You Be the Scientist

Grade Level: upper middle school/ high school
Duration: one 40 to 50-minute class period.
Skills: critical thinking, communication/presentation, formation of hypotheses, vocabulary, discussion, and team building.
Subjects: science and language arts

Concepts
- There are still many unanswered questions about shorebirds and how we can best conserve them.
- The Scientific Method of Inquiry is the method researchers use to develop a clear hypothesis and a strong study plan.
- Some shorebirds concentrate in great numbers at stopover sites which provide large populations of birds for study.

Vocabulary
- hypothesis
- Scientific Method of Inquiry
- data
- procedure
- study plan

Overview
Students work in pairs to develop a study plan that will help them investigate a question about shorebirds.

Objectives
After this activity, students will be able to:
- Explain the *Scientific Method of Inquiry*.
- Rewrite a scientific question into a hypothesis statement.
- Develop a scientific study plan that includes a hypothesis, procedures, and materials list.

Materials
- One *Scientific Question Card* for each pair of students
- One copy of the student reading *The Scientific Method of Inquiry* for each student.

Activity Preparation
1. Photocopy and cut a set of *Scientific Question Cards*. Students can write their own questions or rewrite an existing question in the form of a hypothesis in the blank cards provided.

Procedure
1. Push desks aside; arrange the students and their chairs in a circle.

2. Form teams of two and give each pair a copy of the reading *The Scientific Method of Inquiry*. Ask them to carefully read the handout. Answer any questions about what they read before proceeding.

3. Have each team choose a *Scientific Question Card* without reading it first.

4. Give them ten minutes to prepare answers to the questions. Each team must develop a *study plan* that includes at least five procedures, how, when, and where (time of year, and possibly time of day or tide, etc.) they will conduct their observations or experiments and a list of materials they will need.

   Note: Remind students that the object of this activity is to figure out how they would go about trying to answer their questions if they were biologists studying shorebirds. The answers to many of these questions are not yet known for many species. In fact, they may never be completely answered.

   Here are just a few methods that students might use to gather information:
   - Literature research/interviews (to find out what is already known)
   - Captivity experiments (on organisms brought into the laboratory rather than observed in the wild, natural habitat, or "field")
   - Dissections
   - Banding or marking birds
   - Observations
   - Volunteer observations
   - Censuses (counting)
   - Transects (extrapolating from what is found in one area)
   - Averaging a number of observations
   - Comparing seasonal data or annual data to show changes or trends
   - Presenting results as a bar, line or pie graph (for example: comparing the diet of Dunlins and Western Sandpipers by graphing the percentage of worms in their diet as Y-axis and bird species as X-axis)

5. When all teams are ready, have each team read its card and present its study plan to the class.

6. Each team should ask the rest of the class: Is this a good study plan? Why or why not? How could it be better?

Additional Activities:

Cultural Connection
Students can write a question to a shorebird scientist in another country, asking about the people's attitudes towards shorebirds and their habitats (wetland or grassland). Submit the question on-line: *http://sssp.fws.gov*, click on "References", go to "Ask a Biologist."

What Are Your Questions?
Have students brainstorm a shorebird question they want answered and develop study plans to find out the answer. Are any of their questions already the topic of scientific research? Go to the Shorebird Sister Schools Web site at http://sssp.fws.gov. and click on the "Tracking" or "Reference" links. Through the program's Web site, your students can meet real biologists and read about what they do, learn about current shorebird tracking projects, ask a question, and browse the Web site archives to read the questions other students have posted to biologists.

Develop Hypotheses
Instead of devising study plans, use this activity format to have students develop and present *hypotheses* or possible theories (answers) to the science questions.

Examples:
1. Why do shorebirds tend to be *circumpolar* in their breeding distribution (breed on more than one continent or in different hemispheres of the globe)?

2. Say Daniel counted 56,800 Western Sandpipers on the peak day (most birds) of spring migration on a beach in the Copper River Delta. In the fall he counted 783 on the peak day. How many were missing and where did they go?

You Be the Scientist, Part II
Have students conduct research projects designed to answer a question, or ask them to write a paper based on the research they do.

You Be the Scientist
Scientific Questions Cards

(Make one photocopy so every two students get a card.)

You Be the Scientist Question	You Be the Scientist Question
How could you prove if a species is territorial or not?	How could you find out if a shorebird's territory is three-dimensional (like a polygon) or two-dimensional (like a line along the beach)?
You Be the Scientist Question	**You Be the Scientist Question**
How could you devise a plan to find out if female shorebirds are territorial?	How could you measure the size of a home range or territory?
You Be the Scientist Question	**You Be the Scientist Question**
How could you find out what a shorebird eats?	If studying nests, how could you keep predators from following your scent trail to the nests you are observing?
You Be the Scientist Question	**You Be the Scientist Question**
How could you find out the percentage of breeders versus non-breeders in a shorebird population?	How could you find out if a population of shorebirds comes back to the same place every year?
You Be the Scientist Question	**You Be the Scientist Question**
How could you find out if there is a greater *diversity* of breeding shorebirds in tundra or in coastal marsh? If there is greater diversity of breeding in the tundra than elsewhere, why?	Scientists believe that shorebird eggs are slightly pointed at one end to minimize heat loss when the eggs are lying next to each other in the nest. How could you prove or disprove this theory?
You Be the Scientist Question	**You Be the Scientist Question**
How could you answer the question "Are shorebirds *sexually segregated* when feeding?"	How could you find out if plastic leg bands interfere with the bird's lifestyle (flying, walking, feeding, mate selection, etc.)?

You Be the Scientist
Scientific Questions Cards

(Make one photocopy so every two students get a card.)
(Write your own research questions in the blank cards provided.)

You Be the Scientist Question	**You Be the Scientist Question**
How could you find out how oil development in Arctic breeding grounds impacts the survivorship of shorebird chicks?	How could you find out why a population of migratory breeding shorebirds is declining?
You Be the Scientist Question	**You Be the Scientist Question**
Migrating shorebirds stop at the Delaware Bay by the thousands during spring migration. How can you find out why?	Shorebirds are breeding in nearby prairie grassland but not in one area that looks like good habitat. How can you find out why?
You Be the Scientist Question	**You Be the Scientist Question**
You Be the Scientist Question	**You Be the Scientist Question**
You Be the Scientist Question	**You Be the Scientist Question**
You Be the Scientist Question	**You Be the Scientist Question**

The Scientific Method of Inquiry

In science, if you want to answer, or propose a theory to answer, the questions "Why?" or "How?" it is important to have a good study plan. The *Scientific Method* is the framework that scientists use to form a study plan when they are trying to answer questions about our world.

The Scientific Method involves making observations and then forming a *hypothesis*, a statement that answers your question. For example, you watch shorebirds feeding and wonder if the males feed in different places than the females. You guess that the do not feed separately. Your hypothesis statement might read: "*Male and female shorebirds do not feed separately.*"

Unfortunately, you are not a shorebird and you cannot tell the males apart from the females by watching. Now, in order to prove or disprove your hypothesis, you need a plan. Whether you are right or wrong is not the point. You just want to know the answer.

A plan involves a list of *procedures* you are going to conduct to answer your question and a list of *materials* you will need in order to carry out the procedures. You also need to decide how to present the *results* of your plan — for example, by table, graph, or picture.

Now that you have a plan, it is time to put it into action. You carefully collect your *data* and come up with a *conclusion* that answers your hypothesis. Your method, or plan, must be something that can be repeated by another person in order to verify your work and determine if you indeed came to the correct conclusion.

You have hypothesized that there is no *sexual segregation* of shorebirds while feeding. Now what is your plan? First you have to tell the males and females apart. One way to do this is by *color-banding* individual shorebirds. This involves catching the birds in nets, determining whether each bird is male or female by taking certain measurements, and then attaching a color-coded leg bracelet that you can distinguished at a distance. To ensure that you do not injure the birds you are studying, you must have the proper training and permission to band birds. If you do not already have a bird banding license, this would be the first step in your procedure.

Let us say you decide to put green bands on female shorebirds and red bands on the males. Now you need a plan for observing the birds and recording which bird is eating where. Where, when, and how will you make these observations? How will you record your results?

After you have completed the study and gathered your data, you might find that you are not able to come to a conclusion based on your data because there were problems with your plan. Perhaps your data did not provide you with a clear answer. It might be necessary to redesign your plan and then try again.

Often, a scientific plan has to account for a variety of *variables*. This is especially true in the field of biology. Living organisms are part of an ecosystem and are affected by many living and nonliving components of their environment. Consider the *biotic* and *abiotic* factors in your environment that affect your life — air, pollution, kinds of food available, your parents or people you live with, etc. Some variables that might affect a shorebird experiment or a scientist's conclusions include the time of year, the species of bird being observed, the weather, or the availability of food during the study.