Exploring Natural Populations
Ecology – 6th Grade

Unit Summary: This unit is designed to allow students to explore concepts presented in their text through the use of inquiry and real-world data collection techniques. Students are introduced to simple data collection, inferences, and inquiry in the first activity, in which they are asked to observe a simulated ecosystem, to describe the relationships between organisms, and to classify the role each population plays in the ecosystem. Next, students move beyond simple observation to gather data about populations using scientific techniques. These data are then used to estimate the size of the studied populations. In the final activity, students begin to explore the dynamics and cycles of populations through the use of a computer simulation. The role of abiotic factors is highlighted in the conclusion of this activity.

Students will have already been introduced to basic ecosystem elements and properties (e.g. producer, consumer, energy, population). The present unit serves to reinforce and to delve deeper into these topics. Additionally, students learn about real-world techniques and scenarios through which scientists study populations and ecosystems.

Keywords: observation, inference, producer, consumer, decomposer, trophic level, biotic, abiotic, population, population dynamics

Michigan Content Expectations:

S.IP.M.1 Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation.
S.IP.06.11 Generate scientific questions based on observations, investigations, and research.
S.IP.06.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, models, sieves, microscopes) appropriate to scientific investigations.
S.IP.06.15 Construct charts and graphs from data and observations.
S.IP.06.16 Identify patterns in data.

S.IA.M.1 Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations.
S.IA.06.11 Analyze information from data tables and graphs to answer scientific questions.
S.IA.06.13 Communicate and defend findings of observations and investigations using evidence.

L.OL.M.5 Producers, Consumers, and Decomposers – Producers are mainly green plants that obtain energy from the sun by the process of photosynthesis. All animals, including humans, are consumers that meet their energy needs by eating other organisms or their products. Consumers break down the structures of the organisms they eat to make the materials they need to grow and function. Decomposers, including bacteria and fungi, use dead organisms or their products to meet their energy needs.
L.OL.06.51 Classify producers, consumers, and decomposers based on their source of food (the source of energy and building materials).
L.OL.06.52 Distinguish between the ways in which consumers and decomposers obtain energy.

L.EC.M.1 Interactions of Organisms- Organisms of one species form a population. Populations of different organisms interact and form communities. Living communities and nonliving factors that interact with them form ecosystems.
L.EC.06.11 Identify and describe examples of populations, communities, and ecosystems including the Great Lakes region.
L.EC.06.21 Describe common patterns of relationships between and among populations (competition, parasitism, symbiosis, predator/prey).

L.EC.06.23 Predict how changes in one population might affect other populations based upon their relationships in the food web.
L.EC.06.31 Identify the living (biotic) and nonliving (abiotic) components of an ecosystem.
L.EC.06.32 Identify the factors in an ecosystem that influence changes in population size.
L.EC.06.41 Describe how human beings are part of the ecosystem of the Earth and that human activity can purposefully, or accidentally, alter the balance in ecosystems.
L.EC.06.42 Predict possible consequences of overpopulation of organisms, including humans, (for example: species extinction, resource depletion, climate change, pollution).

Learning Objectives:

1) Students will be able to define *observation* and *inference*, and to explain how each relates to the scientific process.
2) Students will be able to make accurate observations in a novel simulated ecosystem.
3) Students will be able to summarize their observations and use these summaries to infer relationships or patterns observed within ecosystem elements.
4) Students will be able to construct tables and figures to present their observations.
5) Students will be able to evaluate the appropriateness of inferences based upon observational evidence.
6) Students will be able to formulate questions for additional experimentation, and propose a methodology by which these questions could be answered.
7) Students will be able to define "population."
8) Students will be able to explain why extrapolation of population sizes from a representative sample is often required.
9) Students will be able to calculate the quantity of trees in a local population, as well as the area they cover.
10) Students will be able to apply an existing methodology to complete a forest inventory, and suggest ways in which the methodology could be improved.
11) Students will be able to interpret and describe overall trends in data presented in a graphical format.
12) Students will be able to compare results between trials that simulate varying conditions within an ecosystem.
13) Students will be able to assess the impact of changes in population size at a given trophic level on other species within an ecosystem.
14) Students will be able to formulate real-world scenarios that could result in the conditions described in the scenarios.
15) Students will be able to predict the results of new simulations based upon prior trials.

Table of Lessons:

Lesson Title- Brief Description	Learning Objectives	Content Standards Addressed	Materials
"Observations and inferences in a novel ecosystem: An investigation of members of a new class of organisms, Gummia."	1) Students will be able to define observation and inference, and to explain how each relates to the scientific process.	**S.IP.06.11** Generate scientific questions based on observations, investigations, and research. **S.IP.06.15** Construct	• Computer and projector • Worksheets • Colored pencils/markers • Poster board • Gummy bears (and

Students are introduced to a newly discovered class of organisms (gummy bears) in a simulated ecosystem. Students make observations and draw inferences based on data collected in this ecosystem. Students present their data and inferences in poster form. Time: Three class periods.	2) Students will be able to make accurate observations in a novel simulated ecosystem. 3) Students will be able to summarize their observations and to use these summaries to infer relationships or patterns observed within ecosystem elements. 4) Students will be able to construct tables and figures to present their observations. 5) Students will be able to evaluate the appropriateness of inferences based upon observational evidence. 6) Students will be able to formulate questions for additional experimentation, and to propose a methodology by which these questions could be answered.	charts and graphs from data and observations. **S.IP.06.16** Identify patterns in data. **S.IA.06.11** Analyze information from data tables and graphs to answer scientific questions. **S.IA.06.13** Communicate and defend findings of observations and investigations using evidence. **L.OL.06.51** Classify producers, consumers, and decomposers based on their source of food (the source of energy and building materials). **L.OL.06.52** Distinguish between the ways in which consumers and decomposers obtain energy. **L.EC.06.21** Describe common patterns of relationships between and among populations (competition, parasitism, symbiosis, predator/prey). **L.EC.06.31** Identify the living (biotic) and nonliving (abiotic) components of an ecosystem.	possibly other candy) • Outdoor/indoor space in which to set up the simulated ecosystem
"Conducting a Forest Inventory." Students learn techniques for conducting a standard forest inventory. Students will be introduced to methodologies for establishing inventory plots, measuring tree diameters, identifying local tree species, and calculating basal area. Students will also learn	1) Students will be able to define "population." 2) Students will be able to explain why extrapolation of population sizes from a representative sample is often required. 3) Students will be able to calculate the quantity of trees in a local population, as well as the area they cover. 4) Students will be able to apply an existing methodology to complete a forest inventory,	**S.IP.06.12** Design and conduct scientific investigations. **S.IP.06.13** Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, models, sieves, microscopes) appropriate to scientific investigations. **S.IA.06.11** Analyze	• Field guides/tree keys • Tape measure (at least 25' for round plots or 165' for rectangular plots) • Diameter tapes or small, flexible fabric tape measures • Pin flags • Datasheets and clipboards • Computer and projector

about the importance of taking a representative sample and scaling data from a sample to a larger population. Time: Three to five class periods.	and suggest ways in which the methodology could be improved.	information from data tables and graphs to answer scientific questions. **S.IA.06.13** Communicate and defend findings of observations and investigations using evidence. **L.EC.06.32** Identify the factors in an ecosystem that influence changes in population size. **L.EC.06.41** Describe how human beings are part of the ecosystem of the Earth and that human activity can purposefully, or accidentally, alter the balance in ecosystems.	
"Population Dynamics – Exploring Interactions Between Populations and With Their Environment." Students are introduced to the study of population dynamics through the use of real scientific studies. They then use an online population simulator to investigate how changes in one population affect other populations. A worksheet is provided to guide their investigation. Students then create simulations of their own design and predict the outcome. Finally, examples are used to introduce the effect of abiotic factors on populations. Time: One class period.	1) Students will be able to interpret and describe overall trends in data presented in a graphical format. 2) Students will be able to compare results between trials that simulate varying conditions within an ecosystem. 3) Students will be able to assess the impact of changes in population size at a given trophic level on other species within an ecosystem. 4) Students will be able to formulate real-world scenarios that could result in the conditions described in the scenarios. 5) Students will be able to predict the results of new simulations based upon prior trials.	**S.IP.06.16** Identify patterns in data. **S.IA.06.11** Analyze information from data tables and graphs to answer scientific questions. **L.EC.06.11** Identify and describe examples of populations, communities, and ecosystems including the Great Lakes region. **L.EC.06.21** Describe common patterns of relationships between and among populations (competition, parasitism, symbiosis, predator/prey). **L.EC.06.23** Predict how changes in one population might affect other populations based upon their relationships in the food web. **L.EC.06.32** Identify the factors in an ecosystem that influence changes in population size.	• Computer lab/laptops (individual or one per pair of students) • Computer and projector • Worksheets

		L.EC.06.41 Describe how human beings are part of the ecosystem of the Earth and that human activity can purposefully, or accidentally, alter the balance in ecosystems. **L.EC.06.42** Predict possible consequences of overpopulation of organisms, including humans, (for example: species extinction, resource depletion, climate change, pollution)	

Safety Considerations:
Food allergies should be considered prior to the Gummia investigation (Lesson One).

Students should be aware of any potential hazards in the area (poison plants, stinging insects, etc.) during the outdoor portion of the forest inventory (Lesson Two). Closed-toe shoes and long pants may be recommended.

Evaluation Plan: "Observations and inferences in a novel ecosystem: An investigation of members of a new class of organisms, Gummia." Students produce a poster presenting their data, inferences drawn from these data, and questions for future study. These posters will be used to evaluate students' comprehension of the terms *observation* and *inference*, to assess students' ability to summarize data graphically, and to assess students' ability to generate new scientific questions based on existing knowledge.

"Conducting a Forest Inventory." Students will produce a report that summarizes the data they gathered in a standard forestry or forest ecology format, and scales to the population of interest. Questions that can be adapted to a formal assessment are suggested at the end of the lesson.

"Population Dynamics – Exploring Interactions Between Populations and With Their Environment." Students complete a worksheet during the simulations, assessing both their understanding of the driving forces within the system, and their ability to predict the impact of changes in one population to other populations. Students also create and predict the outcome of new simulations. At the conclusion of the lesson, students are asked to describe all of the factors that affected population dynamics in the examples covered during the lesson, and to think of additional factors that we did not discuss that may be important.

Summative Unit Assessment: Upon completing the unit, students can be asked to conduct a research project into the interactions between a set of organisms in an ecosystem of their choosing. For example, students may choose to investigate the impact of an invasive insect on native tree or insect populations. The reports should include a description of the role of each of the organisms within the ecosystem (producer, consumer, etc.), the interaction between the organisms (predator-prey, competitive, etc.), and how the population sizes or structure are changing or have changed over time. Reports should also include a brief description of how the data were obtained; if such information is not available, students may be asked to investigate ways in which these populations are studied in other situations.

Resources (websites):
"Conducting a Forest Inventory."
Forest Inventory and Analysis homepage:
www.fia.fs.fed.us/
FIA data:
apps.fs.fed.us/fido/standardrpt.html
FIA protocols:
www.fia.fs.fed.us/library/field-guides-methods-proc/docs/2013/Core%20FIA%20P2%20field%20guide_6-0_6_27_2013.pdf
Alternative plot example (Whittaker plot):
labs.bio.unc.edu/Peet/ecoinfo/stohlgren/stohlgren1995.pdf
Allometric equations for biomass calculations:
www.treesearch.fs.fed.us/pubs/7058

"Population Dynamics – Exploring Interactions Between Populations and With Their Environment."
Population dynamics game:
puzzling.caret.cam.ac.uk/game.php?game=foodchain
Background information on the Isle Royale wolf/moose example (hyperlink does not work, copy and paste):
www.isleroyalewolf.org/http%3A//www.cpc.ncep.noaa.gov/products/precip/CWlink/pna/nao.shtml

Brief description of how this unit relates to your graduate research. (1 page):
My research investigates the impacts of simulated emerald ash borer infestation on vegetation dynamics and nutrient cycling in black ash wetlands. Specifically, I am investigating the post-disturbance response of species composition and growth rates, as well as nitrogen dynamics and export in hydrologically isolated wetlands.

The first lesson in the unit, "Observations and inferences in a novel ecosystem: An investigation of members of a new class of organisms, Gummia" provides important context on the study of relatively unexplored systems. The lesson reviews concepts covered during the previous school year. It also provides an important base for discussing interactions between populations, and the dynamics of multi-trophic level interactions.

Following this lesson, the unit moves into activities that introduce the students to one of the most basic measures taken of populations: population size ("Conducting a Forest Inventory"). Students are introduced to the importance of standardized and representative sampling, which is important in many scientific disciplines. The techniques described in the lesson are very similar to those I use in the vegetation dynamics aspect of my research. These techniques will help students learn to critically evaluate the means by which data can be obtained, and the importance of applying appropriate techniques to the population of interest. Studies of vegetation dynamics are based upon standardized sampling strategies, of which the FIA plot is a common and easily applied example. Students will be identifying plants, measuring diameter (secondarily, through measurements of circumference), and estimating biomass. Accurate application of plant keys and measurement equipment plays a critical role in my research.

The final activity, "Population Dynamics – Exploring Interactions Between Populations and With Their Environment," explores the interactions between populations of organisms. While the simulation focuses on multi-trophic level interactions, the concepts covered are broadly applicable to interactions within trophic levels (competition, resource scarcity, etc.) The activity will conclude with a discussion of environmental factors on population dynamics. Effects such as these potentially play a large role in the system that I study, as changes in environmental conditions may drive species succession in these wetlands.

Throughout these activities, students will experience real-world scientific techniques used in my research, and in other research around the world. Further, this unit covers the dynamic, interconnected nature within and between ecosystems at multiple levels. Such interactions are foundational to research in ecosystem and disturbance ecology, including my own.