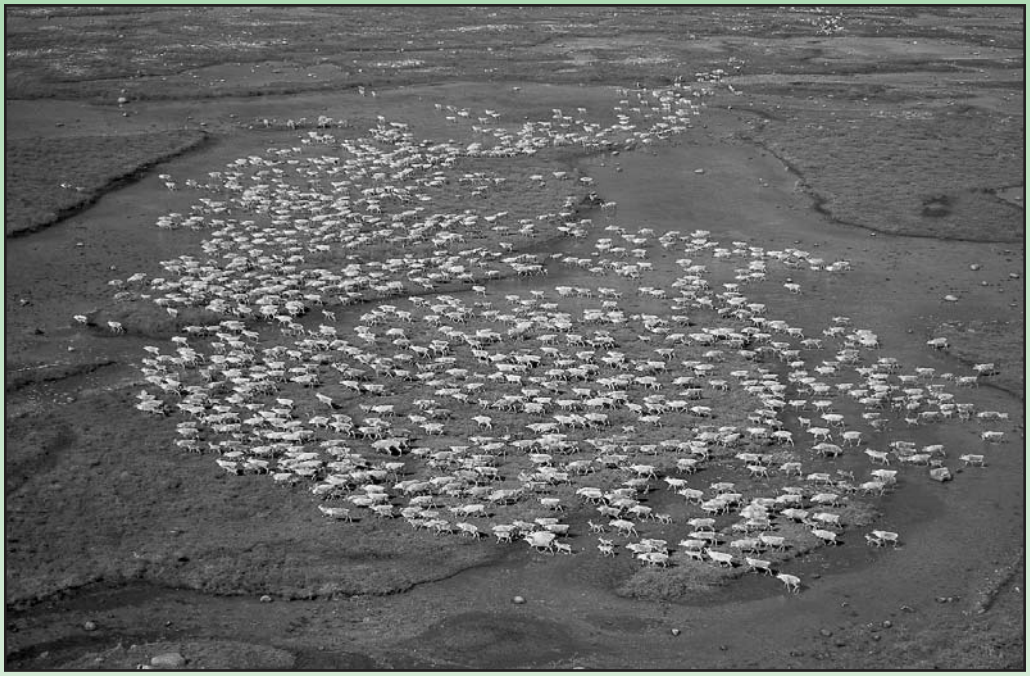
OVERVIEW

POPULATIONS AND ECOSYSTEMS COURSE



WELCOME TO AN ECOSYSTEM

Look around...you 're in an ecosystem. How do you know? Because there are organisms everywhere. An ecosystem is an organizational unit of life on Earth, defined by a physical environment and the organisms that live there.

Organisms depend on their ecosystem for survival. Disruption to one element of the ecosystem produces waves and ripples that touch every member of the system. The ripple 's impact on an individual organism depends on the relationship between the organism and the change as well as the traits expressed by the individual. Changes may produce pressures in the ecosystem.

When changes in ecosystems are incremental, genetic flexibility may allow a population to change over time to adjust to the new conditions. When change is precipitous, a population may be exterminated.

One powerful change agent in just about every ecosystem on Earth is humans. Human mobility, technology, and institutions place pressures on many ecosystems. The first step toward placing less disruptive pressure on natural systems is understanding how they work and what they need to remain healthy.

This course provides students with the first steps along the path of ecological understanding, with the hope that their future steps will be considered and measured, serving the interests of all life.

FOSS AND NATIONAL STANDARDS

The **Populations and Ecosystems Course** for grades 7 –8 supports the following National Science Education Standards.

SCIENCE AS INQUIRY

Develop students' abilities to do and understand scientific inquiry.

- Design and conduct scientific investigations.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the connections between evidence and explanations.
- Communicate scientific procedures and explanations.
- Use mathematics in scientific inquiry.
- Understand that different kinds of questions suggest different kinds of scientific investigations; current knowledge guides scientific investigations; and mathematics and technology are important scientific tools.
- Understand that scientific explanations emphasize evidence.

CONTENT: LIFE SCIENCE

- Develop students' understanding of populations and ecosystems.
- A population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.
- Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some microorganisms are producers—they make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.
- For ecosystems, the major source of energy is sunlight. Producers use photosynthesis to transform energy entering ecosystems as sunlight into chemical energy. That energy then passes from organism to organism in food webs.
- The number of organisms an ecosystem can support depends on the resources available and abiotic factors, such as quantity of light and water, range of temperatures, and soil composition.

Given adequate biotic and abiotic resources, and no disease or predators, populations (including humans) increase at rapid rates. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystems.

Develop students' understanding of reproduction and heredity.

- Reproduction is a characteristic of all systems; because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce asexually. Other organisms reproduce sexually.
- Every organism needs a set of instructions for specifying its traits. Heredity is the passage of these instructions from one generation to another.
- Hereditary information is contained in genes, located in the chromosomes of each cell. Each gene carries a single unit of information. An inherited trait of an individual can be determined by one or by many genes, and a single gene can influence more than one trait.
- The characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited, and others result from interactions with the environment.

Develop students' understanding of diversity and adaptations of organisms.

- Biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variation in populations. Biological adaptations include changes in structures, behaviors, and physiology that enhance survival and reproductive success in a particular environment.

SCIENCE IN SOCIAL PERSPECTIVES

Develop students' understanding of changes in environments.

- Environments are the space, conditions, and factors that affect an individual's and a population's ability to survive and quality of life.
- Changes in environments can be natural or influenced by humans. Some changes are good, some are bad, and some are neither good nor bad.

FOSS MIDDLE SCHOOL PROGRAM COMPONENTS

FOSS for Middle School is a general science curriculum for students and their teachers in grades 6–8. The curriculum is organized into topical courses in three strands: **Earth and Space Science, Life Science, and Physical Science and Technology**. Each course is an in-depth unit requiring 9–12 weeks to teach. This course, designed for students in grades 7–8, includes the following five interconnected components:

- A detailed ***Populations and Ecosystems Teacher Guide*** in a three-ring binder, including overview, materials preparation, goals and objectives, at-a-glance investigation chart, science background, lesson plans, transparency masters, teacher answer sheets, assessments with masters and scoring guides, CD-ROM user guide, and references (books and websites). Chapters of the teacher guide are separated by tabs for easy use. **Populations and Ecosystems** has ten investigations, each with one to four parts.
- **Kit of student laboratory equipment** packaged for multiple classes of 32 students each. The kit also contains class resource materials such as videos. Each course is designed for one teacher working with five sections of students per day. The kit includes 34 transparencies for the investigations.
- ***FOSS Populations and Ecosystems Lab Notebook*** consisting of student sheets and organizers for students to use while they engage in the investigations. One copy comes in the kit.The lab notebook can be a consumable item if one is purchased for each student. The book is rendered in black and white and the sheets are perforated, so individual sheets can be used as duplication masters, adding flexibility to your use of the notebook.
- ***FOSS Populations and Ecosystems Resource*** is a book containing data and readings that are used throughout the course. It is intended to be used as classroom resource, shared by all students.
- ***FOSS Populations and Ecosystems* CD-ROM** for use as a whole-class demonstration tool as well as an individual or small-group interactive instructional tool. The multimedia is woven into the instruction and is linked to most investigations. Five CD-ROMs come in the kit; additional CDs can be purchased in lab packs of 5, 10, 20, and 50 for use with multiple computers. For this course, we strongly recommend that you have a CD for each pair of students in your class.

POPULATIONS AND ECOSYSTEMS: LIFE IS ORGANIZED

Feeding ducks at the park is a riot. A handful of dry bread brings a mob of paddling and gabbling waterfowl right up to your ankles, each positioning itself to pounce on the proffered crumbs. When the last crust is gobbled down, the tension of opportunity dissipates almost immediately, and the ducks wander off placidly on individual paths.

With the ducks dispersed, the pond settles back to its more usual state of activity—algae growing in the shallow water, a snail gliding over a rock, a small school of nondescript fish, often called minnows, scooting furtively past. A pastoral underwater scene. This is life conducted at a relaxed pace.

Life is everywhere, represented by innumerable kinds of individuals and in astronomically large numbers. Each unit of free-living life is an **organism**. A microscopic single-celled bacterium has equal status with the blue whale and the giant sequoia tree in this regard.

Organisms live in essential relationships with others of their kind in units called **populations**. Populations are reproducing groups of organisms of the same species living together. Every organism is a member of a population.

Populations always live in relationships with other populations in **communities**, not for companionship, but for the resources needed to maintain life. These resources, including energy and chemical building blocks, are essential for every organism. Organisms have functions that benefit other organisms, not for altruistic reasons, but because the consequences of self-serving actions have secondary effects that benefit others.

Communities of organisms exist in an environment. The totality of the community and the environment in which they live constitutes an **ecosystem**. Ecosystems are the largest, most complex units of organization in the study of life. Ecologists are the scientists who try to understand the interactions between and among all the factors in the ecosystem. They try to determine the lines of influences between the organisms and the physical factors in the environment.

The ducks on the pond and the host of other organisms living in the water are there because they are adapted to acquire the resources they need from that environment. The oak trees, birds, squirrels, and insects living in the woods near the pond live there for precisely the same reason.

What prepared land organisms for a life in the woods ecosystem and aquatic organisms for a life in the pond ecosystem? This was the mystery that Charles Darwin addressed in his natural selection theory, a process that guides the sequential appearance and disappearance of species on Earth. In this course, students are introduced to the genetic basis for inherited characteristics, the cornerstone of biological evolution.

POPULATIONS AND ECOSYSTEMS COURSE MATRIX

SYNOPSIS	*SCIENCE CONCEPTS*	*THINKING PROCESSES*
1. Milkweed Bugs (3+ sessions)		
In an 8-week investigation, students raise milkweed bugs in a supportive habitat to study the insect's reproductive biology. The information from this study is used to study milkweed-bug population dynamics in Investigation 6.	• An organism is any living thing. • An organism's habitat is where it lives—the place where it can meet all of its requirements. • Milkweed bugs have a predictable life cycle. • A kind of organism that is different from other kinds is a species.	• Observe milkweed-bug individuals and populations to monitor changes. • Describe and communicate a sequence of events during a long-term study.
2. Sorting Out Life (2–3 sessions)		
Students use ecosystem sorting cards to reflect on organizing concepts in ecology and develop the vocabulary associated with those concepts. Through a Jane Goodall video, students become familiar with a specific population study of chimpanzees individuals of one kind in an area.	• A population is all the interacting individuals of one kind in an area. • A community is all the interacting populations in a specified area. • An ecosystem is a system of interacting organisms and nonliving factors in a specified area.	• Analyze and sort images on cards to determine which represent individuals, populations, communities, and ecosystems. • Identify biotic and abiotic elements. • Relate the characteristics of a population, community, and ecosystem.
3. Miniecosystems (3+ sessions)		
Students construct aquatic and terrestrial ecosystems in the classroom and observe them over time to understand ecosystem interactions. They use a group scientific log to observe, describe, and monitor changes in biotic and abiotic factors.	• An aquatic ecosystem functions in water. • A terrestrial system functions on land. • An ecosystem is a web of interactions and relationships among the organisms and abiotic factors in an area.	• Use reference information about organisms to construct a classroom ecosystem. • Observe, describe, and record changes to an ecosystem, using a scientific log. • Describe the relationships among biotic and abiotic factors.
4. Mono Lake (3 sessions)		
Students use Mono Lake, an important alkaline lake, as a simple ecosystem case study. They study the functional roles of populations to construct a food web.	• The sequence of organisms that eat one another is a food chain. • All the feeding relationships in an ecosystem define the food web for that system. • The Mono Lake ecosystem is defined by interactions among organisms and physical factors.	• Research the functional roles of organisms in an ecosystem. • Use data to construct feeding relationships (food web).
5. Finding the Energy (7 sessions)		
Students measure energy in food by burning it. They learn that food is produced by photosynthetic organisms and explore how food energy moves from one trophic level to another through feeding relationships.	• Food is energy-rich organic matter that organisms need for life. • Energy is measured in kilocalories. • In photosynthesis, food is made from water and carbon dioxide with light. • Feeding relationships define trophic levels: producers, consumers, and decomposers.	• Investigate and measure the amount of energy from a food source. • Determine the mass of production needed to support primary, secondary, and third-level consumers. • Relate food webs to trophic levels. • Infer how energy moves through an ecosystem.

MEDIA	FOSS READINGS	EXTENSIONS
	• *Milkweed Bugs*	• Maintain a milkweed-bug colony.
Video: *Among the Wild Chimpanzees*	• *Life in a Community*	
FOSS CD-ROM: Organism Database	• *Biosphere 2: An Experiment in Isolation* • *Miniecosystem Organisms*	• Localize your miniecosystems. • Observe the effects of a decomposer.
Video: *Of Ice and Fire: A Portrait of the Mono Basin* FOSS CD-ROM: Ecoscenarios, Mono Lake, Food Web	• *Where does food come from?* • *Trophic Levels*	• Diagram humans in food web. • Describe human trophic levels.

POPULATIONS AND ECOSYSTEMS COURSE MATRIX

SYNOPSIS	SCIENCE CONCEPTS	THINKING PROCESSES
6. Population Size (5–6 sessions)		
Students explore some of the variables in an ecosystem that limit population size. Based on their milkweed-bug study, they predict what the population would be in 12 months. Students use simulations to explore population interactions and outcomes.	• Reproductive potential is the theoretical unlimited growth of a population over time. • A limiting factor is any biotic or abiotic component of the ecosystem that controls the population size.	• Calculate theoretical growth of a milkweed-bug population with no limits. • Analyze results of experiments on abiotic factors and bug egg hatching. • Relate abiotic and biotic factors to the growth or decline of populations.
7. Ecoscenarios (5 sessions)		
Working in groups, students use knowledge developed in previous investigations to analyze a specific ecosystem and prepare reports. The FOSS CD-ROM provides a tool to research ten ecosystems.	• Similar ecosystems occur in areas of similar abiotic conditions on Earth. • An ecosystem is a group of interacting organisms and abiotic factors in a specified area. • All ecosystems have characteristics in common, such as trophic levels.	• Describe and communicate the abiotic and biotic components and their interrelations in a specific area. • Apply understanding of ecological concepts to a new system. • Describe ways that ecosystems are the same and different.
8. Adaptations (7 sessions)		
Students are introduced to adaptation first through a video and then by working with a multimedia simulation of a population of walkingsticks that exhibit color variation. Students study the impact of predation on the insects in different environments.	• Variation is the range of expression of a feature in a population. • An adaptation is any trait of an organism that helps it survive and reproduce in its environment. • Variation in a population helps the population survive when the environment changes.	• Use a multimedia simulation to investigate the adaptive value of protective coloration. • Explain how adaptations help organisms survive in a specific environment. • Describe how a population can change over time in response to environmental factors.
9. Genetic Variation (6 sessions)		
Students investigate the underlying mechanisms of change in population by breeding imaginary animals called larkeys. They learn how organisms inherit traits from their parents and how dominant and recessive alleles interact to produce traits in a population.	• Genes are the basic units of heredity carried by chromosomes in the nucleus of every cell. Genes code for features of organisms. • An organism's particular combination of paired alleles is its genotype; the traits produced by those alleles result in the phenotype.	• Use a simulation to determine the transfer of genetic information during breeding and the traits that result. • Explain how organisms inherit traits from parents. Describe the interaction of dominant and recessive alleles. • Use Punnett squares to predict the proportion of offspring that will have certain traits.
10. Natural Selection (5 sessions)		
Students study natural selection with larkeys and take a video journey to the Galápagos Islands to revisit the location where Charles Darwin gathered data for his theory of natural selection.	• Environmental factors put selective pressure on populations. • Natural selection is the process by which the individuals best adapted to their environment tend to survive and pass their traits to subsequent generations.	• Describe how selective pressure can affect the genetic makeup of a population. • Explain how the traits expressed by the members of a population can change naturally over time.

FOSS CD-ROM	FOSS READINGS	EXTENSIONS
FOSS CD-ROM: Milkweed Bugs, Unlimited FOSS CD-ROM: Milkweed Bugs, Limited	• *Limiting Factors* • *Mono Lake in the Spotlight*	• Discuss other population limitations.
FOSS CD-ROM: Ecoscenarios, Food Web	• *Ecoscenario Introductions*	• Investigate local ecosystem issues.
Video: *Hawaii: Strangers in Paradise* FOSS CD-ROM: Organism Database, Octopus Color Change FOSS CD-ROM: Walkingstick Predation	• *Adaptations*	
FOSS CD-ROM: Larkeys • Offspring Genotype and Phenotype • Impossible Traits • Punnett Square	• *From Mendel to Human Genome: Solving the Heredity Puzzle* • *A Larkey Yammer*	
Video: *Voyage to the Galápagos* FOSS CD-ROM: Larkeys • Natural Selection • Selective Breeding FOSS CD-ROM: Walkingstick Predation	• *Natural and Unnatural Selection*	• Use walkingsticks simulation.

FOSS TEACHER GUIDE

The ***Populations and Ecosystems Teacher Guide*** is just that—a guide. It is designed to be an information and planning tool to help you understand and enjoy your introduction to ecology, much like an interpretive brochure might guide your visit to historic Williamsburg. A good guide will suggest the best path to follow, and will enrich your visit with history, facts, and lore as you proceed. Like any good guide, it will also point out places to rest, and where to stop for refreshments. You should feel comfortable and confident that you know what you are doing as you go along.

Like a good guide, it may be pressed into service less as you become more and more familiar with the territory. On your third visit to Williamsburg, you might head straight for the main street, passing by some of the introductory exhibits, and you might visit your favorite spots in a slightly different order than you did before. You might even leave the trail here and there to drink in some of the historical ambiance in a way quite different from that intended by the preparer of the guide brochure.

The first time you visit the **FOSS Populations and Ecosystems Course**, we hope you will follow our suggested sequence to get the lay of the land. The guide is filled with information to help you have an excellent first use of the course. It may seem overwhelming at first, but in a short time you will discover how to use it effectively.

Here's what we suggest:

Look at the **Table of Contents** to see how the teacher guide is assembled. You'll notice that the guide is subdivided into 19 chapters. Turn each tab to see how much information there is in each section.

Next read the **Overview** chapter completely. This describes the scope of the course content and discusses issues of instruction, assessment, management, and safety.

Now turn all the pages in the guide, pausing to read the **Goal and Objectives** of each investigation carefully. In this way, you will be able to get a very good sense of the curriculum.

Finally, digest Investigation 1, *Milkweed Bugs,* thoroughly. Read the science background carefully and study the **at-a-glance chart** to see how the investigation is subdivided. The chart also provides a dissected overview of the several days of classroom actions, including the use of media (CD-ROM, video, and readings) and the assessments. Project the actions you read about into your classroom. Visualize students grappling with the issues and working with materials in small groups. If you have the kit at hand, bring out the materials as you read, and do the investigations. Discover where you are in the ecosystem. Then read Investigation 2 carefully, then 3, 4, 5, and so forth. Keep the *Populations and Ecosystems Teacher Guide* close at hand (even in hand) during your first excursion into this topic to ensure a safe and productive adventure.