Native American Lummi Nation of Washington State on the effects that human activity has had on the salmon population in their region over time. To facilitate the close reading, instruct students to:

1. **Watch the video** attentively and take notes on key points, visuals, and any questions or observations that arise.
2. **Summarize the main content** of the video and identify the primary themes or messages it conveys.
3. **Discuss the visual and auditory elements** used in the video and how they contribute to its storytelling impact.
4. **Explore the concept of populations and human activity** in fishing mentioned in the video. Talk about its importance and its impact on the food chain, human food supply, and the livelihood of those who work in fishing.
5. **Engage in a class discussion**, sharing insights, reactions, and interpretations of the video.
6. **Analyze the video's effectiveness** in conveying its message. Did the video achieve its intended purpose? Were there any elements that could have been improved?

D. Background Information Notes

Explain that we are about to learn more about population dynamics. Then, give the **Teacher Background Notes** to students.

TEACHER BACKGROUND INFORMATION

by Gary G. Abud, Jr., Great Lakes Now Contributor

*This information can be presented by the teacher as notes to students at the teacher's discretion.

The wolf-moose population dynamics of Isle Royale National Park provide an intriguing ecological case study. This isolated island context located in Lake Superior is an ideal location for studying predator-prey interactions and the impacts of ecological factors such as food, migration, and climate.

The wolf-moose population study on Isle Royale dates back to the late 1950s when researchers began monitoring the species and the interactions between them. Wolves and moose immigrated to the island, likely by crossing the ice from the mainland, during the early 20th century. Initially, the moose population on the island flourished, with abundant food resources and no natural predators.

Over time, the wolf population established itself on the island, and the classic **predator-prey relationship** dynamic began. Moose serve as the primary food source for wolves, and as the wolf population grew, it exerted **predation pressure** on the moose population. This predation pressure led to fluctuations in both populations, with moose numbers declining as wolves increased, and vice versa, over time.

Given the limited size and resources of the island, there is a maximum population size, or **carrying capacity**, a that an ecosystem can support over the long term. In the case of Isle Royale, the carrying capacity for moose is influenced by factors such as available vegetation for food and habitat quality. The wolf population's carrying capacity, in turn, is determined by the availability of moose, their primary food source on Isle Royale.

Weather and climate impact population size and genetic diversity as they determine the conditions necessary for the waters to freeze around Isle Royale, permitting migration between the island and mainland.

The predator-prey **population dynamics** exhibit cycles, with moose numbers following the availability of food and wolf numbers tracking moose abundance. When moose numbers reach a peak, they exhaust their food supply, leading to a decline. This decline in moose population can trigger a wolf population decline due to food scarcity for wolves. The wolf population, in turn, experiences a lag in its response to changes in moose numbers; thus, less wolves around to hunt moose and exert predation pressure on moose. These population cycles are easily seen when wolf and moose population data is graphed.

On Isle Royale, wolves and moose do not exhibit a **uniform distribution** of their populations throughout the island. Instead, their distribution is influenced by factors such as the availability of food, terrain, and the density of competitors or predators. The prey species, moose, tend to concentrate in certain areas, known as. **clumped distribution,** with suitable vegetation, while the predators, wolves, follow the same distribution of their prey.

The influence of human activity on the wolf-moose population dynamics on Isle Royale has been minimal until recent years. Inbreeding among wolves, largely due to their isolation and low population numbers on the island, prompted human intervention in the form of wolf reintroductions in 2018 and 2019.

The loss of genetic diversity due to inbreeding can lead to a variety of detrimental characteristics for a species, including weakened immunity, increased instance of harmful traits, infertility, and poor adaptability and species resilience. As humans introduced new wolves from outside the population, genetic diversity increased, helping the wolf population to bounce back from dangerously low numbers to a self-sustaining level. That allows the natural dynamic between these species and their environment to play out.

ACTIVITY 1: WATCH A GREAT LAKES NOW SEGMENT

This activity is a video discussion of a *Great Lakes Now* episode segment.

First, inform students that they will be watching a *Great Lakes Now* segment about how Isle Royale National Park is home to an ongoing study of biology: namely the moose and wolf population dynamics. During the video they need to jot down four things they took away from the video using the **4 Notes Summary Protocol**.

Then, if students are not already familiar, introduce them to the 4 Notes Summary Protocol, which they will use after they finish watching the video, where they write down one of each of the following notes:

- **Oooh!** (something that was interesting)
- **Aaah!** (something that was an ah-ha moment)
- **Hmmm…** (something that left them wanting to know more)
- **Huh?** (a question they have afterward)

Next, have students watch the segment from **episode 2310** of *Great Lakes Now* called **Wild Islands**.

Last, have students complete their individual 4 Notes Summary and then discuss those in groups of 3-4 students.

Teaching Tip: Use the Student Handouts to help students organize their thinking in writing around each of the lesson protocols.

Post-Video Discussion

After the groups have had time to go over their 4 Notes Summaries, invite a handful of students to share out some of their notes, eliciting at least 1-2 of each of the 4 Notes and listing those somewhere for the whole group to see.

Ask students to turn back and talk with their groups to make connections between the *Great Lakes Now* video and what they remember from the warm-up activities.

How is what we saw in the video related to what we discussed earlier during the lesson launch activities?

After giving the groups some time to talk, bring the whole group back together for a shareout and discussion of ideas.

In this culminating discussion, the goal is to help students make connections between the video segment and what they discussed during the launch activities earlier in the lesson about what they knew about **populations.**

Once the discussion finishes, have each student write a "**Sum It Up**" statement in their notebooks. This is a single sentence that captures the big idea of what was just learned.

Have 2-3 students share out their **Sum It Up** statements before concluding this activity.

ACTIVITY 2: READ ABOUT THE BALD EAGLE'S COMEBACK

In this activity, students will read about how Michigan's bald eagle population has made a remarkable recovery from the brink of extinction, with over 900 breeding pairs in the state as of 2019, a significant increase from just 52 breeding pairs in the 1960s.

In this activity, students will use a **Think Pair Square Protocol** for discussing what they will read about this very topic.

First, have students partner up and distribute the article **[Michigan Bald Eagles Soar Back From Near-Extinction](#)** by Ashley Zhou of *Bridge Magazine*. Allow time for students to individually read the article, and have them jot down three things they took away from the article using the **Rose Thorn Bud Protocol**—in their notebook or using the handout.

Then, give students time after reading to discuss the article that they read with their partner. Have students share their rose, thorn, and bud with each other, including how those points connect to each other. The pair should come up with a statement to summarize all of their article takeaways.

Next, have two student pairs join up, standing near each other to form the four corners of a square, to discuss the article and what they talked about in their pairs. Encourage them to come to a consensus about which point they found most important or interesting in the article.

Last, have each group craft a summary statement of the most important point from their discussion and ask for a volunteer in each group to share that key point with the whole group. As student groups share their most important point, record their ideas on the board and have students copy the list of student ideas down into their notebooks. Once the shareout is complete, ask students to return to their groups and discuss one last question based on the article:

How might the efforts of bald eagle conservation help other populations to increase in number and prevent becoming an endangered species or even going extinct altogether?

You can keep this as a class discussion based on the article itself, or this can be extended into a writing assignment, presentation project, or further research on the topic to allow students to engage more deeply with the issue.

Teaching Tip:
If the reading level of the article is going to be tough for some students to read individually, have partners or small groups read the article together aloud while each follows along.

ACTIVITY 3: MODELING PREDATORY-PREY DYANMICS
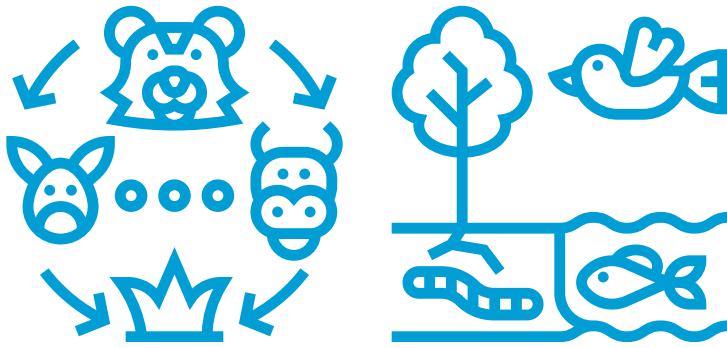
The purpose of this activity is to model the wolf-moose populations on Isle Royale and better understand how population graphs can tell us about what's happening with a predator-prey relationship in an ecosystem.

Materials

- Access to the Internet to visit the isleroyalewolf.org website
- graph paper
- pencils
- Moose-Wolf Population Data

First, inform students that they will be graphing and analyzing data from the Isle Royale Wolf Project. Display the interactive graphical timeline of five decades of wolf-moose population data available on the Data & Interpretation page under the Technical tab in the website menu on the **Isle Royale Wolf Project website**. As you take students through the progression of population data available in this interactive, discuss with them what story this data might tell about the wolves and moose over time. Have a couple volunteers share some ideas.

Next, have students obtain a data set from the **Moose-Wolf Population Modeling Student Handout** and partner up with one other person to graph the data. Give groups time to graph the wolf and the moose populations, respectively, on their own separate curves over time. Monitor students and help them build their graphs.

Then, once students have finished constructing their graphs, have them label different portions of the graph, such as the maximum and minimum for both the wolf and the moose populations in their data. Have them analyze the data with their partners to be able to explain what these maxima and minima represent and how they relate to one another.

Last, have students tell a story about the populations of the wolves and moose over time based on their data and the analysis that they did of it using their graphs. Engage the entire class in a discussion where they each can display their graphs for all to see, and have them use the **Notice and Wonder** protocol on the student handout to guide discussion about the similarities and differences of their graphs.

Discussion points:

In the discussion, intentionally select specific groups to point out either features of their graphs or ideas that they shared in their analysis of their data to help draw students' attention to the oscillations in the population curves for both the wolves and the moose over time. Through continued questioning, help them to see the inverse relationship between each population and the interaction cycles of the populations.

FIVE DECADES OF FLUCTUATING WOLF AND MOOSE POPULATIONS
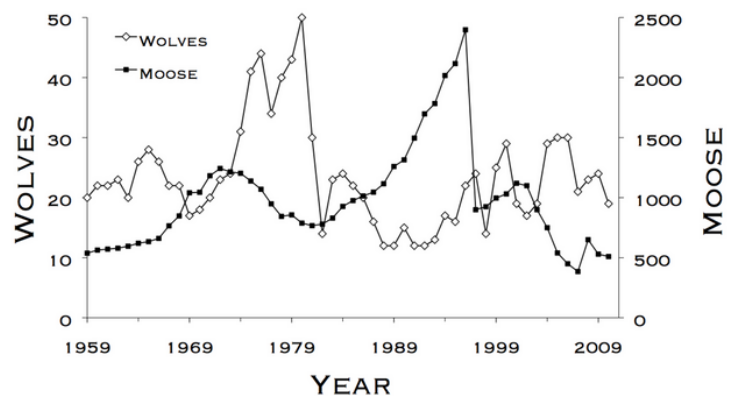
ACTIVITY 4: POPULATION FIELD RESEARCH

In this activity, students will conduct field research in an area near where they live to observe, record, and monitor the populations of different species.

Materials:
- Field notebook and pen
- spreadsheet tool (option)
- graph paper and pencil

First, inform students that they will be playing the role of a real-life ecologist by observing and learning about population relationships in their local ecosystem. Have them find a partner to conduct the field research with and encourage them to determine the location where they will do their observations. It could be a park, somewhere in their neighborhood, or another nearby area. Remind them that they need to plan with their families and coordinate with one another about going out to collect data in their areas.

Next, have them discuss, or do research, on potential species that they could observe in the location they chose. The ideal situation would be to find a predator prey relationship, if possible. It could be birds hunting worms, plants being grazed by herbivores like deer or rabbit, or something else unique to their chosen area. Have them formulate a plan for how they will collect their data and establish a time period for collecting it.

Then, have students make a hypothesis about what they expect they will find with the populations they are researching. Give students time to collect data from their environments. It could be over the course of several days, or weeks, but have students bring their data into class to graph and analyze with their partners.

Last, give students time and guidance to determine how to visually represent their data and findings. It could be a single graph or a series of graphs. They may choose to include other visual elements such as food chains/webs, flowcharts, or diagrams to illustrate how the species they observed interact with their environment and the ecosystem.

Provide an opportunity for students to present and discuss the findings of their field research. Engage students in a discussion about what were the limitations of their field research and how that might influence the reliability of their data. Extend the discussion by asking what they can know for certain based on their data and how the limitations they encountered could be addressed and avoided in the future if the field research were to be repeated. Challenge students to extend their thinking by mathematically modeling— predicting or explaining using their data—what would happen if one of the species they observed changed dramatically for some reason (such as a population decline due to disease.) Have them discuss their responses. Sum up the findings with common trends.

ACTIVITY 5: EXPLORE WOLF-MOOSE POPULATION RESEARCH
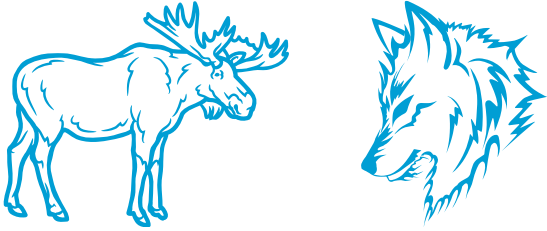
The purpose of this activity is to learn about Isle Royale's extensive research on the wolf and moose population over the years, and to ask questions about the datasets available.

First, inform students that they will work with a partner to explore the existing research on Isle Royale's wolf-moose population biology. They should gather facts, data, and information about the Isle Royale Wolf Project, choose a data-driven research question to ask, and be prepared to summarize and communicate their findings with others in a chart.

Next, allow students time to research the **isleroyalewolf.org** website and learn more about the research of scientists Rolf and Candy Peterson, who were featured in the *Great Lakes Now* segment Wild Islands in Activity 1. Direct them to the "Technical" tab in the navigation bar and then have them select "data and interpretation" from the menu. There, they'll be able to find and download a Wolf-Moose dataset on the menu on the righthand side of the page. Assist students in obtaining and opening the dataset in their spreadsheet tool. Give students a guided tour of how to navigate the data in this spreadsheet and then let them explore all the data that's available.

Then, have them generate a research question to ask about the data set. This is an open-ended task for students to explore mathematical relationships that they think might be meaningful from the dataset.

Some examples of questions might include:
- **What is the relationship between the kill predation rate of wolves and the moose population size?**
- **How do climate-related factors (e.g., temperature, snow depth) correlate with changes in wolf and moose populations?**

Last, they should utilize the dataset available to try and answer their research question by graphing the data relevant to their question and analyzing any trends that would help answer the research question they generated. Upon completing their research and generating their graphs, they should prepare to present their research project—by telling a story with their data to explain how they answered their research question with data—in a World Café and communicate what they learned from the Isle Royale Wolf Project with their peers.

World Café Presentations:
The World Café model is a collaborative discussion and knowledge-sharing process that can be used to engage participants in a dynamic and interactive presentation activity.
1. Pair up three student project groups together, ideally seated around separate café tables lined chart paper for jotting notes.
2. Group 1 will be the host for each round, but they will not add their input until round 4. Hosts facilitate discussion and take notes.
3. The teacher poses a specific question to the entire class related to the overall theme of the project and groups 2 and 3 discuss it using their research findings for 10 minutes.
4. Groups 2 and 3 switch to new tables.
5. Hosts brief newcomers on the previous discussion before the teacher poses a new question for this round to discuss.
6. The rotation happens again for round 3.
7. Hosts brief newcomers on the previous discussion before the teacher poses a new question for this round to discuss.
8. The rotation happens one last time.
9. Hosts brief newcomers before everyone discusses a final question from the teacher.
10. This time the hosts add their ideas to the table discussion first before others chime in.
11. All groups should make connections to prior ideas visible in the notes on the tabletop.
12. Come back together as a whole class and have the hosts summarize their café table conversations while the teacher collects and displays insights from everyone before giving the class a chance to identify common themes and draw overarching conclusions about the wolf-moose population dynamics.

LESSON CLOSURE

After the conclusion of all the activities, help students to make connections* between everything they did in the lesson and what they learned overall.

A. Free Recall
Group students in pairs or triads (e.g., in groups of 2-3 partners) and distribute the **Free Recall Protocol handout**, Alternatively, you can have students do this in their notebooks. Set a 3-min timer and have students generate a list of everything they can remember learning about in this lesson related to the central topic of the lesson. This doesn't have to be in depth, just whatever each group can call to mind. Have them draw lines between any terms that relate to one another. After the timer finishes, give groups a chance to volunteer to share aloud 2-3 things from their free recall lists and any of the connections that they made with those. Jot down any ideas that come up multiple times during the shareout for the whole group to see.

B. Lesson Synthesis
Give students individual thinking and writing time in their notebooks to synthesize their learning, by jotting down their own reflections using the **Word, Phrase, Sentence Protocol.**

In the Word-Phrase-Sentence Protocol, students write:

- A **word** that they thought was most important from the lesson
- A **phrase** that they would like to remember
- A **sentence** that sums up what they learned in the lesson

C. Cool Down
After the individual synthesis is complete, students should share their synthesis with a partner.

After sharing their syntheses, have students complete a **3, 2, 1 Review** for the lesson with their partner, recording in their notebooks or, optionally, on exit ticket slips to submit, each of the following:

- **3 things** that they liked or learned
- **2 ideas** that make more sense now
- **1 question** that they were left with

Invite several students to share aloud what they wrote in either the synthesis or 3, 2, 1 Review.

Lastly, ask one student volunteer to summarize what has been heard from the students as a final summary of student learning.

Optionally here, the teacher can revisit the learning objectives and make connections more explicit for students.

> **Teaching Tip: Use the Student Handouts to help students organize their thinking in writing around each of the lesson protocols.**

NAME: _____

Moose-Wolf Population Modeling.

Directions:

1. Graph and analyze the following dataset of the populations of the wolves and moose on Isle Royale over a given set of years.
2. Create separate curves on the graph for the wolf and moose populations, respectively.
3. Create different vertical axes, one on the right and another on the left side of the graph, to scale accordingly for each of the populations, since their numbers are different by a scale factor of roughly 100.
4. Label different regions of the graphs that you think are meaningful, such as maximum or minimum points on each.
5. Next to your graph, write an explanation for what the labeled regions of your graph mean.
6. Be prepared to tell a story about the population dynamics of wolves and moose based on your graphs and the label regions on them.

Year	Wolf Population	Moose Population
1988	12	1116
1989	12	1260
1990	15	1315
1991	12	1496
1992	12	1697
1993	13	1784
1994	17	2017
1995	16	2117
1996	22	2398
1997	24	900
1998	14	925
1999	25	997
2000	29	1031
2001	19	1120
2002	17	1100
2003	19	900
2004	29	750
2005	30	540
2006	30	450
2007	21	385

NAME: _____

Notice & Wonder Protocol

NOTICE	WONDER
Things that you noticed about the topic	*Things that you wondered about the topic*

NAME: _____

4 Notes Summary Protocol

OOOH!

Something that was interesting to you

AAAH!

Something that became clearer; an "ah-ha" moment

HMMM...

Something that left you wanting to learn more

HUH?

Something you questioned or wondered

Sum It Up Statement:

Summarize your group discussion about your 4 Notes Summaries below:

NAME: _____

Rose, Thorn, Bud Protocol

ROSE
Something that "blossomed" for you in your learning

THORN
Something that challenged your thinking or was difficult to understand

BUD
Something that's new and growing in your mind — a "budding" idea

NAME: _____

Think Pair Square Protocol

THINK
Write down your own individual ideas

PAIR
Summarize what you and your partner discussed

SQUARE
Summarize what your group discussed

NAME: _____

Free Recall Protocol

With 1-2 partners, generate a list of everything you can remember learning about in this lesson related to the central topic of the lesson. Draw lines between any terms that relate to one another.

NAME: _____

A Word, Phrase, Sentence Protocol

What is a **word** that you thought was most important from this lesson?

What is a **phrase** that you would like to remember from this lesson?

What is a **sentence** that sums up what you learned in this lesson?

3, 2, 1 Review Protocol

What are **3 things that you liked or learned** from this lesson's activities?

-
-
-

What are **2 ideas that make more sense** now to you?

-
-

What is **1 question that you were left with** after this lesson?

-