



Environmental Literacy Model

Title	The Buck Stops Here: Is an Increasing Deer Population impacting biodiversity in Baltimore County?
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School, District	BCPS
Audience (grade, course)	10th grade, Living Systems

Curriculum Anchor

Defining the Learning Objectives and Curriculum Connection

Curriculum indicators, performance expectations, and/or student learning objectives.

HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect the carrying capacity of ecosystems at different scales

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems at different scales

HS-LS2-4: Use mathematical representations to support claims for cycling of matter and flow of energy among organisms in an ecosystem.

HS-LS2-6: Evaluate claims, evidence, and reasoning that the complex interactions in ecosystem maintain relatively consistent numbers and types of organisms in stable conditions but changing conditions may result in a new ecosystem.

Describing the Local Context

The life-relevant issue that will serve as the context for learning.

In the last century, the white-tailed deer population in Maryland has grown exponentially. This growth has caused many problems for the inhabitants of Maryland, including but not limited to economic losses in the agricultural sector, increased automobile accidents, higher incidence of Lyme disease, and decreased biodiversity in Maryland's habitats. As people living in Maryland, Baltimore County students face both direct and indirect consequences of the boom in the white-tailed deer population.

Most students see deer during their daily lives and likely understand that they are a common sighting throughout Baltimore County, even in developed areas. However, they likely do not consider the ecological and economic impacts associated with high population densities of deer in Baltimore County. Furthermore, properly managing the deer population in Maryland with a lack of natural predators is difficult.

Identifying the Driving Question

A broad, open-ended, life-relevant question that is based on the standards/learning objectives. Guides inquiry for the investigation(s), prompts the development of actionable claims.

To what extent does the current deer population affect Maryland's biodiversity?

****To be done prior to investigation 1****

- When teachers introduce Unit 5: Top Predator, also introduce the “Deer Opinion Survey” to gauge student and community perceptions of deer and their impact on local habitats, etc. The results of this survey will be used in Issue Investigation 2.
- Advanced Academics Option: Student groups or the entire class can develop their own survey (based on differentiation/scaffolding preferences of teacher and type of class) for parents, teachers, members of the community to complete. The survey would ask about deer sightings and evidence of deer damage on property/in the community.

Issue Investigation

Asking Questions, Defining Issues and Problems

Students define the issue, problem, or phenomenon to be investigated and develop supporting questions that are relevant for investigation.

Issue Investigation 1	Issue Investigation 2	Issue Investigation 3
<p>1. How does the local habitat support biodiversity?</p> <p>2. How is energy transferred in the local habitat?</p> <p>As an engagement, teachers have students analyze satellite image(s) of the schoolyard, local community, and/or local park. Students identify areas with potential suitable habitat to support native top predators and other organisms and areas in which human actions have altered habitat (see video about wolves in Yellowstone). Students also identify cause and effect relationships such as, but not limited to:</p> <ul style="list-style-type: none"> What does a food web look like for this habitat? How do roads impact biodiversity? Are natural areas connected? Are there wildlife corridors that predators may use? What native predators could live in our community and why? 	<p>1. How many deer are supported by the local habitat?</p> <p>2. Why is the deer population overpopulated in areas throughout Baltimore County and Maryland?</p> <ul style="list-style-type: none"> - focus is placed on how lack of, or absence of predators (bears, bobcat, wolves, coyotes, and cougars) and habitat alterations by humans has increased deer population densities. <p>3. How has the deer population impacted the local habitat?</p> <p>4. How do humans interact with local habitats?</p> <p>Students research general biology and habitat requirements of white-tailed deer. See provided deer resources. https://dnr.maryland.gov/wildlife/Pages/hunt_trap/Deer.aspx</p> <p>Students conduct a gallery walk and explore deer artifacts provided through the BCPS Deer Bin (See and/or DNR White-tailed deer education trunk https://dnr.maryland.gov/wildlife/Pages/Education/education_trunks.aspx See “Deer Trunk Materials Checklist” and “Deer Education Resources”; ask questions and collate information from their exploration.</p>	<p>1. How has overpopulation of white-tailed deer affected the human community?</p> <p>2. How has overpopulation of white-tailed deer affected forest biodiversity?</p> <p>Students explain how a dramatic increase in deer population and a dramatic decline or extirpation of a top predator who would prey on deer affects the function of the ecosystem. Students are required to show how organisms in each trophic level would be affected and ultimately how the producers in the forest are affected.</p>

	<p>Students complete a graphic organizer identifying impacts of the overpopulation of deer on people in Baltimore County, MD (ex. automobiles/insurance, crop damage, Lyme disease numbers) and categorizing them based on environmental, economic, and societal impacts.</p>	
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Issue Investigation (cont.)

Planning and Conducting Investigations

Students plan and conduct investigations and classroom activities (indoor and outdoor) that actively address students' supporting questions. Students collect data that will be used to inform actionable claims.

Issue Investigation 1	Issue Investigation 2	Issue Investigation 3
<ol style="list-style-type: none"> 1. Analysis of local food web (provided for students) 2. Students conduct an owl pellet investigation (see "Owl Pellet Worksheet Middle and High School" and "Owl-pellet-dissection-ngss.pdf") 3. Students revisit food web and pick one consumer to research (general habitat requirements for survival); they can plan an investigation of their schoolyard to see if their chosen organism could survive (see habitat surveys listed below for guidance) <ul style="list-style-type: none"> • considerations: food, water, cover, space for reproduction, limited human impacts, all in appropriate-sized space • revisit engagement pictures of schoolyard to hypothesize where chosen organism(s) might survive 4. Students conduct a habitat survey of their schoolyard with special focus on the organism they researched. Teachers can use one or more of the following habitat assessment survey tools (if students are focusing on their researched organism, choose "Who Can Live Here"): <p>Habitat Assessment - see "Schoolyard Habitat Assessment Amended"</p> <p>"Is This Property Good for Wildlife?" - see "Quick Schoolyard Assessment - GMR"</p> <p>"Who Can Live Here?" - NWF - See pages 79-82 in "Schoolyard Habitats How to Guide"</p> 	<ol style="list-style-type: none"> 1. Students complete Project Wild's "Oh Deer!" activity or "Oh Deer Card Game" <ul style="list-style-type: none"> • https://georgiawildlife.com/ProjectWILD/OhDeerCardGame <ul style="list-style-type: none"> • extension includes addition of predator/prey and graphing of populations 2. Students conduct a deer pellet survey and/or browse impact survey (see "Deer Pellet Count and Habitat Assessment Resources" folder; other suggested activities include Project Wild's "Dropping in on Deer") <ul style="list-style-type: none"> • Students plan the best places to conduct the school yard or park survey and justify their plan. Plans are shared to determine the best investigation plan for both the deer pellet survey and browse impact survey. Teacher input or planning may be required to conduct the most effective schoolyard survey. Students may choose particular areas of the schoolyard to focus on or determine roles for group members while conducting the survey. 	<ol style="list-style-type: none"> 1. Students identify human stakeholders concerned with the deer population <ul style="list-style-type: none"> • Suggested activity: Project Wild "Deer Dilemma" • Students may be able to determine roles on their own; supplement with "Deer Dilemma" roles if necessary. 2. Compare/contrast activity, debate, campaign, etc. for local predators (mountain lions, wolves; bears, bobcats, fishers, coyotes; red foxes, owls, red-tailed hawks; spiders) <ul style="list-style-type: none"> • "Top" predators (mountain lions, wolves) vs. other predators

https://www.nwf.org/-/media/PDFs/Eco-schools/SchoolyardHabitatsHowToGuide_Part4.ashx?la=en&hash=DC3286835F1EF9A82FCE4E70B26BCDEB636FD5C9

Students conducting this survey could do it based on white-tailed deer or they could do it based on various native top predators - red fox, hawks, owls, bald eagle, black bear, coyote, bobcat, etc.

Issue Investigation (cont.)

Analyzing and Interpreting Data

Students analyze data through graphs, models, and other methods to reveal patterns and relationships. Students synthesize and apply evidence from their investigations to draw conclusions that address the supporting questions.

Issue Investigation 1	Issue Investigation 2	Issue Investigation 3
<p>Students analyze results of their investigations:</p> <ol style="list-style-type: none"> 1) Owl pellet investigation analyzed first in order to calculate average biomass eaten per day vs. per year 2) Values then applied to their food web in order to account for energy flow between trophic levels in their local habitat <p>Questions to pose to students: Based on the schoolyard assessments, is there suitable habitat to provide for deer? top predators? other organisms? Does the habitat provide enough energy to support multiple trophic levels?</p>	<ol style="list-style-type: none"> 1. Students determine the density of deer in their investigation area. 2. Students compare their investigation data to local/state population data 3. Students apply a score to their investigation data to label the deer population. 4. Students calculate energy needs of observed deer population (i.e., can ecosystem support the deer population?) 5. Analyze the changes in the deer population over time (see historic data and compare with current data) <p>Questions to pose to students: What has affected deer population sizes? Are deer densities affecting the habitat and biodiversity?</p>	<ol style="list-style-type: none"> 1. Students analyze the following: <ol style="list-style-type: none"> a. the findings of community/household deer impact surveys b. data from schoolyard/ park deer pellet survey c. observations and data from schoolyard/park browse impact survey 2. Students also analyze resources such as those in the White-tailed Deer Population at Valley Forge Teachers Guide showcasing more specific impacts an overpopulation deer population can have on native wildlife and forest biodiversity. Impacts to biodiversity can include, but are not limited to: <ul style="list-style-type: none"> - over-browsing seedlings and saplings of native forest trees affecting forest regeneration and the ecosystem services provided by certain valuable tree species such as oaks - increasing levels of nitrogen, phosphorus, and sediment in waterways, thus affecting fish and macroinvertebrate biodiversity - dispersing invasive species' seeds <p>Students can read the article, Deer Can Be Too Many, Too Few, or Just Enough for Healthy Forests which briefly details the effects that different deer population densities have on the forest ecosystem based on studies conducted by scientists in the Northeast United States.</p>

		<p>Students explain how the forest ecosystem and biodiversity have been shown to be affected by a high deer population density, low population density, and a balanced or natural population density level.</p>
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Constructing and Communicating a Claim

Students draw on the conclusions from their investigations to make a claim about the driving question and communicate these evidence-based claims to internal and/or external audiences.

Issue Investigation 1	Issue Investigation 2	Issue Investigation 3
<ol style="list-style-type: none"> 1. Students make a claim about the ability of their schoolyard to support biodiversity. 2. Students construct a food web focusing on the transfer of energy and matter. They should base the food web on a native predator such as red fox, barred owl, bald eagle, red tailed hawk, cooper’s hawk) in order to determine if there is enough suitable habitat to support each trophic level and, thus, the top predator. 	<ol style="list-style-type: none"> 1. Students conclude that there is an overpopulation of deer. 	<ol style="list-style-type: none"> 1. Students conclude that the overpopulation of deer has led to a decrease in forest biodiversity. Students make a claim about how the overpopulation of deer is destroying forest biodiversity (see LC3 Summative - “LC3.SR_Summative.TopPred.docx”

Stewardship and Civic Action

Identifying Solutions

Students identify and explore solutions that directly address the problem, challenge, or opportunity reflected in their claim. Students use decision making processes to identify the solution(s) to implement.

1. Review and evaluate current deer management strategies to:
 - Reduce the deer population below its carrying capacity and sustain a healthy population in a given area.
 - Reduce damage caused by deer to preserve or increase native biodiversity.

https://dnr.maryland.gov/wildlife/Pages/hunt_trap/ddmt_problems.aspx

https://dnr.maryland.gov/wildlife/Pages/hunt_trap/Deer.aspx

Students evaluate the pros and cons of strategies for managing deer population and its impacts. Students can contact experts about management strategies (current and past).

A good resource that teachers can use to have students investigate management strategies is [An Evaluation of Deer Management](#) pgs 8-23. Teachers can conduct a jigsaw by breaking up the class into small groups to investigate each management strategy and then share an overview of each strategy. See “Analysis of Deer Management Strategies Student Chart.docx”

Designing a Plan and Taking Informed Action

Students design a plan for implementing solutions through informed action in their classrooms, schools, and/or communities. The plans should include criteria for determining the extent to which the action successfully addresses the problem, challenge, or opportunity reflected in the claim. Students implement their plans.

1. Students propose an action plan to improve biodiversity of local habitats in the face of the growing deer population.
 - a. Possible focus of action plan:
 - i. propose management strategies to reduce the deer population below carrying capacity in an area such as the school grounds and surrounding community, local park, or region/town.
 - ii. propose management strategies to reduce damage caused by deer for homeowners and members of the community
2. Students implement their action plan by developing product(s) to showcase their research findings such as data and observations, conclusions, and how their proposed action plan will be implemented. Products can vary and students should be given options by the teacher to encourage student choice. Products could be virtual boards/posters, power point, weebly, video/commercial, display board/bulletin board, etc.

Evaluating Action

Students reflect on the action and determine the extent to which it successfully addresses the problem, challenge, or opportunity reflected in the claim. Students communicate their findings and share proposals for sustaining or extending the action.

1. Plans can be presented to local stakeholders (neighborhood associations, local government, landowners, etc.). They can also be shared with the school community through displays in hallways, gallery walks by other visiting classes, school website, or through school announcements/commercials.
2. Students perform a cost-benefit analysis of proposed plan and revise proposal based on feedback and feasibility.