2025-2026 High School - Biology with Earth & Space Science - Unit 5 Part B - Ecosystems Unit Framework

Unit 1 Unit 2 Unit 3 Unit 4 **Unit 5B**

Kentucky Academic Standards for Science

Unit 5B Title	**Estimated Time Frame**
Unit 5B - Ecosystems: How do matter and energy flow through the ecosystem?	**12 Blocks / 24 Days**

Unit Anchor Phenomenon (Big Idea):

Megafauna Extinction: Humans or Climate?
Attack Of The Killer Fungi
Biosphere 2
Galapagos Finch Evolution
Ant Cooperation
Shrew Caravan

Unit 5B - Problem Students are Trying to Solve (Essential Question):

How are ecosystems driven by energy transfer?

Essential Standards (KAS for Science):

HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.
Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.
KILP: 1 - Recognize that text is anything that communicates a message.
2 - Employ, develop, and refine schema to understand and create text.
7 - Utilize digital resources to learn and share with others.

HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.
Assessment Boundary: Assessment is limited to provided data.
KILP: 1 - Recognize that text is anything that communicates a message.
2 - Employ, develop, and refine schema to understand and create text.
7 - Utilize digital resources to learn and share with others.

HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
Clarification Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.
Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.
KILP: 1 - Recognize that text is anything that communicates a message.
2 - Employ, develop, and refine schema to understand and create text.
7 - Utilize digital resources to learn and share with others.

HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.
Assessment Boundary: None Provided
KILP: 5 - Apply strategic practices, with scaffolding and then independently, to approach new literacy tasks.
9 - Apply high level cognitive processes to think deeply and critically about text.
10 - Develop a literacy identity that promotes lifelong learning.

HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
Clarification Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.
Assessment Boundary: None provided.
KILP: 5 - Apply strategic practices, with scaffolding and then independently, to approach new literacy tasks.
9 - Apply high level cognitive processes to think deeply and critically about text.
10 - Develop a literacy identity that promotes lifelong learning.

Supporting Standards (Connections to Other Performance Expectations)**:**

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.
Assessment Boundary: None Provided

HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning.
Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*
Clarification Statement: Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).
Assessment Boundary: None Provided

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.
Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*
Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.
Assessment Boundary: None Provided

Connections to Kentucky Interdisciplinary Literacy Practices (KILP):

1. Recognize that text is anything that communicates a message.
2. Employ, develop and refine schema to understand and create text.
5. Apply strategic practices, with scaffolding and then independently, to approach new literacy tasks.
7. Utilize digital resources to learn and share with others..
9. Apply high-level cognitive processes to think deeply and critically about text.
10. Develop a literacy identity that promotes lifelong learning.

Connections to Standards for Mathematical Practice:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.

5. Use appropriate tools strategically.
6. Attend to precision.
8. Look for and express regularity in repeated reasoning.

Science & Engineering Practices Identified in Standards (While only a subset of science and engineering practices are explicitly identified as the mechanism for how students demonstrate mastery at the end of instruction, students should still utilize all of the science and engineering practices as they develop their understanding.) NGSS Appendix F	Priority Content Disciplinary Core Ideas NGSS Appendix E	Crosscutting Concepts Identified in Standards (While only a subset of crosscutting concepts are explicitly identified as the mechanism for how students demonstrate mastery at the end of instruction, students should still utilize all of the crosscutting concepts as they develop their understanding.) NGSS Appendix G
Using Mathematics and Computational Thinking ● Use mathematical and/or computational representations of phenomena or design solutions to support explanations. ● Use mathematical representations of phenomena or design solutions to support and revise explanations. ● Use mathematical representations of phenomena or design solutions to support claims. **Engaging in Argument from Evidence** ● Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. ● Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.	**LS2.A: Interdependent Relationships in Ecosystems** ● Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. ● These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. ● Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. ● This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ● A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. ● If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. ● Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.	**Scale, Proportion, and Quantity** ● The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. ● Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. **Energy and Matter** ● Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. **Stability and Change** ● Much of science deals with constructing explanations of how things change and how they remain stable.

	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems ● Plants or algae form the lowest level of the food web. ● At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. ● Given this inefficiency, there are generally fewer organisms at higher levels of a food web. ● Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. ● The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. ● At each link in an ecosystem, matter and energy are conserved. **LS2.D: Social Interactions and Group Behavior** ● Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.	**Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Prerequisite Skills for Focal Performance Expectations Science & Engineering Practices (from NGSS Appendix F and/or FCPS Enduring Science Skills Document)	**Prerequisite Disciplinary Core Ideas** from NGSS Appendix E) (Prerequisite Content Knowledge)	**Prerequisite Crosscutting Concepts** (from NGSS Appendix G **)**
1. Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends. (6-8) 2. Use mathematical representations to describe and/or support scientific conclusions and design solutions. (6-8) 3. Create algorithms (a series of ordered steps) to solve a problem. (6-8)	**LS2.A: Interdependent Relationships in Ecosystems** ● Plants depend on water and light to grow, and also depend on animals for pollination or to move their seeds around. (K-2) ● The food of almost any animal can be traced back to plants. (3-5)	1. use relative scales (e.g., bigger and smaller; hotter and colder; faster and slower) to describe objects. (K-2) 2. use standard units to measure length. (K-2) 3. recognize natural objects and observable phenomena exist from the very small to the immensely large. (3-5)

4. Apply mathematical concepts and/or processes (such as ratio, rate, percent, basic operations, and simple algebra) to scientific and engineering questions and problems. (6-8) 5. Use digital tools and/or mathematical concepts and arguments to test and compare proposed solutions to an engineering design problem. (6-8) 6. Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts. (6-8) 7. Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail. (6-8) 8. Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (6-8) 9. Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system, based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints. (6-8) 10. Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (6-8)	● Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants, while decomposers restore some materials back to the soil. (3-5) ● Organisms and populations are dependent on their environmental interactions both with other living things and with nonliving factors, any of which can limit their growth. Competitive, predatory, and mutually beneficial interactions vary across ecosystems but the patterns are shared. (6-8) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ● When the environment changes some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die. (3-5) ● Ecosystem characteristics vary over time. Disruptions to any part of an ecosystem can lead to shifts in all of its populations. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (6-8) **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** ● Animals obtain food they need from plants or other animals. Plants need water and light. (K-2) ● Matter cycles between the air and soil and among organisms as they live and die. (3-5) ● The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (6-8)	4. use standard units to measure and describe physical quantities such as weight, time, temperature, and volume. (3-5) 5. observe time, space, and energy phenomena at various scales using models to study systems that are too large or too small. (6-8) 6. understand phenomena observed at one scale may not be observable at another scale, and the function of natural and designed systems may change with scale. (6-8) 7. use proportional relationships (e.g., speed as the ratio of distance traveled to time taken) to gather information about the magnitude of properties and processes. (6-8) 8. represent scientific relationships through the use of algebraic expressions and equations. (6-8) 9. observe objects may break into smaller pieces, be put together into larger pieces, or change shapes. (K-2) 10. matter is made of particles and energy can be transferred in various ways and between objects. (3-5) 11. observe the conservation of matter by tracking matter flows and cycles before and after processes and recognizing the total weight of substances does not change. (3-5) 12. matter is conserved because atoms are conserved in physical and chemical processes. (6-8) 13. learn within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (6-8)

	● Food webs model how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact within an ecosystem. (6-8) **<u>LS2.D: Social Interactions and Group Behavior</u>** ● Being part of a group helps animals obtain food, defend themselves, and cope with changes. (3-5)	14. energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (6-8) 15. the transfer of energy can be tracked as energy flows through a designed or natural system. (6-8) 16. observe some things stay the same while other things change, and things may change slowly or rapidly. (K-2) 17. measure change in terms of differences over time, and observe that change may occur at different rates. (3-5) 18. some systems appear stable, but over long periods of time they will eventually change. (3-5) 19. explain stability and change in natural or designed systems by examining changes over time, and considering forces at different scales, including the atomic scale. (6-8) 20. changes in one part of a system might cause large changes in another part, systems in dynamic equilibrium are stable due to a balance of feedback mechanisms, and stability might be disturbed by either sudden events or gradual changes that accumulate over time (6-8) 21. events have causes that generate observable patterns.)K-2) 22. design simple tests to gather evidence to support or refute their own ideas about causes. (K-2) 23. identify and test causal relationships and use these relationships to explain change. (3-5) 24. understand events that occur together with regularity might or might not signify a cause and effect relationship. (3-5)

		25. classify relationships as causal or correlational, and recognize that correlation does not necessarily imply causation. (6-8) 26. use cause and effect relationships to predict phenomena in natural or designed systems. (6-8) 27. understand that phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (6-8)

Preconceptions/Misconceptions:
1. Carrying capacity affected by interspecies competition for resources 2. Changes in a population size as a result of biotic and abiotic factors 3. Carrying capacity of different species with different niches 4. Boom and bust cycles 5. Carrying capacity is a fixed number. 6. Populations cannot increase in size beyond their carrying capacities. 7. Ecosystems do not change. 8. Change in an ecosystem will always decrease the number of individuals who can survive in a population. 9. Food webs only have linear relationships. 10. Water is an energy source for producers. 11. Energy can be recycled. 12. Disturbances are always detrimental to an ecosystem. 13. New species are beneficial to an ecosystem because they increase biodiversity. 14. Group behavior increases survival for all animals. 15. Individual behaviors increase survival more than group behaviors. 16. Organisms must select one type of behavior; they do not have multiple approaches to survival.

Essential Vocabulary:

Mathematical Representation	Computational Representation	Explanation	Factors	Carrying Capacity
Ecosystems	Scales	Quantitative Analysis	Comparison	Relationships
Interdependent Factors	Mathematical Comparison	Histogram	Population	Simulation
Data Set	Phenomena	Solutions	Interdependent	Ecosystem
Predation	Competition	Finite	Fundamental Tension	Abundance
Scale	Proportion	Support	Revise	Evidence
Biodiversity	Trends	Graphical Comparison	Biological Disturbance	Physical Disturbance
Resilient	Fluctuations	Habitat	Orders of Magnitude	Model
Claims	Cycling of Matter	Flow of Energy	Mathematical Model	Stored Energy
Biomass	Transfer of Energy	Trophic Level	Conserved	Atoms
Molecules	Carbon	Hydrogen	Oxygen	Nitrogen
Plants	Algae	Food Web	Link	Cellular Respiration
Inefficiency	Elements	Soil	Recombined	Evaluate
Claims	Evidence	Complex Interaction	Organisms	Reasoning
Merit	Argument	Stable Conditions	Group Behavior	Species
Survive	Reproduce	Flocking	Schooling	Herding
Migrating	Swarming	Evolved	Genetic Relatives	Empirical Evidence
Cause	Correlation	Cause-and-Effect		

Assessment Profile:

FCPS Biology with Earth & Space Science Common Unit Assessment Folder

Formative Assessments:

HS-LS2-1: Carrying Capacity

1) Representation
   a) Students identify and describe* the components in the given mathematical and/or computational representations (e.g., trends, averages, histograms, graphs, spreadsheets) that are relevant to supporting given explanations of factors that affect carrying capacities of ecosystems at different scales. The components include:
      i) The population changes gathered from historical data or simulations of ecosystems at different scales;
      ii) Data on numbers and types of organisms as well as boundaries, resources, and climate.
   b) Students identify the given explanation(s) to be supported, which include the following ideas: Factors (including boundaries, resources, climate, and competition) affect carrying capacity of an ecosystem, and:
      i) Some factors have larger effects than do other factors.
      ii) Factors are interrelated.
      iii) The significance of a factor is dependent on the scale (e.g., a pond vs. an ocean) at which it occurs.

2) Mathematical and/or computational modeling
    a) Students use given mathematical and/or computational representations (e.g., trends, averages, histograms, graphs, spreadsheets) of ecosystem factors to identify changes over time in the numbers and types of organisms in ecosystems of different scales.
3) Analysis
    a) Students analyze and use the given mathematical and/or computational representations
        i) To identify the interdependence of factors (both living and nonliving) and resulting effect on carrying capacity;
        ii) As evidence to support the explanation and identify the factors that have the largest effect on the carrying capacity of an ecosystem for a given population.

HS-LS2-2: Factors affecting biodiversity and populations

1) Representation
    a) Students identify and describe* the components in the given mathematical representations (which include trends, averages, and graphs of the number of organisms per unit of area in a stable system) that are relevant to supporting and revising the given explanations about factors affecting biodiversity and ecosystems, including:
        i) Data on numbers and types of organisms are represented.
        ii) Interactions between ecosystems at different scales are represented.

    b) Students identify the given explanation(s) to be supported by factors affecting biodiversity and population levels, which include the following ideas:
        i) The populations and number of organisms in ecosystems vary as a function of the physical and biological dynamics of the ecosystem.
        ii) The response of an ecosystem to a small change might not significantly affect populations, whereas the response to a large change can have a large effect on populations that then feeds back to the ecosystem at a range of scales.
        iii) Ecosystems can exist in the same location on a variety of scales (e.g., plants and animals vs. microbes), and these populations can interact in ways that significantly change these ecosystems (e.g., interactions among microbes, plants, and animals can be an important factor in the resources available to both a microscopic and macroscopic ecosystem).
2) Mathematical Modeling
    a) Students use the given mathematical representations (including trends, averages, and graphs) of factors affecting biodiversity and ecosystems to identify changes over time in the numbers and types of organisms in ecosystems of different scales.
3) Analysis
    a) Students use the analysis of the given mathematical representations of factors affecting biodiversity and ecosystems
        i) To identify the most important factors that determine biodiversity and population numbers of an ecosystem.
        ii) As evidence to support explanation(s) for the effects of both living and nonliving factors on biodiversity and population size, as well as the interactions of ecosystems on different scales.
        iii) To describe* how, in the model, factors affecting ecosystems at one scale can cause observable changes in ecosystems at a different scale.
    b) Students describe* the given mathematical representations in terms of their ability to support explanation(s) for the effects of modest to extreme disturbances on an ecosystems' capacity to return to original status or become a different ecosystem.

4) Revision
    a) Students revise the explanation(s) based on new evidence about any factors that affect biodiversity and populations (e.g., data illustrating the effect of a disturbance within the ecosystem).

<u>HS-LS2-4: Cycling of matter and energy flow in ecosystems</u>

1) Representation
    a) Students identify and describe* the components in the mathematical representations that are relevant to supporting the claims. The components could include relative quantities related to organisms, matter, energy, and the food web in an ecosystem.
    b) Students identify the claims about the cycling of matter and energy flow among organisms in an ecosystem.
2) Mathematical modeling
    a) Students describe* how the claims can be expressed as a mathematical relationship in the mathematical representations of the components of an ecosystem
    b) Students use the mathematical representation(s) of the food web to:
        i) Describe* the transfer of matter (as atoms and molecules) and flow of energy upward between organisms and their environment;
        ii) Identify the transfer of energy and matter between trophic levels;
        iii) Identify the relative proportion of organisms at each trophic level by correctly identifying producers as the lowest trophic level having the greatest biomass and energy and consumers decreasing in numbers at higher trophic levels.
3) Analysis
    a) Students use the mathematical representation(s) to support the claims that include the idea that matter flows between organisms and their environment.
    b) Students use the mathematical representation(s) to support the claims that include the idea that energy flows from one trophic level to another as well as through the environment.
    c) Students analyze and use the mathematical representation(s) to account for the energy not transferred to higher trophic levels but which is instead used for growth, maintenance, or repair, and/or transferred to the environment, and the inefficiencies in transfer of matter and energy.

<u>HS-LS2-6: Homeostasis</u>

1) Identifying the given explanation and the supporting claims, evidence, and reasoning.
    a) Students identify the given explanation that is supported by the claims, evidence, and reasoning to be evaluated, and which includes the following idea: The complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
    b) From the given materials, students identify:
        i) The given claims to be evaluated;
        ii) The given evidence to be evaluated;
        iii) The given reasoning to be evaluated.

2) Identifying any potential additional evidence that is relevant to the evaluation
    a) Students identify and describe* additional evidence (in the form of data, information, or other appropriate forms) that was not provided but is relevant to the explanation and to evaluating the given claims, evidence, and reasoning:
        i) The factors that affect biodiversity;
        ii) The relationships between species and the physical environment in an ecosystem;
        iii) Changes in the numbers of species and organisms in an ecosystem that has been subject to a modest or extreme change in ecosystem conditions.
3) Evaluating and critiquing
    a) Students describe* the strengths and weaknesses of the given claim in accurately explaining a particular response of biodiversity to a changing condition, based on an understanding of the factors that affect biodiversity and the relationships between species and the physical environment in an ecosystem.
    b) Students use their additional evidence to assess the validity and reliability of the given evidence and its ability to support the argument that resiliency of an ecosystem is subject to the degree of change in the biological and physical environment of an ecosystem.
    c) Students assess the logic of the reasoning, including the relationship between degree of change and stability in ecosystems, and the utility of the reasoning in supporting the explanation of how:
        i) Modest biological or physical disturbances in an ecosystem result in maintenance of relatively consistent numbers and types of organisms.
        ii) Extreme fluctuations in conditions or the size of any population can challenge the functioning of ecosystems in terms of resources and habitat availability, and can even result in a new ecosystem.
        iii)

HS-LS2-8: Social interactions and group behavior

1) Identifying the given explanation and the supporting evidence
    a) Students identify the given explanation that is supported by the evidence to be evaluated, and which includes the following idea: Group behavior can increase the chances for an individual and a species to survive and reproduce.
    b) Students identify the given evidence to be evaluated.
2) Identifying any potential additional evidence that is relevant to the evaluation
    a) Students identify additional evidence (in the form of data, information, or other appropriate forms) that was not provided but is relevant to the explanation and to evaluating the given evidence, and which includes evidence for causal relationships between specific group behaviors (e.g., flocking, schooling, herding, cooperative hunting, migrating, swarming) and individual survival and reproduction rates.
3) Evaluating and critiquing
    a) Students use their additional evidence to assess the validity, reliability, strengths, and weaknesses of the given evidence along with its ability to support logical and reasonable arguments about the outcomes of group behavior.
    b) Students evaluate the given evidence for the degree to which it supports a causal claim that group behavior can have a survival advantage for some species, including how the evidence allows for distinguishing between causal and correlational relationships, and how it supports cause and effect relationships between various kinds of group behavior and individual survival rates (for example, the relationship between moving in a group and individual survival rates, compared to the survival rate of individuals of the same species moving alone or outside of the group).

Individual lesson information to be completed at the school level based on pre-unit assessment data and formative assessment data.

Lesson Learning Intention	Lesson Success Criteria	High Quality Resources for Use
We are learning identify the parts of an ecosystem which can be represented mathematically so that we can develop mathematical models of ecosystems.	I will know I am successful when I can ● explain what an ecosystem is. ● define trophic levels. ● identify the components of an ecosystem ● define biomass. ● show how matter and energy flow can be represented in a food web ● show where mathematical values of "flows" in an ecosystem model (food web).	● Moose-Wolves of Isle Royale ● Temperature-Precipitation & Biomes (Climatograms) ● Predator-Prey Simulation (Wolf & Sheep) ● Population Explosion (Simulation) ● African Lions: Modeling Populations ● Data Nugget- Getting to the roots of serpentine soils ● Limiting Factors in Ecosystems ● EL Reading Text- Coral Reef Ecosystems ● Data Nugget- Fertilizer and Fire Change Microbes ● Life as a Hunter ● Niche Partitioning ● HHMI- Biointeractive Population Dynamics ● CREATING CHAINS AND WEBS TO MODEL ECOLOGICAL RELATIONSHIPS ● Energy Pyramids: Tying It All Together ● Data Nuggets- Longterm Bird Study Data ● Data Nugget- Is chocolate for the birds? ● Gorongosa Biodiversity
We are learning to apply mathematical representations to energy flow within an ecosystem so we can predict the effect of changing variables within the system.	I will know I am successful when I can: ● identify how mathematical representations can be used as evidence to make or support a claim. ● explain photosynthesis and the flow of energy in an ecosystem. ● identify the flow of energy in an ecosystem using a mathematical model. ● describe the transfer and flow of energy upward between organisms and their environments ● describe the inefficiency of energy flow in an ecosystem. ● analyze the flow of energy between trophic levels using mathematical evidence.	
We are learning to correlate organism position within an ecosystem to the biomass of a system to that we can so that we apply mathematical applications to that model.	I will know I am successful when I can: ● correctly identify producers in an ecosystem and discuss their relative biomass based on their level in the system. ● predict the relative proportion of organisms, biomass, and energy at each trophic level. ● explain why C, H, and N are primary elements in biomass. ● explain how energy drives the cycling of matter within and between systems.	

We are learning to apply mathematics to matter and energy flow in ecosystems so that we can transfer this ability among global ecosystems.	I will know I am successful when I can: • use the mathematical representation(s) to support the claims that include the idea that matter flows between organisms and their environment. • use the mathematical representation(s) to support the claims that include the idea that energy flows from one trophic level to another as well as through the environment. • analyze and use the mathematical representation(s) to account for the energy not transferred to higher trophic levels but which is instead used for growth, maintenance, or repair, and/or transferred to the environment, and the inefficiencies in transfer of matter and energy.	• Elephant Conservation Efforts • The Island Biogeography Simulator • Black-Footed Ferrets Edited • Zebra Mussel Filtering • Measuring the Biodiversity of the BMGR • Who Needs Mussels? Edited • Fire Ants & Garden Insects Edited • Yellow River Estuary • The Effect of Mercury on Biomagnification • Biomass & Trophic Levels • Biomagnification • The Big Biodiversity Experiment • Operation Cat Drop Edited • Operation Cat Drop • Northern Bobwhite Covey Size • Defending the Hive to Survive…To Bee Aggressive or not
We are learning… so that we can…	I will know I am successful when I can •	

Other High Quality Resources:

HHMI BioInteractive Classroom Resources

Open SciEd Classroom Resources

Next Generation Science Standards - Quality Examples of Science Lessons and Units

Ponds made to control floods can spew climate-warming gases, study finds

Meat-eating bees have something in common with vultures

Healthy soils are life-giving black gold

Whales get a second life as deep-sea buffets

Shading corals during midday heat can limit bleaching

Rewilding returns lost species to strengthen ecosystems

Urchin takeover underlies California's vanishing kelp forests

Changing climate now threatens northern lakes year round

Jumping 'snake worms' are invading U.S. forests

Cougars pushed out by wildfires took more risks around roads

Eight billion people now live on Earth — a new record

Bees and butterflies struggle to find flowers in polluted air

Here's how some sea-loving trees ended up far from the coast

Only 3 percent of Earth's land is unchanged by people

Summer 2023 is when the ocean first turned 'hot tub' hot

Why dandelions are so good at widely spreading their seeds

Study finds big drop in animal populations since 1970

Should we use a genetic weapon against mosquitoes carrying malaria?

Palm-size marsupials may face extinction from wild 'house' cats
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