3. Fish Population Dynamics

Overview and Purpose

To understand how the populations of a predator and prey fish species relate to one another, as well as to describe the impact that external factors may play in the population dynamics between aquatic species in the Great Lakes.

Lesson Summary

Students will model how the population of two freshwater fish species change over time and depend on one another.

The background context that is needed for this lesson is for students to know the food chains and food webs. An optional activity to first acquaint students with this concept in the context of the Great Lakes can be found here from Michigan Sea Grant. Students also need to know how to collect data in a data table and construct a line graph from a data table.

This lesson focuses on developing and using models to explain or predict phenomena that may be difficult to directly observe.

ESSENTIAL THEMES	● Predator-Prey Relationships ● Population Dynamics ● The influence of environmental changes to populations
NEXT GENERATION SCIENCE STANDARDS	➔ MS-LS2-1 Ecosystems: Interactions, Energy and Dynamics. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. ➔ MS-LS2-2 Ecosystems: Interactions, Energy and Dynamics. Construct an explanation about how the different parts of the food chain are dependent on each other. ➔ MS-LS2-3 Ecosystems: Interactions, Energy and Dynamics. Develop a model to describe the cycling of matter and flow of energy among living parts of the food chain. ➔ MS-LS2-4 Ecosystems: Interactions, Energy and Dynamics. Construct an argument, supported by evidence gathered through observation and experience, showing how changes to physical or biological components of an ecosystem affect populations. Ecosystems are dynamic in nature; their

	characteristics can vary over time. Disruptions to any physical or biological components of an ecosystem can lead to shifts in all its populations. ➔ MS-LS2-5 Ecosystems: Interactions, Energy and Dynamics. Evaluate competing design solutions for maintaining biodiversity and ecosystem services. ➔ MS-ESS3-3 Earth and Human Activity. Answer questions about how pollution affects food chains by applying scientific principles to design a monitoring plan for minimizing the human impact on the environment. ➔ SEP3: Develop and/or use a model to predict and/or describe phenomena.
OBJECTIVES	❏ Develop and use a model to analyze the relationship between populations of a predator and prey ❏ Understand the impact of external factors on the population of species in an ecosystem
ESTIMATED TIME	❖ **2 class periods**

Materials Needed

- Video projection monitor or screen/speakers
- Internet access via computers or mobile devices (e.g., tablets, cellphones)
- Notebooks and pencils
- Chart paper or a dry erase board and markers
- Flat surface, 12″ × 12″ square made from masking tape
- 300 yellow perch cards per group (tip: laminate or print on cardstock before cutting out)
- Paper cutter or scissors
- Colored tape or masking tape
- 4 walleye cards per group (represents an adult walleye)
- Population data table

Facilitation Steps

WARM UP: Begin by asking students what they already know about the essential themes of the lesson and what they wonder about it. Have them turn and talk with a shoulder partner. Then, after a minute of conversation, elicit responses from a couple of volunteers and jot down 2-3 ideas on the board under the categories KNOW and WONDER. The teacher should help students clarify their ideas as they are shared by checking for understanding using a talk move such as "so you are saying..." or help students think together by asking for a show of hands of agreement from the class in response to what individual students share.

LAUNCH: Once the warm up has concluded, give a brief overview of the background context to students, making connections to their KNOW and WONDER responses as well as any other relevant prior knowledge they would have from other lessons they have learned. Describe the activities planned for this lesson to students.

ACTIVITY 1: Introduction to Freshwater Fish Populations

First, share with students that in this lesson they will be examining the relationship between certain species in order to learn about a phenomenon that affects all species in an ecosystem: population dynamics. Take a moment to create an operational definition of the term "population dynamics" with students, and then inform them that they will be exploring population dynamics with a predator species and prey species of fish.

Next, show the class this video clip from Great Lakes Now about Native Species of Fish in the Great Lakes from 25 Days of Fishmas. Ask them to focus on how many different native species of fish are shown in the video.

Then, distribute copies of (or direct students to view online) the article from Michigan Sea Grant about the Decline in Prey Fish. Have students take turns reading each paragraph aloud.

Last, ask four student volunteers to share one response each to one of the 4 Notes Summary protocol prompts about the article they just read, where they share one of each of the following:

- Oooh! (something that was interesting)
- Aaah! (something that was an ah-ha moment)
- Hmmm... (something that left them thinking afterward)
- Huh? (a question they have afterward)

ACTIVITY 2: Walleye and Perch Population Dynamics [Simulation]

First, have students get into groups of four and distribute materials for the activity to each group:

- masking tape,
- rulers,
- activity cards for the predator and prey, and
- copies of the data table (duplicate the data table to be two-sided so students can record up to 24 generations of data total).

Have students create a 12” by 12” square area with masking tape, on a tabletop surface or on the floor. Explain that they will be doing a predator-prey simulation of freshwater fish species using the cards in an aquatic ecosystem represented by the square area. Describe to students that walleye feed on smaller fish, such as yellow perch. While it may consume other species in nature, for the purpose of this activity we will consider only the relationship between the walleye as predator and the yellow perch as prey by assuming the yellow perch as the primary food source for walleye. In other words, if there are no yellow perch, the walleye go hungry.

Next, explain the rules of the simulation activity and demonstrate how it works with one group to the whole class:

1. Each group should begin with three yellow perch distributed throughout the square area. They will record this for the first generation on their data table.
2. Group members should take turns tossing each walleye card into the area once.
3. If the walleye card lands touching a perch card, the walleye has caught its prey, and that perch is gone from the population. If a perch is untouched by a walleye, it survives.
4. After each toss of the walleye card, remove it (and any caught perch) before the next is thrown.
5. In order to survive and have offspring, a walleye must catch three perch, or it dies.
6. Walleye offspring are added by tossing the card an additional time for each new walleye. Remember that for every three perch a walleye catches, a new walleye is added to the population. That means if a walleye catches eight perch, it survives and has two offspring that all enter the next generation.
7. In order to survive, a perch must avoid being eaten by all the walleye in a generation.
8. The surviving perch population doubles each generation (add additional perch cards before the start of the next generation to the area to show this.)
9. If no walleye survived the previous generation, another swims into the area; if no perch survive, three new perch mature and enter into the area in the next generation.

10. Be careful to track and record the number of each population over the course of the generations. Carry out the simulation to about 20 or so generations, as time allows.

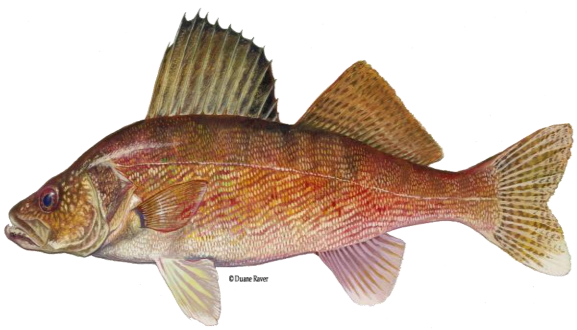
Then, allow students time to conduct the simulation of the predator-prey population dynamics and record their data in the data table. Monitor the groups as the progress through the activity and ask critical thinking questions to groups based on what you observe of their progress.

Last, after groups have completed the simulation and have their data table completed, give them time to graph the predator and prey population data (in different colors on the same graph) on a large whiteboard or chart paper. Have each group include with their graph a couple of statements summarizing their data or drawing conclusions about the simulation.

Fish Population Data Table

Generation Number	Starting Number of Walleye (Total)	Starting Number of Perch (Total)	Total of Perch Eaten	Perch Survived	Walleye Starved to Death	Walleye Survived	Walleye Offspring Produced	Starting Ratio of Walleye to Perch (W/P)

<u>Fish Population Activity Cards Template:</u> *Before cutting out the fish, make 15 copies of this sheet for each group doing the activity, giving them 300 yellow perch and four walleye cards.



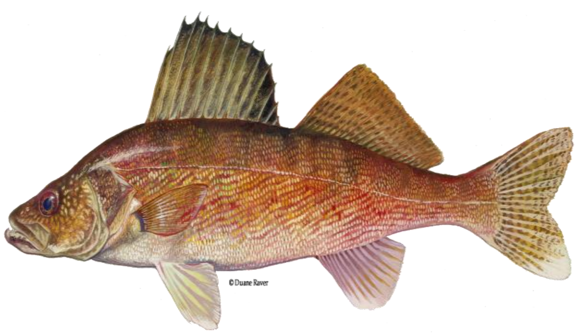
WALLEYE

PERCH

PERCH

PERCH

PERCH



WALLEYE

PERCH

PERCH

PERCH

PERCH

PERCH

PERCH

PERCH

PERCH

 PERCH	 PERCH	 PERCH	 PERCH
 PERCH	 PERCH	 PERCH	 PERCH

ACTIVITY 3: Influences on Population Dynamics

First, display all the graphs side-by-side for the entire class to see before holding the class discussion to debrief the results of the simulation activity. Ask the class to analyze (e.g., compare and connect) the results of all the groups, as well as to draw an overall conclusion (taking into account every group's data) about the relationship between the populations of each fish in the simulation. Allow students to talk directly to one another about their data, and facilitate the conversation as needed to promote understanding and answer questions.

Next, assign each group one of the following questions to go back into their groups to answer. Inform them that they will be returning to the whole-group discussion afterward to explain their response to the question. The questions are:

1. How would the population of the walleye and perch have changed over time if there were excessive **commercial fishing of walleye** throughout the first ten generations?
2. How would the population of the walleye and perch have changed over time if there were excessive **commercial fishing of perch** throughout the first ten generations?
3. How would the population of the walleye and perch have changed over time if there were **a disease that only affected perch** in the 10th generation?
4. How would the population of the walleye and perch have changed over time if there were **contaminated runoff** that entered the water of this ecosystem and killed the source of food for the yellow perch in the 10th generation?
5. How would the population of the walleye and perch have changed over time if there were **an invasive species that also ate yellow perch** as its primary source of food throughout the first ten generations?

6. What is an estimate of **the upper limit of the population of walleye** that this ecosystem can support.
7. What is an estimate of **the ideal number of walleye** that this ecosystem can support without getting too high or too low?
8. What could we conclude about the populations of walleye and perch at any given time based solely on **the ratio of walleye to perch**?

Then, allow students time to confer with their group on their question and to prepare responses to share with the class. Groups should write a response to their question by including their claim, relevant evidence from the simulation, and the reasoning that supports their claim.

Last, return to the whole-group discussion to allow each group to present their question and the response their group prepared. After each presentation, engage the class in further questions to deepen their understanding. (*An optional teacher resource for facilitating whole-group discussion questions is the Talk Science Primer from the Technical Education Research Centers).

SYNTHESIS: Give students individual thinking and writing time in their notebooks to synthesize their learning by jotting down their own reflections using a Word, Phrase, Sentence protocol, with:

- 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

After the individual synthesis is complete, students should share their synthesis with a shoulder partner.

COOL DOWN: Have students complete a 3, 2, 1 Review protocol for the lesson with a partner, recording in their notebooks or, optionally, on exit ticket slips to submit, the following:

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

CLOSURE: Have one student share a response from each of the categories of the 3, 2, 1 Review. Depending on the available time, the teacher can make connections between the ideas students share and the learning objectives of the lesson, and respond to the question that is shared.

EXIT TICKET: Students write what they think is the biggest threat to the fish populations they investigated in their simulation and provide reasoning as to why they selected that factor.

About the Author

Gary is an educational consultant, award-winning science educator and the author of *Science With Scarlett*. He is also a double cornea transplant recipient who, since having his sight restored, was moved to use his teaching gifts to make science fun for kids. He lives with his family near Detroit and designs learning experiences to inspire children, like his own daughter, to love science. Gary is the 2014 recipient of the Michigan Teacher of the Year honor. Contact him via his consulting firm, Saga Educators, or connect with him on Twitter.

About Great Lakes Now

With a monthly magazine-style television program and daily online reports at GreatLakesNow.org, the ***Great Lakes Now*** initiative offers in-depth coverage of news, issues, events and developments affecting the lakes and the communities that depend on them, while capturing the character and culture of the region.