SCIENCE 3D

HELLBENDERS

SCIENCE PERFORMANCE EXPECTATIONS AND DISCIPLINARY CORE IDEAS

In the Middle School Mission, students will address the following general topics. Keep reading below to find the NGSS standards for each component of the Mission. *Note: Be sure to complete the **Mission Reader** and **Mission Research** before viewing the full **Mission Video**. Explore How to Use Science 3D to get suggestions on how to pace the Mission and options for the order of activities. Math and Language Arts standards will be added shortly.*

- In the **Mission Reader**, *Hellbenders*, students will explore the biology of hellbenders, sexual and asexual reproduction, weathering, erosion and deposition, genetic variation, biotechnology, and human impacts on the environment. They will also learn about traits and adaptations. Students will see how genetic and morphological traits are used to understand relationships of current and fossil organisms, and explore the physics of light, sound and pressure. Finally, they will read about human threats to hellbenders and the technology scientists use to study them.
- During **Mission Research**, students will reinforce their understanding of sexual and asexual reproduction and conduct an independent investigation into ancient amphibians and their environments.
- In the **Science Mission**, students will use data from the field, including eDNA (environmental DNA), to create hypotheses about the presence of hellbenders and changes in their populations. Then, they will explore how different types of data and information are needed to support claims. Finally, students will integrate the data they have analyzed to make recommendations on how to restore hellbender populations.
- In the **STEM Project**, students will explore different engineering careers and discuss how these fields work to develop solutions to environmental problems. They will then propose a solution for hellbender conservation that each subfield might work on. Finally, they will collaborate to modify and improve their proposed solutions.
- Using the **Explore Your Backyard** activity, students will explore constructive and destructive processes and how they shaped a local environment. Then they will investigate traits of a local organism of their choice and see how those traits influence its ability to survive and reproduce.

SCIENCE/ENGINEERING AND DESIGN DISCIPLINARY CORE IDEAS AND PERFORMANCE EXPECTATIONS

MISSION READER

LS1.A	Structure and function: body is a system of multiple interacting subsystems. Partial coverage.
MS-LS1-4	Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants. Focus here is on animals. Plants are covered in other missions.
LS1.B	Growth and development of organisms: plant and animal reproduction and behavior. Focus here is on animals. Plants are covered in other missions.
MS-LS1-5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. Students should consider how genetic differences among hellbender populations influence their growth, and how this would be affected by negative changes in their physical environment.
MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
LS2.A	Interdependent relationships in ecosystems. Although not a focus of this mission, the importance of crayfish as prey for hellbenders is explored and can be used to reinforce some of these concepts.
MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
LS2.A	Interdependent relationships in ecosystems: predation, mutualism, interactions similar across ecosystems.
MS-LS2-4	Construct and argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
LS2.C	Ecosystem dynamics, functioning and resilience: change through time possible.
LS4.D	Biodiversity and humans.
ET1.B	Developing possible solutions: process, criteria, and constraints.
LS3.A	Inheritance of traits: genes and how they work.

*ELA and Math standards to come

MS-LS3-2	Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
LS1.B	Growth and development of organisms: sexual and asexual reproduction.
LS3.A	Inheritance of traits: variation comes from getting a subset of chromosomes from each parent.
LS3.B	Variation of traits: chromosomes in sexual reproduction.
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.
LS4.B	Natural selection: difference in frequency of traits.
LS4.C	Adaptation.
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
ESS3.C	Human impacts on Earth systems.
MS-ESS2-2	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
ESS2.C	The roles of water in Earth's surface processes: weathering and erosion above and underground. In this mission, only above ground processes are considered.
MS-ESS3-4	Construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth's systems. To adequately link this standard to the mission, have students consider how human population size affects the degradation of rivers.

MISSION RESEARCH

LS1.B	Growth and development of organisms: plant and animal reproduction and behavior. Focus here is on animals. Plants are covered in other missions.
MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
LS2.C	Ecosystem dynamics, functioning and resilience: change through time possible.
LS3.A	Inheritance of traits: genes and how they work.
MS-LS3-2	Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
LS1.B	Growth and development of organisms: sexual and asexual reproduction.
LS3.A	Inheritance of Traits: variation comes from getting a subset of chromosomes from each parent.
LS3.B	Variation of traits: chromosomes in sexual reproduction.
MS-LS4-1	Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.
LS4.A	Evidence of common ancestry and diversity: collection of fossils and placement is known from position and dating known as the fossil record; it documents existence, diversity, extinction.
MS-LS4-2	Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and modern and fossil organisms to infer evolutionary relationships.
LS4.A	Evidence of common ancestry and diversity: anatomical similarities and differences between fossils and modern taxa allow evolutionary history reconstruction.

SCIENCE MISSION

MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
LS2.A	Interdependent relationships in ecosystems: Although not a focus of this mission, the importance of hellbender predators and prey is explored and can be used to reinforce some of these concepts.
LS1.B	Growth and development of organisms: plant and animal reproduction and behavior. Focus here is on animals. Plants are covered in other missions.
MS-LS2-4	Construct and argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
LS2.C	Ecosystem dynamics, functioning and resilience: change through time possible.
MS-LS1-5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. Students should consider how genetic differences among hellbender populations influence their growth and how this would be affected by negative changes in their physical environment.
MS-LS2-5	Evaluate competing design solutions for maintaining biodiversity and ecosystem services. This can be explored primarily in the **STEM Project**. Have students compare and contrast the solutions they develop, thinking beyond hellbenders to how the designs will affect general biodiversity in rivers.
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.

*ELA and Math standards to come

ETS1.B	Developing possible solutions: systematic processes for evaluating solutions to make sure they meet criteria and constraints.
MS-ETS1-1	Define the criteria and constrains of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. Partial coverage relative to designing natural solutions.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. Partial coverage relative to designing natural solutions.
ETS1.B	Developing possible solutions: systematic processes for evaluating solutions to make sure they meet criteria and constraints. Partial coverage relative to designing natural solutions.

STEM PROJECT

MS-LS2-5	Evaluate competing design solutions for maintaining biodiversity and ecosystem services. This can be explored primarily in the STEM Project. Have students compare and contrast the solutions they develop, thinking beyond hellbenders to how the designs will affect general biodiversity in rivers.
MS-ETS1-1	Define the criteria and constrains of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
ETS1.A	Defining and delimiting engineering problems: more precision in constraints and criteria is better.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
ETS1.B	Developing possible solutions: systematic processes for evaluating solutions to make sure they meet criteria and constraints.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. Partial coverage.
ETS1.C	Optimizing the design solution: iterative process leads to optimal solutions.
ETS1.B	Developing possible solutions: solutions must be tested, and models are important.
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment
ESS3.C	Human impacts on Earth systems.
MS-ESS2-2	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
ESS2.C	The roles of water in Earth's surface processes: weathering and erosion above and underground. In this mission, only above ground processes are considered.
ESS3.C	Human impacts on Earth systems.

EXPLORE YOUR BACKYARD

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. This activity does not include the genetic component but focuses on advantages of traits. The activity could be expanded to have students consider the genetic basis of such adaptation.
LS4.C	Adaptation.
MS-ESS2-2	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scale. This is covered relative to weathering, erosion and deposition and their influence on landforms. The focus is on change, but not on timescales explicitly. The **Explore Your Backyard** extension could address timeframes (see teacher instructions).
ESS2.C	The roles of water in Earth's surface processes: weathering and erosion above and underground.
ESS2.C	The roles of water in Earth's surface processes: how winds, landforms, ocean temp and currents affect movement of water in atmosphere and weather.

CROSS CUTTING CONCEPTS

Cause and Effect: Mechanisms and Predictions: Mission Reader, Science Mission, Explore Your Backyard
Patterns: Mission Reader, Science Mission
Scale, proportion and quantity: Science Mission, STEM Project
System and system models: Mission Reader, Mission Research, Science Mission, STEM Project
Structure and function: Mission Reader
Energy and matter: Mission Reader
Stability and change: Mission Reader, Mission Research, Science Mission, Explore Your Backyard

*ELA and Math standards to come

CONNECTION TO NATURE OF SCIENCE
Scientific investigations use a variety of methods: Mission Reader, Science Mission, STEM Project
Scientific knowledge is based on empirical evidence: Mission Reader, Mission Research, Science Mission
Scientific knowledge is open to revision in light of new evidence: Science Mission (although this is not covered explicitly, discussions of how interpretation of data changed between eDNA samples and in-river data in the Science Mission helps show how scientists update their understanding through time)
Science models, laws, mechanisms and theories explain natural phenomena: Mission Reader, Mission Research, Science Mission
Science is a way of knowing: Mission Reader, Science Mission, Explore Your Backyard
Scientific knowledge assumes an order and consistency in natural systems: Mission Reader, Science Mission
Science addresses questions about the natural and material world: All
Science is a human endeavor: Mission Reader, Science Mission, STEM Project

SCIENCE AND ENGINEERING PRACTICES
Asking questions and defining problems: Science Mission, STEM Project
Developing and using models: Mission Reader, Mission Research, Science Mission
Planning and carrying out investigations: Mission Research, Science Mission, STEM Project, Explore Your Backyard
Analyzing and interpreting data: Mission Research, Science Mission, STEM Project
Constructing explanations and designing solutions: Mission Research, Science Mission, STEM Project
Engaging in argument from evidence: Science Mission, STEM Project, Explore Your Backyard
Obtaining, evaluating and communicating information: All

*ELA and Math standards to come