Nest Construction: Building artificial nests to study predation

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Age Level/Subject- 9-12 Natural Resources and Ecology
STEM Biology

Total Time Required- ?

Prepared by: Jennifer Kuhl-Depp and Joe Evans
Kent County High School, Worton, MD
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Unit Objectives:

Students will be able to:

- understand the ecological relationship between predator and prey.
- understand the role that environment, habitat, geographical features, and urbanization play in ecological relationships.
- understand biological structures in predators.
- Gain experience in CAD and 3D printing.
- Students will utilize place-based learning to understand their role in ecological relationships.
- Students will report findings to a wider audience.
- Students will gain practical knowledge in data collection and analysis.

Science Standards and Standards for Technology Literacy

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**

HS-LS2-6.	**Evaluate 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.**

HS-LS2-7.	**Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.***

HS-LS4-6.	**Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.***

International Technology and Engineering Educators Association

- C. The design process is a purposeful method of planning practical solutions to problems.
- D. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.
- D. When designing an object, it is important to be creative and consider all ideas.
- D. Identify and collect information about everyday problems that can be solved by technology, and generate ideas and requirements for solving a problem.
- D. Follow step-by-step directions to assemble a product.

Next Generation Science Standards

Life Sciences

3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. Examples of evidence could include needs and characteristics of the organisms and habitats involved.

Engineering Design

3-5-ETS1.2 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints.

Lesson Plan 1:

Science Inquiry Investigation: Guiding Question - Why are birds an indicator of the ecological health of an environment?

Lesson Focus:

Students will learn what birds are native to Maryland and their role in the ecosystem.

Total Time: 1-2 Hours

Lesson Objectives:

Students will be able to:

- identify birds native to Maryland and their nesting styles
- understand the ecological importance of native Maryland birds by investigating their role in the local ecosystem
- Define biomimicry and list examples

Lesson Procedure:

Warmup: Sketch a food web that includes a native Maryland bird. Indicate the role of the bird in the web. Consider what may happen given population changes of the bird.

*Go over warmup. Briefly discuss biomimicry and the final outcome of the lesson (using 3D technology to make artificial nests).

Spark Video:
https://www.spark101.org/lessons/chesapeake-bay-foundation-what-do-land-use-and-bir/

Lecture: 30-35 minute introduction on native Maryland birds and their habitats. Focus on nesting habits. Have students take some time to independently research Maryland birds. Share out.
Resources for lecture: https://dnr.maryland.gov/wildlife/Pages/plants_wildlife/mdbirds.aspx
Powerpoint for common birds found in Kent County, MD (to be built).
https://mdbirds.org/young-birders/birding-basics/bird-identification/
https://www.birdwatchingacademy.com/backyard-birds-of-maryland/

Post-Lecture Questions:

1. Why do we focus our attention on native birds?
2. What factors could impact local bird populations?
3. What further impact could changing populations have on the ecosystem itself?

- Show students some examples of native nests.

Activity: Nest-building

Pre-Activity Discussion:

1. Strength material – helps to hold the nest up during strong winds or adverse weather conditions
2. Binders and adhesives – holds or glues the nest together
3. Liners – makes the nest cozy, soft, and warm
4. Predator protection – keeps the eggs and young safe from predators: camouflage, secure structure, etc.

Materials:

- Clay
- Natural materials (twigs, leaves, grasses, etc.)
- Fur like materials
- Moss
- Fiber materials

Have students work with one partner. Students should sketch a basic design of their nest prior to building their nest. Students should include what materials they would like to use on their sketches (using pre-activity discussion as a guide. Allow students to build their nests.

Post-Activity Assessment:

1. What things are considered during nest building. How do birds know how to build their nests?
2. Of all the considerations for nest building, what do you think is most important and why?

Lesson Plan 2:

Science Inquiry Investigation: Guiding Question - What role do predators play in bird populations in Maryland?

Lesson Focus:

Students will learn about the natural predators of native Maryland birds.

Total Time: 1-2 Hours

Lesson Objectives:

Students will be able to:

- identify nest predators native to Maryland
- understand the ecological relationship between predators and birds in Maryland.
- Understand the basic physiology of the predators that impact native bird populations in Maryland

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Lesson Procedure:

Warmup: Sketch a food web that includes a predator of a native Maryland bird. Indicate the role of the predator in the web. Consider what may happen given population changes of the predator.

*Go over warmup. Briefly discuss the ecological relationships present in the webs.

Lecture: 30-35 minute introduction on native bird predators. Overview on predator physiology. What makes a predator a predator?

Resources for lecture:
Powerpoint, to be made.
https://birdwatchingpro.com/maryland-birds-of-prey/?utm_source=rss&utm_medium=rss&utm_campaign=maryland-birds-of-prey
https://nestwatch.org/learn/all-about-birdhouses/dealing-with-predators/

https://www.atshq.org/what-animal-eats-bird/

Post-lecture questions:

1. What makes something a predator beyond the fact that it consumes prey?
2. What does a predator consider when seeking/hunting food?
3. What impact could changing predator populations have on the ecosystem at large?

*Students will be given time to further investigate potential predators and their methods. Brief share out.

Activity: Field Observation

Materials:

- Field Journal
- Camera
- Collection Container

Have students work with a partner. Students will go to the Tree Project on campus in order to investigate ecological relationships present. Students will investigate the habitat. Students will scout locations for possible nest/testing sites. Students will record observations in their notebooks. Students will assess and consider what will make an ideal location for a nest (consider: weather, shade, height from ground, biodiversity present, spacing, etc.). Students will record and witness ecological interactions with both their cameras and in their notes. Students will go to the community center pond for comparison. Students will use what they have learned about the physiology and behavior of a predator to assess locations to study using 3D printed models.

Post-Activity Assessment:

1. What did you notice about ecological relationships present in our outdoor locations?
2. How did the locations vary in terms of biodiversity and relationships? Why?

Lesson Plan 4:

Science Inquiry Investigation: Guiding Question- How do scientists assess biodiversity of an ecosystem?

Lesson Focus:

Students will investigate methods of population surveying of organisms in ecosystems.

Total Time: 1-2 hours

Lesson Objectives:

Students will be able to:

- Define biodiversity
- Understand methods in assessing biodiversity of an ecosystem
- Understand how population survey methods are used

Lesson Procedure:

Warmup: How would you figure out how many deer are on Eastern Neck Island?

*Share out

Lecture: 35-40 lecture on population survey methods. Touch on: Berlese funnel, trail cams, transect, quadrat, mark-recapture, etc. Bring in someone from DNR to discuss population methods/biodiversity.

Resources: https://www.slideshare.net/gurya87/population-ecology-11685161
https://open.oregonstate.education/monitoring/chapter/field-techniques-for-population-sampling-and-estimation/
https://www.dummies.com/article/academics-the-arts/science/biology/biology-basics-population-ecology-169038/

Activity: Population Survey

To be decided:

Possibly: Mark-Recapture, Transect Sampling, Quadrat

Post-Activity Questions:

1. Given mark-recapture data: analyze
2. Given two images: Compare density and biodiversity.

Lesson Plan 4:

Science Inquiry Investigation: Guiding Question - What role does nest structure and location play in predation?

Lesson Focus:

Students will learn how to utilize 3D printing to build an artificial nest. Students will consider factors of structure and placement.

Total Time: 3-4 Hours

Lesson Objectives:

Students will be able to:

- Further define biomimicry and how this lesson will demonstrate biomimicry factors
- Gain a broad understanding of the 3D printing process
- Apply their knowledge of nest building in an engineering capacity

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Lesson Procedure:

Warmup: Engineering Sketch Activity (to be decided)

*Go over warmup. Share out.

Lecture: 30-35 minute broad introduction to the sketch engineering process and 3D printing. Engineering teacher will present for this portion .

Post-Lecture Questions:

1. Why would we want to use biomimicry to understand ecological relationships?
2. In what other ways do you think we could use biomimicry to engineer solutions?

Activity: CAD sketches/3D printing

Materials:

- Lab Notebooks (Sketchbooks)
- Sketch Pencils
- CAD software (Fusion 360?)
- 3D printer
- Additional nest materials (to mimic outer layers of nests)
- Materials for 3D printing

Students will work with a partner to design their nest. Students will consider all they have learned about native Maryland birds and their nest predators to design their nests. Students will have their sketches approved by both the teacher and the partnering engineering teacher. Students will need to label dimensions and textures. Once their sketches are approved, students will work with engineering classes to 3D print their models.

Post-Activity Questions:

1. Why is it important to consider the natural environment in your CAD design?
2. How does utilizing the engineering process allow you to study these ecological and natural relationships further?

Lesson 5- Hypothesizing/Experimental design/Data collection

Science Inquiry Investigation: Guiding Question - What factors affect predation?

Lesson Focus:

Students will learn how to utilize 3D printing to build an artificial nest. Students will consider factors of structure and placement.

Total Time: 1-2 Hours

Lesson Objectives:

Students will be able to:

- generate hypotheses (null & alternative)
- Collect data & analyze results

Lesson Procedure:

Warmup questions:

1. Brainstorm what predators will prey upon bird eggs.

Student questions/hypotheses- Instructor will lead students into a discussion of factors that affect predation rates such as

- Color of eggs- white vs color vs cryptic
- Number of eggs- do more or fewer attract more predation?
- Nest height- closer to ground versus higher in shrubs or trees

- Nest distribution- clumped versus random spacing

Can students generate a null and alternative hypothesis?

Lecture/Lesson Body: Depending upon student ideas, nests can then be placed in habitats close to the school. Students can wear gloves to prevent transfer of human scent when handling clay eggs or the nests. Small landscape flags can be used to mark nest location (GPS coordinates too?). Students can draw/take notes/photograph pertinent information on placement.

After one week nests can be inspected for signs of predation. Eggs can be retrieved and examined in class and types of tooth or beak marks can be viewed with magnifying glasses.

Discussion questions:

1. What factors seem to influence predation rates?
2. How do you think artificial nests estimate actual predation rates?
3. How does the influence of parent birds being present alter predation?
4. How might real eggs as opposed to clay ones have influenced results?
5. Do any results suggest opportunities for landowners to alter their plantings to help bird populations?