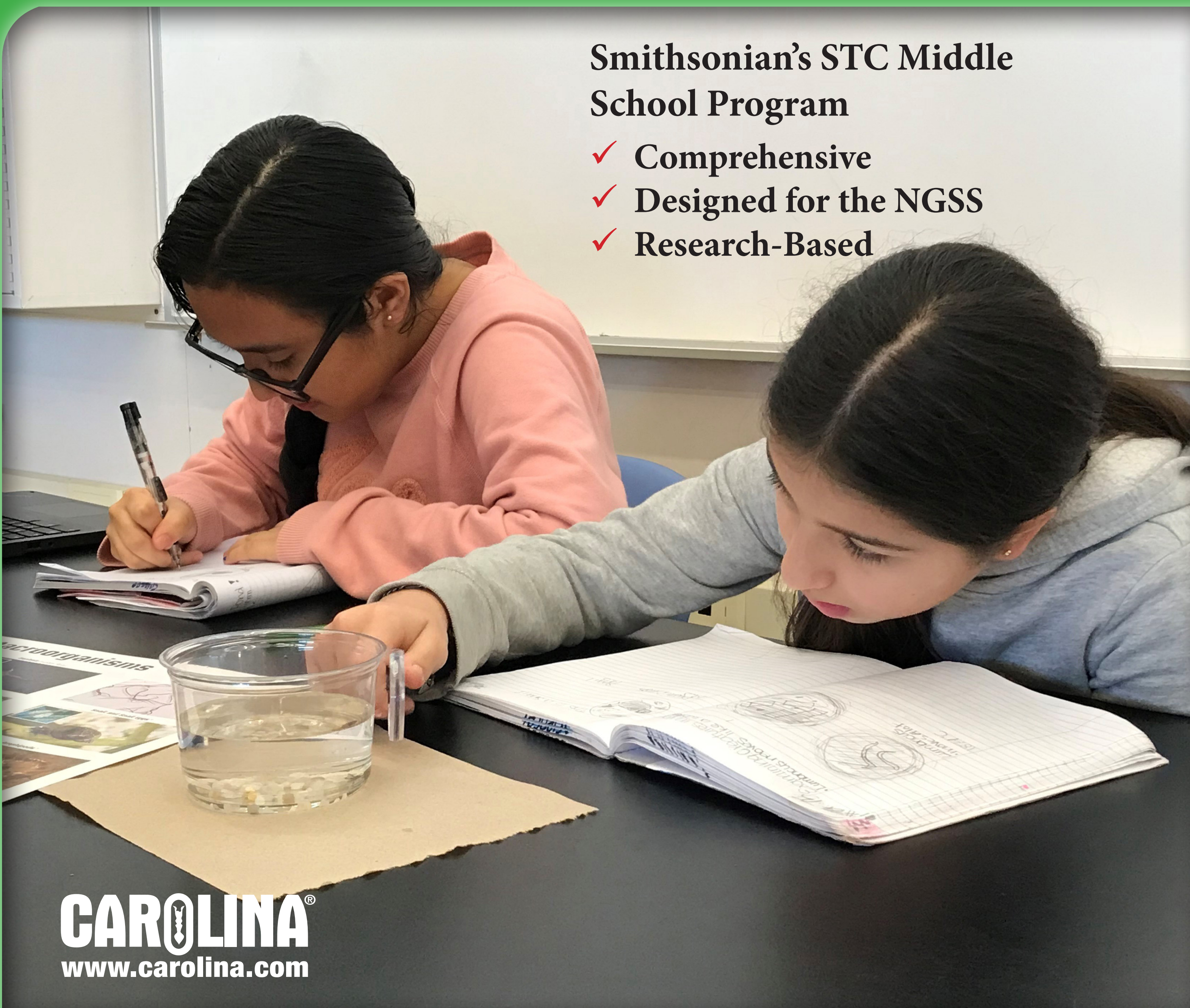
Smithsonian | STC
SCIENCE AND TECHNOLOGY CONCEPTS™
MIDDLE SCHOOL

ENGAGE. INSPIRE. CONNECT.



Smithsonian's STC Middle School Program

- ✓ Comprehensive
- ✓ Designed for the NGSS
- ✓ Research-Based

CAROLINA®
www.carolina.com

Table of Contents

A Comprehensive Science Program for Middle School

The Smithsonian's STC Middle School (STCMS) offers everything teachers and students need to be successful in one program.

The four components of STCMS modules provide the instructional materials necessary for phenomena-based, active learning:

- Teacher Edition (print and digital)
- Student Edition (print and digital)
- Digital resources and videos from the Smithsonian and Carolina Science Online
- Durable lab equipment that is always included

Everything You Need to Teach a Module. One Price.

Put phenomena directly into students' hands

Lesson 1 **Pre-Assessment: Ecosystems and Their Interactions**

Investigation 1.2: Constructing Your Pond

Procedure

NOTE

Provide a pair of disposable gloves for each student for this investigation and suggest that students wear them while constructing the model pond. Model safety yourself by wearing gloves as well. All students should wash their hands thoroughly before leaving class at the end of the investigation.

1. Explain that in this investigation, students will work with a group to set up a model pond that they will observe over time. You may wish to have students create a T-chart in their science notebooks to compare the model ponds to their real ponds. If you choose to do this, be sure to show students how to utilize a T-chart. A sample T-chart for this investigation is shown in Figu… discuss the m… used and wha… each material… the model.

2–4. Review t… assembling th… shade that w… entering the s… Demonstrate… construction… the shade. Th… these steps is… the measurer…

light from entering the sides of the pond.

5–7. Explain that the gravel will form the bottom portion of the students' pond ecosystem. Describe how to spread wheat seeds, timothy hay, and soil evenly over the gravel in the aquarium. Emphasize that the materials should be spread evenly over the bottom and should extend from edge to edge of the aquarium.

8–9. Describe how to place half of a Petri dish in the bottom of an aquarium and direct the stream of water to land on the dish as students fill the aquarium just below the top of the aluminum foil with spring

Investigation 1.2

Constructing Your Pond

Material

For you

- Science notebook
- Pair of disposable gloves

For your group

- 2 Containers of aquarium gravel
- 1 Bag of soil
- 1 Bag of timothy hay
- 1 Graduated cylinder, 50 mL
- 1 Metric ruler, 30 cm
- 1 Permanent marker
- 1 Petri dish half
- 1 Plastic aquarium
- Measuring spoon, 1 tsp
- Scissors
- Wheat seeds

For your class

- Access to water
- Alga-Gro® Freshwater Medium Concentrate
- Aluminum foil
- Light bank
- Paper towels
- Soap
- Spring water
- Tape

Procedure

1. In this investigation, you will set up a model of a pond that you will observe and collect data from throughout the unit. Consider the materials that you will use to create your pond. Examine the image of the pond in Figure 1.3. In your science notebook, record what parts of a real pond each

Lesson 8 **Natural Selection**

	GETTING STARTED	INVESTIGATION 8.1: Variation	INVESTIGATION 8.2: Natural Selection: Feeding Strategies	INVESTIGATION 8.3: Natural Selection: Coloration
Overview	• Students discuss the term "variation" and its significance in the living world. • Students discuss their ideas about the phrase "survival of the fittest" and how it relates to living things.	• Students closely observe groups of organisms to find similarities and differences between the individuals. • Students continue to explore variation in populations in the reading Building Your Knowledge: *Variation*.	• Students create a model to simulate feeding strategies in birds based on beak design and food type.	• Students model natural selection using coloration in a prey population. • Students further explore the phenomenon of natural selection as they read Building Your Knowledge: *Natural Selection*.
Objectives	• Recognize that individuals in a population differ from each other in various ways.	• Observe variation between individuals in two different types of organisms.	• Use physical models of feeding strategies to explore the process of natural selection.	• Use physical models of prey coloration to explore the process of natural selection.
Concepts	• Trait variation contributes to the chance of survival for different individuals in a population.	• Recognize that trait variation requires careful observation and that not all variations can be seen with the naked eye.	• Different organisms are adapted to meet their needs for different resources. • Differences in traits allow for variable survival of organisms in a population in different ecosystems.	• Mutation is a way new traits are introduced in a population. • Variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. • Natural selection may lead to increases and decreases of specific traits in a population over time.
Assessment	Pre-Assessment	Formative	Formative	Formative
Key Terms	Population Variation	DNA Evolution Mutation Population Selection Variation	Natural selection Population	Evolution Natural selection Population
Time	0.5 period	1 period	2 periods	1 period

Standards

Alignment to Next Generation Science Standards

Performance Expectations
- MS-LS4-4
- MS-LS4-6

Science and Engineering Practices
- Using mathematics and computational thinking
- Constructing explanations and designing solutions

Crosscutting Concepts
- Cause and effect
- Patterns

Disciplinary Core Ideas
- LS4.B: Natural selection
- LS4.C: Adaptation

Instructional Resources Designed to Support Teachers

- **Easy-to-follow lesson planning** guide, setup, and investigation procedures
- **Lesson-by-lesson correlations** to the standards reassure teachers that they are teaching three-dimensional lessons

Alignment to Next Generation Science Standards

- MS-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.
- MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

Lesson 8 aligns to NGSS performance expectations MS-LS4-4 and MS-LS4-6. Investigation 8.1 partially addresses MS-LS4-4 as students observe variation of traits in real populations. During Investigation 8.2, students model how feeding strategies and food available in an environment influence trait variation and foraging success, partially addressing MS-LS4-4. In Investigation 8.3, students simulate and mathematically model how coloration impacts the predator–prey relationship, partially addressing both MS-LS4-4 and MS-LS4-6. In Investigation 8.4, students use a computer simulation to model how traits influence population size in different environments with different selection pressures, meeting both MS-LS4-4 and MS-LS4-6. Finally, during Investigation 8.5, students observe their model ponds to determine if natural selection has occurred. Throughout the lesson, students apply survival probability to the concept of natural selection.

This lesson thoroughly addresses the science and engineering practices of using mathematics and computational thinking and constructing explanations. Students track the success of different traits over many generations by calculating changes in population size over time. Students construct explanations about why certain traits are more or less prevalent in a population and how those traits impact the probability of survival and reproduction of organisms.

Lesson 8 also addresses the crosscutting concepts of patterns and cause and effect. Throughout the lesson, students look for patterns in how traits move through or decline in populations to understand how natural selection works. They address cause and effect as they see that variable survival based on traits leads to changes in populations.

Lesson 5 **Energy Flow**

Lesson Overview

This lesson focuses on energy flow through an ecosystem using food chains and food webs. Students become familiar with the patterns among feeding relationships and begin to develop an understanding of energy flow in an ecosystem. Students also observe patterns in energy transfer between trophic levels in an ecosystem.

To begin the lesson, students examine images of living things and predict how they get energy. Then, students explore feeding relationships in the African savanna. After analyzing and interpreting this information, they create a food web to display the energy flow for that ecosystem. Students then model the transfer of energy between trophic levels and observe patterns between the different levels. Finally, students monitor changes in their pond ecosystems and consider how energy is transferred among the different organisms that live in it.

Common Misconceptions

- If a population in a food web is disturbed, there will be little or no effect on populations below it or those not within the linear sequence in the food web. (A disturbance to any part of the food web affects all populations connected by that food web.)
- Varying the size of a population of organisms will affect only those populations of organisms that are directly connected to it in a feeding relationship, not organisms that are one or more steps removed/away from it. (A change in size to any population in a food web affects all populations connected by that food web.)
- Organisms higher in a food web eat everything that is lower in the food web. (Organisms eat only those organisms that are linked directly below them in a food web; secondary consumers do not necessarily eat all primary consumers.)
- If the size of one population in a food web is altered, all other populations in the web will be altered in the same way. (Any change in size of one population can cause certain other populations to increase and certain other populations to decrease or stay the same.)
- A change in the size of a prey population has no effect on its predator population. (If prey become abundant, predator populations will increase, at least in the short term. If prey become rare, predator populations will decrease.)
- The top predator in a food web will never be significantly affected by changes in the populations of organisms below it in the food web. (Predator populations depend on one or more of the populations below them for food, so other changes in the food web affect top predators.)

Background

Learning about energy transfer can be challenging for students because the concept of energy itself is not always easily understood. Consider explaining that energy can be stored or used to light, heat, or move something.

Once the concept of energy is no longer a stumbling block, students will easily understand and interpret the food chains and food webs described in the lesson. Encourage students to research food chains made up of living things that interest them on their own time and to share what they find with the class.

Think about discussing with students how food webs can effectively illustrate the interconnectedness found within ecosystems. This can help when considering how one change might impact other parts of the ecosystem. Conservation scientists are often called upon to do just that as they examine how a threat to one part of a food web might impact other parts. It is often difficult to predict all of the relevant links.

- **Common misconceptions** are addressed at the beginning of each lesson to help teachers guide their students through conceptual change.
- **Background information** in each lesson provides support for the content so teachers can feel comfortable teaching any topic

STCMS Assessment

Powerful tools allow you to assess your students every step of the way and use the results to adjust instruction to help prepare them for middle school testing

- **Pre-assessment** reveals student misconceptions and informs your instruction
- **Formative assessment**, including Exit Slips and Reflecting on What You've Done, gauge student understanding through writing, technical drawing, and claims and evidence
- **Summative assessments** include performance and written components that assess three-dimensional learning

Lesson 11 **Assessment: Ecosystems and Their Interactions**

FOCUS QUESTION What have you learned about ecosystems and their interactions?

Introduction

In this unit, you learned about how ecosystems are organized, how matter and energy flow through an ecosystem, how organisms interact with both the biotic and abiotic components of an ecosystem, how natural selection occurs, and how humans have impacted and continue to impact ecosystems.

During the first part of the assessment, you will research a specific ecosystem service and local threats to that service. You will also research possible solutions to the problem. Together with your group, you will synthesize the information from multiple sources to evaluate those solutions. Next, you will design a solution that you think will best solve or lessen the threat to your assigned ecosystem service while meeting the needs of different stakeholders. Then, you will communicate what you learned about the ecosystem service, its threats, and your solution to your classmates in a presentation. In the second part of the assessment, you will answer written questions about resources, matter and energy flow, organism interactions, natural selection, and human impacts to further demonstrate what you have learned throughout this unit.

Figure 11.1
The Delmarva Peninsula fox squirr
the first species listed as endange
Endangered Species Protection Ac
Endangered Species Act in 1973. T
listed because timber harvesting a
habitat. Following an increase in p
plan, these squirrels were removed fi
CREDIT: moosehenderson/Shutterstock.com

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EXIT SLIP

Explain why you would not use the same sampling technique to measure the population size of dolphins as you would to measure the population size of mushrooms.

Appendix D: Assessing Three-Din

Science and Engineering Practices		
Criterion	**1. Beginning**	**2. Developing**
Asking Questions and Defining Problems	Student cannot ask questions to identify and clarify evidence and/or the premise(s) of an argument.	Student can partially asl questions to identify an evidence and/or the pre of an argument.
	Student cannot ask questions that can be investigated using available facilities and resources.	Student can partially asl questions that can be investigated using availa facilities and resources.
	Student cannot generate hypotheses/predictions based on observations and scientific principles.	Student can partially ge hypotheses/predictions on observations and sci principles.
	Student cannot identify multiple criteria and constraints that may limit possible solutions.	Student can partially ide multiple criteria and cor that may limit possible solutions.
Developing and Using Models	Student cannot develop a model to predict phenomena.	Student can partially de model to predict pheno
	Student cannot develop a model to describe unobservable mechanisms.	Student can partially de model to describe unob mechanisms.
	Student cannot develop and use a model to describe phenomena.	Student can partially de and use a model to des phenomena.
	Student cannot develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.	Student can partially de model to generate data ideas about designed sy including those represe inputs and outputs.

Appendix D: Assessing Three-Dimension

Science and Engineering Practices *continued*		
Criterion	**1. Beginning**	**2. Developing**
Planning and Carrying Out Investigations	Student cannot plan an investigation individually and collaboratively or identify independent and dependent variables and controls.	Student can partially plan an investigation individually and collaboratively and identify independent and dependent variables and controls.
	Student cannot plan an investigation individually and collaboratively or identify what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.	Student can partially plan an investigation individually and collaboratively and identify what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.
	Student cannot conduct an investigation or evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.	Student can partially conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.
	Student cannot collect data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.	Student can partially collect data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.
Analyzing and Interpreting Data	Student cannot analyze or interpret data to determine similarities and differences.	Student can partially analyze and interpret data to determine similarities and differences.
	Student cannot construct or interpret graphical displays of data to identify linear and nonlinear relationships.	Student can partially construct and interpret graphical displays of data to identify linear and nonlinear relationships.
	Student cannot analyze or interpret data to provide evidence for phenomena.	Student can partially analyze and interpret data to provide evidence for phenomena.
Using Mathematics and Computational Thinking	Student does not use mathematical representations to describe and/or support scientific conclusions and design solutions.	Student occasionally uses mathematical representations to describe and/or support scientific conclusions and design solutions.

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Crosscutting Concepts			
Criterion	**1. Beginning**	**2. Developing**	**3. Proficient**
Patterns	Student rarely observes how patterns of forms and events guide organization and classification while prompting questions about relationships and the factors that influence them.	Student occasionally observes how patterns of forms and events guide organization and classification while prompting questions about relationships and the factors that influence them.	Student frequently observes how patterns of forms and events guide organization and classification while prompting questions about relationships and the factors that influence them.
	Student rarely uses graphs and charts to identify patterns in data.	Student occasionally uses graphs and charts to identify patterns in data.	Student frequently uses graphs and charts to identify patterns in data.
	Student rarely uses patterns to identify cause-and-effect relationships.	Student occasionally uses patterns to identify cause-and-effect relationships.	Student frequently uses patterns to identify cause-and-effect relationships.
	Student rarely observes that patterns in rates of change and other numerical relationships can provide information about natural systems.	Student occasionally observes that patterns in rates of change and other numerical relationships can provide information about natural systems.	Student frequently observes that patterns in rates of change and other numerical relationships can provide information about natural systems.
Cause and Effect	Student rarely classifies relationships as causal or correlational.	Student occasionally classifies relationships as causal or correlational.	Student frequently classifies relationships as causal or correlational.
	Student rarely recognizes that correlation does not necessarily imply causation.	Student occasionally recognizes that correlation does not necessarily imply causation.	Student frequently recognizes that correlation does not necessarily imply causation.
	Student rarely uses cause-and-effect relationships to predict phenomena in natural or designed systems.	Student occasionally uses cause-and-effect relationships to predict phenomena in natural or designed systems.	Student frequently uses cause-and-effect relationships to predict phenomena in natural or designed systems.
	Student rarely understands that phenomena may have more than one cause.	Student occasionally understands that phenomena may have more than one cause.	Student frequently understands that phenomena may have more than one cause.
Scale, Proportion, and Quantity	Student rarely explains that time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.	Student occasionally explains that time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.	Student frequently explains that time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.
	Student rarely explains that a phenomena that can be observed at one scale may not be observable at another scale.	Student occasionally explains that a phenomena that can be observed at one scale may not be observable at another scale.	Student frequently explains that a phenomena that can be observed at one scale may not be observable at another scale.

continued

Tab 7 / Resources 13

- **Rubrics** help you evaluate student proficiency in all three dimensions of the NGSS

Instructional Resources that Meet the Needs of ALL Students

Differentiation strategies and integrated literacy selections support ELA standards, motivate under-performing students, and provide enrichment for students that are ready for a challenge.

- Active investigations provide **all students** equal opportunities to experience science phenomena firsthand and begin building explanations

Investigation 2.1

What's Your Habitat?

Materials

For you

- Science notebook

For you and your partner

- Poster board
- Set of markers

Procedure

1. Read Building Your Knowledge: *Habitats* and then answer the following questions in your science notebook:
   a. What is the main function of a habitat?
   b. Why do you think habitats come in different sizes?
2. Discuss with a partner what you think your basic needs are. Record your ideas in your science notebook. Discuss your ideas with your class and revise your list as needed.
3. Discuss with your partner how you meet each of these basic needs. Record your ideas in your science notebook. Discuss your ideas with your class and revise your list as needed.
4. Together with your partner, draw a diagram of your habitat. Include labels to indicate which of your needs are being met by each part of your habitat.
5. Share your diagram with your class. Then, answer the following questions in your science notebook:
   a. Are all the diagrams the same? How are they alike and how are they different?
   b. Would you make any changes to your diagram?
   c. How might the habitat of a student living in a city differ from the habitat of a student living in the country?
   d. How do you think that the diagram created by a student living in a different country would differ from yours?

EXIT SLIP

Explain what a habitat is.

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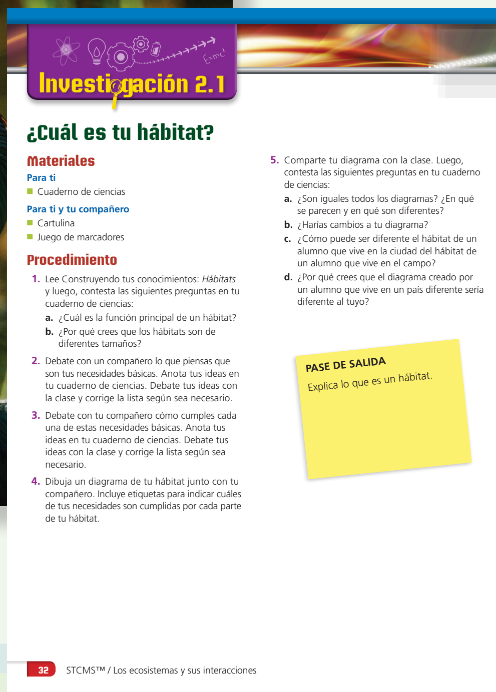
- Investigations provide **multiple modalities** and opportunities for students to develop the skills and confidence in listening, speaking, reading, and writing to demonstrate knowledge



Investigación 2.1

¿Cuál es tu hábitat?

Materiales

Para ti
- Cuaderno de ciencias

Para ti y tu compañero
- Cartulina
- Juego de marcadores

Procedimiento

1. Lee Construyendo tus conocimientos: *Hábitats* y luego, contesta las siguientes preguntas en tu cuaderno de ciencias:
   a. ¿Cuál es la función principal de un hábitat?
   b. ¿Por qué crees que los hábitats son de diferentes tamaños?
2. Debate con un compañero lo que piensas que son tus necesidades básicas. Anota tus ideas en tu cuaderno de ciencias. Debate tus ideas con la clase y corrige la lista según sea necesario.
3. Debate con tu compañero cómo cumples cada una de estas necesidades básicas. Anota tus ideas en tu cuaderno de ciencias. Debate tus ideas con la clase y corrige la lista según sea necesario.
4. Dibuja un diagrama de tu hábitat junto con tu compañero. Incluye etiquetas para indicar cuáles de tus necesidades son cumplidas por cada parte de tu hábitat.
5. Comparte tu diagrama con la clase. Luego, contesta las siguientes preguntas en tu cuaderno de ciencias:
   a. ¿Son iguales todos los diagramas? ¿En qué se parecen y en qué son diferentes?
   b. ¿Harías cambios a tu diagrama?
   c. ¿Cómo puede ser diferente el hábitat de un alumno que vive en la ciudad del hábitat de un alumno que vive en el campo?
   d. ¿Por qué crees que el diagrama creado por un alumno que vive en un país diferente sería diferente al tuyo?

PASE DE SALIDA
Explica lo que es un hábitat.

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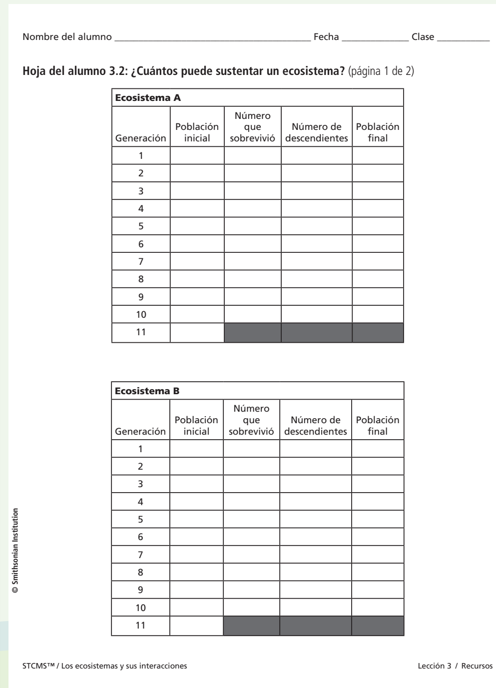

Nombre del alumno ______________ Fecha ________ Clase ________

Hoja del alumno 3.2: ¿Cuántos puede sustentar un ecosistema? (página 1 de 2)

Ecosistema A				
Generación	Población inicial	Número que sobrevivió	Número de descendientes	Población final
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

Ecosistema B				
Generación	Población inicial	Número que sobrevivió	Número de descendientes	Población final
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

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STCMS™ / Los ecosistemas y sus interacciones — Lección 3 / Recursos

- Student procedures and student sheets in **English and Spanish** support your EL students so they can focus on investigations of phenomena.

Ecological engineering also works to restore habitats or ecosystems that have been disrupted or harmed because of human interference. This can include removing pollutants from an area or repopulating a species that has been depleted.

Another important principle in ecological engineering is conserving nonrenewable sources such as oil and coal as much as possible. For this reason, ecological engineering is concerned with alternative power sources, such as solar power, wind power, and cutting-edge resources like tidal power. Likewise, ecological engineers are interested in architecture and design that minimize energy use and provide opportunities for native plants to grow and flourish.

If you enjoy solving cha... have a passion for the en... engineering might be a g... you. Students who are in... engineering study a numb... to be prepared for this fiel... well versed in the life scien... (especially around energy),... well as policy and communication. ■

The author used this title to describe what ecological engineering is meant to be. "The design of sustainable
Note

Collecting rainwater and using it to water a garden is an example of ecological engineering.
CREDIT: schulzie/iStock/Thinkstock

Architects and urban planners may collaborate with ecological engineers to develop environmentally friendly spaces for people to live and work, like this shopping mall in Sao Paulo, Brazil.
CREDIT: gianliguori/iStock/Thinkstock

Ensuring the health and safety of all components of the environment is the ultimate goal of an ecological engineer.
CREDIT: Top Photo Corporation/Top Photo Group/Thinkstock

Discussion Questions

1. Use the reading to explain where the title of this selection ("For the Benefit of Both") comes from. Why did the author select this title?
2. The article mentions that chemistry, the study of matter and its interactions, is important for ecological engineers to know. Why do you think that is? What can a knowledge of chemistry tell you about an ecosystem? Provide examples.
3. The author writes, "Our waste pollutes water and land. Our roads interrupt the movements and migrations of animals. Our cities encroach on habitats, and our agricultural needs disrupt food webs." Is this a fact or an opinion? How can you tell? What sources might you use to verify whether or not this statement is accurate?

Lesson 2 / Ecosystem Organization 47

- **Digital literacy tools and activities** for struggling readers and English learners enrich, extend, and remediate the hands-on investigations that students have already experienced.

STCMS—Designed for the NGSS

STCMS puts real-world and experiential phenomena in students' hands—in every lesson.


Lesson 8 Natural Selection

FOCUS QUESTION How does natural selection change a population over time?

Introduction

Ecosystems are continuously changing. Both the biotic and abiotic factors in ecosystems change. How do populations of organisms respond to the changes? Because there is variation among organisms in a population, some are better able to survive changes in an ecosystem. What causes variation among organisms—even within populations of the same species—and how did that variation come to be? How does variation allow some organisms in a population to survive better? In this lesson, you will explore these questions as you study the natural variation among organisms and how populations change over time through natural selection.

Objectives for This Lesson

- Observe the variation among the indiv
- Model the process of natural selection
- Describe the patterns in natural selecti

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EXTENDING YOUR KNOWLEDGE READING SELECTION

ARE FISH SHRINKING?

Something strange is happening in our oceans: fish are shrinking. You may recall stories from your grandparents about the giant fish they would catch when they were younger. Those stories might have seemed fishy, but it turns out that your grandparents were not exaggerating after all. Scientists learned about this phenomenon in a variety of ways, but one of the more interesting stories involves a graduate student named Loren McClenachan. McClenachan stumbled upon a stack of old photos from a fishing tour company in Florida. The collection of photos spanned many years, from the late 1950s to present day, and what McClenachan saw in them surprised her. Photos from the late 1950s showed customers standing proudly with their catches as the fish towered over them! McClenachan determined that the largest fish from the 1950s catches were

When fish are caught, you usually get variation in the size. Often, only the largest fish are kept and the small ones are returned. What effect might that have on fish populations?

over 1.8 meters (6 feet) long, while the largest catches today are barely 0.3 meters (1 foot). Not only that, but the weight of the fish caught has decreased by 88 percent. These fish had all been caught in the same part of the ocean using the same fishing practices. So what changed? Scientists have two different prevailing ideas about what is happening to these fish.

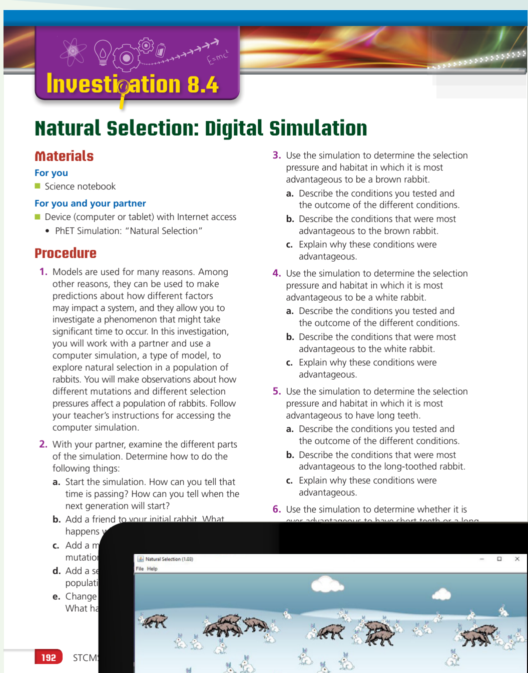
Warming Waters

Canadian scientists started their research not by observing this phenomenon of shrinking fish over years but by asking a question: What would happen to fish if the water got warmer?

continued

Lesson 8 / Natural Selection 195

- **Focus questions** for every lesson **question phenomena** like scientists do.
- Lesson introductions and literacy selections present **phenomena in real-world** contexts and **connect those phenomena to students' lives.**


Investigation 8.4

Natural Selection: Digital Simulation

Materials

For you
- Science notebook

For you and your partner
- Device (computer or tablet) with Internet access
  - PhET Simulation: "Natural Selection"

Procedure

1. Models are used for many reasons. Among other reasons, they can be used to make predictions about how different factors may impact a system, and they allow you to investigate a phenomenon that might take significant time to occur. In this investigation, you will work with a partner and use a computer simulation, a type of model, to explore natural selection in a population of rabbits. You will make observations about how different mutations and different selection pressures affect a population of rabbits. Follow your teacher's instructions for accessing the computer simulation.
2. With your partner, examine the different parts of the simulation. Determine how to do the following things:
   a. Start the simulation. How can you tell that time is passing? How can you tell when the next generation will start?
   b. Add a friend to your initial rabbit. What happens
3. Use the simulation to determine the selection pressure and habitat in which it is most advantageous to be a brown rabbit.
   a. Describe the conditions you tested and the outcome of the different conditions.
   b. Describe the conditions that were most advantageous to the brown rabbit.
   c. Explain why these conditions were advantageous.
4. Use the simulation to determine the selection pressure and habitat in which it is most advantageous to be a white rabbit.
   a. Describe the conditions you tested and the outcome of the different conditions.
   b. Describe the conditions that were most advantageous to the white rabbit.
   c. Explain why these conditions were advantageous.
5. Use the simulation to determine the selection pressure and habitat in which it is most advantageous to have long teeth.
   a. Describe the conditions you tested and the outcome of the different conditions.
   b. Describe the conditions that were most advantageous to the long-toothed rabbit.
   c. Explain why these conditions were advantageous.
6. Use the simulation to determine whether it is

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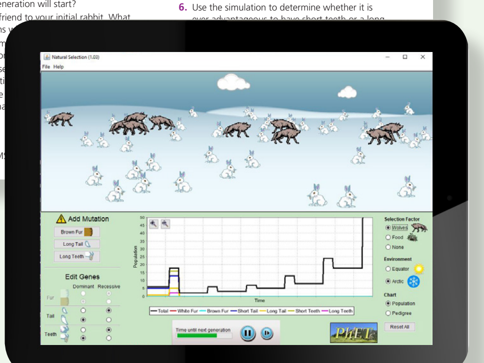

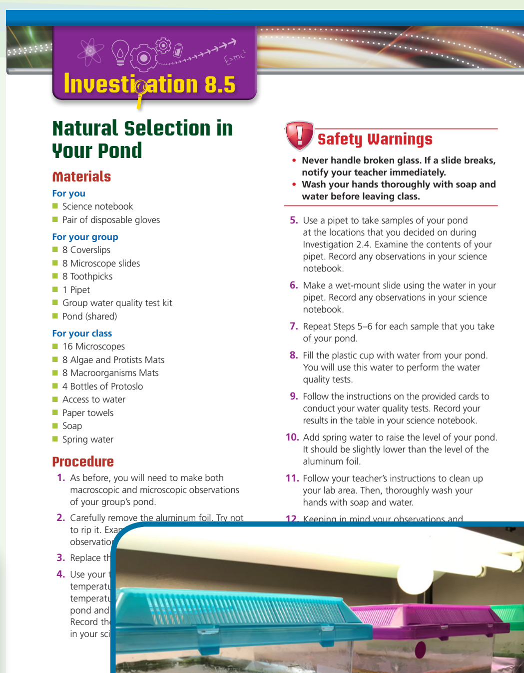
Investigation 8.5

Natural Selection in Your Pond

Materials

For you
- Science notebook
- Pair of disposable gloves

For your group
- 8 Coverslips
- 8 Microscope slides
- 8 Toothpicks
- 1 Pipet
- Group water quality test kit
- Pond (shared)

For your class
- 16 Microscopes
- 8 Algae and Protists Mats
- 8 Macroorganisms Mats
- 4 Bottles of Protoslo
- Access to water
- Paper towels
- Soap
- Spring water

Procedure

1. As before, you will need to make both macroscopic and microscopic observations of your group's pond.
2. Carefully remove the aluminum foil. Try not to rip it.
3. Replace th
4. Use your

Safety Warnings
- **Never handle broken glass. If a slide breaks, notify your teacher immediately.**
- **Wash your hands thoroughly with soap and water before leaving class.**

5. Use a pipet to take samples of your pond at the locations that you decided on during Investigation 2.4. Examine the contents of your pipet. Record any observations in your science notebook.
6. Make a wet-mount slide using the water in your pipet. Record any observations in your science notebook.
7. Repeat Steps 5–6 for each sample that you take of your pond.
8. Fill the plastic cup with water from your pond. You will use this water to perform the water quality tests.
9. Follow the instructions on the provided cards to conduct your water quality tests. Record your results in the table in your science notebook.
10. Add spring water to raise the level of your pond. It should be slightly lower than the level of the aluminum foil.
11. Follow your teacher's instructions to clean up your lab area. Then, thoroughly wash your hands with soap and water.

- Investigations **put phenomena directly into students' hands**
- High-quality **digital resources extend students' engagement with phenomena** beyond the confines of the classroom

Investigations integrate the three dimensions of the NGSS

- **DCIs, SEPs, and CCCs are integrated into investigations** that ask students to **investigate, model, and explain science phenomena**

Alignment to Next Generation Science Standards

- MS-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.
- MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

Lesson 8 aligns to NGSS performance expectations MS-LS4-4 and MS-LS4-6. Investigation 8.1 partially addresses MS-LS4-4 as students observe variation of traits in real populations. During Investigation 8.2, students model how feeding strategies and food available in an environment influence trait variation and foraging success, partially addressing MS-LS4-4. In Investigation 8.3, students simulate and mathematically model how coloration impacts the predator–prey relationship, partially addressing both MS-LS4-4 and MS-LS4-6. In Investigation 8.4, students use a computer simulation to model how traits influence population size in different environments with different selection pressures, meeting both MS-LS4-4 and MS-LS4-6. Finally, during Investigation 8.5, students observe their model ponds to determine if natural selection has occurred. Throughout the lesson, students apply survival probability to the concept of natural selection.

This lesson thoroughly addresses the science and engineering practices of using mathematics and computational thinking and constructing explanations. Students track the success of different traits over many generations by calculating changes in population size over time. Students construct explanations about why certain traits are more or less prevalent in a population and how those traits impact the probability of survival and reproduction of organisms.

Lesson 8 also addresses the crosscutting concepts of patterns and cause and effect. Throughout the lesson, students look for patterns in how traits move through or decline in populations to understand how natural selection works. They address cause and effect as they see that variable survival based on traits leads to changes in populations.

Concept Storyline

Ecosystems and Their Interactions
Concept Storyline

Unit Driving Question: How do organisms interact with one another and their environments?

Lesson 1: *Pre-Assessment: Ecosystems and Their Interactions*
Focus Question: What do you already know about ecosystems and their interactions?

Students perform short, simple investigations that evaluate their existing knowledge of one or more concepts related to ecosystems and the interactions that occur within them. Students engineer a model pond that they will use throughout the unit to investigate different aspects of ecosystems. Students also create concept maps and KWL charts to explore their existing knowledge.

Lesson 2: *Ecosystem Organization*
Focus Question: How are ecosystems organized?

Students investigate the organization of ecosystems and begin laying the framework for further studies of ecosystems. They begin learning about engineering and its relationship to ecology as they discuss the criteria and constraints that would have to be met to create an artificial habitat for an organism. Students conclude the lesson by applying their understanding of ecosystem organization to their model pond ecosystem.

Lesson 3: *Resources*
Focus Question: How does the availability of resources affect a population of organisms?

Students design and carry out an investigation to determine how the availability of resources affects plant growth, and they extrapolate that to the environment. Students also analyze data based on a model of an ecosystem showing carrying capacity. In the final investigation of the lesson, students consider the resources available in their pond. Then, they apply their understanding of resources to their model pond ecosystem.

Lesson 4: *Matter Cycles*
Focus Question: How do organisms get matter to grow and repair their bodies?

After reading about the movement of water in the ecosystem, students design a model to show the movement of water in an ecosystem. Then, they conduct an experiment using algae and yeast and construct an explanation for the flow of carbon in an ecosystem. Students also take the role of a nitrogen atom as they model the flow of nitrogen through an ecosystem. Based on the information gathered in this lesson and the data they have collected from their pond, students explain how matter is flowing through their model pond.

Lesson 5: *Energy Flow*
Focus Question: How do organisms get energy to live and grow?

Students create a model to show the flow of energy through an African savanna ecosystem. Students also explore the phenomenon of more prey than predators, view a physical demonstration of energy transfer, and model energy transfer across different trophic levels. Through these models, students should develop an understanding of energy transfer, trophic levels, food chains, and food webs. The lesson concludes as students use the data they have collected about their model pond to construct food chains for the organisms in the pond.

Lesson 6: *Organism Interactions*
Focus Question: How do organisms interact with one another?

Students model predation through a simulation. Then, students view videos showing different types of competition. They create their own models of competition based on their experiences. They also analyze presented information about organisms to determine patterns in the relationships that exist between different sets of organisms. Students begin to ask questions that will be answered in a later lesson on natural selection. Using their model pond, students cite evidence to identify relationships that exist between different organisms.

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Lesson 7: *Population Changes*
Focus Question: How do changes to the physical or biological components of an ecosystem affect a population?

Students continue to explore how changes to an ecosystem can affect the populations of organisms that live within it. Students plan and carry out an investigation to determine how changing one aspect of their model pond impacts the populations found there. They also model the introduction of a nonnative species to an ecosystem and explore the patterns of characteristics common to invasive species. Students also examine the different types of succession that occur in an ecosystem and consider the importance of natural disturbances.

Lesson 8: *Natural Selection*
Focus Question: How does natural selection change a population over time?

Students construct explanations about the importance of variation in a population after conducting several investigations on natural selection. Students examine sunflower seeds to observe the variation that occurs between organisms in an ecosystem. Next, they design a simulation in which they model beak and food types of various birds, and then they determine what would occur if a change were to happen in their ecosystem. Students also explore natural selection in a population due to variable survival through two different simulations, one physical and one digital. They again revisit their pond and discuss how changing conditions can lead to selection within their model.

Lesson 9: *Biodiversity*
Focus Question: What is biodiversity and why is it important?

Students model ways in which scientists measure biodiversity and then use mathematics to approximate the number of organisms in their ecosystem. Students explore ecological engineering as they obtain, evaluate, and communicate information about the reintroduction of a species. They engage in argument from evidence as they determine whether a species should be reintroduced to an area in which it no longer exists. Students use their newly learned techniques for measuring biodiversity to communicate how they would measure the biodiversity in their model pond.

Lesson 10: *Human Impact*
Focus Question: How can human impact on the environment be monitored and minimized?

Students plan and carry out an investigation to determine how human activities affect plant growth. They also research the impact that a human activity is having on the ecosystem and create a plan to monitor that human impact. Students also take a final look at their model pond and predict what human activities could impact a natural pond.

Lesson 11: *Assessment: Ecosystems and Their Interactions*
Focus Question: What have you learned about ecosystems and their interactions?

This unit concludes with a two-part assessment. The first part is a Performance Assessment, in which students apply the knowledge and skills they have acquired during the unit to obtain, evaluate, and communicate information about an ecosystem's services. Students are presented with an ecosystem service and must explore threats to the ecosystem service. Then, student groups design a solution to the problem. In the second part, students complete a Written Assessment that covers the performance expectations, disciplinary core ideas, crosscutting concepts, and science and engineering practices incorporated in this unit.

More resources for teachers and students found at:
www.carolinascienceonline.com
www.ssec.si.edu/STCMS

Tab 1 / Unit Overview and Lesson Planner 11

- Lessons follow a **coherent learning progression** that develops deep understanding over the course of the module

Integration of ELA and Math

- **Literacy integration** develops student understanding by making direct connections between experiential phenomena and the real world

BUILDING YOUR KNOWLEDGE READING SELECTION

Measuring Biodiversity

The diversity of living things on Earth is incredible. But understanding biodiversity is important for more than just appreciating nature. Measuring biodiversity can help us take care of the environment and protect people. Changes in biodiversity can influence human access to resources and ecosystem services. When biodiversity decreases, we can lose access to resources such as food, energy, and medicine. Changes in biodiversity can also make it harder for the environment to maintain its ecosystem services. Biodiversity helps ecosystems do things such as purify water that we drink and pollinate crops we eat. So, it is important to monitor changes in biodiversity.

To measure biodiversity, people collect data on which organisms live in an area. Then, they can calculate **indices of diversity**, which are measurements of biodiversity based on both species richness and species evenness. **Species richness** is the number of species in an area. **Species evenness** is the relative population size of each species. These measurements are not easy to make. One reason is that even defining which organisms belong to one species can be tricky! Most scientists roughly define species as groups of individuals that can produce viable, fertile

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The African bush elephant (*Loxodonta africana*) and the African forest elephant (*Loxodonta cyclotis*) look similar, but they are actually different species.

Preserving biodiversity in a meadow helps support the pollinators that help maintain our food supply.

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offspring together. But since natural selection is always occurring in populations, it is not always obvious when two populations are becoming different enough to be two separate species.

It is rare for scientists to count literally every organism in an environment. Usually, they use a sampling technique. In sampling, individuals and species are counted in a few small areas that represent a larger area. Sampling techniques include the use of quadrats and transects as well as mark-and-recapture activities and removal sampling. To use **quadrats**, scientists count all the species and/or individuals in several small frames. To use **transects**, scientists count the number of species and/or individuals present at regular intervals along a straight line.

To use mark and recapture, scientists capture a group of individuals, mark them, and release

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Investigation 8.3

Natural Selection: Coloration

Materials

For you

- Science notebook
- Student Sheet 8.3: *Natural Selection: Coloration*

For your group

- 3 Plastic cups
- 1 Plastic container
- Container of blue pompoms
- Container of red pompoms
- Container of white pompoms
- Container of yellow pompoms
- Natural Selection Habitat Map
- Stopwatch or other timing device

Procedure

1. In this investigation, you will explore the survival of different-colored individuals, pompoms, in a particular ecosystem, the Natural Selection Habitat Map. As you conduct this investigation, discuss with your group how the model relates to a natural system.
2. Choose one group member to be the timekeeper. This group member will time a 5-second hunting period during this activity. The other group members will be hunters who will collect pompoms.
3. Ensure that each hunter has an empty cup in front of them.
4. Place the Natural Selection Habitat M your desk.
5. Place 25 blue pompon pompoms into your container and mix initial numbers i 8.3: *Natural Sel*
6. All hunters should close their eyes. The timekeeper should carefully pour the pompoms evenly over the Natural Selection Habitat Map.
7. When the timekeeper says, "Start," all the hunters should open their eyes, pompom, and place it in their c continue to put one pompom a their cup until the timekeeper c The timekeeper should call for to stop after 5 seconds.
8. After stop is called, the hunters their collected pompoms.
9. Count how many pompoms of e were captured. Record this unde Captured" in the table on your s
10. Subtract the number of each co from the initial number of each determine how many pompoms color remain. Record this in the "Number Remaining."
11. Each pompom that remains will another pompom of the same c offspring for the next generation how many offspring of each col produced. Record this under "N Offspring" in the table on your s
12. Return any remaining pompoms Habitat Map to your group's em Add pompoms to represent the offspring you recorded on your s the pompoms together.

umber of offspring to This is your starting p eration. Record it o "Number for the Ne

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MP4 Model with mathematics

Investigation 9.1

Measuring Biodiversity

Materials

For you

- Science notebook
- Student Sheet 9.1a: *Measuring Biodiversity Group Data*
- Student Sheet 9.1b: *Measuring Biodiversity Class Data*
- Student Sheet: *Graph Paper*

For your class

- 28 Plastic cups
- 8 Biodiversity Mats
- 4 Aquarium nets
- 4 Containers of red pompoms
- 4 Containers of white pompoms
- 4 Containers of yellow pompoms
- 4 Metric rulers
- 4 Plastic trays of water
- 4 Transparency quadrats
- 4 Transparent rulers

Procedure

1. In this investigation, you will measure some aspects of biodiversity in model populations. Consider the different ecosystems in the images in Figure 9.3. Discuss the following questions with your group and record your answers in your science notebook:
   a. Describe how could you tell which ecosystem has greater biodiversity.
   b. Explain how you could measure the biodiversity of the different ecosystems.
   c. What problems exist with measuring the biodiversity of an ecosystem?
   d. Describe how you could determine the number of organisms in a population of a species of interest.
   e. Explain whether you think all species can be measured in the same way.

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Figure 9.3

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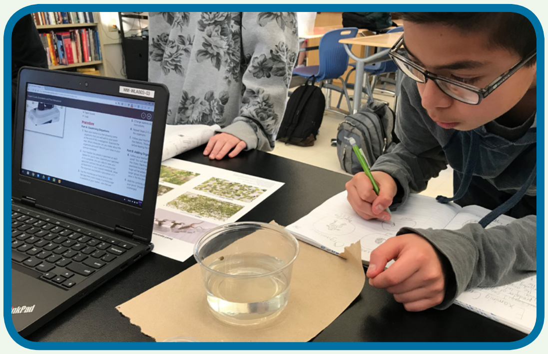
- **Middle school–appropriate math integration** allows students to learn to quantitatively describe and measure objects, events, and processes

MP2 Reason abstractly and quantitatively MP4 Model with mathematics

The Research Base of the Smithsonian's STCMS



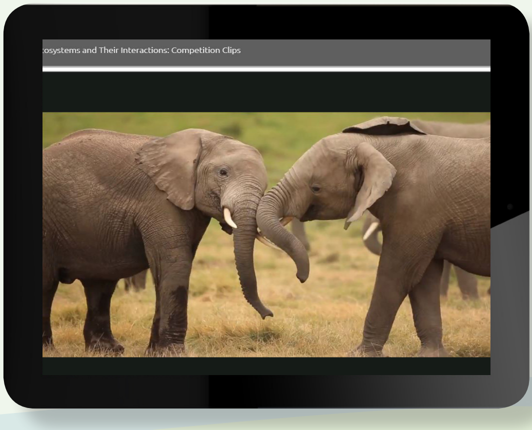
Proven Research

Research on how students learn best is clear. When you start with hands-on investigations and add digital experiences, the learning sticks.

- To provide true phenomena-based learning experiences that deepen understanding, your students need to engage in hands-on, active learning.
- Digital and interactive content—including videos, simulations, interactive maps, and more—give students opportunities to explore concepts through multiple lenses.

STCMS brings these two experiences together, providing teachers with guidance on how to structure the use of digital materials.

Find out more. Visit www.carolina.com/physicalstuff



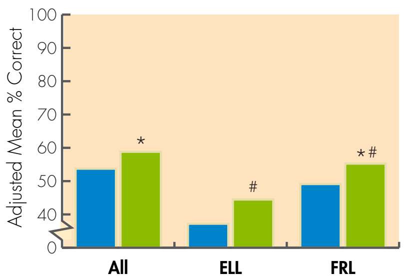
Proven Effectiveness

In a five-year randomized control trial with 9,000 students, reading, math, and science test scores increased for ALL students.

The LASER group using STC showed statistically significant and educationally meaningful test results even in the middle school years where test-score increases are a challenge!

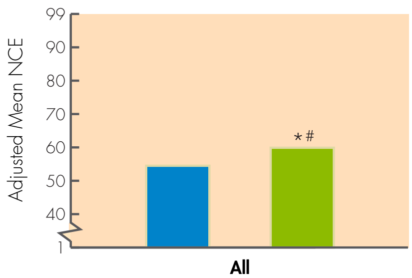
Science Scores Increased

Middle School – All Regions Combined PASS Performance Task



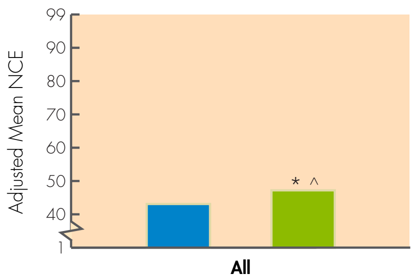
Math Scores Increased

HISD Middle School – Stanford Mathematics Test



Reading Scores Increased

HISD Middle School – Stanford Reading Test



* statistically significant results # educationally meaningful results

LASER group Comparison group

Find out more. Download the complete LASER i3 results: https://ssec.si.edu/our-results

Engage. Inspire. Connect.
Learning Framework for Middle School

Units for Grades 6—8

Physical Science	Life Science	Earth/Space Science
Energy, Forces, and Motion PS2-1, PS2-2, PS2-3, PS2-5, PS3-1, PS3-2, PS3-5, ETS1-1, ETS1-2, ETS1-3, ETS1-4	**Ecosystems and Their Interactions** LS1-5, LS1-6, LS2-1, LS2-2, LS2-3, LS2-4, LS2-5, LS4-4, LS4-6, ESS3-3, ETS1-1, ETS1-2	**Weather and Climate Systems** ESS2-4, ESS2-5, ESS2-6, ESS3-2, ESS3-4, ESS3-5, PS3-4, ETS1-1, ETS1-2
Matter and Its Interactions PS1-1, PS1-2, PS1-3, PS1-4, PS1-5, PS1-6, PS3-4, ETS1-1, ETS1-2, ETS1-3, ETS1-4	**Structure and Function** LS1-1, LS1-2, LS1-3, LS1-6, LS1-7, LS1-8, LS4-2, LS4-3	**Earth's Dynamic Systems** LS4-1, ESS1-4, ESS2-1, ESS2-2, ESS2-3, ESS3-1,ESS3-2, ETS1-1, ETS1-2, ETS1-3, ETS1-4
Electricity, Waves, and Information Transfer LS1-8, PS2-3, PS2-5, PS3-3, PS3-4, PS3-5, PS4-1, PS4-2, PS4-3, ETS1-1, ETS1-2, ETS1-3, ETS1-4	**Genes and Molecular Machines** LS1-1, LS1-4, LS3-1, LS3-2,LS4-4, LS4-5, LS4-6	**Space Systems Exploration** PS2-4, ESS1-1, ESS1-2, ESS1-3, ETS1-1, ETS1-2

About the Partnership

Carolina Biological Supply Company and Smithsonian Science Education Center

For 30 years, the Smithsonian Science Education Center (formerly the National Science Resources Center) has been transforming the teaching and learning of formal science in PreK to 12th-grade classrooms around the world by providing students and teachers with authentic STEM experiences.

Carolina Biological Supply Company has partnered with educators for more than 90 years to provide quality, dependable science materials and expert assistance when teachers have questions or concerns. As a partner of the Smithsonian, Carolina works closely with the Smithsonian during each module's development and tests all STCMS module equipment for durability and age-appropriateness.

Have a question? Contact us at curriculum@carolina.com or visit carolina.com/stcms

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