Exploring the Hubbard Brook Experimental Forest

Student Handout #1: Virtual Tour & Introduction Questions.

Student Name(s) _____ Date _____

Use the back of the page if you need more room to answer questions.

1) How big is a hectare, in acres? How big is the HBEF, in hectares? **2.5 acres. Page 1; 3,160 hectares, Page 1.**

2) Define the term "evapotranspiration." **The loss of water from a given area during a specified time by evaporation from the soil surface and by transpiration from plants. Glossary and the Page 4A-Answer (get to this page by going to Page 4, clicking on the "to learn more" link at the bottom, and then finding the link to the answer for the precipitation graph at the bottom of page 4A).**

3) Give a reason for why there is less calcium, an element that is used by plants, in the forest soil at the HBEF now, compared to fifty years ago. **Acid precipitation has leached much of this calcium out of the soil. Page 9D.**

4) Define "biogeochemistry." Explain. **The study of the relationship between the geochemistry of a region and the animal and plant life in that region. Glossary, throughout tour.**

5) How many marked watersheds are there in the HBEF? How many have weirs? **There are 10 marked watersheds in the HBEF, and 9 of them have weirs. Page 8.**

6) Describe one of the watershed experiments and some of the results from that experiment. **There have been 4 watershed experiments. See Page 9 for details.**

7) On the back, describe one of the shorter-term research experiments that has been conducted at the HBEF. **See Page 15 for details.**

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Student Handout #2: Virtual Tour & Introduction Questions.

Student Name(s) _____ Date _____

Use the back of the page if you need more room to answer questions.

1) What was your favorite part of the Virtual Tour? Why?

2) What was the most surprising part of the Tour?

3) List three other things you learned by taking the Tour. Explain

4) During the tour did you see any words with which you were not familiar (for example, "biogeochemistry")? List three words (or concepts) that are new to you, and explain them in your own words.

5) If you were a scientist working at Hubbard Brook, what would you want to study? What types of questions might you try to answer? Why? Explain.

6) Do scientists at Hubbard Brook work only individually, or do they sometimes work with each other? Describe why collaboration and cooperation can help scientists do better research. **Page 7.**

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Student Handout #3: Virtual Tour & Introduction Questions.

Student Name(s) _____ Date _____

Use the back of the page if you need more room to answer questions.

1) What is an "ecosystem?" **A community of different species interacting with one another and with the chemical and physical factors making up the nonliving environment. Glossary, throughout tour.**

2) What should scientists know about a forest before they begin to experiment with it? **Scientists need to know about characteristics like: Temperature, Precipitation, Soil, Geology, and Streams. Page 4.**

3) What do you think would happen if scientists did not know much about these characteristics? **Page 4.**

4) Which of the watersheds at the HBEF are used as references (hint: there are two)? Why are these referred to as reference watersheds? In an experiment, what is the purpose of the reference watershed? **Watersheds 3 and 6. These are reference watersheds because scientists use them to compare to the experimental watersheds, and never will conduct experiments on them. These watersheds are similar to "controls". Page 9A.**

5) In the early 1900's the federal government became interested in buying private land, such as that in the Hubbard Brook Valley, in an effort to protect the large watersheds of major river systems like the Pemigewasset and Merrimack. Why do you think it might be important to protect these watersheds? **Page 5.**

6) How does the type of bedrock present at Hubbard Brook compare to that found near where you live? **The granitic bedrock of the HB valley is dominated by metamorphic rock of igneous and sedimentary origin. Page 4A.**

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Student Handout #4: Virtual Tour & Introduction Questions.

Student Name(s) _____ Date _____

Use the back of the page if you need more room to answer questions.

1) Why do you think streamflow is much lower in the summer at the HBEF? Explain this pattern using the streamflow & precipitation graph on Page 4A, and then look at the answer (there is a link to the answer on the bottom of Page 4A). How did you do? Did you have other ideas? **Streamflow is lower in the summer because trees are evapotranspiring at higher rates than they are at other times of the year. Page 4.**

2) As you have seen, we know that on average rainfall is about the same every month of the year at the HBEF, and streamflow levels are highest in March, April and May. And we also know if a year is drier or wetter than average. According to the graph on Page 11A, what are the three wettest years? The two driest? Was the year you were born wetter or drier than normal? What does this graph indicate about the annual variability of precipitation at the HBEF? Describe reasons why it might be important to know the Valley has received more (or less) precipitation in one year than it does in an "average" year? **1973, 1990 and 1996 are the three wettest years. 1961 and 1988 are the two driest. Page 11A.**

3) The Scientific Advisory Committee (SAC) works to keep scientific standards high, helps prevent research duplication, and keeps forest resources intact (i.e., the SAC insures that any destructive experiments, such as forest cutting, are only conducted for very good reasons). Can you think of more reasons it might be important to have a group of concerned scientists overseeing research at Hubbard Brook? **Page 6.**

4) What was the purpose of the “Weeks Act?” **The Weeks Act was designed to help the federal government buy land to protect the watersheds of large, navigable rivers. Page 5.**

5) What are ecosystem budgets? **At Hubbard Brook scientists work to determine the budget of elements, nutrients, or other compounds by quantifying both where in the ecosystem these different compounds are located (pools), and how they move between and among these locations (fluxes). Page 8A & the Glossary.**

6) As you might imagine, there can be problems with sampling precipitation: leaves and other contaminants fall into the funnels, and it's often raining on sampling days. Can you think of other problems with sampling precipitation? How would you solve some of these problems? **Page 13.**

7) Explain the "Small Watershed Concept." **Page 8 & 8A.**

8) What questions would you be interested in studying if you worked at the HBEF?

9) What did you learn by taking the virtual Tour? Explain.

10) Consider nitrate (NO_3^-), a form of nitrogen available to plants, and at high levels is a water pollutant. If, over the course of an entire year, scientists measured 500 units of nitrate entering a watershed in precipitation, and 650 units of nitrate leaving a watershed in streamflow, they might be able to conclude that the watershed was losing nitrate and was a source of pollution to the stream. Why could it be important to know if watersheds are losing or accumulating nitrate over long periods of time? **Page 8A.**

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Student Handout #5: Virtual Tour & Introduction Questions.

Student Name(s) _____ Date _____

Use the back of the page if you need more room to answer questions.

1) What can you tell from the snowpack graph on Page 11A? Is early February snowpack variable in the HBEF, or is it the same every year? **It is variable. Page 11A.**

2) What is the best way to describe the overall ecosystem type found at the HBEF? Explain. **Northern Hardwood Forest. Page 3.**

3) According to the graph on Page 4A, in April how much does it rain on average in Watershed 3? **10 cm. Page 4A**

4) Describe the type of bedrock commonly found throughout the HBEF. **The granitic bedrock of the HB valley is dominated by metamorphic rock of igneous and sedimentary origin. Page 4A.**

5) How old are the majority of mature trees in the HBEF? Why are they that old? **As a result of the logging in the early 1900s and the 1938 hurricane, much of the forest today is approximately 80 years old with some patches of younger trees and other patches of older trees. Page 5.**

6) Why is there less calcium in the forest soil at the HBEF now than there was 50 years ago? **Acid precipitation has washed much of this calcium out of the soil. Page 9 and 9D.**

7) Describe two ways that Cone Pond and Mirror Lake are different from each other. **The Cone Pond watershed has not been logged, while the area around Mirror Lake and the HBEF has. Cone Pond is very acidic, and with its pH of ~ 4.6, it is about 100 times more acidic that Mirror Lake (pH of ~ 6.3 - 6.8). Page 14 and 14A.**

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Student Handout #6: Virtual Tour & Introduction Questions.

Student Name(s) _____ Date _____

Use the back of the page if you need more room to answer questions.

1) What are some benefits to having a research site like the HBEF located far from major human activities? What are some drawbacks to having such a remote site? **Page 2.**

2) Describe and give characteristics of two of the following at the HBEF: temperature, precipitation, soil, geology, or streams. **Page 4 and 4A.**

3) How do you think a short growing season like that in the HBEF could affect trees? **Page 4.**

4) Why do you think it might be important for scientists to have a good understanding of the land use history in the HBEF? **Often, knowing what happened previously at a site will help explain what is currently happening or may be useful in predicting future events. Page 5.**

5) Why do you think it could be difficult to measure how water moves through soil? **Page 8A.**

6) List and explain three other things you learned while taking the Tour.

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Student Handout #7: Virtual Tour & Introduction Questions.

Student Name(s) _____ Date _____

Use the back of the page if you need more room to answer questions.

List the dates of the whole-watershed treatments. Describe each of the treatments. What were the main results of the Watershed 5 experiment? **Page 9 - 9D.**

If you were studying a certain part of a forest - for example, what types of trees grow best there - how long would you want to conduct your research? Would you be able to learn all about these trees in just one year, or would it take many years? Is it possible that it could even take decades? Explain some reasons why long-term research might help you understand more about these trees. **Page 10.**

When precipitation was first measured in the HBEF in 1964, the pH of samples was ~ 4.0 - 4.2. Examine the graph on the Long-Term Example Page 1 (you can get to this page from Introduction Page 10). Does it appear that annual precipitation acidity decreases over the five years represented here? Can you make any conclusions from this graph? **Long-Term Example Page 1.**

What do the five years represented by the graph on Long-Term Example Page 2 seem to indicate? Does it appear that precipitation acidity is increasing or decreasing? How does this compare with the five years in the previous graph? Can you make any conclusions about long-term precipitation acidity trends at the HBEF based on this and the other graph? **Long-Term Example Page 2.**

The graph on Long-Term Example Page 3 shows all the available precipitation pH data currently available. What do these data suggest? Does it appear that precipitation acidity is increasing or decreasing at the HBEF? How is this graph different from the two previous graphs? What do these three graphs show about the benefits of long-term research? **Long-Term Example Page 3.**

What does the graph on Page 11 suggest about the number of birds present in the HBEF? Does it appear that bird abundance has increased or decreased since 1969? What could be some reasons for this apparent trend? Could it be that all species are following this trend, or could some be following a different trend? **Page 11.**

Why do you think it might be important to know how much lead is present in soil? Describe what could explain the apparent decline in lead as shown in the graph on Page 11A. **Page 11A.**

Can you tell from this the graph on Page 11A alone if more snow falls now than in 1956 - or would you need more information? What are some reasons for long-term snowpack monitoring? **Page 11A.**

Read the top section of Page 14 of the Introduction. Can you think of other questions that would require you to compare other sites to the HBEF? **Page 14.**

At the HBEF, some scientists are interested in the growth of fine roots, and are trying to answer questions like: How quickly do they grow? How long do they live? Describe why you think scientists might be interested in these questions. **Page 15A.**

While long-term research and monitoring are crucial to understanding big ecological questions, it is possible to answer some questions in a few months or years. Describe ecological research that might only take a few months or years to answer. **Page 15 & 15A**