Saving Pelicans: A STEM Integration Unit

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Saving Pelicans: A STEM Integration Unit
(Curriculum Exchange)

Target Grade Level: 5-8

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Project Description
The EngrTEAMS project is an engineering, design-based approach to teacher professional development that has 50 teachers per year designing curricular units for science topic areas related to the Next Generation Science Standards (NGSS). The project includes summer professional development and curriculum writing workshops, paired with coaching, to allow teams of teachers to design engineering curricular units focused on science concepts, meaningful data analysis, and measurement. Each unit goes through an extensive design research cycle to ensure its quality and is published in an online format.

Unit Description
The Saving Pelicans STEM unit uses the context of American white pelicans. The unit uses the American white pelican as a context since students who received this unit live in Minnesota where large numbers of pelicans breed. However, in this unit, any migratory birds can replace American white pelican based on students’ prior knowledge and interest and local habitats. The unit includes six lessons and each lesson leads students through a series of activities that introduce them to several science concepts and scientific and engineering practices. The implementation of the unit takes 8-10 days. The unit was designed to address the NGSS standards MS- ETS1: Engineering Design and MS-LS2: Ecosystems: Interactions, Energy and the crosscutting concept Stability and Change (NGSS Lead States 2013). The following disciplinary core ideas can be taught to extend the unit or after the unit: Ecosystem Dynamics, Functioning, and Resilience (MS- LS2.C) or Biodiversity and Humans (MS-LS4.D).

Unit Summary
The STEM unit can be implemented in middle school life-sciences classes. See Table 1 for the overview of the unit. The first lesson introduces students to American white pelicans and helps to build the context for the engineering challenge. Students read an actual newspaper article about a farmer who destroyed a pelican colony by smashing thousands of pelican chicks and eggs on a farm that pelicans use as a nesting site. After reading, students identify the different physical characteristics of the pelicans, their nesting sites in their state, and the impacts of these pelicans on farmlands. Rich discussions around these topics among students help the teacher to see what students know about pelicans and to build a context for the engineering challenge. Following the discussion, the engineering challenge is introduced to the students.
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Table 1: Overview of the unit

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Objectives</th>
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<tbody>
<tr>
<td>Lesson 1: Setting the context</td>
<td>To introduce American white pelican, their immigration pattern, feeding habits, and breeding sites, and probable treats to their survival.</td>
</tr>
<tr>
<td>(1 class period, approx. 45</td>
<td></td>
</tr>
<tr>
<td>min.)</td>
<td></td>
</tr>
<tr>
<td>Lesson 2: Estimating the</td>
<td>To pose the data-analysis problem to calculate the number of pelicans in a breeding area.</td>
</tr>
<tr>
<td>number of nests in pelican</td>
<td></td>
</tr>
<tr>
<td>colonies (1 class period)</td>
<td></td>
</tr>
<tr>
<td>Lesson 3: Scale of ecology,</td>
<td>To learn interaction of organisms in an ecosystem.</td>
</tr>
<tr>
<td>food webs, and species</td>
<td></td>
</tr>
<tr>
<td>interactions (1-2 class</td>
<td></td>
</tr>
<tr>
<td>periods)</td>
<td></td>
</tr>
<tr>
<td>Lesson 4: Designing pelican</td>
<td>To apply an engineering design process that includes identifying criteria and constraints, designing a prototype, testing and evaluating the prototype, and redesigning the product.</td>
</tr>
<tr>
<td>nests (3-4 class periods)</td>
<td></td>
</tr>
<tr>
<td>Lesson 5: Relocating pelican</td>
<td>To use geographic information system technologies to make predictions about appropriate places to locate pelican chicks.</td>
</tr>
<tr>
<td>chicks using GIS (1 class</td>
<td></td>
</tr>
<tr>
<td>period)</td>
<td></td>
</tr>
<tr>
<td>Lesson 6: Socio-scientific</td>
<td>To enhance socio-scientific reasoning skills by recognizing inherent complexity of the issue, analyzing issues from multiple perspective, and appreciating the need for ongoing inquiry.</td>
</tr>
<tr>
<td>issues (1 class period)</td>
<td></td>
</tr>
</tbody>
</table>

Lesson 2 integrates data analysis and measurement for scientific purposes. Students use two aerial pictures of pelican nesting sites to develop and test their procedures to estimate the number of nests in the areas shown on these aerial pictures (See Appendix for the student worksheet). Lesson 3 introduces ecosystem dynamics. Students also explore food webs and species interaction. Giving different ecological scales such as individual, population, community, and ecosystem in the context of American white pelicans, students are expected to gain some understanding of each scale. The concepts introduced in the instruction are strengthened by using multimedia images related to each level. Students are also introduced to the key terms such as herbivore, carnivore, consumer, producer, and decomposer. Following this activity, the concept of food web is addressed by using the ecosystem that American white pelicans visit in MN. Students do Food Web Activity by using the organisms in these particular habitats with the exclusion of white pelicans (e.g., coyote, wolf, double-crested cormorant, fish, snail, frog.
bacteria). Lesson 4 requires students to solve an engineering challenge of designing pelican nests in order to transfer abandoned pelican eggs to a research lab at the DNR for a successful hatching process. Design criteria and constrains are introduced to students (See below for details).

In the past few years, several American White Pelican nest sites were destroyed in Minnesota. Fish and Wildlife Service need your help to save pelican eggs that were abandoned due to the human destruction on the Big Island on Marsh Lake area in MN. You need to design pelican nests to transfer 650 abandoned pelican eggs from the island on Marsh Lake to the research laboratories in the U.S. Fish and Wildlife Service so that eggs will be able to hatch successfully.

There are several design challenges you need to consider in order to successfully accomplish this task:

- **Protect**: The strength and stability of the nests are pretty important. Eggs in the nests should be transferred to the research labs safely. An egg drop test will be performed on your nest design. When you drop your nest 10 inches above the desk or table the eggs should not break.

- **Preserve temperature**: Your nest design should be insulated well to preserve temperature. You need to provide eggs with a warm nest. Using the heading blanket you need to keep the temperature in the nest box between 96˚ F and 100˚ F for at least 5 minutes. If the temperature gets too hot or too cold it will affect the eggs.

- **Cost**: Cost of your nest design is also important. Since hundreds of eggs need to be transferred to the research lab, the nest design should be cost effective.

- **Replication of real environment**: You need to consider using nest-building materials that are commonly used by pelican parents in the natural environment.

- **Number of eggs**: You can put more than two eggs in your nest.

In their designs, students need to consider the following specific constraints and criteria: (1) capacity - the number of eggs nests can carry, (2) replication - the use of real environment materials (e.g., soil, mulch, pebbles, feathers), (3) cost - the cost effectiveness of the nest designs, (4) preserve - temperature stabilization for the pelican eggs, and (5) protect - the strength and stability of the nests. A rubric to evaluate the designs are shared with the students. After students calculate the cost of their materials and complete the temperature and egg drop tests, students receive feedback from the teachers and other students and start redesign.
Figure 1: Sample nest designs

In Lesson 5, students use GIS to make predictions about appropriate places to locate pelican chicks around a chosen lake. The last lesson of the unit, lesson 6, was designed to increase students’ socio-scientific reasoning skills. Students participate in a classroom debate playing different roles related to American white pelicans, such as wildlife specialists, farmers, fishermen, and ornithologists. Students obtain different perspectives and assume different positions about the same controversial environmental issue in order to fully understand its complexity.

In this unit, by designing and building pelican nests, students participate in engineering practices in science classrooms. The unit has been implemented in a variety of settings. Students always show high interest in building nests to save pelicans. This engaging STEM integration unit can be easily modified to other scenarios in which students design nests for other animals.
Appendix: Sample Lesson from the Unit

Lesson 2: Estimating the number of nests in pelican colonies

Pelican Colonies at Marsh Lake-Part A

Read the following article and complete the individual exercise that follows.

The American White Pelican (Scientific name: *Pelicanus erythrorhynchos*) is a large waterbird that is found mainly in the northwestern part of North America like the Marsh lake at Minnesota during the breeding season, and the coasts of the southern United States and Mexico during the winter. This species nests on islands in large lakes or along rivers, or on high dry areas in inland marshes. The birds make their nests on flat or mildly sloped areas with little vegetation. They may nest at sites where the substrate is soil, gravel, rock, or sand. Their nests are simple shallow depressions in the ground. As pelicans are colonial nesters, large groups of breeding pairs make their nests in one area, and the nests are very close together.

After the female pelican lays her eggs (almost always 2 eggs), the parents take turns incubating the eggs. Eggs must be kept at the right temperature while the chicks are developing inside; if the parents do not sit on the eggs to keep them warm in cold weather and keep them shaded from the hot sun, the developing chick will not survive. When one parent is sitting on the nest, the other parent leaves the nest site and flies to the feeding grounds to catch fish.

When pelicans are nesting, they are very shy and are easily disturbed. If humans enter a breeding colony, the adult birds will leave their nests. Pelicans may also be disturbed by loud motorboats or other noises. Another danger to unguarded eggs are predators like gulls, coyotes, and foxes.

Pelican eggs hatch in 30 days and pelican chicks eat by digging digested food out of the adult's pouch. As chicks mature, they join a "pod" of young pelicans and feed in large groups until they are ready to fly at about 10 weeks.

In September, white pelicans leave their nesting grounds and head south. The pelicans nesting in the Minnesota area overwinter in Mexico, Louisiana and other Gulf States. White pelicans can live as long as 30 years.
MEMORANDUM

To: Students in _____ School  
From: Alice Heart  
Wildlife Specialist, U. S. Fish and Wildlife Service  
Subject: American White Pelican monitoring and management  

Wildlife specialists at the U.S. Fish and Wildlife Service in Minnesota monitor breeding colonies of American White Pelican each year in order to determine which areas birds are using as colony sites, and estimate the population size of each colony. Knowing where the birds are nesting helps them decide which sites they might undertake conservation efforts at, and what those efforts should be. Protecting every site known to have breeding colonies is not a realistic option. There are many constraints on conservation actions to protect breeding colonies, including cost and political implications. Therefore, wildlife specialists can only protect a subset of known colonies. One key criterion used to determine which sites should be protected is the number of bird nests. Sites with the largest number of nests are considered more important to protect.

Wildlife specialists at U.S. Fish and Wildlife Service needs a procedure to estimate the number of nests at each pelican colony. Because pelicans are very sensitive to disturbances while they are incubating their eggs, wildlife specialists cannot physically walk through every colony and count nests. Pilots are hired to fly wildlife specialists over nesting colonies so they can take aerial photographs of the sites. As pelican colonies can be quite large, each photograph shows only a portion of the entire site. They have maps based on satellite images that are taken annually, which show them the shape and size of each colony site. They enlist your team’s help to create a procedure that will allow them to estimate the number of nests in a pelican colony, based on the photograph that shows a sample of the colony, and a map that shows the size and shape of the entire site.

You will find two photographs taken at two different pelican colonies in Marsh Lake, MN, and a map showing the size and shape of each of these colony sites. You can assume that pelicans will nest in the entire area of each site, as the habitat is uniform across a given site.
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Colony A – Aerial Photograph

Colony A – Site Map
Area inside lines is nesting site
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Colony B – Site Map
Area inside lines is nesting site
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Pelican Colonies at Marsh Lake- Part B

Team Exercise

As a team develop a procedure for estimating the number of nests at a pelican colony, using the documents provided by the U.S. Fish and Wildlife Service and materials available in the classroom. Write a memo that includes a detailed explanation of your procedure, an explanation of how you have tested your procedure, and your estimates for the number of pelican colonies in the two photographs included in your packet. Be sure to include a description of any assumptions you have made. Also include any requests for additional information or data from U.S. Fish and Wildlife Service that you think might allow you to improve the accuracy of your procedure.